EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

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A thesis submitted to the

School of Graduate Studies

in partial fulfillment of the

requirements for the degree of

Master of Science in Kinesiology

School of Human Kinetics and Recreation

Memorial University of Newfoundland

27 May, 2012

St. John's Newfoundland

ABSTRACT

An inverted body posture is not common. During unusual situations (e.g. overturned helicopters or motor vehicle accidents) when the body is inverted, the neuromuscular responses can change. In order to manage these situations, it is necessary to examine changes in muscle force output and activation.

Although the exact mechanisms are unknown, it is believed that both central and peripheral factors can contribute to changes in muscle force output. Increase in cerebral blood pooling, increase in hydrostatic pressure, and decrease in sympathetic activity during rapid and slow transitions from upright to inverted seated position are considered to be the main central factors leading to decrease in inversion-induced muscle force output. Peripheral factors such as decreased blood flow to the contracting muscle resulting in decrease perfusion pressure and oxygen deficit within the muscle are most likely to summate along with central factors inducing neuromuscular impairments during rapid and slower inversion rotations.

There is no evidence examining possible impairments in neuromuscular functioning with more rapid versus slower inverted rotations as compared to an upright seated position. Maximal voluntary contraction (MVC) and electromyographic (EMG) activity were recorded and analyzed in biceps and quadriceps, concurrently and individually, for maximal force output and activation with upright seated position, and inverted within 1s and 3s rotations. It was anticipated that changes in muscle force and activation within 1s and 3s inversion rotations would suggest impairments in the functioning of neuromuscular system, as compared to the upright position. In addition,

heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were also recorded.

Both biceps and quadriceps exhibited significant decreases in maximal voluntary force and EMG activity, both concurrently and individually, when inverted within 1s and 3s rotations compared to an upright position. HR, SBP, and DBP also demonstrated significant decreases when inverted within 1s and 3s rotations compared to upright position. This suggests both rapid and slower inversion impairs neuromuscular function.

ACKNOWLEDGEMENTS

On completing this thesis as I look back on the whole experience from its very inception, I feel humbled. All along I was assured of the presence of god to who goes all the glory and honor for the successful completion of this thesis.

I am very much grateful and indebted to my supervisor Dr. David Behm, who immensely helped and rendered his valuable advice, precious time, knowledge and relevant information regarding the collection of material and whose suggestions and guidance have enlightened me on this thesis. It has been a great experience working under his supervision.

My sincere thanks to Dr. Duane Button and Dr. Tim Alkanani for their kind professional help and cooperation.

I would be biased if I don't mention the name of Varun Grover and Mario DiSanto who really helped me while working on this thesis. It has been a great help and support to have them.

A special thanks to all the subjects whom I have worked with. I owe a special regard and gratitude to all of them. Lastly, thanks to all those whose names are not mentioned here, for their unrelenting encouragement.

PRAMOD JOHAR

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Main effects for Condition: MVC

2. Main effects for Condition: EMG

3. Main effects for Time: MVC

4. **Heart Rate and Blood Pressure**

5. **Force Profiles**

LIST OF ABBREVIATIONS

BP	Blood pressure
CVP	Central venous pressure
DBP	Diastolic blood pressure
EMG	Electromyography
HDT	Head-down tilt
HR	Heart rate
LBNP	Lower body negative pressure
MVC	Maximum voluntary contraction
SBP	Systolic blood pressure
SV	Stroke volume

LIST OF APPENDICES

Variability in Rotation Times

INTRODUCTION

The human body is adapted to work in an upright position. In situations when an individual is required to manage circumstances where the body is forced into inverted positions (e.g. completely overturned helicopter or motor vehicle accidents), physiological responses can change. It is important to know the neuromuscular and cardiovascular responses when a person is inverted from an upright position.

Only two studies have been published which examine the elbow flexion (Hearn et. al. 2009) and the knee extension (Paddock and Behm 2009) force and activation during inverted seated position. Both studies were performed to determine the changes in neuromuscular responses between upright and inverted seated positions. The results for both studies illustrated decreases in neuromuscular performance with an inverted seated posture. Also, both studies exhibited significant decreases in heart rate and blood pressure in the inverted position attributed to alterations of sympathetic nervous system stimulation. In addition, Neary et al. (2011*a*, 2011*b*) demonstrated a tendency for quadriceps maximal voluntary contraction (MVC) force to decrease in inverted position but no significant difference was found for biceps brachii MVC between upright and inverted positions. They also found a significant decrease in heart rate as well as cardiac output with inverted position as compared to upright position, which were in accordance with the results from Hearn et al. (2009) and Paddock and Behm (2009). Hence, it can be established that an inverted seated posture results in neuromuscular and cardiovascular system impairments.

There are a number of physiological mechanisms involved when the body responds to an inverted position. Hydrostatic pressure (pressure exerted by a fluid due to

the force of gravity) is considered as one of the major contributing factors related to the decline in the muscle force output during inversion. Mechanisms to reduce hydrostatic pressure in the lower body when upright, such as respiratory muscle pump (Miller et al. 2005), skeletal muscle pump (Delp and Laughlin 1998), and veno-vasoconstriction (Vissing et al. 1997) offset the effect of increased lower body hydrostatic pressure and ensure adequate venous return to the heart. Bosone et al. (2004) demonstrated ten minutes of 30° head down tilt caused a significant increase in arterial pressure at the cranial level due to the development of the hydrostatic pressure gradient between the heart and brain levels. It is speculated that the inversion-induced increase in hydrostatic pressure could have a negative impact on the ability of the brain to function appropriately. This response could affect optimal performance during sport, and occupational tasks or emergency situations.

Furthermore, inhibition of sympathetic activity during head down body tilt (Bosone et al. 2004; Cooke and Dowlyn 2000; Cooke et al. 2004; Fu et al. 2000) is associated with decreased heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), and total peripheral resistance (Goodman and LeSage 2002). This inhibition of the sympathetic nervous system adversely affects the peripheral perfusion (Thomas and Segal 2004), resulting in decreased muscle force output. Head-down tilt postures also lead to decreased oxygen supply to the working muscle via compensatory increases in the inspiratory muscle contraction force (Aleksandrova et al. 2005), decreased lung compliance (Donina et al. 2009), impaired gaseous exchange (Prisk et al. 2002), and increased airflow impedance of the respiratory system (Donina et al. 2009), which further adds to the factors causing reduced muscle force output with inverted

position. However, all inversion studies to date have involved slow and deliberate transitions from upright to inverted positions. In most situations such as overturned vehicle accidents and ditched helicopters, these events will occur rapidly. Due to the rapid transition of the body from an upright to inverted position, there is the possibility that force output will be augmented abruptly due to the activation of the sympathetic nervous system (fight or flight phenomenon). However, it is unknown whether the typical inversion-induced decrements are more predominant than possible sympathetic system excitation.

Consequently, it is important to observe the changes in force output, muscle activation and cardiac functioning when inverted at different rotational times compared to an upright seated position. The following sections will provide a critical and in-depth evaluation of the physiological responses and underlying mechanisms related to inverted body posture.

1. EFFECTS OF INVERSION ON NEUROMUSCULAR PROPERTIES

An inverted seated position is not a common body posture. Neuromuscular responses change with an inverted position as compared to an upright position. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated decreases in force production and muscle activation. Hearn et al. (2009) found significant decreases in elbow flexor MVC force, voluntary rate of force development, and biceps electromyographic (EMG) activity with complete inversion. A similar study by Paddock and Behm (2009) focusing on lower limb quadriceps muscle activation, showed a significant reduction in maximal voluntary contraction force, rate of force development, and EMG activity with seated inversion. In

addition, Neary et al. (2011*a*, 2011*b*) also found a tendency for quadriceps MVC to decrease in inverted position but no significant difference was found for biceps MVC between upright and inverted positions. Hence, it can be inferred that the inverted position generally has a negative impact on an individual's neuromuscular functioning.

2. PERFUSION PRESSURE

Inversion-induced muscle performance impediments may be attributed to a number of mechanisms. Peripheral perfusion pressure; a graded difference between arterial blood pressure and venous pressure (Ganong 2003), is an important factor affecting muscle force output. During activity, regulation of blood pressure plays a vital role in optimizing perfusion to the working muscles and supplying essential nutrients and oxygen needed for proper functioning. Hobbs and McCloskey (1987) found a decrease in blood flow and force production near maximal workloads when an isolated cat soleus muscle was treated with a reduced mean blood pressure. This suggests that the amount of workload is associated with the alterations in the perfusion pressure and force production. Perfusion pressure in the muscle can increase or decrease depending upon the distance the muscle is from the heart. Raising the arm above the heart level leads to a decrease in the perfusion pressure in hand, resulting in lower force production (Fitzpatrick et al. 1996). Sundberg and Kaijser (1992) found the same effect in lower limbs. They found a decrease in muscle perfusion followed by a decrease in muscle force when a positive pressure of 50 mmHg was applied.

All the above-mentioned studies support the changes in neuromuscular responses demonstrated by Hearn et al. (2009) and Paddock and Behm (2009). These studies

exhibited decreased elbow flexion (Hearn et al. 2009) and knee extension (Paddock and Behm 2009) muscle force when upright seated position was compared with inverted seated posture. Both the studies attributed inversion-induced reduction in peripheral perfusion in contracting muscles as a major contributing peripheral factor.

3. HYDROSTATIC PRESSURE

Hydrostatic pressure is defined as a pressure change caused by fluid changes in the capillary network (Guyton and Hall 2006). A number of studies on animals and humans have demonstrated a significant effect on working capacity of the muscles due to alteration in hydrostatic pressure with or without changes in body position. The majority of the studies related to hydrostatic pressure are conducted on animals. Both rabbit psoas (Fortune et al. 1994) and rat extensor digitorum longus (Ranatunga and Geeves 1991) muscles have responded with decreased tetanic force when subjected to high hydrostatic pressure. Ranatunga and Geeves (1991) also found that the peak tension, the time to peak and the time to half-relaxation of a twitch contraction increased when the muscle fiber bundles isolated from the rat extensor digitorum longus of the rat were exposed to increasing hydrostatic pressures. However, when a maximally calcium activated rabbit psoas muscle fiber was subjected to high hydrostatic pressure, a 15% decrease in isometric active tension was reported (Geeves and Ranatunga 1987). It was hypothesized that a lower number of active-cross bridges or decrease in the force per cross-bridge was responsible for this impairment due to an increased pressure. Alternatively, twitch tension was potentiated with an increase in hydrostatic pressure in response to enhanced release of calcium (Vawda et al. 1996). High hydrostatic pressure causes pulsing acetylcholine

receptor release, decreasing muscle firing frequency (Heinman et al. 1987), and enzymatic activity of lactate dehydrogenase (Schmid et al. 1979). Therefore, based on animal research, the increased hydrostatic pressure can have adverse effects on neuromuscular performance.

In humans, a number of mechanisms work *in vivo* in upright position to compensate for the effect of increased hydrostatic pressure and consequent blood pooling in the lower limbs. These mechanisms, such as respiratory muscle pump (Miller et al. 2005), skeletal muscle pump (Delp & Laughlin 1998), and veno-vasoconstriction (Vissing et al.1997) ensure adequate venous return to the heart. In addition, vasoconstriction triggered by venous distension and a local neural veni-arteriolar response is important for counteracting increases in capillary hydrostatic pressure during upright posture or limb dependency (Henriksen 1991). Bosone et al. (2004) found that 10 min of 30^{o} head down tilt caused significant increase in arterial pressure at the cranial level, due to the development of the hydrostatic pressure gradient between the heart and brain. Furthermore, minimal changes in hydrostatic pressure and perfusion pressure are observed in a supine position (Laughlin and Scharge 1999).

In conclusion, previous published studies related to complete seated inversion (Hearn et al. 2009; Paddock and Behm 2009) illustrated decreases in muscle activation and force production with an inverted body position. Neither of these studies investigated hydrostatic pressure directly, but suggested it may be an important central factor leading to impairments in neuromuscular system responses.

4. LOWER BODY NEGATIVE PRESSURE AND BARORECEPTOR REFLEXS

A lower body negative pressure (LBNP) is the application of an external negative pressure below the waist under well-controlled conditions. LBNP is most often used as a perturbation to the cardiovascular system and has been applied to simulate gravitational stress (Levine et al. 1991; Savard and Stonehouse 1995; Zhang et al. 1999). During upright body posture, vasomotor sympathetic activity plays an essential role in maintaining arterial pressure via the baroreceptor reflex mechanism (Fu et al. 2006). Baroreceptors are the stretch receptors that are located in the aortic arch and the carotid sinuses (Fox 2006). These receptors play a vital role in maintaining the blood pressure within limits. With the change in position from lying to standing there is a shift of blood from the veins in the thoracic cavity to the veins in the lower extremities. This results in lower blood pressure due to decreases in venous return and cardiac output, which is counteracted via activation of the baroreceptor reflex (Fox 2006). Thus, it helps in maintaining homeostasis by playing an important role during changes in body posture.

Hughson et al. (1993) investigated the effect of cycling exercise in upright and supine positions, and compared it with -40 mmHg lower body negative pressure in supine position. The baroreceptor reflex was activated during supine exercise, as LBNP caused more pooling of blood in lower extremities as compared to upright position. Cooper and Hainsworth (2001) determined that -40 mmHg LBNP has no effect on cardiac responses. However, they illustrated a significant increase in vascular resistance response during LBNP along with the increase in the peak gain of the baroreceptor reflex. They also suggested that an increase in baroreflex gain may help in maintenance of blood pressure during orthostatic stress.

Baroreceptor reflex also helps to maintain adequate cerebral perfusion (Ponte and Purves 1974). The sensitivity of the baroreflex control of sympathetic nerve activity decreases from upright to tilted position due to an increase in central venous pressure (CVP) (Charkoudian et al. 2004). Hearn et al. (2009) and Paddock and Behm (2009) have illustrated significant decreases in blood pressure, both systolic and diastolic with complete seated inversion. A subsequent study from the same laboratory reported similar inversion-induced decreases in mean arterial pressure and cardiac output (Neary et al. 2011*a*, 2011*b*). Thus, it can be hypothesized that with the increase in hydrostatic pressure during inversion, CVP may also increase, resulting in reduced sensitivity of the baroreceptor reflex with inverted body posture. However, no research has been conducted to determine the role of baroreceptors during complete seated inversion; therefore, the adjustments made by baroreceptors have not been fully clarified.

5. VESTIBULAR SYSTEM

The vestibular system assists with the control of balance and equilibrium. It accomplishes this function by assessing head and body movement and position in space, generating a neural code representing this information, and distributing this code to appropriate sites located throughout the central nervous system. Vestibular function is largely reflex and unconscious in nature (Ganong 2003). The otolith organs and semi-circular canals are the two main components of the vestibular system associated with postural adjustments. The semicircular canals respond to rotational movements of the head, whereas otolith organs sense linear motion (Ganong 2003).

Gravity also plays an important role with the vestibulosympathetic reflex. Tanaka et al. (2006) found that vestibular deficient rats are less able to regulate blood pressure as compared to gravitational stressed rats with the inner ear intact. Therefore, it can be proposed that the vestibulosympathetic reflex is vital to maintain homeostasis during gravity related changes with inversion. However, further research is necessary to determine the possible mechanisms and/or adjustments, and the role played by the vestibular system during complete inversion.

Ray (2000) found that the vestibulosympathetic reflex, via an increase in sympathetic outflow, plays an important role in maintaining orthostasis in humans. During upright standing, vestibulosympathetic reflex assists in regulating blood pressure changes in humans (Ray and Carter 2003). Kerman et al. (2000) also suggested that the vestibular system plays a role during postural adjustments by regulating autonomic outflow. They illustrated, that based upon the anatomical location and innervation target of a particular sympathetic nerve; the vestibular sympathetic reflexes may result in local blood flow changes. Though none of these studies were directly related to rapid and slow seated inversion of the human body, they would insinuate that changes occur in neuromuscular performance during downward rotation.

6. SYMPATHETIC NERVOUS SYSTEM

In order to maintain arterial blood pressure, sympathetic nerve activity decreases blood flow to the active muscles via vasoconstriction (Fox 2006). However, it has been noted that even though the sympathetic neural discharge increases with the increase in intensity of the activity, the muscle blood flow also increases, indicating a reduced

responsiveness to sympathetic activation (Thomas and Segal 2004). Wallin and Sundlof (1982) reported vasoconstriction in skeletal muscles during a standing upright posture. During standing, an increase in the sympathetic activity to the vessels is accompanied by an over-activity of the sympathetic system leading to an exaggerated increase in the heart rate (Furlan 2001). As the response of muscle nerve sympathetic activity is not directly studied in inversion, it is reasonable to expect the opposite (decreased heart rate) with an inverted body position.

The sympathetic nervous system also influences muscle force contractility, alertness through stimulation of the reticular activating system, glycogen utilization, and muscle tone (Martini and Nath 2008). Additionally, a decrease in heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), and total peripheral resistance (Goodman and LeSage 2002) are also attributed to inhibition of sympathetic nervous system activity. Significant increase in intracranial pressure and inhibition of sympathetic outflow (Bosone et al. 2004) may reduce the ability to sustain maximal force output by decreasing the neural outflow to the motor neurons.

Furthermore, tilt studies have also shown a decrease in sympathetic activity. Acute head down body tilt studies have reported lower sympathetic nervous activity (Cooke and Dowlyn 2000: Cooke et al. 2004), which could play a role in the ability of the central nervous system to adequately activate motor neuron activity (Roatta et al. 2008). During 6° head down tilt the muscle sympathetic nerve activity decreased by 27% (Fu et al. 2000). A recent study by Wang et al. (2011) also demonstrated that a 6° head-down bed rest decreased the working capacity of the muscle. Additionally, Bosone et al. (2004) have reported that 10 min of 30° head down tilt inhibit the sympathetic nervous

system response along with a decrease in heart rate and arterial blood pressure. Heart rate and cardiac output decreased significantly (Yao et al. 1999) with 24 h- 6° head down body tilt bed rest. Kawanokuchi et al. (2001) demonstrated that vestibulosympathetic reflex rather than cardiopulmonary baroreceptors suppress sympathetic outflow with 6-8° head down body-tilt with LBNP.

However, when encountering vulnerable situations in which the human body is forced to be inverted (e.g. overturned helicopters, motor vehicle accidents etc.), the sympathetic nervous system will typically be highly activated (fight or flight phenomenon) (Guyton and Hall 2006). Stimulation of the sympathetic system results in an increased heart rate and blood pressure to provide better perfusion of the vital organs and muscles, and decreases the threshold in the reticular formation, reinforcing the arousal and alert states (Ganong 2003). Hearn et al. (2009), Paddock and Behm (2009), and Neary et al. (2011*a*, 2011*b*) have illustrated significant decreases in heart rate, systolic, and diastolic blood pressure with complete seated inversion. They have suggested that changes in heart rate and blood pressure during inverted body posture are due to the alterations in sympathetic nervous system stimulation. Since seated inversion has shown significant reductions in cardiovascular activity, which have been proposed to be due to altered sympathetic activity, it would be of interest to examine the cardiovascular responses with rapid and slower transitions from upright to inverted positions to determine whether the more rapid and slower rotations elicit a sympathetic response that may overcome typical inversion-induced decrements.

7. HEART RATE AND BLOOD PRESSURE

An inverted seated posture alters the cardiovascular responses. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated significant decreases in heart rate, systolic and diastolic blood pressures with complete seated inversion. Furthermore, two published abstracts (Neary et al. 2011*a*, 2011*b*) also demonstrated significant decrease in heart rate and cardiac output with inverted position as compared to upright position. These studies attributed this decline in heart rate and blood pressure with reduction in sympathetic nervous system activity.

In addition to the studies performed with seated inversion, a number of studies have been performed to demonstrate the changes in cardiovascular responses with anti-orthostatic posture. Anti-orthostatic posture is defined as a posture in which the body is upside down or inverted at an angle with head down and feet unsupported. Anti-orthostatic posture has shown an association with alterations in systemic circulation in both humans (Gavrikov and Isupov 1999) as well as rats (Osadchii et al. 1997; Bychkova et al. 1990). In addition, Bychkova et al. (1990) have also illustrated changes in skeletal muscle blood flow during anti-orthostatic position.

Moreover, Balueva and Sergeev (2010) found that 45° head-down tilt decreases blood pressure and cardiac output in rats. Bosone et al. (2004) also illustrated decrease in heart rate and blood pressure during 10 min of 30° head down tilt, due to the inhibition of sympathetic nervous system. Vestibular system also plays an important role in maintaining arterial pressure during changes in body postures (Tanaka et al. 2009). During upright body posture, the baroreceptor reflex counteracts the decrease in blood pressure due to gravity and maintains adequate cerebral perfusion. However, it is still

unknown whether this reflex adequately regulates the changes in blood pressure during seated inversion.

In contrast to the aforementioned studies, Yao et al. (1999) and Butler et al. (1991) demonstrated an increase in cardiac output and decrease in stroke volume (SV) with head down tilt. Both these studies suggest an increase in heart rate, which proposes that some other cardiovascular mechanisms are also present which assist in regulating the changes during alterations in body position. Raffai et al. (2009) also showed an increase in heart rate and blood pressure after 45° head down tilt in rats. Therefore, it would be of interest to investigate the functioning of the cardiovascular system to respond to possible changes during rapid and slower seated inversion.

8. RESPIRATORY SYSTEM

Head down tilt (HDT) position impairs functioning of the respiratory (Henderson et al.2006) and cardiovascular (Soubiran et al. 1996) systems. Aleksandrova et al. (2005) found that HDT posture decreases orthostatic stability and leads to contractile failure of the diaphragm musculature due to alteration in excitation- contraction coupling. In addition, impaired gaseous exchange (Prisk et al. 2002), decreased lung compliance (Donina et al. 2009), and increased airflow impedance of respiratory system (Donina et al. 2009) also contribute to the changes in the ventilatory system functioning during HDT. Furthermore, there is a possibility that inversion may lead to an augmentation of intrathoracic and/or intra-abdominal pressure, resulting in increased work for inspiratory and expiratory musculature followed by fatigue. These responses could lead to difficulties with breathing.

Lu et al. (2000) proposed that HDT might lead to a reduction in pulmonary ventilation and lung capacity, but an increase in pulmonary diffusion. They suggested that this rise in the pulmonary diffusion might be associated with the uniform distribution of the pulmonary blood flow and increased effectiveness of the pulmonary vascular bed. On the contrary, Hillebrecht et al. (1992) found alterations in the pulmonary blood flow due to HDT.

Acute HDT posture also causes compensatory increases in the inspiratory muscle contraction force (Aleksandrova et al. 2005). Reduction in oxygen supply may result in alterations in the force production capacity of the muscle due to reduction in levels of creatine phosphate (Brechue et al. 1995) and impaired excitation-contraction coupling (Aleksandrova et al. 2005). However, it is not known if the respiratory system responses could contribute to the changes in inversion-induced neuromuscular performance impairments with rapid and slower rotations to inversion.

CONCLUSION

This literature review has presented a number of mechanisms that may lead to alterations in both neuromuscular and cardiovascular functioning. All previous published inversion studies (Hearn et al. 2009; Paddock and Behm 2009; Neary et al. 2011*a*, 2011*b*) demonstrated the inversion-induced alterations in neuromuscular and cardiovascular response during upper limb and lower limb muscle activity. These studies suggested the involvement of central and peripheral factors in altering the muscle force, cardiac output, and arterial pressure changes during seated inversion.

In addition, there is evidence to show the probable decrease in baroreflex sensitivity and increase in hydrostatic pressure are associated with altered responses during inversion, due to excessive pooling of blood towards the brain. These can be considered as major contributing factors influencing changes in upper and lower limb muscle activity functioning during complete inversion.

Furthermore, inhibition of sympathetic nervous system and stimulation of vestibulosympathetic reflex are also strongly associated with reduction in neuromuscular system activity in both upper limb and lower limb during inversion. Both these factors also lead to a decrease in heart rate and blood pressure, resulting in less peripheral blood perfusion oxygen delivery, and ultimately low force output during contractions. Additionally, alterations in the respiratory system functioning during inversion also lead to reduced oxygen supply to the contracting muscles and may lead to impairments in neuromuscular performance.

Consequently, no research has been conducted to study the effectiveness of the above-mentioned mechanisms during seated inversion. However, it is speculated that these mechanisms play an important role when body is inverted. The rapidity of the response is an important question for basic physiology while there can be functional applications for sport, work and emergency environments. Therefore, the focus of the research portion of this thesis is to determine the changes in muscle force output, muscle activity, and heart rate and blood pressure during rapid and slower transition from upright to seated inversion at different rotational times.

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EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

by

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CO-AUTHORSHIP STATEMENT

Pramod Johar was involved in all aspects of the thesis including formulating the research idea and methodology; collecting, analyzing and interpreting all data; and writing the thesis. Dr. David Behm provided the genesis for the original research idea and guidance and input into the methodology, interpretation of data and revisions of the written thesis. Varun Grover and Mario DiSanto provided assistance with data collection.

ABSTRACT

The purpose of this study was to determine and compare the changes in neuromuscular and cardiovascular responses with rapid and slower transitions from upright to inverted seated positions. Twenty-two subjects performed concurrent unilateral biceps and quadriceps maximal voluntary contractions (MVCs) in the upright position, and when inverted within 1s and 3s. Ten of the 22 subjects also performed individual biceps and quadriceps MVCs in all three positions. Maximal force of biceps and quadriceps; muscle activation of biceps, triceps, quadriceps and hamstrings; and heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured. Whether the biceps or quadriceps was contracted concurrently or individually, significant ($p < 0.05$) decreases in MVC force were found when inverted within 1s and 3s rotations compared to the upright position. Similarly, biceps and quadriceps EMG activity with either concurrent or individual contractions significantly ($p < 0.05$) decreased when inverted within 1s and 3s rotations compared to the upright position. Quadriceps MVC demonstrated significant ($p < 0.05$) increase from the first second to 3-6s time period. Triceps and hamstrings EMG activity significantly ($p < 0.05$) decreased when inverted within 1s rotation compared to the upright position. HR, SBP, and DBP demonstrated significant ($p < 0.001$) decreases when inverted within 1s and 3s rotations compared to the upright position. In conclusion, similar to the slow and deliberate rotation of previous inversion studies, rapid and slower transitions from an upright to inverted seated positions also lead to neuromuscular impairments and decreases in HR and BP.

Key words: tilt, force, EMG, heart rate, blood pressure

INTRODUCTION

In day-to-day life, humans hardly perform any activities in which the body is inverted. To date, only two studies (Hearn et al. 2009 and Paddock and Behm 2009) have examined the level of muscle activation, force output, and changes in cardiovascular functioning during complete seated inversion compared to an upright body posture. Both studies demonstrated decreases in force production, muscle activation, heart rate, and blood pressure. In addition, two studies (Neary et al. 2011*a*, 2011*b*) also demonstrated a significant decrease in heart rate and cardiac output with inverted position as compared to upright position. They also found a tendency for quadriceps maximal voluntary contraction (MVC) to decrease in inverted position but no significant difference was found for biceps MVC between upright and inverted positions.

All the studies related to inverted seated posture (Hearn et al. 2009; Paddock and Behm 2009; Neary et al. 2011*a*, 2011*b*) have suggested inversion-induced inhibition of sympathetic nervous system activity as a rationale for decrease in neuromuscular and cardiovascular responses. A number of tilt studies have also supported this rationale. The most similar protocols to the inversion studies utilized head-down body tilt. Acute head-down body tilt inhibits sympathetic activity (Bosone et al. 2004; Cooke and Dowlyn 2000; Cooke et al. 2004; Fu et al. 2000), which is associated with decreased heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), total peripheral resistance (Goodman and LeSage 2002), and muscle blood flow (Thomas and Segal 2004). Other factors that could contribute to the decline in the muscle force output during inversion include an increase in hydrostatic pressure (Ranatunga and Geeves 1991), an increase in central venous pressure (CVP) (Charkoudian et al. 2004), and altered

functioning of the respiratory system (Henderson et al. 2006). Hence, it can be inferred that while an individual is inverted neuromuscular and cardiovascular systems may not function normally. In contrast to the above-mentioned studies, there are also head-down tilt studies, which suggest an increase in heart rate (Yao et al. 1999; Butler et al. 1991; Raffai et al. 2009) and arterial blood pressure (Wilkins et al. 1950). Furthermore, Hobbs and McCloskey (1987) found an increase in electromyographic (EMG) activity of soleus and medial gastrocnemius as the contracting muscles were raised above the heart level.

It is known that when an individual encounters a vulnerable situation, the activation of the sympathetic nervous system prepares the individual to cope via flight or fight reactions. Stimulation of the sympathetic system results in increased heart rate and blood pressure (Guyton and Hall 2006). Since the previously published seated inversion and head-tilt studies were conducted with slow rotation speeds, it is not known whether the typical inversion-induced responses (i.e. impaired force, decreased heart rate and blood pressure) found in these studies would be offset during a rapid rate of inversion by possible stimulation of the sympathetic system.

Accordingly, it is important to know the alterations in human body systems due to encounter of inversion-induced situations. To our knowledge no research has been published examining the changes in neuromuscular and cardiovascular systems and their related responses during rapid and slower inversion of human body posture. The purpose of the study was to determine the rapidity of changes in force output, muscle activation and cardiovascular functioning due to seated inversion at different rotation times. It was hypothesized that inversion of the body position within 1-3 seconds would initially

increase force production, muscle activation, heart rate and blood pressure subsequently followed by reductions over 3-6 seconds.

METHODOLOGY

1. Subjects

Twenty-two (24.2 $\pm$ 7.1 yrs., 76.5 $\pm$ 19.9 kg, 167.5 $\pm$ 10.6 cm) healthy and physically active subjects from Memorial University of Newfoundland volunteered for the study. All twenty-two subjects did simultaneous unilateral biceps and quadriceps contraction. Ten of the twenty-two subjects also performed unilateral biceps and quadriceps contraction both individually and concurrently. This was done to compare the effects of rapid and slower inversion rates on both unilateral concurrent and individual contractions. No participant had previous history of any hypertensive or cerebral related condition or serious injury. All subjects were verbally informed of the procedure of study and read and signed a consent form and Physical Activity Readiness Questionnaire (Health Canada, Canadian Society for Exercise Physiology 2004) prior to participation. The study was approved by Memorial University of Newfoundland Human Investigation Committee.

2. Experimental Design

2.1 Protocol

Subjects were instructed to not eat food for at least 2 h prior to testing and to not smoke, drink alcohol, or exercise at least 6 h prior to testing (Health Canada, Canadian Society for Exercise Physiology 2004). An initial orientation session was given to all subjects to allow them to become familiar with the protocol under both upright and inverted seated position. Prior to testing, subjects performed a 5 min warm up on a cycle ergometer set at an intensity of 1 kp and 70 rpm. All subjects were tested in both upright

and inverted seated positions. Among the twenty-two subjects, twelve subjects performed only concurrent unilateral contractions of biceps and quadriceps in upright and inverted positions within 1s and 3s rotations. Ten other subjects performed unilateral biceps and quadriceps contractions, concurrently and individually in upright and inverted positions within 1s and 3s rotations. The conditions (upright, inverted within 1s, and inverted within 3s rotations) were randomly allocated during the experiment.

All subjects were rotated from a seated upright to a seated inverted position by the primary investigator within 1s and 3s via a manual wheel attached to one side of the rotational chair. During data collection (experimental trials), a research assistant timed the manual rotation and any rotations that deviated by more than 0.3 seconds were not included in the data analysis.

Changes in neuromuscular activation were tested for a period of 6s for each trial. All participants were tested for right elbow flexors and right knee extensors force and activation in both upright and inverted positions. During upright and inverted positions within 1s and 3s rotations, all subjects performed 2 isometric MVCs of 6s duration for each condition.

The subjects started the muscle contraction at the initiation of inversion rotation for both 1s and 3s. The time when all subjects initiated muscle contraction for both upright and inverted seated rotations is defined as time zero. To prevent the discomfort related to an increase in pressure around head and eyes during seated inversion, a 3 min rest period was provided to every subject between each voluntary contraction. The 3 min rest period allowed the cardiovascular system to adjust to the upright posture and blood pressure (BP) and heart rate (HR) to return to baseline in < 1 min (information obtained

from pilot studies). Both upright and inverted positions were tested in the same experimental session. In the present study, rotation in 1s was considered rapid and rotation in 3s was described as slow in comparison to 1s rotation. For the purpose of analysis, the MVC force and EMG activity recorded over a period of 6s was divided into three phases – the first second, the first three seconds, and 3-6s. The first second provided information regarding the effect of rapid rotation, the second phase (0-3 seconds) provided information regarding the effect of slower rotation, whereas the third phase (3-6s) provided information regarding the effect of inversion on the dependent variables. Consequently, the significant changes were determined by comparing these three phases for upright position, and inverted within 1s and 3s rotations.

2.2 Apparatus

The subjects sat in a specially constructed rotational chair (Technical Services: Memorial University of Newfoundland) capable of being rotated over a 360° range. All subjects were rotated from an upright to an inverted position within 1s and 3s via a manual wheel attached to one side of the rotational chair. Subjects sat in an upright position with hips, knees and elbows flexed at 90° with forearms supinated and resting on padded support. The Velcro straps were secured to the upper arms at biceps (mid-belly). The upper torso rested against the backrest and was secured via straps around the waist, shoulder, and groin. Both legs were secured using a padded attachment placed over the thighs. The non-contracting leg and forearm were also placed in a strap so that it would not dangle while inverted. The right wrist and the right ankle were inserted into the padded straps attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.) to measure the force output during the isometric

elbow flexion and knee extension MVCs. During data analysis, the mass of the resting arm was subtracted from the force output readings of the inverted MVC since in the upright position the elbow flexors had to overcome the mass of the arm associated with the pull of gravity. The mass of the resting arm in the inverted position was measured by inverting the subject 180° with arm hanging in a padded strap attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.). The mean mass of the arm when hanging inverted was 39.26 N $\pm$ 17.32. All forces detected by the strain gauge were amplified (Biopac Systems Inc. DA 100 and analog to digital (A/D) converter MP100WSW; Holliston, MA) and monitored on computer (Dell Inspiron 6000, St. John's, Newfoundland) at a sampling rate of 2000 Hz. Data was analog to digitally converted and was stored on a computer for further analysis on a commercially designed software program (Acqknowlegde 4.1, Biopac Systems Inc., Holliston, MA).

3. Dependent Variables

3.1 MVC Force

For all subjects, MVC trials were recorded for upright as well as 1s and 3s rotations to an inverted position. During testing, subjects contracted biceps and quadriceps concurrently or individually at least twice in each position. Each contraction lasted 6s. A six-second MVC duration was chosen since from previous experience from this laboratory (Button and Behm 2008); this duration was the maximum that could be endured without eliciting a fatigue response (decrease in force). If more than 5% difference was found between the first two MVCs, a third trial was performed. Three-minute rest periods were allocated between each MVC to diminish the effects of fatigue.

To collect MVC data for biceps and quadriceps the padded velcro straps holding right wrist and right ankle were attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.). When performing individual contractions, the non-contracting right forearm and right leg were secured using different velcro straps to avoid dangling while inverted. All participants were provided verbal motivation to push as hard and fast as possible, to promote the maximal response. The highest difference between the baseline value and the greatest force amplitude was considered as peak force.

3.2 Electromyography

Muscle activation of the right knee extensors and right elbow flexors were recorded during concurrent and individual voluntary contractions. Thorough skin preparation for all electrodes included shaving of hair, removal of dead epithelial cells with an abrasive sand paper around the designated areas followed by cleansing with an isopropyl alcohol swab. Four pairs of surface EMG recording electrodes (Kendall Meditrace 100 series, Chikopee, Mass) were placed approximately 2 cm apart over the midbelly of the vastus lateralis, semitendinosis, mid-portion of biceps brachii (in alignment with the muscle fibers), and triceps with ground electrode placed on the fibular head. The electrodes were wrapped to ensure no movement during inversion. EMG activity was sampled at 2000 Hz, with a Blackman 61 dB band-pass filter between 10 and 500 Hz, amplified (Biopac Systems MEC 100 amplifier, Santa Barbara, Calif; input impedance = 2M, common mode rejection ratio > 100 dB (50/60 Hz); noise >5 UV), and analog to digitally converted (Biopac MP150) to be stored on a personal computer for further analysis (Dell Inspiron 6000). EMG data was integrated (rectified), averaged over

3 samples, and the root mean square (RMS) of the signal calculated using the software (AcqKnowledge 4.1, Biopac Systems Inc., Holliston, MA). From this transformation the rectified RMS mean amplitude of the signal was calculated by the software over the three segments. EMG was analyzed over 1s during the first phase, over 3s (0-3s) for the second phase and over 3s (3-6s) for the third phase. Co-contraction ratios were determined by dividing the antagonist (hamstrings and triceps) into the agonist (quadriceps and biceps) rectified RMS mean amplitude values.

4. Heart rate and blood pressure

Prior to testing, heart rate and blood pressure were monitored in the upright seated position and immediately after subjects were inverted within 1s and 3s rotations. Heart rate was monitored with a Polar A1 monitor (Woodbury, N.Y.). Blood pressure was measured with a battery operated A+ Med 7-62 pressure cuff (AMG Medical Inc., Montreal, Que.).

5. Statistical analysis

Two-way analysis of variance (ANOVA), (3x3) with repeated measures was conducted on force and EMG variables. The factors were body position (upright, inverted within 1s, and inverted within 3s), and time periods (first sec, 0-3s, and 3-6s). HR and BP data was analyzed with a 2 way ANOVA (3 x 2) with factors being body position and time (upright and completion of inversion). Data was analyzed using SPSS (SPSS for MS Windows, version 17.0, Polar Engineering and Consulting). Differences were considered significant when p values were below an alpha level of 0.05. A post hoc Bonferonni–

Dunn's procedure test was also utilized to determine the values of pair-wise comparisons and to detect the location of significant differences between upright and inverted positions. Data was reported as mean $\pm$ SD.

RESULTS

1. Force

When both biceps and quadriceps were contracted concurrently (n = 22), the average biceps MVC force significantly (F (2,189) = 15.01, $p < 0.05$) decreased by 35.4% when inverted within 1s and 15.9 % within 3s as compared to the upright position (Fig.1). Compared to the upright position, the average quadriceps MVC force was significantly (F (2,189) = 31.59, $p < 0.05$) lowered by 37.2% when inverted within 1s and 12.1% within 3s (Fig.2). Additionally, biceps and quadriceps MVC significantly ($p <$ 0.05) increased 30.1% and 39.8% respectively when inverted within a 3s rotation compared to inverted within a 1s.

When only the biceps was contracted (n = 10); the average biceps MVC force was significantly (F (2, 81) = 5.03, $p < 0.05$) lower by 21.1% and 18.9 % when inverted within 1s and 3s respectively as compared to the upright position (Fig.3). During quadriceps only contraction, MVC force significantly (F (2, 81) = 4.29, $p < 0.05$) decreased by 19.2% and 19.6% when inverted within 1s and 3s respectively as compared to the upright position (Fig.4).

Based on the analysis of the main effect of time when both biceps and quadriceps are contracted simultaneously (n = 22), the average quadriceps MVC force significantly (F (2, 189) = 4.25, $p < 0.05$) increased 16.9% from the first second to 3-6s time period, and demonstrated a tendency (F (2,189) = 4.25, p = 0.06) for a 14.7% increase from first second to the first three seconds time period (Fig. 11). Biceps MVC force demonstrated no significant main effect. No significant results were found with individual biceps and

quadriceps MVC contractions. Additionally, table 1 demonstrates average (n = 22) changes in the upper and lower limb MVC force values over the time period of the first second, 0-3s, and 3-6s for the upright position, inverted within 1s, and inverted within 3s of rotations.

2. Electromyography (EMG)

During simultaneous contraction of unilateral biceps and quadriceps (n = 22), the average biceps EMG activity demonstrated significant (F (2, 189) = 7.63, $p < 0.05$) decrease of 40.9% and 39.5% when inverted within 1s and 3s respectively as compared to the upright position (Fig.5). The average triceps EMG activity significantly (F (2, 189) = 3.80, $p < 0.05$) decreased by 43.9% when inverted within 1s compared to the upright position (Fig.6). The average quadriceps EMG activity significantly (F (2, 189) = 11.67, $p < 0.05$) decreased by 50.1% and 27.3% when inverted within 1s and 3s respectively as compared to the upright position (Fig.7). The average hamstrings EMG activity was significantly (F (2,189) = 6.23, $p < 0.05$) lowered by 44.1% when inverted within 1s compared to the upright position (Fig.8).

During individual biceps contraction (n = 10), the average biceps EMG activity was significantly (F (2, 81) = 3.51, $p < 0.05$) decreased by 21.7% when inverted within 1s and 35.9% lower when inverted within 3s compared to the upright position (Fig.9). When quadriceps was contracted individually, the average quadriceps EMG significantly (F (2, 81) = 6.91, $p < 0.05$) lowered by 39.1% and 40.2% when inverted within 1s and 3s respectively as compared to the upright position (Fig. 10).

No significant results were found for triceps to biceps and hamstrings to quadriceps co-contraction ratios for force and time when both biceps and quadriceps were contracted concurrently as well as individually. The average (n = 22) changes in the upper and lower limb EMG values over the time period of the first second, 0-3s, and 3-6s for the upright position, inverted within 1s, and inverted within 3s of rotations are illustrated in table 2.

3. Heart Rate and Blood Pressure

Heart rate significantly (F (2, 63) = 26.21, $p < 0.001$) decreased 16.8% and 21.1% when inverted within 1s and 3s respectively as compared to the upright position (Fig.12). Similarly, average (n = 22) systolic blood pressure significantly (F (2, 63) = 29.36, $p <$ 0.001) decreased by 10.8% when inverted within 1s and 12.4 % within 3s as compared to the upright position (Fig.13). Average (n = 22) diastolic blood pressure also significantly (F (2, 63) = 29.32, $p < 0.001$) decreased by 14.1% and 17.1% when inverted within 1s and 3s respectively as compared to the upright position (Fig.14).

DISCUSSION

This study investigated changes in neuromuscular and cardiovascular functioning with rapid and slower rotations from seated upright to seated inversion. Whether biceps and quadriceps were contracted concurrently or individually, MVC force and EMG decreased significantly when inverted within 1s and 3s compared to upright position. In addition, both biceps and quadriceps MVC increased significantly when inverted within 3s compared to 1s during concurrent contraction. Quadriceps MVC force subsequently increased from the first second to 3-6s time periods, but demonstrated a tendency for an increase from the first second to 0-3s time periods. No significant changes were found for elbow flexor MVC force for main effect for time. Triceps and hamstrings EMG activity significantly decreased when inverted within 1s as compared to upright position. Heart rate, systolic blood pressure, and diastolic blood pressure demonstrated significant decreases when inverted within 1s and 3s compared to upright position.

Neuromuscular impairments may be attributed to both central and peripheral factors with rapid and slower transitions from upright to inverted seated positions. When inverted within 1s and 3s both biceps and quadriceps MVC and EMG activity decreased suggesting the involvement of central mechanisms. The major possible central factors include inversion-induced increase in hydrostatic pressure (Parazynski et al. 1991) and decreased baroreflex activity (Charkoudian et al. 2004) due to elevated cerebral blood flow or intracranial pressure. However, the mechanisms underlying changes in force and

EMG during rapid and slower transitions to seated inversion are unknown. Further research is needed to determine these mechanisms.

It was hypothesized that rapid and slower transition to seated inversion would initially increase neuromuscular and cardiovascular responses followed by a drop-off. However, the results of this study demonstrated significant decreases in neuromuscular as well as cardiovascular responses suggesting rapid inversion-induced inhibition of sympathetic nervous system activity. Hearn et al. (2009), Paddock and Behm (2009), and Neary et al. (2011*a*, 2011*b*) exhibited similar responses with slow deliberate transitions to seated inversion compared to upright posture and proposed an inhibition of sympathetic nervous system activity. The significant decrease in heart rate and blood pressure (Bosone et al. 2004) and total peripheral resistance (Goodman and Lesage 2002) with head-down body tilt position also suggests a possible sympathetic system inhibition. Moreover, the adverse effects of sympathetic nervous system inhibition on muscle blood flow (Thomas and Segal 2004) and muscle force contractility (Martini and Nath 2008) might be related to a decrease in MVC force output and EMG activity with rapid movements at different rotational times from an upright to an inverted position. A decline in blood volume (Cerretelli et al. 1977) of upper and lower extremity working muscles, resulting in reduced oxygen and nutrient supply, may also be considered as a factor contributing to the lower force output and EMG activity with rapid and slower transitions to seated inversion.

Impairment of respiratory system functioning with head-down tilt (Henderson et al. 2006) might also contribute to inversion-induced neuromuscular deficit. Oxygen is necessary for the proper functioning of the skeletal muscles (Hepple et al. 2002). Head-

down tilt interferes with adequate gaseous exchange (Prisk et al. 2002), decreases pulmonary ventilation and lung capacity (Lu et al. 2000), and increases airflow impedance by decreasing lung compliance (Donina et al. 2009). Muscle hypoxia should have a greater detrimental effect upon prolonged muscle contractions, which have a greater reliance upon oxygen utilization. An altered oxygen supply to the contracting muscle during head-down tilt has been reported to alter muscle force output due to impaired excitation-contraction coupling (Aleksandrova et al. 2005). However, the very rapid response in the present study would suggest that the respiratory mechanisms would not have played a substantive role in neuromuscular impairments as the adverse effect on oxygen supply would in all probability need duration of greater than 3-6 seconds. Secondly, a brief MVC would not be as affected by a hypoxic environment as more prolonged contractions.

In contrast to the study of Hearn et al. (2009) and Paddock and Behm (2009), no changes were observed in upper extremity co-contraction (triceps to biceps) and lower extremity co-contraction (hamstrings to quadriceps) when biceps and quadriceps were contracted concurrently. Similar results were found with individual biceps and quadriceps contractions. Hence, the inversion-induced decreases in force could not be attributed to changes in motor control or inter-muscular co-ordination.

Quadriceps MVC force changed over different time periods (0-1s, 0-3s, and 3-6s) was independent of the condition (upright, inverted within 1s, and inverted within 3s). The force generated over a period of 6s reached its maximum value after three seconds. Button and Behm (2008) used 4s MVC to ensure maximum force was achieved. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated significant impairments in

neuromuscular responses using 4s MVCs in upright and inverted seated positions. Thus, it can be concluded that MVC forces need approximately 3 to less than 6s to reach maximum whether the individual is upright or in the process of being inverted.

The main limitation of the present study was that the subjects were manually inverted within 1s and 3s rotations via a detachable wheel attached to the rotational chair. Rotating manually with the help of a stopwatch to maintain 1s and 3s rotations made it difficult to attain exact rotation times for all the subjects. The variability in times was recorded for subjects when inverted within 1s and 3s rotations. The mean rotation times were 1.14s $\pm$ 0.07 when inverted within 1s and 3.13s $\pm$ 0.04 when inverted within 3s rotations. To overcome this limitation, future inversion-related research should use a motorized rotational chair. Additionally, the contraction of the biceps and quadriceps concurrently and unilaterally could lead to a disruptive torque to the trunk. However, the subjects were securely strapped into the chair so this possibility was minimal. There was also the possibility of a similar bilateral deficit mechanism whereby the contraction of the same two muscles bilaterally results in decreased force compared to the contraction of the two muscles individually. Since, no significant differences were found when upright, inverted within 1s, and inverted within 3s concurrent unilateral biceps and quadriceps contractions were respectively compared with upright, inverted within 1s, and inverted within 3s individual biceps and quadriceps contractions it was not considered a major limiting factor in the present study.

CONCLUSION

With rapid and slower transitions from upright to seated inversion, the biceps and quadriceps MVC force, EMG activity, heart rate, and blood pressure decreased for concurrent biceps and quadriceps contraction, as well as individual biceps and quadriceps contraction compared to the upright position. This inhibition of neuromuscular and cardiovascular measures occurred within approximately 1s of rotation to inversion. These results were in contradiction to the proposed hypothesis, which was based upon the activation of the flight or fight response of the sympathetic nervous system. The increase in sympathetic activity typically increases the heart rate and blood pressure, resulting in possible increased blood flow to the working muscles and the required force output. However, the expected increase in sympathetic nervous system activity seemed to be inhibited with rapid (1s) and slower (3s) transitions from upright to seated inversion. Another contributing factor could have been related to increased hydrostatic pressure. The aforementioned mechanism could immediately impact neuromuscular and cardiovascular responses when individuals are forced into inverted positions such as overturned helicopters or motor vehicle accidents. Further research is recommended to determine the effectiveness of these mechanisms and their practical implications.

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TABLES

Interactions with Concurrent Contractions		Upright	Inverted in 1s	Inverted in 3s
Biceps MVC Force (N)	1st sec	251.3263 ± 101.28*	152.6702 ± 62.87*	202.6819 ± 83.06*
	0-3s	261.9656 ± 112.56*	160.3608 ± 71.89*	215.6326 ± 100.03
	3-6s	258.0059 ± 119.06*	156.1803 ± 72.88*	217.5324 ± 97.49
Quadriceps MVC Force (N)	1st sec	467.3115 ± 161.65*	285.3885 ± 101.23*	400.8303 ± 135.30
	0-3s	527.8818 ± 170.38*	330.9764 ± 118.39*	464.7685 ± 153.76*
	3-6s	530.7031 ± 141.23*	342.6585 ± 117.41*	474.9801 ± 139.47*

Table 1. The interaction of time and condition for the changes in the upper and lower limb average (n = 22) MVC force (N) values over the time periods of the first second, 0-3s, and 3-6s in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations over the time periods of the first second, 0-3s, and 3-6s.

Biceps EMG (mv)	1st sec	1.3721 + 1.06	0.7724 + 0.54*	0.9005 + 0.62
	0-3s	1.4174 + 1.19	0.9438 + 0.66	1.0899 + 0.83
	3-6s	1.6852 + 1.49*	0.8901 + 0.64	1.1613 + 0.96
Triceps EMG (mv)	1st sec	0.1330 + 0.09	0.0707 + 00.05	0.1695 + 0.04
	0-3s	0.1572 + 0.11	0.0908 + 0.06	0.1182 + 0.07
	3-6s	0.1752 + 0.12	0.1000 + 0.07	0.1358 + 0.09
Quadriceps EMG (mv)	1st sec	0.5987 + 0.51	0.2546 + 0.21*	0.3736 + 0.29
	0-3s	0.6561 + 0.49*	0.3268 + 0.25	0.4389 + 0.31
	3-6s	0.5700 + 0.42	0.3271 + 0.28	0.5130 + 0.37
Hamstrings EMG (mv)	1st sec	0.0539 + 00.05	0.0281 + 0.02	0.0370 + 0.03
	0-3s	0.0603 + 00.05	0.0319 + 0.03	0.0538 + 0.05
	3-6s	0.0614 + 0.04	0.0399 + 0.04	0.0411 + 0.04

Table 2. The interaction of time and condition for the changes in the upper and lower limb average (n = 22) EMG (mv) values over the time periods of the first second, 0-3s, and 3-6s in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations over the time periods of the first second, 0-3s, and 3-6s.

Main Effect for Condition with Concurrent Contractions	Upright	Inverted in 1s	Inverted in 3s
Biceps MVC (N)	252.134 $\pm$ 134.49*	162.901 $\pm$ 62.94*	211.949 $\pm$ 92.93*
Biceps EMG (mv)	1.4916 $\pm$ 1.24*	0.8786 $\pm$ 0.60*	1.0506 $\pm$ 0.81*
Triceps EMG (mv)	0.1551 $\pm$ 0.10*	0.08716 $\pm$ 0.06*	0.1412 $\pm$ 0.08
Quadriceps MVC (N)	508.632 $\pm$ 158.53*	319.674 $\pm$ 113.63*	446.859 $\pm$ 114.67*
Quadriceps EMG (mv)	0.6083 $\pm$ 0.47*	0.3028 $\pm$ 0.25*	0.4418 $\pm$ 0.33*
Hamstrings EMG (mv)	0.0585 $\pm$ 0.049*	0.0333 $\pm$ 0.03*	0.04497 $\pm$ 0.04

Table 3. The main effect for condition for the changes in the upper and lower limb average (n = 22) MVC force (N) and EMG (mv) values in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps are contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

Main Effect for Time Concurrenrt Contractions	First second	0-3s	3-6s
Biceps MVC (N)	200.88 $\pm$ 91.57	213.58 $\pm$ 102.59	212.50 $\pm$ 103.42
Biceps EMG (mv)	1.0249 $\pm$ 0.80	1.1503 $\pm$ 0.93	1.2455 $\pm$ 0.99
Triceps EMG (mv)	0.1244 $\pm$ 0.10	0.1220 $\pm$ 0.09	0.1370 $\pm$ 0.09
Quadriceps MVC (N)	384.51 $\pm$ 152.98*	441.20 $\pm$ 168.49	449.44 $\pm$ 153.29*
Quadriceps EMG (mv)	0.4901 $\pm$ 0.38	0.4739 $\pm$ 0.39	0.4700 $\pm$ 0.37
Hamstrings EMG (mv)	0.0396 $\pm$ 0.02	0.0487 $\pm$ 0.03	0.0485 $\pm$ 0.03

Table 4. The main effect for time for the changes in the upper and lower limb average (n = 22) MVC force (N) and EMG (mv) values for the time periods of the first second, 0-3s, and 3-6s when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences for the time periods of the first second and 3-6s.

Main Effect for Condition with Individual Contractions	Upright	Inverted in 1s	Inverted in 3s
Biceps MVC (N)	318.675 ± 94.39*	251.3507 ± 78.23*	258.2243 ± 89.988*
Biceps EMG (mv)	1.5719 ± 0.98*	1.2303 ± 0.8365*	1.007 ± 0.59*
Triceps EMG (mv)	0.1592 ± 0.0760	0.1371 ± 0.3230	0.1462 ± 0.0906
Quadriceps MVC (N)	551.8389 ± 174.15*	446.0418 ± 157.69*	443.750 ± 150.26*
Quadriceps EMG (mv)	1.0002 ± 0.60*	0.6092 ± 0.40*	0.5984 ± 0.37
Hamstrings EMG (mv)	0.0870 ± 0.1206	0.0681 ± 0.0381	0.0596 ± 0.0464

Table 5. The changes in the upper and lower limb average (n =10) MVC force (N) and EMG (mv) values in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted individually. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

Main Effect for Condition	Upright	Inverted in 1s	Inverted in 3s
HR	82.0491 ± 9.50*	68.5455 ± 8.17*	65.0455 ± 7.45*
SBP	130.1818 ± 8.06*	116.0909 ± 8.23*	113.9545 ± 6.48*
DBP	78.6364 ± 7.39*	67.5455 ± 6.33*	65.1818 ± 4.64*

Table 6. The main effect for condition with average (n = 22) values for the changes in heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) in the upright position, inverted within 1s and inverted with 3s rotations. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

FIGURES

1. **Main effects for Condition: Force**

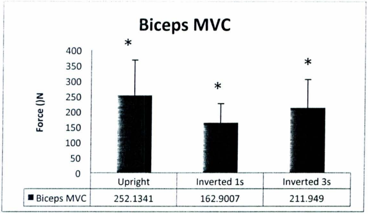


Fig.1. The average (n = 22) biceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

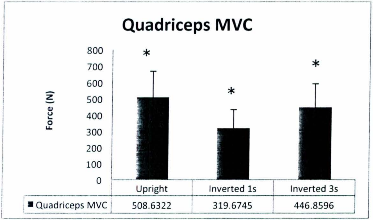


Fig.2. The average (n = 22) quadriceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

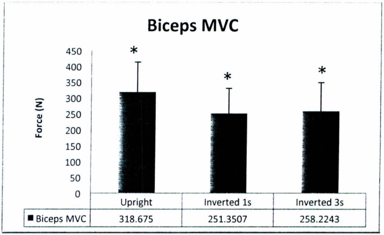


Fig.3. The average (n = 10) biceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps contracted individually. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

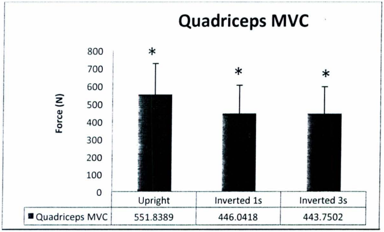


Fig.4. The average (n = 10) quadriceps MVC force (N) in the upright and inverted within 1s and 3s rotations when quadriceps contracted individually. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

2. <u>Main effects for condition: Electromyography (EMG)</u>

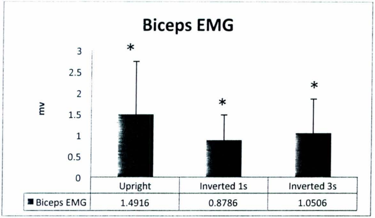


Fig.5. The average (n = 22) biceps EMG activity (mv) during the MVC of the biceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations ($\pm$ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

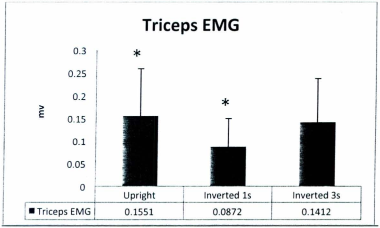


Fig.6. The average (n = 22) triceps EMG activity (mv) during the MVC of the biceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations ($\pm$ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s rotations.

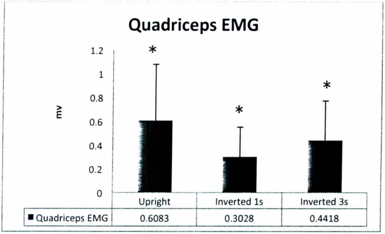


Fig.7. The average (n = 22) quadriceps EMG activity (mv) during the MVC of the quadriceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

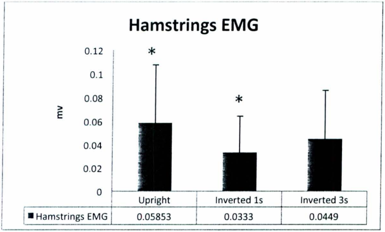


Fig.8. The average (n = 22) hamstrings EMG activity (mv) during the MVC of the quadriceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s rotations

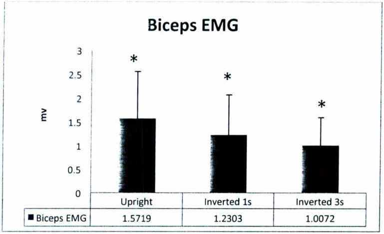


Fig.9. The average (n = 10) biceps EMG activity (mv) during the MVC of the biceps when biceps contracted individually in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

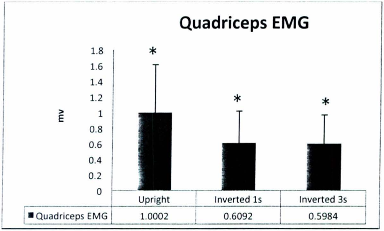


Fig.10. The average (n = 10) quadriceps EMG activity (mv) during the MVC of the quadriceps when quadriceps contracted individually in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

3. Main effects for Time: Force

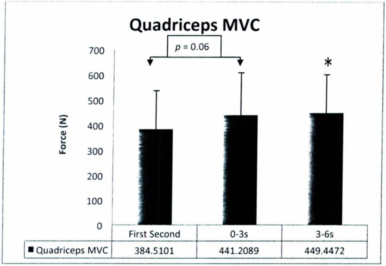


Fig.11. The average (n = 22) changes in quadriceps MVC force (N) in the first sec, 0-3s, and 3-6s time periods when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between the first second and 3-6s periods. A tendency ($p = 0.06$) was observed from the first second to 0-3s.

4. Heart Rate and Blood Pressure

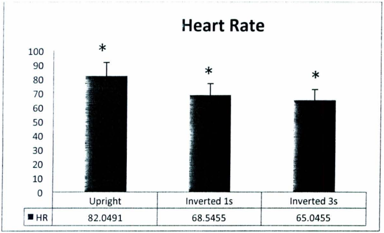


Fig.12. The average (n = 22) heart rate (beats/min) in the upright and inverted within 1s and 3s rotations. Columns represent average values of beats/min and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

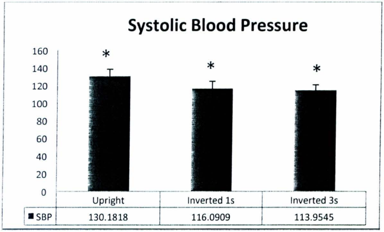


Fig.13. The average (n = 22) systolic blood pressure (mmHg) in the upright and inverted within 1s and 3s rotations. Columns represent average values of the pressure and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations

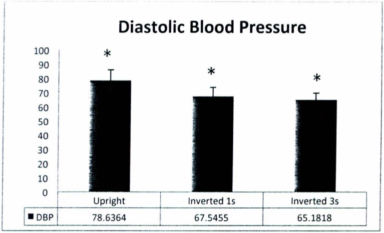


Fig.14. The average (n = 22) diastolic blood pressure (mmHg) in the upright and inverted within 1s and 3s rotations. Columns represent average values of the pressure and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations

5. Force Profiles

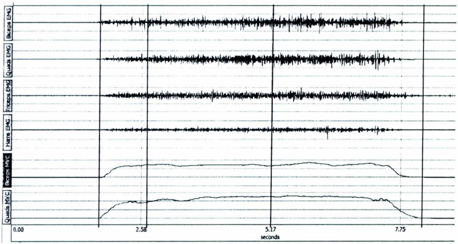


Fig. 15. Image represents the force profile when inverted within 1s rotation. The lines represent three different phases of analysis (0-1s, 0-3s, 3-6s).

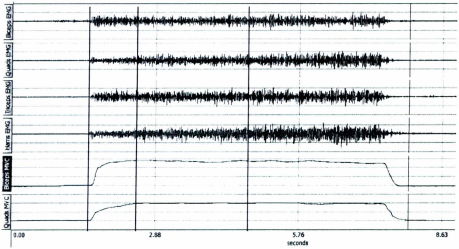


Fig. 16. Image represents the force profile when inverted within 3s rotation. The lines represent three different phases of analysis (0-1s, 0-3s, 3-6s).

APPENDICES

Variability in Rotation Times

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.12	3.07
Subject 2	1.23	3.21
Subject 3	1.09	3.14
Subject 4	1.11	3.11
Subject 5	1.17	3.17
Subject 6	1.21	3.01
Subject 7	1.08	3.26
Subject 8	1.19	3.04
Subject 9	1.14	3.12
Subject 10	1.02	3.13
Subject 11	1.17	3.00
Subject 12	1.00	3.22
Subject 13	1.24	3.03
Subject 14	1.16	3.19
Subject 15	1.19	3.14
Subject 16	1.23	3.17
Subject 17	1.12	3.26
Subject 18	1.27	3.08
Subject 19	1.05	3.20
Subject 20	1.14	3.16
Subject 21	1.11	3.21
Subject 22	1.02	3.02

Table 1. The variability in rotation times when subjects were inverted within 1s and 3s with concurrent biceps and quadriceps contraction.

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.15	3.01
Subject 2	1.09	3.20
Subject 3	1.21	3.16
Subject 4	1.17	3.11
Subject 5	1.23	3.11
Subject 6	1.07	3.09
Subject 7	1.19	3.19
Subject 8	1.02	3.05
Subject 9	1.11	3.16
Subject 10	1.06	3.18

Table 2. The variability in rotation times when subjects were inverted within 1s and 3s with individual biceps contraction.

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.13	3.23
Subject 2	1.11	3.02
Subject 3	1.24	3.19
Subject 4	1.07	3.14
Subject 5	1.19	3.18
Subject 6	1.15	3.11
Subject 7	1.17	3.00
Subject 8	1.05	3.13
Subject 9	1.22	3.05
Subject 10	1.04	3.17

Table 3. The variability in rotation times when subjects were inverted within 1s and 3s with individual quadriceps contraction.

Figure: Photo of rotational chair in upright position.

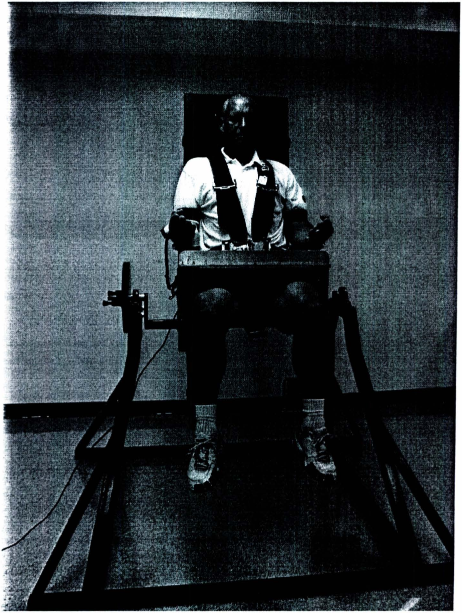
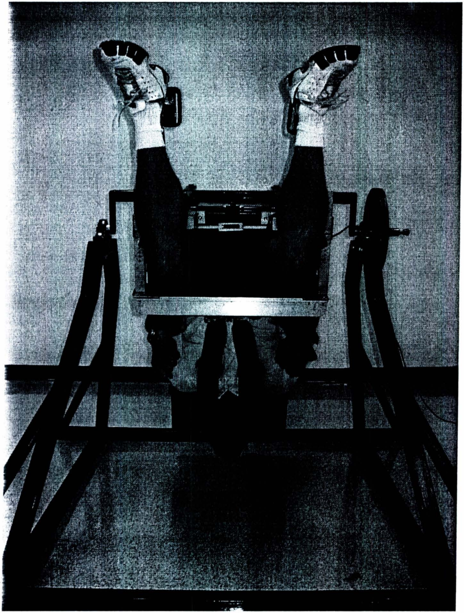


Figure: Photo of rotational chair in inverted position



EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

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EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

by

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A thesis submitted to the

School of Graduate Studies

in partial fulfillment of the

requirements for the degree of

Master of Science in Kinesiology

School of Human Kinetics and Recreation

Memorial University of Newfoundland

27 May, 2012

St. John's Newfoundland

ABSTRACT

An inverted body posture is not common. During unusual situations (e.g. overturned helicopters or motor vehicle accidents) when the body is inverted, the neuromuscular responses can change. In order to manage these situations, it is necessary to examine changes in muscle force output and activation.

Although the exact mechanisms are unknown, it is believed that both central and peripheral factors can contribute to changes in muscle force output. Increase in cerebral blood pooling, increase in hydrostatic pressure, and decrease in sympathetic activity during rapid and slow transitions from upright to inverted seated position are considered to be the main central factors leading to decrease in inversion-induced muscle force output. Peripheral factors such as decreased blood flow to the contracting muscle resulting in decrease perfusion pressure and oxygen deficit within the muscle are most likely to summate along with central factors inducing neuromuscular impairments during rapid and slower inversion rotations.

There is no evidence examining possible impairments in neuromuscular functioning with more rapid versus slower inverted rotations as compared to an upright seated position. Maximal voluntary contraction (MVC) and electromyographic (EMG) activity were recorded and analyzed in biceps and quadriceps, concurrently and individually, for maximal force output and activation with upright seated position, and inverted within 1s and 3s rotations. It was anticipated that changes in muscle force and activation within 1s and 3s inversion rotations would suggest impairments in the functioning of neuromuscular system, as compared to the upright position. In addition,

ACKNOWLEDGEMENTS

On completing this thesis as I look back on the whole experience from its very inception, I feel humbled. All along I was assured of the presence of god to who goes all the glory and honor for the successful completion of this thesis.

I am very much grateful and indebted to my supervisor Dr. David Behm, who immensely helped and rendered his valuable advice, precious time, knowledge and relevant information regarding the collection of material and whose suggestions and guidance have enlightened me on this thesis. It has been a great experience working under his supervision.

My sincere thanks to Dr. Duane Button and Dr. Tim Alkanani for their kind professional help and cooperation.

I would be biased if I don't mention the name of Varun Grover and Mario DiSanto who really helped me while working on this thesis. It has been a great help and support to have them.

A special thanks to all the subjects whom I have worked with. I owe a special regard and gratitude to all of them. Lastly, thanks to all those whose names are not mentioned here, for their unrelenting encouragement.

PRAMOD JOHAR

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Main effects for Condition: MVC

2. Main effects for Condition: EMG

3. Main effects for Time: MVC

4. Heart Rate and Blood Pressure

5. Force Profiles

LIST OF ABBREVIATIONS

BP	Blood pressure
CVP	Central venous pressure
DBP	Diastolic blood pressure
EMG	Electromyography
HDT	Head-down tilt
HR	Heart rate
LBNP	Lower body negative pressure
MVC	Maximum voluntary contraction
SBP	Systolic blood pressure
SV	Stroke volume

LIST OF APPENDICES

Variability in Rotation Times

INTRODUCTION

The human body is adapted to work in an upright position. In situations when an individual is required to manage circumstances where the body is forced into inverted positions (e.g. completely overturned helicopter or motor vehicle accidents), physiological responses can change. It is important to know the neuromuscular and cardiovascular responses when a person is inverted from an upright position.

Only two studies have been published which examine the elbow flexion (Hearn et. al. 2009) and the knee extension (Paddock and Behm 2009) force and activation during inverted seated position. Both studies were performed to determine the changes in neuromuscular responses between upright and inverted seated positions. The results for both studies illustrated decreases in neuromuscular performance with an inverted seated posture. Also, both studies exhibited significant decreases in heart rate and blood pressure in the inverted position attributed to alterations of sympathetic nervous system stimulation. In addition, Neary et al. (2011*a*, 2011*b*) demonstrated a tendency for quadriceps maximal voluntary contraction (MVC) force to decrease in inverted position but no significant difference was found for biceps brachii MVC between upright and inverted positions. They also found a significant decrease in heart rate as well as cardiac output with inverted position as compared to upright position, which were in accordance with the results from Hearn et al. (2009) and Paddock and Behm (2009). Hence, it can be established that an inverted seated posture results in neuromuscular and cardiovascular system impairments.

There are a number of physiological mechanisms involved when the body responds to an inverted position. Hydrostatic pressure (pressure exerted by a fluid due to

the force of gravity) is considered as one of the major contributing factors related to the decline in the muscle force output during inversion. Mechanisms to reduce hydrostatic pressure in the lower body when upright, such as respiratory muscle pump (Miller et al. 2005), skeletal muscle pump (Delp and Laughlin 1998), and veno-vasoconstriction (Vissing et al. 1997) offset the effect of increased lower body hydrostatic pressure and ensure adequate venous return to the heart. Bosone et al. (2004) demonstrated ten minutes of 30^{o} head down tilt caused a significant increase in arterial pressure at the cranial level due to the development of the hydrostatic pressure gradient between the heart and brain levels. It is speculated that the inversion-induced increase in hydrostatic pressure could have a negative impact on the ability of the brain to function appropriately. This response could affect optimal performance during sport, and occupational tasks or emergency situations.

Furthermore, inhibition of sympathetic activity during head down body tilt (Bosone et al. 2004; Cooke and Dowlyn 2000; Cooke et al. 2004; Fu et al. 2000) is associated with decreased heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), and total peripheral resistance (Goodman and LeSage 2002). This inhibition of the sympathetic nervous system adversely affects the peripheral perfusion (Thomas and Segal 2004), resulting in decreased muscle force output. Head-down tilt postures also lead to decreased oxygen supply to the working muscle via compensatory increases in the inspiratory muscle contraction force (Aleksandrova et al. 2005), decreased lung compliance (Donina et al. 2009), impaired gaseous exchange (Prisk et al. 2002), and increased airflow impedance of the respiratory system (Donina et al. 2009), which further adds to the factors causing reduced muscle force output with inverted

position. However, all inversion studies to date have involved slow and deliberate transitions from upright to inverted positions. In most situations such as overturned vehicle accidents and ditched helicopters, these events will occur rapidly. Due to the rapid transition of the body from an upright to inverted position, there is the possibility that force output will be augmented abruptly due to the activation of the sympathetic nervous system (fight or flight phenomenon). However, it is unknown whether the typical inversion-induced decrements are more predominant than possible sympathetic system excitation.

Consequently, it is important to observe the changes in force output, muscle activation and cardiac functioning when inverted at different rotational times compared to an upright seated position. The following sections will provide a critical and in-depth evaluation of the physiological responses and underlying mechanisms related to inverted body posture.

1. EFFECTS OF INVERSION ON NEUROMUSCULAR PROPERTIES

An inverted seated position is not a common body posture. Neuromuscular responses change with an inverted position as compared to an upright position. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated decreases in force production and muscle activation. Hearn et al. (2009) found significant decreases in elbow flexor MVC force, voluntary rate of force development, and biceps electromyographic (EMG) activity with complete inversion. A similar study by Paddock and Behm (2009) focusing on lower limb quadriceps muscle activation, showed a significant reduction in maximal voluntary contraction force, rate of force development, and EMG activity with seated inversion. In

addition, Neary et al. (2011*a*, 2011*b*) also found a tendency for quadriceps MVC to decrease in inverted position but no significant difference was found for biceps MVC between upright and inverted positions. Hence, it can be inferred that the inverted position generally has a negative impact on an individual's neuromuscular functioning.

2. PERFUSION PRESSURE

Inversion-induced muscle performance impediments may be attributed to a number of mechanisms. Peripheral perfusion pressure; a graded difference between arterial blood pressure and venous pressure (Ganong 2003), is an important factor affecting muscle force output. During activity, regulation of blood pressure plays a vital role in optimizing perfusion to the working muscles and supplying essential nutrients and oxygen needed for proper functioning. Hobbs and McCloskey (1987) found a decrease in blood flow and force production near maximal workloads when an isolated cat soleus muscle was treated with a reduced mean blood pressure. This suggests that the amount of workload is associated with the alterations in the perfusion pressure and force production. Perfusion pressure in the muscle can increase or decrease depending upon the distance the muscle is from the heart. Raising the arm above the heart level leads to a decrease in the perfusion pressure in hand, resulting in lower force production (Fitzpatrick et al. 1996). Sundberg and Kaijser (1992) found the same effect in lower limbs. They found a decrease in muscle perfusion followed by a decrease in muscle force when a positive pressure of 50 mmHg was applied.

All the above-mentioned studies support the changes in neuromuscular responses demonstrated by Hearn et al. (2009) and Paddock and Behm (2009). These studies

exhibited decreased elbow flexion (Hearn et al. 2009) and knee extension (Paddock and Behm 2009) muscle force when upright seated position was compared with inverted seated posture. Both the studies attributed inversion-induced reduction in peripheral perfusion in contracting muscles as a major contributing peripheral factor.

3. HYDROSTATIC PRESSURE

Hydrostatic pressure is defined as a pressure change caused by fluid changes in the capillary network (Guyton and Hall 2006). A number of studies on animals and humans have demonstrated a significant effect on working capacity of the muscles due to alteration in hydrostatic pressure with or without changes in body position. The majority of the studies related to hydrostatic pressure are conducted on animals. Both rabbit psoas (Fortune et al. 1994) and rat extensor digitorum longus (Ranatunga and Geeves 1991) muscles have responded with decreased tetanic force when subjected to high hydrostatic pressure. Ranatunga and Geeves (1991) also found that the peak tension, the time to peak and the time to half-relaxation of a twitch contraction increased when the muscle fiber bundles isolated from the rat extensor digitorum longus of the rat were exposed to increasing hydrostatic pressures. However, when a maximally calcium activated rabbit psoas muscle fiber was subjected to high hydrostatic pressure, a 15% decrease in isometric active tension was reported (Geeves and Ranatunga 1987). It was hypothesized that a lower number of active-cross bridges or decrease in the force per cross-bridge was responsible for this impairment due to an increased pressure. Alternatively, twitch tension was potentiated with an increase in hydrostatic pressure in response to enhanced release of calcium (Vawda et al. 1996). High hydrostatic pressure causes pulsing acetylcholine

receptor release, decreasing muscle firing frequency (Heinman et al. 1987), and enzymatic activity of lactate dehydrogenase (Schmid et al. 1979). Therefore, based on animal research, the increased hydrostatic pressure can have adverse effects on neuromuscular performance.

In humans, a number of mechanisms work *in vivo* in upright position to compensate for the effect of increased hydrostatic pressure and consequent blood pooling in the lower limbs. These mechanisms, such as respiratory muscle pump (Miller et al. 2005), skeletal muscle pump (Delp & Laughlin 1998), and veno-vasoconstriction (Vissing et al.1997) ensure adequate venous return to the heart. In addition, vasoconstriction triggered by venous distension and a local neural veni-arteriolar response is important for counteracting increases in capillary hydrostatic pressure during upright posture or limb dependency (Henriksen 1991). Bosone et al. (2004) found that 10 min of 30^{o} head down tilt caused significant increase in arterial pressure at the cranial level, due to the development of the hydrostatic pressure gradient between the heart and brain. Furthermore, minimal changes in hydrostatic pressure and perfusion pressure are observed in a supine position (Laughlin and Scharge 1999).

In conclusion, previous published studies related to complete seated inversion (Hearn et al. 2009; Paddock and Behm 2009) illustrated decreases in muscle activation and force production with an inverted body position. Neither of these studies investigated hydrostatic pressure directly, but suggested it may be an important central factor leading to impairments in neuromuscular system responses.

4. LOWER BODY NEGATIVE PRESSURE AND BARORECEPTOR REFLEXS

A lower body negative pressure (LBNP) is the application of an external negative pressure below the waist under well-controlled conditions. LBNP is most often used as a perturbation to the cardiovascular system and has been applied to simulate gravitational stress (Levine et al. 1991; Savard and Stonehouse 1995; Zhang et al. 1999). During upright body posture, vasomotor sympathetic activity plays an essential role in maintaining arterial pressure via the baroreceptor reflex mechanism (Fu et al. 2006). Baroreceptors are the stretch receptors that are located in the aortic arch and the carotid sinuses (Fox 2006). These receptors play a vital role in maintaining the blood pressure within limits. With the change in position from lying to standing there is a shift of blood from the veins in the thoracic cavity to the veins in the lower extremities. This results in lower blood pressure due to decreases in venous return and cardiac output, which is counteracted via activation of the baroreceptor reflex (Fox 2006). Thus, it helps in maintaining homeostasis by playing an important role during changes in body posture.

Hughson et al. (1993) investigated the effect of cycling exercise in upright and supine positions, and compared it with -40 mmHg lower body negative pressure in supine position. The baroreceptor reflex was activated during supine exercise, as LBNP caused more pooling of blood in lower extremities as compared to upright position. Cooper and Hainsworth (2001) determined that -40 mmHg LBNP has no effect on cardiac responses. However, they illustrated a significant increase in vascular resistance response during LBNP along with the increase in the peak gain of the baroreceptor reflex. They also suggested that an increase in baroreflex gain may help in maintenance of blood pressure during orthostatic stress.

Baroreceptor reflex also helps to maintain adequate cerebral perfusion (Ponte and Purves 1974). The sensitivity of the baroreflex control of sympathetic nerve activity decreases from upright to tilted position due to an increase in central venous pressure (CVP) (Charkoudian et al. 2004). Hearn et al. (2009) and Paddock and Behm (2009) have illustrated significant decreases in blood pressure, both systolic and diastolic with complete seated inversion. A subsequent study from the same laboratory reported similar inversion-induced decreases in mean arterial pressure and cardiac output (Neary et al. 2011*a*, 2011*b*). Thus, it can be hypothesized that with the increase in hydrostatic pressure during inversion, CVP may also increase, resulting in reduced sensitivity of the baroreceptor reflex with inverted body posture. However, no research has been conducted to determine the role of baroreceptors during complete seated inversion; therefore, the adjustments made by baroreceptors have not been fully clarified.

5. VESTIBULAR SYSTEM

The vestibular system assists with the control of balance and equilibrium. It accomplishes this function by assessing head and body movement and position in space, generating a neural code representing this information, and distributing this code to appropriate sites located throughout the central nervous system. Vestibular function is largely reflex and unconscious in nature (Ganong 2003). The otolith organs and semi-circular canals are the two main components of the vestibular system associated with postural adjustments. The semicircular canals respond to rotational movements of the head, whereas otolith organs sense linear motion (Ganong 2003).

Gravity also plays an important role with the vestibulosympathetic reflex. Tanaka et al. (2006) found that vestibular deficient rats are less able to regulate blood pressure as compared to gravitational stressed rats with the inner ear intact. Therefore, it can be proposed that the vestibulosympathetic reflex is vital to maintain homeostasis during gravity related changes with inversion. However, further research is necessary to determine the possible mechanisms and/or adjustments, and the role played by the vestibular system during complete inversion.

Ray (2000) found that the vestibulosympathetic reflex, via an increase in sympathetic outflow, plays an important role in maintaining orthostasis in humans. During upright standing, vestibulosympathetic reflex assists in regulating blood pressure changes in humans (Ray and Carter 2003). Kerman et al. (2000) also suggested that the vestibular system plays a role during postural adjustments by regulating autonomic outflow. They illustrated, that based upon the anatomical location and innervation target of a particular sympathetic nerve; the vestibular sympathetic reflexes may result in local blood flow changes. Though none of these studies were directly related to rapid and slow seated inversion of the human body, they would insinuate that changes occur in neuromuscular performance during downward rotation.

6. SYMPATHETIC NERVOUS SYSTEM

In order to maintain arterial blood pressure, sympathetic nerve activity decreases blood flow to the active muscles via vasoconstriction (Fox 2006). However, it has been noted that even though the sympathetic neural discharge increases with the increase in intensity of the activity, the muscle blood flow also increases, indicating a reduced

responsiveness to sympathetic activation (Thomas and Segal 2004). Wallin and Sundlof (1982) reported vasoconstriction in skeletal muscles during a standing upright posture. During standing, an increase in the sympathetic activity to the vessels is accompanied by an over-activity of the sympathetic system leading to an exaggerated increase in the heart rate (Furlan 2001). As the response of muscle nerve sympathetic activity is not directly studied in inversion, it is reasonable to expect the opposite (decreased heart rate) with an inverted body position.

The sympathetic nervous system also influences muscle force contractility, alertness through stimulation of the reticular activating system, glycogen utilization, and muscle tone (Martini and Nath 2008). Additionally, a decrease in heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), and total peripheral resistance (Goodman and LeSage 2002) are also attributed to inhibition of sympathetic nervous system activity. Significant increase in intracranial pressure and inhibition of sympathetic outflow (Bosone et al. 2004) may reduce the ability to sustain maximal force output by decreasing the neural outflow to the motor neurons.

Furthermore, tilt studies have also shown a decrease in sympathetic activity. Acute head down body tilt studies have reported lower sympathetic nervous activity (Cooke and Dowlyn 2000: Cooke et al. 2004), which could play a role in the ability of the central nervous system to adequately activate motor neuron activity (Roatta et al. 2008). During 6° head down tilt the muscle sympathetic nerve activity decreased by 27% (Fu et al. 2000). A recent study by Wang et al. (2011) also demonstrated that a 6° head-down bed rest decreased the working capacity of the muscle. Additionally, Bosone et al. (2004) have reported that 10 min of 30° head down tilt inhibit the sympathetic nervous

system response along with a decrease in heart rate and arterial blood pressure. Heart rate and cardiac output decreased significantly (Yao et al. 1999) with 24 h- 6° head down body tilt bed rest. Kawanokuchi et al. (2001) demonstrated that vestibulosympathetic reflex rather than cardiopulmonary baroreceptors suppress sympathetic outflow with 6-8° head down body-tilt with LBNP.

However, when encountering vulnerable situations in which the human body is forced to be inverted (e.g. overturned helicopters, motor vehicle accidents etc.), the sympathetic nervous system will typically be highly activated (fight or flight phenomenon) (Guyton and Hall 2006). Stimulation of the sympathetic system results in an increased heart rate and blood pressure to provide better perfusion of the vital organs and muscles, and decreases the threshold in the reticular formation, reinforcing the arousal and alert states (Ganong 2003). Hearn et al. (2009), Paddock and Behm (2009), and Neary et al. (2011*a*, 2011*b*) have illustrated significant decreases in heart rate, systolic, and diastolic blood pressure with complete seated inversion. They have suggested that changes in heart rate and blood pressure during inverted body posture are due to the alterations in sympathetic nervous system stimulation. Since seated inversion has shown significant reductions in cardiovascular activity, which have been proposed to be due to altered sympathetic activity, it would be of interest to examine the cardiovascular responses with rapid and slower transitions from upright to inverted positions to determine whether the more rapid and slower rotations elicit a sympathetic response that may overcome typical inversion-induced decrements.

7. HEART RATE AND BLOOD PRESSURE

An inverted seated posture alters the cardiovascular responses. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated significant decreases in heart rate, systolic and diastolic blood pressures with complete seated inversion. Furthermore, two published abstracts (Neary et al. 2011*a*, 2011*b*) also demonstrated significant decrease in heart rate and cardiac output with inverted position as compared to upright position. These studies attributed this decline in heart rate and blood pressure with reduction in sympathetic nervous system activity.

In addition to the studies performed with seated inversion, a number of studies have been performed to demonstrate the changes in cardiovascular responses with anti-orthostatic posture. Anti-orthostatic posture is defined as a posture in which the body is upside down or inverted at an angle with head down and feet unsupported. Anti-orthostatic posture has shown an association with alterations in systemic circulation in both humans (Gavrikov and Isupov 1999) as well as rats (Osadchii et al. 1997; Bychkova et al. 1990). In addition, Bychkova et al. (1990) have also illustrated changes in skeletal muscle blood flow during anti-orthostatic position.

Moreover, Balueva and Sergeev (2010) found that 45° head-down tilt decreases blood pressure and cardiac output in rats. Bosone et al. (2004) also illustrated decrease in heart rate and blood pressure during 10 min of 30° head down tilt, due to the inhibition of sympathetic nervous system. Vestibular system also plays an important role in maintaining arterial pressure during changes in body postures (Tanaka et al. 2009). During upright body posture, the baroreceptor reflex counteracts the decrease in blood pressure due to gravity and maintains adequate cerebral perfusion. However, it is still

unknown whether this reflex adequately regulates the changes in blood pressure during seated inversion.

In contrast to the aforementioned studies, Yao et al. (1999) and Butler et al. (1991) demonstrated an increase in cardiac output and decrease in stroke volume (SV) with head down tilt. Both these studies suggest an increase in heart rate, which proposes that some other cardiovascular mechanisms are also present which assist in regulating the changes during alterations in body position. Raffai et al. (2009) also showed an increase in heart rate and blood pressure after 45° head down tilt in rats. Therefore, it would be of interest to investigate the functioning of the cardiovascular system to respond to possible changes during rapid and slower seated inversion.

8. RESPIRATORY SYSTEM

Head down tilt (HDT) position impairs functioning of the respiratory (Henderson et al.2006) and cardiovascular (Soubiran et al. 1996) systems. Aleksandrova et al. (2005) found that HDT posture decreases orthostatic stability and leads to contractile failure of the diaphragm musculature due to alteration in excitation- contraction coupling. In addition, impaired gaseous exchange (Prisk et al. 2002), decreased lung compliance (Donina et al. 2009), and increased airflow impedance of respiratory system (Donina et al. 2009) also contribute to the changes in the ventilatory system functioning during HDT. Furthermore, there is a possibility that inversion may lead to an augmentation of intrathoracic and/or intra-abdominal pressure, resulting in increased work for inspiratory and expiratory musculature followed by fatigue. These responses could lead to difficulties with breathing.

Lu et al. (2000) proposed that HDT might lead to a reduction in pulmonary ventilation and lung capacity, but an increase in pulmonary diffusion. They suggested that this rise in the pulmonary diffusion might be associated with the uniform distribution of the pulmonary blood flow and increased effectiveness of the pulmonary vascular bed. On the contrary, Hillebrecht et al. (1992) found alterations in the pulmonary blood flow due to HDT.

Acute HDT posture also causes compensatory increases in the inspiratory muscle contraction force (Aleksandrova et al. 2005). Reduction in oxygen supply may result in alterations in the force production capacity of the muscle due to reduction in levels of creatine phosphate (Brechue et al. 1995) and impaired excitation-contraction coupling (Aleksandrova et al. 2005). However, it is not known if the respiratory system responses could contribute to the changes in inversion-induced neuromuscular performance impairments with rapid and slower rotations to inversion.

CONCLUSION

This literature review has presented a number of mechanisms that may lead to alterations in both neuromuscular and cardiovascular functioning. All previous published inversion studies (Hearn et al. 2009; Paddock and Behm 2009; Neary et al. 2011*a*, 2011*b*) demonstrated the inversion-induced alterations in neuromuscular and cardiovascular response during upper limb and lower limb muscle activity. These studies suggested the involvement of central and peripheral factors in altering the muscle force, cardiac output, and arterial pressure changes during seated inversion.

In addition, there is evidence to show the probable decrease in baroreflex sensitivity and increase in hydrostatic pressure are associated with altered responses during inversion, due to excessive pooling of blood towards the brain. These can be considered as major contributing factors influencing changes in upper and lower limb muscle activity functioning during complete inversion.

Furthermore, inhibition of sympathetic nervous system and stimulation of vestibulosympathetic reflex are also strongly associated with reduction in neuromuscular system activity in both upper limb and lower limb during inversion. Both these factors also lead to a decrease in heart rate and blood pressure, resulting in less peripheral blood perfusion oxygen delivery, and ultimately low force output during contractions. Additionally, alterations in the respiratory system functioning during inversion also lead to reduced oxygen supply to the contracting muscles and may lead to impairments in neuromuscular performance.

Consequently, no research has been conducted to study the effectiveness of the above-mentioned mechanisms during seated inversion. However, it is speculated that these mechanisms play an important role when body is inverted. The rapidity of the response is an important question for basic physiology while there can be functional applications for sport, work and emergency environments. Therefore, the focus of the research portion of this thesis is to determine the changes in muscle force output, muscle activity, and heart rate and blood pressure during rapid and slower transition from upright to seated inversion at different rotational times.

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EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

by

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CO-AUTHORSHIP STATEMENT

Pramod Johar was involved in all aspects of the thesis including formulating the research idea and methodology; collecting, analyzing and interpreting all data; and writing the thesis. Dr. David Behm provided the genesis for the original research idea and guidance and input into the methodology, interpretation of data and revisions of the written thesis. Varun Grover and Mario DiSanto provided assistance with data collection.

ABSTRACT

The purpose of this study was to determine and compare the changes in neuromuscular and cardiovascular responses with rapid and slower transitions from upright to inverted seated positions. Twenty-two subjects performed concurrent unilateral biceps and quadriceps maximal voluntary contractions (MVCs) in the upright position, and when inverted within 1s and 3s. Ten of the 22 subjects also performed individual biceps and quadriceps MVCs in all three positions. Maximal force of biceps and quadriceps; muscle activation of biceps, triceps, quadriceps and hamstrings; and heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured. Whether the biceps or quadriceps was contracted concurrently or individually, significant ($p < 0.05$) decreases in MVC force were found when inverted within 1s and 3s rotations compared to the upright position. Similarly, biceps and quadriceps EMG activity with either concurrent or individual contractions significantly ($p < 0.05$) decreased when inverted within 1s and 3s rotations compared to the upright position. Quadriceps MVC demonstrated significant ($p < 0.05$) increase from the first second to 3-6s time period. Triceps and hamstrings EMG activity significantly ($p < 0.05$) decreased when inverted within 1s rotation compared to the upright position. HR, SBP, and DBP demonstrated significant ($p < 0.001$) decreases when inverted within 1s and 3s rotations compared to the upright position. In conclusion, similar to the slow and deliberate rotation of previous inversion studies, rapid and slower transitions from an upright to inverted seated positions also lead to neuromuscular impairments and decreases in HR and BP.

Key words: tilt, force, EMG, heart rate, blood pressure

INTRODUCTION

In day-to-day life, humans hardly perform any activities in which the body is inverted. To date, only two studies (Hearn et al. 2009 and Paddock and Behm 2009) have examined the level of muscle activation, force output, and changes in cardiovascular functioning during complete seated inversion compared to an upright body posture. Both studies demonstrated decreases in force production, muscle activation, heart rate, and blood pressure. In addition, two studies (Neary et al. 2011*a*, 2011*b*) also demonstrated a significant decrease in heart rate and cardiac output with inverted position as compared to upright position. They also found a tendency for quadriceps maximal voluntary contraction (MVC) to decrease in inverted position but no significant difference was found for biceps MVC between upright and inverted positions.

All the studies related to inverted seated posture (Hearn et al. 2009; Paddock and Behm 2009; Neary et al. 2011*a*, 2011*b*) have suggested inversion-induced inhibition of sympathetic nervous system activity as a rationale for decrease in neuromuscular and cardiovascular responses. A number of tilt studies have also supported this rationale. The most similar protocols to the inversion studies utilized head-down body tilt. Acute head-down body tilt inhibits sympathetic activity (Bosone et al. 2004; Cooke and Dowlyn 2000; Cooke et al. 2004; Fu et al. 2000), which is associated with decreased heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), total peripheral resistance (Goodman and LeSage 2002), and muscle blood flow (Thomas and Segal 2004). Other factors that could contribute to the decline in the muscle force output during inversion include an increase in hydrostatic pressure (Ranatunga and Geeves 1991), an increase in central venous pressure (CVP) (Charkoudian et al. 2004), and altered

functioning of the respiratory system (Henderson et al. 2006). Hence, it can be inferred that while an individual is inverted neuromuscular and cardiovascular systems may not function normally. In contrast to the above-mentioned studies, there are also head-down tilt studies, which suggest an increase in heart rate (Yao et al. 1999; Butler et al. 1991; Raffai et al. 2009) and arterial blood pressure (Wilkins et al. 1950). Furthermore, Hobbs and McCloskey (1987) found an increase in electromyographic (EMG) activity of soleus and medial gastrocnemius as the contracting muscles were raised above the heart level.

It is known that when an individual encounters a vulnerable situation, the activation of the sympathetic nervous system prepares the individual to cope via flight or fight reactions. Stimulation of the sympathetic system results in increased heart rate and blood pressure (Guyton and Hall 2006). Since the previously published seated inversion and head-tilt studies were conducted with slow rotation speeds, it is not known whether the typical inversion-induced responses (i.e. impaired force, decreased heart rate and blood pressure) found in these studies would be offset during a rapid rate of inversion by possible stimulation of the sympathetic system.

Accordingly, it is important to know the alterations in human body systems due to encounter of inversion-induced situations. To our knowledge no research has been published examining the changes in neuromuscular and cardiovascular systems and their related responses during rapid and slower inversion of human body posture. The purpose of the study was to determine the rapidity of changes in force output, muscle activation and cardiovascular functioning due to seated inversion at different rotation times. It was hypothesized that inversion of the body position within 1-3 seconds would initially

increase force production, muscle activation, heart rate and blood pressure subsequently followed by reductions over 3-6 seconds.

METHODOLOGY

1. Subjects

Twenty-two (24.2 $\pm$ 7.1 yrs., 76.5 $\pm$ 19.9 kg, 167.5 $\pm$ 10.6 cm) healthy and physically active subjects from Memorial University of Newfoundland volunteered for the study. All twenty-two subjects did simultaneous unilateral biceps and quadriceps contraction. Ten of the twenty-two subjects also performed unilateral biceps and quadriceps contraction both individually and concurrently. This was done to compare the effects of rapid and slower inversion rates on both unilateral concurrent and individual contractions. No participant had previous history of any hypertensive or cerebral related condition or serious injury. All subjects were verbally informed of the procedure of study and read and signed a consent form and Physical Activity Readiness Questionnaire (Health Canada, Canadian Society for Exercise Physiology 2004) prior to participation. The study was approved by Memorial University of Newfoundland Human Investigation Committee.

2. Experimental Design

2.1 Protocol

Subjects were instructed to not eat food for at least 2 h prior to testing and to not smoke, drink alcohol, or exercise at least 6 h prior to testing (Health Canada, Canadian Society for Exercise Physiology 2004). An initial orientation session was given to all subjects to allow them to become familiar with the protocol under both upright and inverted seated position. Prior to testing, subjects performed a 5 min warm up on a cycle ergometer set at an intensity of 1 kp and 70 rpm. All subjects were tested in both upright

and inverted seated positions. Among the twenty-two subjects, twelve subjects performed only concurrent unilateral contractions of biceps and quadriceps in upright and inverted positions within 1s and 3s rotations. Ten other subjects performed unilateral biceps and quadriceps contractions, concurrently and individually in upright and inverted positions within 1s and 3s rotations. The conditions (upright, inverted within 1s, and inverted within 3s rotations) were randomly allocated during the experiment.

All subjects were rotated from a seated upright to a seated inverted position by the primary investigator within 1s and 3s via a manual wheel attached to one side of the rotational chair. During data collection (experimental trials), a research assistant timed the manual rotation and any rotations that deviated by more than 0.3 seconds were not included in the data analysis.

Changes in neuromuscular activation were tested for a period of 6s for each trial. All participants were tested for right elbow flexors and right knee extensors force and activation in both upright and inverted positions. During upright and inverted positions within 1s and 3s rotations, all subjects performed 2 isometric MVCs of 6s duration for each condition.

The subjects started the muscle contraction at the initiation of inversion rotation for both 1s and 3s. The time when all subjects initiated muscle contraction for both upright and inverted seated rotations is defined as time zero. To prevent the discomfort related to an increase in pressure around head and eyes during seated inversion, a 3 min rest period was provided to every subject between each voluntary contraction. The 3 min rest period allowed the cardiovascular system to adjust to the upright posture and blood pressure (BP) and heart rate (HR) to return to baseline in < 1 min (information obtained

from pilot studies). Both upright and inverted positions were tested in the same experimental session. In the present study, rotation in 1s was considered rapid and rotation in 3s was described as slow in comparison to 1s rotation. For the purpose of analysis, the MVC force and EMG activity recorded over a period of 6s was divided into three phases – the first second, the first three seconds, and 3-6s. The first second provided information regarding the effect of rapid rotation, the second phase (0-3 seconds) provided information regarding the effect of slower rotation, whereas the third phase (3-6s) provided information regarding the effect of inversion on the dependent variables. Consequently, the significant changes were determined by comparing these three phases for upright position, and inverted within 1s and 3s rotations.

2.2 Apparatus

The subjects sat in a specially constructed rotational chair (Technical Services: Memorial University of Newfoundland) capable of being rotated over a 360° range. All subjects were rotated from an upright to an inverted position within 1s and 3s via a manual wheel attached to one side of the rotational chair. Subjects sat in an upright position with hips, knees and elbows flexed at 90° with forearms supinated and resting on padded support. The Velcro straps were secured to the upper arms at biceps (mid-belly). The upper torso rested against the backrest and was secured via straps around the waist, shoulder, and groin. Both legs were secured using a padded attachment placed over the thighs. The non-contracting leg and forearm were also placed in a strap so that it would not dangle while inverted. The right wrist and the right ankle were inserted into the padded straps attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.) to measure the force output during the isometric

elbow flexion and knee extension MVCs. During data analysis, the mass of the resting arm was subtracted from the force output readings of the inverted MVC since in the upright position the elbow flexors had to overcome the mass of the arm associated with the pull of gravity. The mass of the resting arm in the inverted position was measured by inverting the subject 180° with arm hanging in a padded strap attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.). The mean mass of the arm when hanging inverted was 39.26 N $\pm$ 17.32. All forces detected by the strain gauge were amplified (Biopac Systems Inc. DA 100 and analog to digital (A/D) converter MP100WSW; Holliston, MA) and monitored on computer (Dell Inspiron 6000, St. John's, Newfoundland) at a sampling rate of 2000 Hz. Data was analog to digitally converted and was stored on a computer for further analysis on a commercially designed software program (Acqknowlegde 4.1, Biopac Systems Inc., Holliston, MA).

3. Dependent Variables

3.1 MVC Force

For all subjects, MVC trials were recorded for upright as well as 1s and 3s rotations to an inverted position. During testing, subjects contracted biceps and quadriceps concurrently or individually at least twice in each position. Each contraction lasted 6s. A six-second MVC duration was chosen since from previous experience from this laboratory (Button and Behm 2008); this duration was the maximum that could be endured without eliciting a fatigue response (decrease in force). If more than 5% difference was found between the first two MVCs, a third trial was performed. Three-minute rest periods were allocated between each MVC to diminish the effects of fatigue.

To collect MVC data for biceps and quadriceps the padded velcro straps holding right wrist and right ankle were attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.). When performing individual contractions, the non-contracting right forearm and right leg were secured using different velcro straps to avoid dangling while inverted. All participants were provided verbal motivation to push as hard and fast as possible, to promote the maximal response. The highest difference between the baseline value and the greatest force amplitude was considered as peak force.

3.2 Electromyography

Muscle activation of the right knee extensors and right elbow flexors were recorded during concurrent and individual voluntary contractions. Thorough skin preparation for all electrodes included shaving of hair, removal of dead epithelial cells with an abrasive sand paper around the designated areas followed by cleansing with an isopropyl alcohol swab. Four pairs of surface EMG recording electrodes (Kendall Medi-trace 100 series, Chikopee, Mass) were placed approximately 2 cm apart over the midbelly of the vastus lateralis, semitendinosis, mid-portion of biceps brachii (in alignment with the muscle fibers), and triceps with ground electrode placed on the fibular head. The electrodes were wrapped to ensure no movement during inversion. EMG activity was sampled at 2000 Hz, with a Blackman 61 dB band-pass filter between 10 and 500 Hz, amplified (Biopac Systems MEC 100 amplifier, Santa Barbara, Calif; input impedance = 2M, common mode rejection ratio > 100 dB (50/60 Hz); noise >5 UV), and analog to digitally converted (Biopac MP150) to be stored on a personal computer for further analysis (Dell Inspiron 6000). EMG data was integrated (rectified), averaged over

3 samples, and the root mean square (RMS) of the signal calculated using the software (AcqKnowledge 4.1, Biopac Systems Inc., Holliston, MA). From this transformation the rectified RMS mean amplitude of the signal was calculated by the software over the three segments. EMG was analyzed over 1s during the first phase, over 3s (0-3s) for the second phase and over 3s (3-6s) for the third phase. Co-contraction ratios were determined by dividing the antagonist (hamstrings and triceps) into the agonist (quadriceps and biceps) rectified RMS mean amplitude values.

4. Heart rate and blood pressure

Prior to testing, heart rate and blood pressure were monitored in the upright seated position and immediately after subjects were inverted within 1s and 3s rotations. Heart rate was monitored with a Polar A1 monitor (Woodbury, N.Y.). Blood pressure was measured with a battery operated A+ Med 7-62 pressure cuff (AMG Medical Inc., Montreal, Que.).

5. Statistical analysis

Two-way analysis of variance (ANOVA), (3x3) with repeated measures was conducted on force and EMG variables. The factors were body position (upright, inverted within 1s, and inverted within 3s), and time periods (first sec, 0-3s, and 3-6s). HR and BP data was analyzed with a 2 way ANOVA (3 x 2) with factors being body position and time (upright and completion of inversion). Data was analyzed using SPSS (SPSS for MS Windows, version 17.0, Polar Engineering and Consulting). Differences were considered significant when p values were below an alpha level of 0.05. A post hoc Bonferonni–

Dunn's procedure test was also utilized to determine the values of pair-wise comparisons and to detect the location of significant differences between upright and inverted positions. Data was reported as mean $\pm$ SD.

RESULTS

1. Force

When both biceps and quadriceps were contracted concurrently (n = 22), the average biceps MVC force significantly (F (2,189) = 15.01, $p < 0.05$) decreased by 35.4% when inverted within 1s and 15.9 % within 3s as compared to the upright position (Fig.1). Compared to the upright position, the average quadriceps MVC force was significantly (F (2,189) = 31.59, $p < 0.05$) lowered by 37.2% when inverted within 1s and 12.1% within 3s (Fig.2). Additionally, biceps and quadriceps MVC significantly ($p < 0.05$) increased 30.1% and 39.8% respectively when inverted within a 3s rotation compared to inverted within a 1s.

When only the biceps was contracted (n = 10); the average biceps MVC force was significantly (F (2, 81) = 5.03, $p < 0.05$) lower by 21.1% and 18.9 % when inverted within 1s and 3s respectively as compared to the upright position (Fig.3). During quadriceps only contraction, MVC force significantly (F (2, 81) = 4.29, $p < 0.05$) decreased by 19.2% and 19.6% when inverted within 1s and 3s respectively as compared to the upright position (Fig.4).

Based on the analysis of the main effect of time when both biceps and quadriceps are contracted simultaneously (n = 22), the average quadriceps MVC force significantly (F (2, 189) = 4.25, $p < 0.05$) increased 16.9% from the first second to 3-6s time period, and demonstrated a tendency (F (2,189) = 4.25, $p = 0.06$) for a 14.7% increase from first second to the first three seconds time period (Fig. 11). Biceps MVC force demonstrated no significant main effect. No significant results were found with individual biceps and

quadriceps MVC contractions. Additionally, table 1 demonstrates average (n = 22) changes in the upper and lower limb MVC force values over the time period of the first second, 0-3s, and 3-6s for the upright position, inverted within 1s, and inverted within 3s of rotations.

2. Electromyography (EMG)

During simultaneous contraction of unilateral biceps and quadriceps (n = 22), the average biceps EMG activity demonstrated significant (F (2, 189) = 7.63, $p < 0.05$) decrease of 40.9% and 39.5% when inverted within 1s and 3s respectively as compared to the upright position (Fig.5). The average triceps EMG activity significantly (F (2, 189) = 3.80, $p < 0.05$) decreased by 43.9% when inverted within 1s compared to the upright position (Fig.6). The average quadriceps EMG activity significantly (F (2, 189) = 11.67, $p < 0.05$) decreased by 50.1% and 27.3% when inverted within 1s and 3s respectively as compared to the upright position (Fig.7). The average hamstrings EMG activity was significantly (F (2,189) = 6.23, $p < 0.05$) lowered by 44.1% when inverted within 1s compared to the upright position (Fig.8).

During individual biceps contraction (n = 10), the average biceps EMG activity was significantly (F (2, 81) = 3.51, $p < 0.05$) decreased by 21.7% when inverted within 1s and 35.9% lower when inverted within 3s compared to the upright position (Fig.9). When quadriceps was contracted individually, the average quadriceps EMG significantly (F (2, 81) = 6.91, $p < 0.05$) lowered by 39.1% and 40.2% when inverted within 1s and 3s respectively as compared to the upright position (Fig. 10).

No significant results were found for triceps to biceps and hamstrings to quadriceps co-contraction ratios for force and time when both biceps and quadriceps were contracted concurrently as well as individually. The average (n = 22) changes in the upper and lower limb EMG values over the time period of the first second, 0-3s, and 3-6s for the upright position, inverted within 1s, and inverted within 3s of rotations are illustrated in table 2.

3. Heart Rate and Blood Pressure

Heart rate significantly (F (2, 63) = 26.21, $p < 0.001$) decreased 16.8% and 21.1% when inverted within 1s and 3s respectively as compared to the upright position (Fig.12). Similarly, average (n = 22) systolic blood pressure significantly (F (2, 63) = 29.36, $p <$ 0.001) decreased by 10.8% when inverted within 1s and 12.4 % within 3s as compared to the upright position (Fig.13). Average (n = 22) diastolic blood pressure also significantly (F (2, 63) = 29.32, $p < 0.001$) decreased by 14.1% and 17.1% when inverted within 1s and 3s respectively as compared to the upright position (Fig.14).

DISCUSSION

This study investigated changes in neuromuscular and cardiovascular functioning with rapid and slower rotations from seated upright to seated inversion. Whether biceps and quadriceps were contracted concurrently or individually, MVC force and EMG decreased significantly when inverted within 1s and 3s compared to upright position. In addition, both biceps and quadriceps MVC increased significantly when inverted within 3s compared to 1s during concurrent contraction. Quadriceps MVC force subsequently increased from the first second to 3-6s time periods, but demonstrated a tendency for an increase from the first second to 0-3s time periods. No significant changes were found for elbow flexor MVC force for main effect for time. Triceps and hamstrings EMG activity significantly decreased when inverted within 1s as compared to upright position. Heart rate, systolic blood pressure, and diastolic blood pressure demonstrated significant decreases when inverted within 1s and 3s compared to upright position.

Neuromuscular impairments may be attributed to both central and peripheral factors with rapid and slower transitions from upright to inverted seated positions. When inverted within 1s and 3s both biceps and quadriceps MVC and EMG activity decreased suggesting the involvement of central mechanisms. The major possible central factors include inversion-induced increase in hydrostatic pressure (Parazynski et al. 1991) and decreased baroreflex activity (Charkoudian et al. 2004) due to elevated cerebral blood flow or intracranial pressure. However, the mechanisms underlying changes in force and

EMG during rapid and slower transitions to seated inversion are unknown. Further research is needed to determine these mechanisms.

It was hypothesized that rapid and slower transition to seated inversion would initially increase neuromuscular and cardiovascular responses followed by a drop-off. However, the results of this study demonstrated significant decreases in neuromuscular as well as cardiovascular responses suggesting rapid inversion-induced inhibition of sympathetic nervous system activity. Hearn et al. (2009), Paddock and Behm (2009), and Neary et al. (2011*a*, 2011*b*) exhibited similar responses with slow deliberate transitions to seated inversion compared to upright posture and proposed an inhibition of sympathetic nervous system activity. The significant decrease in heart rate and blood pressure (Bosone et al. 2004) and total peripheral resistance (Goodman and Lesage 2002) with head-down body tilt position also suggests a possible sympathetic system inhibition. Moreover, the adverse effects of sympathetic nervous system inhibition on muscle blood flow (Thomas and Segal 2004) and muscle force contractility (Martini and Nath 2008) might be related to a decrease in MVC force output and EMG activity with rapid movements at different rotational times from an upright to an inverted position. A decline in blood volume (Cerretelli et al. 1977) of upper and lower extremity working muscles, resulting in reduced oxygen and nutrient supply, may also be considered as a factor contributing to the lower force output and EMG activity with rapid and slower transitions to seated inversion.

Impairment of respiratory system functioning with head-down tilt (Henderson et al. 2006) might also contribute to inversion-induced neuromuscular deficit. Oxygen is necessary for the proper functioning of the skeletal muscles (Hepple et al. 2002). Head-

down tilt interferes with adequate gaseous exchange (Prisk et al. 2002), decreases pulmonary ventilation and lung capacity (Lu et al. 2000), and increases airflow impedance by decreasing lung compliance (Donina et al. 2009). Muscle hypoxia should have a greater detrimental effect upon prolonged muscle contractions, which have a greater reliance upon oxygen utilization. An altered oxygen supply to the contracting muscle during head-down tilt has been reported to alter muscle force output due to impaired excitation-contraction coupling (Aleksandrova et al. 2005). However, the very rapid response in the present study would suggest that the respiratory mechanisms would not have played a substantive role in neuromuscular impairments as the adverse effect on oxygen supply would in all probability need duration of greater than 3-6 seconds. Secondly, a brief MVC would not be as affected by a hypoxic environment as more prolonged contractions.

In contrast to the study of Hearn et al. (2009) and Paddock and Behm (2009), no changes were observed in upper extremity co-contraction (triceps to biceps) and lower extremity co-contraction (hamstrings to quadriceps) when biceps and quadriceps were contracted concurrently. Similar results were found with individual biceps and quadriceps contractions. Hence, the inversion-induced decreases in force could not be attributed to changes in motor control or inter-muscular co-ordination.

Quadriceps MVC force changed over different time periods (0-1s, 0-3s, and 3-6s) was independent of the condition (upright, inverted within 1s, and inverted within 3s). The force generated over a period of 6s reached its maximum value after three seconds. Button and Behm (2008) used 4s MVC to ensure maximum force was achieved. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated significant impairments in

neuromuscular responses using 4s MVCs in upright and inverted seated positions. Thus, it can be concluded that MVC forces need approximately 3 to less than 6s to reach maximum whether the individual is upright or in the process of being inverted.

The main limitation of the present study was that the subjects were manually inverted within 1s and 3s rotations via a detachable wheel attached to the rotational chair. Rotating manually with the help of a stopwatch to maintain 1s and 3s rotations made it difficult to attain exact rotation times for all the subjects. The variability in times was recorded for subjects when inverted within 1s and 3s rotations. The mean rotation times were 1.14s $\pm$ 0.07 when inverted within 1s and 3.13s $\pm$ 0.04 when inverted within 3s rotations. To overcome this limitation, future inversion-related research should use a motorized rotational chair. Additionally, the contraction of the biceps and quadriceps concurrently and unilaterally could lead to a disruptive torque to the trunk. However, the subjects were securely strapped into the chair so this possibility was minimal. There was also the possibility of a similar bilateral deficit mechanism whereby the contraction of the same two muscles bilaterally results in decreased force compared to the contraction of the two muscles individually. Since, no significant differences were found when upright, inverted within 1s, and inverted within 3s concurrent unilateral biceps and quadriceps contractions were respectively compared with upright, inverted within 1s, and inverted within 3s individual biceps and quadriceps contractions it was not considered a major limiting factor in the present study.

CONCLUSION

With rapid and slower transitions from upright to seated inversion, the biceps and quadriceps MVC force, EMG activity, heart rate, and blood pressure decreased for concurrent biceps and quadriceps contraction, as well as individual biceps and quadriceps contraction compared to the upright position. This inhibition of neuromuscular and cardiovascular measures occurred within approximately 1s of rotation to inversion. These results were in contradiction to the proposed hypothesis, which was based upon the activation of the flight or fight response of the sympathetic nervous system. The increase in sympathetic activity typically increases the heart rate and blood pressure, resulting in possible increased blood flow to the working muscles and the required force output. However, the expected increase in sympathetic nervous system activity seemed to be inhibited with rapid (1s) and slower (3s) transitions from upright to seated inversion. Another contributing factor could have been related to increased hydrostatic pressure. The aforementioned mechanism could immediately impact neuromuscular and cardiovascular responses when individuals are forced into inverted positions such as overturned helicopters or motor vehicle accidents. Further research is recommended to determine the effectiveness of these mechanisms and their practical implications.

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TABLES

Interactions with Concurrent Contractions		Upright	Inverted in 1s	Inverted in 3s
Biceps MVC Force (N)	1st sec	251.3263 ± 101.28*	152.6702 ± 62.87*	202.6819 ± 83.06*
	0-3s	261.9656 ± 112.56*	160.3608 ± 71.89*	215.6326 ± 100.03
	3-6s	258.0059 ± 119.06*	156.1803 ± 72.88*	217.5324 ± 97.49
Quadriceps MVC Force (N)	1st sec	467.3115 ± 161.65*	285.3885 ± 101.23*	400.8303 ± 135.30
	0-3s	527.8818 ± 170.38*	330.9764 ± 118.39*	464.7685 ± 153.76*
	3-6s	530.7031 ± 141.23*	342.6585 ± 117.41*	474.9801 ± 139.47*

Table 1. The interaction of time and condition for the changes in the upper and lower limb average (n = 22) MVC force (N) values over the time periods of the first second, 0-3s, and 3-6s in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations over the time periods of the first second, 0-3s, and 3-6s.

Biceps EMG (mv)	1st sec	1.3721 + 1.06	0.7724 + 0.54*	0.9005 + 0.62
	0-3s	1.4174 + 1.19	0.9438 + 0.66	1.0899 + 0.83
	3-6s	1.6852 + 1.49*	0.8901 + 0.64	1.1613 + 0.96
Triceps EMG (mv)	1st sec	0.1330 + 0.09	0.0707 + 00.05	0.1695 + 0.04
	0-3s	0.1572 + 0.11	0.0908 + 0.06	0.1182 + 0.07
	3-6s	0.1752 + 0.12	0.1000 + 0.07	0.1358 + 0.09
Quadriceps EMG (mv)	1st sec	0.5987 + 0.51	0.2546 + 0.21*	0.3736 + 0.29
	0-3s	0.6561 + 0.49*	0.3268 + 0.25	0.4389 + 0.31
	3-6s	0.5700 + 0.42	0.3271 + 0.28	0.5130 + 0.37
Hamstrings EMG (mv)	1st sec	0.0539 + 00.05	0.0281 + 0.02	0.0370 + 0.03
	0-3s	0.0603 + 00.05	0.0319 + 0.03	0.0538 + 0.05
	3-6s	0.0614 + 0.04	0.0399 + 0.04	0.0411 + 0.04

Table 2. The interaction of time and condition for the changes in the upper and lower limb average (n = 22) EMG (mv) values over the time periods of the first second, 0-3s, and 3-6s in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations over the time periods of the first second, 0-3s, and 3-6s.

Main Effect for Condition with Concurrent Contractions	Upright	Inverted in 1s	Inverted in 3s
Biceps MVC (N)	252.134 $\pm$ 134.49*	162.901 $\pm$ 62.94*	211.949 $\pm$ 92.93*
Biceps EMG (mv)	1.4916 $\pm$ 1.24*	0.8786 $\pm$ 0.60*	1.0506 $\pm$ 0.81*
Triceps EMG (mv)	0.1551 $\pm$ 0.10*	0.08716 $\pm$ 0.06*	0.1412 $\pm$ 0.08
Quadriceps MVC (N)	508.632 $\pm$ 158.53*	319.674 $\pm$ 113.63*	446.859 $\pm$ 114.67*
Quadriceps EMG (mv)	0.6083 $\pm$ 0.47*	0.3028 $\pm$ 0.25*	0.4418 $\pm$ 0.33*
Hamstrings EMG (mv)	0.0585 $\pm$ 0.049*	0.0333 $\pm$ 0.03*	0.04497 $\pm$ 0.04

Table 3. The main effect for condition for the changes in the upper and lower limb average (n = 22) MVC force (N) and EMG (mv) values in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps are contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

Main Effect for Time Concurrenrt Contractions	First second	0-3s	3-6s
Biceps MVC (N)	200.88 $\pm$ 91.57	213.58 $\pm$ 102.59	212.50 $\pm$ 103.42
Biceps EMG (mv)	1.0249 $\pm$ 0.80	1.1503 $\pm$ 0.93	1.2455 $\pm$ 0.99
Triceps EMG (mv)	0.1244 $\pm$ 0.10	0.1220 $\pm$ 0.09	0.1370 $\pm$ 0.09
Quadriceps MVC (N)	384.51 $\pm$ 152.98*	441.20 $\pm$ 168.49	449.44 $\pm$ 153.29*
Quadriceps EMG (mv)	0.4901 $\pm$ 0.38	0.4739 $\pm$ 0.39	0.4700 $\pm$ 0.37
Hamstrings EMG (mv)	0.0396 $\pm$ 0.02	0.0487 $\pm$ 0.03	0.0485 $\pm$ 0.03

Table 4. The main effect for time for the changes in the upper and lower limb average (n = 22) MVC force (N) and EMG (mv) values for the time periods of the first second, 0-3s, and 3-6s when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences for the time periods of the first second and 3-6s.

Main Effect for Condition with Individual Contractions	Upright	Inverted in 1s	Inverted in 3s
Biceps MVC (N)	318.675 ± 94.39*	251.3507 ± 78.23*	258.2243 ± 89.988*
Biceps EMG (mv)	1.5719 ± 0.98*	1.2303 ± 0.8365*	1.007 ± 0.59*
Triceps EMG (mv)	0.1592 ± 0.0760	0.1371 ± 0.3230	0.1462 ± 0.0906
Quadriceps MVC (N)	551.8389 ± 174.15*	446.0418 ± 157.69*	443.750 ± 150.26*
Quadriceps EMG (mv)	1.0002 ± 0.60*	0.6092 ± 0.40*	0.5984 ± 0.37
Hamstrings EMG (mv)	0.0870 ± 0.1206	0.0681 ± 0.0381	0.0596 ± 0.0464

Table 5. The changes in the upper and lower limb average (n =10) MVC force (N) and EMG (mv) values in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted individually. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

Main Effect for Condition	Upright	Inverted in 1s	Inverted in 3s
HR	82.0491 ± 9.50*	68.5455 ± 8.17*	65.0455 ± 7.45*
SBP	130.1818 ± 8.06*	116.0909 ± 8.23*	113.9545 ± 6.48*
DBP	78.6364 ± 7.39*	67.5455 ± 6.33*	65.1818 ± 4.64*

Table 6. The main effect for condition with average (n = 22) values for the changes in heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) in the upright position, inverted within 1s and inverted with 3s rotations. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

FIGURES

1. Main effects for Condition: Force

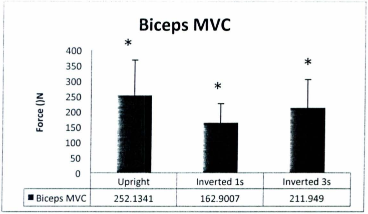


Fig.1. The average (n = 22) biceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

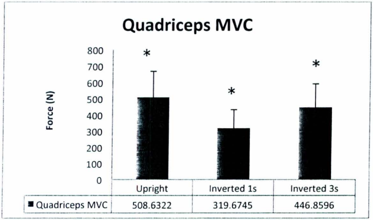


Fig.2. The average (n = 22) quadriceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

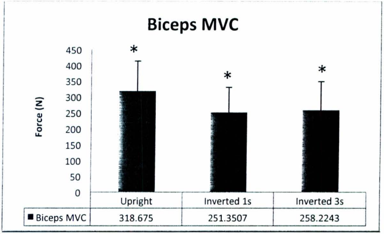


Fig.3. The average (n = 10) biceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps contracted individually. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

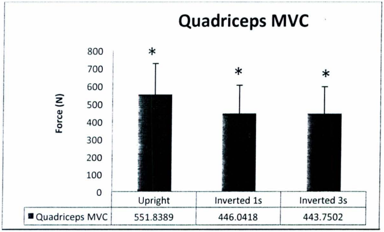


Fig.4. The average (n = 10) quadriceps MVC force (N) in the upright and inverted within 1s and 3s rotations when quadriceps contracted individually. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

2. **Main effects for condition: Electromyography (EMG)**

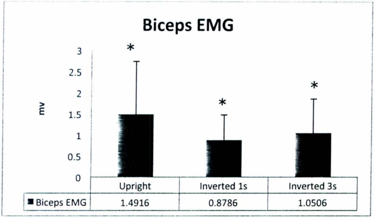


Fig.5. The average (n = 22) biceps EMG activity (mv) during the MVC of the biceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

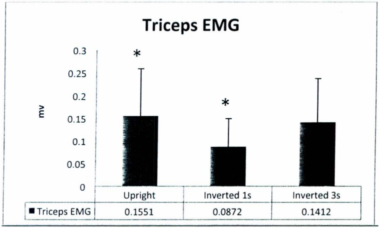


Fig.6. The average (n = 22) triceps EMG activity (mv) during the MVC of the biceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s rotations.

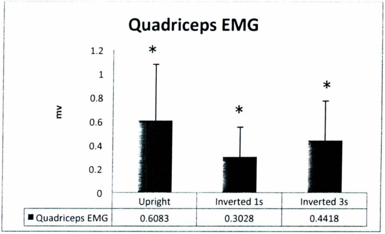


Fig.7. The average (n = 22) quadriceps EMG activity (mv) during the MVC of the quadriceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

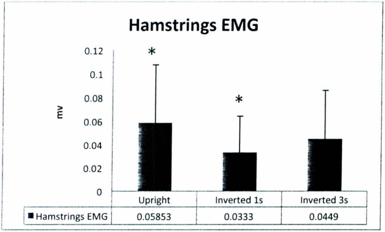


Fig.8. The average (n = 22) hamstrings EMG activity (mv) during the MVC of the quadriceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s rotations

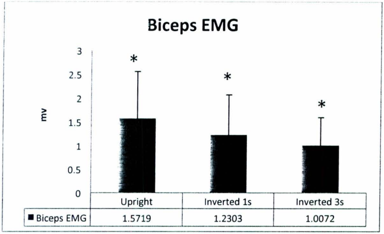


Fig.9. The average (n = 10) biceps EMG activity (mv) during the MVC of the biceps when biceps contracted individually in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

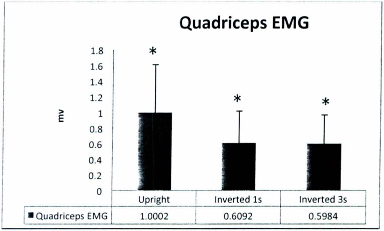


Fig.10. The average (n = 10) quadriceps EMG activity (mv) during the MVC of the quadriceps when quadriceps contracted individually in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

3. Main effects for Time: Force

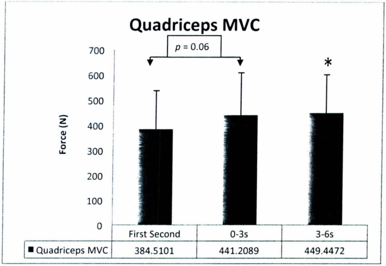


Fig.11. The average (n = 22) changes in quadriceps MVC force (N) in the first sec, 0-3s, and 3-6s time periods when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between the first second and 3-6s periods. A tendency ($p = 0.06$) was observed from the first second to 0-3s.

4. Heart Rate and Blood Pressure

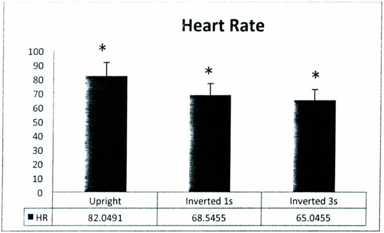


Fig.12. The average (n = 22) heart rate (beats/min) in the upright and inverted within 1s and 3s rotations. Columns represent average values of beats/min and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

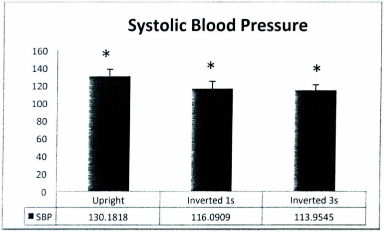


Fig.13. The average (n = 22) systolic blood pressure (mmHg) in the upright and inverted within 1s and 3s rotations. Columns represent average values of the pressure and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations

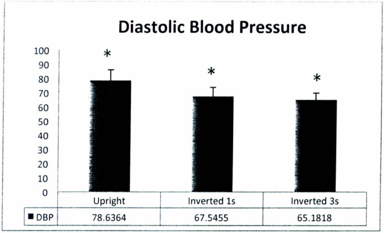


Fig.14. The average (n = 22) diastolic blood pressure (mmHg) in the upright and inverted within 1s and 3s rotations. Columns represent average values of the pressure and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations

5. **Force Profiles**

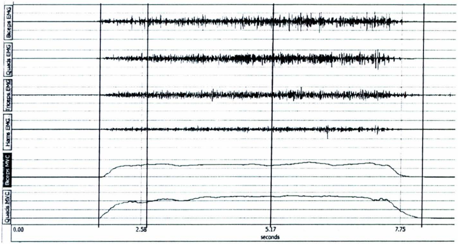


Fig. 15. Image represents the force profile when inverted within 1s rotation. The lines represent three different phases of analysis (0-1s, 0-3s, 3-6s).

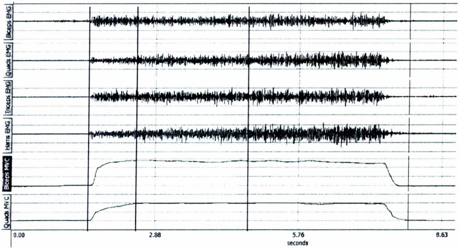


Fig. 16. Image represents the force profile when inverted within 3s rotation. The lines represent three different phases of analysis (0-1s, 0-3s, 3-6s).

APPENDICES

Variability in Rotation Times

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.12	3.07
Subject 2	1.23	3.21
Subject 3	1.09	3.14
Subject 4	1.11	3.11
Subject 5	1.17	3.17
Subject 6	1.21	3.01
Subject 7	1.08	3.26
Subject 8	1.19	3.04
Subject 9	1.14	3.12
Subject 10	1.02	3.13
Subject 11	1.17	3.00
Subject 12	1.00	3.22
Subject 13	1.24	3.03
Subject 14	1.16	3.19
Subject 15	1.19	3.14
Subject 16	1.23	3.17
Subject 17	1.12	3.26
Subject 18	1.27	3.08
Subject 19	1.05	3.20
Subject 20	1.14	3.16
Subject 21	1.11	3.21
Subject 22	1.02	3.02

Table 1. The variability in rotation times when subjects were inverted within 1s and 3s with concurrent biceps and quadriceps contraction.

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.15	3.01
Subject 2	1.09	3.20
Subject 3	1.21	3.16
Subject 4	1.17	3.11
Subject 5	1.23	3.11
Subject 6	1.07	3.09
Subject 7	1.19	3.19
Subject 8	1.02	3.05
Subject 9	1.11	3.16
Subject 10	1.06	3.18

Table 2. The variability in rotation times when subjects were inverted within 1s and 3s with individual biceps contraction.

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.13	3.23
Subject 2	1.11	3.02
Subject 3	1.24	3.19
Subject 4	1.07	3.14
Subject 5	1.19	3.18
Subject 6	1.15	3.11
Subject 7	1.17	3.00
Subject 8	1.05	3.13
Subject 9	1.22	3.05
Subject 10	1.04	3.17

Table 3. The variability in rotation times when subjects were inverted within 1s and 3s with individual quadriceps contraction.

Figure: Photo of rotational chair in upright position.

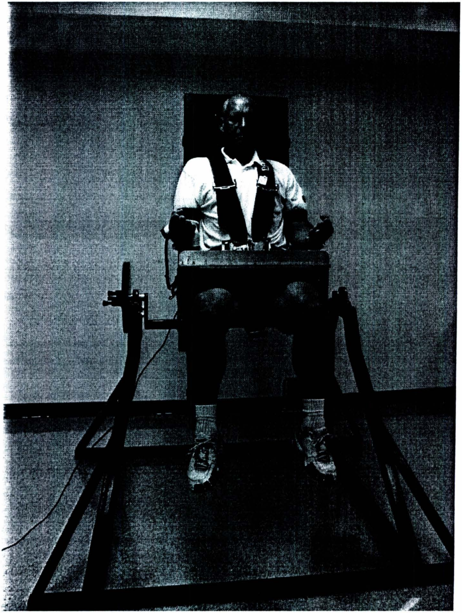
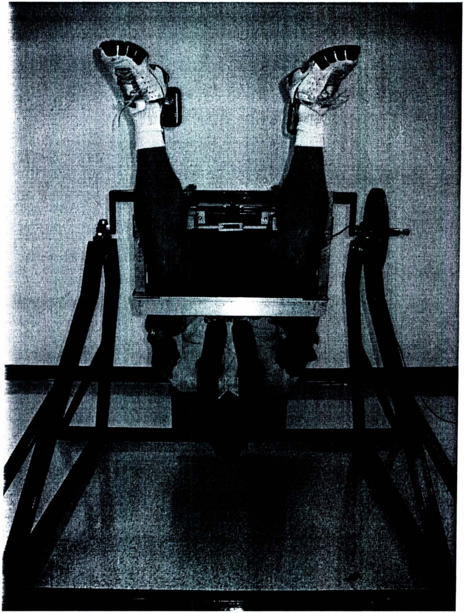


Figure: Photo of rotational chair in inverted position



EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

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EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

by

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A thesis submitted to the

School of Graduate Studies

in partial fulfillment of the

requirements for the degree of

Master of Science in Kinesiology

School of Human Kinetics and Recreation

Memorial University of Newfoundland

27 May, 2012

St. John's Newfoundland

ABSTRACT

An inverted body posture is not common. During unusual situations (e.g. overturned helicopters or motor vehicle accidents) when the body is inverted, the neuromuscular responses can change. In order to manage these situations, it is necessary to examine changes in muscle force output and activation.

Although the exact mechanisms are unknown, it is believed that both central and peripheral factors can contribute to changes in muscle force output. Increase in cerebral blood pooling, increase in hydrostatic pressure, and decrease in sympathetic activity during rapid and slow transitions from upright to inverted seated position are considered to be the main central factors leading to decrease in inversion-induced muscle force output. Peripheral factors such as decreased blood flow to the contracting muscle resulting in decrease perfusion pressure and oxygen deficit within the muscle are most likely to summate along with central factors inducing neuromuscular impairments during rapid and slower inversion rotations.

There is no evidence examining possible impairments in neuromuscular functioning with more rapid versus slower inverted rotations as compared to an upright seated position. Maximal voluntary contraction (MVC) and electromyographic (EMG) activity were recorded and analyzed in biceps and quadriceps, concurrently and individually, for maximal force output and activation with upright seated position, and inverted within 1s and 3s rotations. It was anticipated that changes in muscle force and activation within 1s and 3s inversion rotations would suggest impairments in the functioning of neuromuscular system, as compared to the upright position. In addition,

ACKNOWLEDGEMENTS

On completing this thesis as I look back on the whole experience from its very inception, I feel humbled. All along I was assured of the presence of god to who goes all the glory and honor for the successful completion of this thesis.

I am very much grateful and indebted to my supervisor Dr. David Behm, who immensely helped and rendered his valuable advice, precious time, knowledge and relevant information regarding the collection of material and whose suggestions and guidance have enlightened me on this thesis. It has been a great experience working under his supervision.

My sincere thanks to Dr. Duane Button and Dr. Tim Alkanani for their kind professional help and cooperation.

I would be biased if I don't mention the name of Varun Grover and Mario DiSanto who really helped me while working on this thesis. It has been a great help and support to have them.

A special thanks to all the subjects whom I have worked with. I owe a special regard and gratitude to all of them. Lastly, thanks to all those whose names are not mentioned here, for their unrelenting encouragement.

PRAMOD JOHAR

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

4. **Heart Rate and Blood Pressure**

5. **Force Profiles**

LIST OF ABBREVIATIONS

BP	Blood pressure
CVP	Central venous pressure
DBP	Diastolic blood pressure
EMG	Electromyography
HDT	Head-down tilt
HR	Heart rate
LBNP	Lower body negative pressure
MVC	Maximum voluntary contraction
SBP	Systolic blood pressure
SV	Stroke volume

LIST OF APPENDICES

Variability in Rotation Times

INTRODUCTION

The human body is adapted to work in an upright position. In situations when an individual is required to manage circumstances where the body is forced into inverted positions (e.g. completely overturned helicopter or motor vehicle accidents), physiological responses can change. It is important to know the neuromuscular and cardiovascular responses when a person is inverted from an upright position.

Only two studies have been published which examine the elbow flexion (Hearn et. al. 2009) and the knee extension (Paddock and Behm 2009) force and activation during inverted seated position. Both studies were performed to determine the changes in neuromuscular responses between upright and inverted seated positions. The results for both studies illustrated decreases in neuromuscular performance with an inverted seated posture. Also, both studies exhibited significant decreases in heart rate and blood pressure in the inverted position attributed to alterations of sympathetic nervous system stimulation. In addition, Neary et al. (2011*a*, 2011*b*) demonstrated a tendency for quadriceps maximal voluntary contraction (MVC) force to decrease in inverted position but no significant difference was found for biceps brachii MVC between upright and inverted positions. They also found a significant decrease in heart rate as well as cardiac output with inverted position as compared to upright position, which were in accordance with the results from Hearn et al. (2009) and Paddock and Behm (2009). Hence, it can be established that an inverted seated posture results in neuromuscular and cardiovascular system impairments.

There are a number of physiological mechanisms involved when the body responds to an inverted position. Hydrostatic pressure (pressure exerted by a fluid due to

the force of gravity) is considered as one of the major contributing factors related to the decline in the muscle force output during inversion. Mechanisms to reduce hydrostatic pressure in the lower body when upright, such as respiratory muscle pump (Miller et al. 2005), skeletal muscle pump (Delp and Laughlin 1998), and veno-vasoconstriction (Vissing et al. 1997) offset the effect of increased lower body hydrostatic pressure and ensure adequate venous return to the heart. Bosone et al. (2004) demonstrated ten minutes of 30^{o} head down tilt caused a significant increase in arterial pressure at the cranial level due to the development of the hydrostatic pressure gradient between the heart and brain levels. It is speculated that the inversion-induced increase in hydrostatic pressure could have a negative impact on the ability of the brain to function appropriately. This response could affect optimal performance during sport, and occupational tasks or emergency situations.

Furthermore, inhibition of sympathetic activity during head down body tilt (Bosone et al. 2004; Cooke and Dowlyn 2000; Cooke et al. 2004; Fu et al. 2000) is associated with decreased heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), and total peripheral resistance (Goodman and LeSage 2002). This inhibition of the sympathetic nervous system adversely affects the peripheral perfusion (Thomas and Segal 2004), resulting in decreased muscle force output. Head-down tilt postures also lead to decreased oxygen supply to the working muscle via compensatory increases in the inspiratory muscle contraction force (Aleksandrova et al. 2005), decreased lung compliance (Donina et al. 2009), impaired gaseous exchange (Prisk et al. 2002), and increased airflow impedance of the respiratory system (Donina et al. 2009), which further adds to the factors causing reduced muscle force output with inverted

position. However, all inversion studies to date have involved slow and deliberate transitions from upright to inverted positions. In most situations such as overturned vehicle accidents and ditched helicopters, these events will occur rapidly. Due to the rapid transition of the body from an upright to inverted position, there is the possibility that force output will be augmented abruptly due to the activation of the sympathetic nervous system (fight or flight phenomenon). However, it is unknown whether the typical inversion-induced decrements are more predominant than possible sympathetic system excitation.

Consequently, it is important to observe the changes in force output, muscle activation and cardiac functioning when inverted at different rotational times compared to an upright seated position. The following sections will provide a critical and in-depth evaluation of the physiological responses and underlying mechanisms related to inverted body posture.

1. EFFECTS OF INVERSION ON NEUROMUSCULAR PROPERTIES

An inverted seated position is not a common body posture. Neuromuscular responses change with an inverted position as compared to an upright position. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated decreases in force production and muscle activation. Hearn et al. (2009) found significant decreases in elbow flexor MVC force, voluntary rate of force development, and biceps electromyographic (EMG) activity with complete inversion. A similar study by Paddock and Behm (2009) focusing on lower limb quadriceps muscle activation, showed a significant reduction in maximal voluntary contraction force, rate of force development, and EMG activity with seated inversion. In

addition, Neary et al. (2011*a*, 2011*b*) also found a tendency for quadriceps MVC to decrease in inverted position but no significant difference was found for biceps MVC between upright and inverted positions. Hence, it can be inferred that the inverted position generally has a negative impact on an individual's neuromuscular functioning.

2. PERFUSION PRESSURE

Inversion-induced muscle performance impediments may be attributed to a number of mechanisms. Peripheral perfusion pressure; a graded difference between arterial blood pressure and venous pressure (Ganong 2003), is an important factor affecting muscle force output. During activity, regulation of blood pressure plays a vital role in optimizing perfusion to the working muscles and supplying essential nutrients and oxygen needed for proper functioning. Hobbs and McCloskey (1987) found a decrease in blood flow and force production near maximal workloads when an isolated cat soleus muscle was treated with a reduced mean blood pressure. This suggests that the amount of workload is associated with the alterations in the perfusion pressure and force production. Perfusion pressure in the muscle can increase or decrease depending upon the distance the muscle is from the heart. Raising the arm above the heart level leads to a decrease in the perfusion pressure in hand, resulting in lower force production (Fitzpatrick et al. 1996). Sundberg and Kaijser (1992) found the same effect in lower limbs. They found a decrease in muscle perfusion followed by a decrease in muscle force when a positive pressure of 50 mmHg was applied.

All the above-mentioned studies support the changes in neuromuscular responses demonstrated by Hearn et al. (2009) and Paddock and Behm (2009). These studies

exhibited decreased elbow flexion (Hearn et al. 2009) and knee extension (Paddock and Behm 2009) muscle force when upright seated position was compared with inverted seated posture. Both the studies attributed inversion-induced reduction in peripheral perfusion in contracting muscles as a major contributing peripheral factor.

3. HYDROSTATIC PRESSURE

Hydrostatic pressure is defined as a pressure change caused by fluid changes in the capillary network (Guyton and Hall 2006). A number of studies on animals and humans have demonstrated a significant effect on working capacity of the muscles due to alteration in hydrostatic pressure with or without changes in body position. The majority of the studies related to hydrostatic pressure are conducted on animals. Both rabbit psoas (Fortune et al. 1994) and rat extensor digitorum longus (Ranatunga and Geeves 1991) muscles have responded with decreased tetanic force when subjected to high hydrostatic pressure. Ranatunga and Geeves (1991) also found that the peak tension, the time to peak and the time to half-relaxation of a twitch contraction increased when the muscle fiber bundles isolated from the rat extensor digitorum longus of the rat were exposed to increasing hydrostatic pressures. However, when a maximally calcium activated rabbit psoas muscle fiber was subjected to high hydrostatic pressure, a 15% decrease in isometric active tension was reported (Geeves and Ranatunga 1987). It was hypothesized that a lower number of active-cross bridges or decrease in the force per cross-bridge was responsible for this impairment due to an increased pressure. Alternatively, twitch tension was potentiated with an increase in hydrostatic pressure in response to enhanced release of calcium (Vawda et al. 1996). High hydrostatic pressure causes pulsing acetylcholine

receptor release, decreasing muscle firing frequency (Heinman et al. 1987), and enzymatic activity of lactate dehydrogenase (Schmid et al. 1979). Therefore, based on animal research, the increased hydrostatic pressure can have adverse effects on neuromuscular performance.

In humans, a number of mechanisms work *in vivo* in upright position to compensate for the effect of increased hydrostatic pressure and consequent blood pooling in the lower limbs. These mechanisms, such as respiratory muscle pump (Miller et al. 2005), skeletal muscle pump (Delp & Laughlin 1998), and veno-vasoconstriction (Vissing et al.1997) ensure adequate venous return to the heart. In addition, vasoconstriction triggered by venous distension and a local neural veni-arteriolar response is important for counteracting increases in capillary hydrostatic pressure during upright posture or limb dependency (Henriksen 1991). Bosone et al. (2004) found that 10 min of 30° head down tilt caused significant increase in arterial pressure at the cranial level, due to the development of the hydrostatic pressure gradient between the heart and brain. Furthermore, minimal changes in hydrostatic pressure and perfusion pressure are observed in a supine position (Laughlin and Scharge 1999).

In conclusion, previous published studies related to complete seated inversion (Hearn et al. 2009; Paddock and Behm 2009) illustrated decreases in muscle activation and force production with an inverted body position. Neither of these studies investigated hydrostatic pressure directly, but suggested it may be an important central factor leading to impairments in neuromuscular system responses.

4. LOWER BODY NEGATIVE PRESSURE AND BARORECEPTOR REFLEXS

A lower body negative pressure (LBNP) is the application of an external negative pressure below the waist under well-controlled conditions. LBNP is most often used as a perturbation to the cardiovascular system and has been applied to simulate gravitational stress (Levine et al. 1991; Savard and Stonehouse 1995; Zhang et al. 1999). During upright body posture, vasomotor sympathetic activity plays an essential role in maintaining arterial pressure via the baroreceptor reflex mechanism (Fu et al. 2006). Baroreceptors are the stretch receptors that are located in the aortic arch and the carotid sinuses (Fox 2006). These receptors play a vital role in maintaining the blood pressure within limits. With the change in position from lying to standing there is a shift of blood from the veins in the thoracic cavity to the veins in the lower extremities. This results in lower blood pressure due to decreases in venous return and cardiac output, which is counteracted via activation of the baroreceptor reflex (Fox 2006). Thus, it helps in maintaining homeostasis by playing an important role during changes in body posture.

Hughson et al. (1993) investigated the effect of cycling exercise in upright and supine positions, and compared it with -40 mmHg lower body negative pressure in supine position. The baroreceptor reflex was activated during supine exercise, as LBNP caused more pooling of blood in lower extremities as compared to upright position. Cooper and Hainsworth (2001) determined that -40 mmHg LBNP has no effect on cardiac responses. However, they illustrated a significant increase in vascular resistance response during LBNP along with the increase in the peak gain of the baroreceptor reflex. They also suggested that an increase in baroreflex gain may help in maintenance of blood pressure during orthostatic stress.

Baroreceptor reflex also helps to maintain adequate cerebral perfusion (Ponte and Purves 1974). The sensitivity of the baroreflex control of sympathetic nerve activity decreases from upright to tilted position due to an increase in central venous pressure (CVP) (Charkoudian et al. 2004). Hearn et al. (2009) and Paddock and Behm (2009) have illustrated significant decreases in blood pressure, both systolic and diastolic with complete seated inversion. A subsequent study from the same laboratory reported similar inversion-induced decreases in mean arterial pressure and cardiac output (Neary et al. 2011*a*, 2011*b*). Thus, it can be hypothesized that with the increase in hydrostatic pressure during inversion, CVP may also increase, resulting in reduced sensitivity of the baroreceptor reflex with inverted body posture. However, no research has been conducted to determine the role of baroreceptors during complete seated inversion; therefore, the adjustments made by baroreceptors have not been fully clarified.

5. VESTIBULAR SYSTEM

The vestibular system assists with the control of balance and equilibrium. It accomplishes this function by assessing head and body movement and position in space, generating a neural code representing this information, and distributing this code to appropriate sites located throughout the central nervous system. Vestibular function is largely reflex and unconscious in nature (Ganong 2003). The otolith organs and semi-circular canals are the two main components of the vestibular system associated with postural adjustments. The semicircular canals respond to rotational movements of the head, whereas otolith organs sense linear motion (Ganong 2003).

Gravity also plays an important role with the vestibulosympathetic reflex. Tanaka et al. (2006) found that vestibular deficient rats are less able to regulate blood pressure as compared to gravitational stressed rats with the inner ear intact. Therefore, it can be proposed that the vestibulosympathetic reflex is vital to maintain homeostasis during gravity related changes with inversion. However, further research is necessary to determine the possible mechanisms and/or adjustments, and the role played by the vestibular system during complete inversion.

Ray (2000) found that the vestibulosympathetic reflex, via an increase in sympathetic outflow, plays an important role in maintaining orthostasis in humans. During upright standing, vestibulosympathetic reflex assists in regulating blood pressure changes in humans (Ray and Carter 2003). Kerman et al. (2000) also suggested that the vestibular system plays a role during postural adjustments by regulating autonomic outflow. They illustrated, that based upon the anatomical location and innervation target of a particular sympathetic nerve; the vestibular sympathetic reflexes may result in local blood flow changes. Though none of these studies were directly related to rapid and slow seated inversion of the human body, they would insinuate that changes occur in neuromuscular performance during downward rotation.

6. SYMPATHETIC NERVOUS SYSTEM

In order to maintain arterial blood pressure, sympathetic nerve activity decreases blood flow to the active muscles via vasoconstriction (Fox 2006). However, it has been noted that even though the sympathetic neural discharge increases with the increase in intensity of the activity, the muscle blood flow also increases, indicating a reduced

responsiveness to sympathetic activation (Thomas and Segal 2004). Wallin and Sundlof (1982) reported vasoconstriction in skeletal muscles during a standing upright posture. During standing, an increase in the sympathetic activity to the vessels is accompanied by an over-activity of the sympathetic system leading to an exaggerated increase in the heart rate (Furlan 2001). As the response of muscle nerve sympathetic activity is not directly studied in inversion, it is reasonable to expect the opposite (decreased heart rate) with an inverted body position.

The sympathetic nervous system also influences muscle force contractility, alertness through stimulation of the reticular activating system, glycogen utilization, and muscle tone (Martini and Nath 2008). Additionally, a decrease in heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), and total peripheral resistance (Goodman and LeSage 2002) are also attributed to inhibition of sympathetic nervous system activity. Significant increase in intracranial pressure and inhibition of sympathetic outflow (Bosone et al. 2004) may reduce the ability to sustain maximal force output by decreasing the neural outflow to the motor neurons.

Furthermore, tilt studies have also shown a decrease in sympathetic activity. Acute head down body tilt studies have reported lower sympathetic nervous activity (Cooke and Dowlyn 2000: Cooke et al. 2004), which could play a role in the ability of the central nervous system to adequately activate motor neuron activity (Roatta et al. 2008). During 6° head down tilt the muscle sympathetic nerve activity decreased by 27% (Fu et al. 2000). A recent study by Wang et al. (2011) also demonstrated that a 6° head-down bed rest decreased the working capacity of the muscle. Additionally, Bosone et al. (2004) have reported that 10 min of 30° head down tilt inhibit the sympathetic nervous

system response along with a decrease in heart rate and arterial blood pressure. Heart rate and cardiac output decreased significantly (Yao et al. 1999) with 24 h- 6° head down body tilt bed rest. Kawanokuchi et al. (2001) demonstrated that vestibulosympathetic reflex rather than cardiopulmonary baroreceptors suppress sympathetic outflow with 6-8° head down body-tilt with LBNP.

However, when encountering vulnerable situations in which the human body is forced to be inverted (e.g. overturned helicopters, motor vehicle accidents etc.), the sympathetic nervous system will typically be highly activated (fight or flight phenomenon) (Guyton and Hall 2006). Stimulation of the sympathetic system results in an increased heart rate and blood pressure to provide better perfusion of the vital organs and muscles, and decreases the threshold in the reticular formation, reinforcing the arousal and alert states (Ganong 2003). Hearn et al. (2009), Paddock and Behm (2009), and Neary et al. (2011*a*, 2011*b*) have illustrated significant decreases in heart rate, systolic, and diastolic blood pressure with complete seated inversion. They have suggested that changes in heart rate and blood pressure during inverted body posture are due to the alterations in sympathetic nervous system stimulation. Since seated inversion has shown significant reductions in cardiovascular activity, which have been proposed to be due to altered sympathetic activity, it would be of interest to examine the cardiovascular responses with rapid and slower transitions from upright to inverted positions to determine whether the more rapid and slower rotations elicit a sympathetic response that may overcome typical inversion-induced decrements.

7. HEART RATE AND BLOOD PRESSURE

An inverted seated posture alters the cardiovascular responses. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated significant decreases in heart rate, systolic and diastolic blood pressures with complete seated inversion. Furthermore, two published abstracts (Neary et al. 2011*a*, 2011*b*) also demonstrated significant decrease in heart rate and cardiac output with inverted position as compared to upright position. These studies attributed this decline in heart rate and blood pressure with reduction in sympathetic nervous system activity.

In addition to the studies performed with seated inversion, a number of studies have been performed to demonstrate the changes in cardiovascular responses with anti-orthostatic posture. Anti-orthostatic posture is defined as a posture in which the body is upside down or inverted at an angle with head down and feet unsupported. Anti-orthostatic posture has shown an association with alterations in systemic circulation in both humans (Gavrikov and Isupov 1999) as well as rats (Osadchii et al. 1997; Bychkova et al. 1990). In addition, Bychkova et al. (1990) have also illustrated changes in skeletal muscle blood flow during anti-orthostatic position.

Moreover, Balueva and Sergeev (2010) found that 45° head-down tilt decreases blood pressure and cardiac output in rats. Bosone et al. (2004) also illustrated decrease in heart rate and blood pressure during 10 min of 30° head down tilt, due to the inhibition of sympathetic nervous system. Vestibular system also plays an important role in maintaining arterial pressure during changes in body postures (Tanaka et al. 2009). During upright body posture, the baroreceptor reflex counteracts the decrease in blood pressure due to gravity and maintains adequate cerebral perfusion. However, it is still

unknown whether this reflex adequately regulates the changes in blood pressure during seated inversion.

In contrast to the aforementioned studies, Yao et al. (1999) and Butler et al. (1991) demonstrated an increase in cardiac output and decrease in stroke volume (SV) with head down tilt. Both these studies suggest an increase in heart rate, which proposes that some other cardiovascular mechanisms are also present which assist in regulating the changes during alterations in body position. Raffai et al. (2009) also showed an increase in heart rate and blood pressure after 45° head down tilt in rats. Therefore, it would be of interest to investigate the functioning of the cardiovascular system to respond to possible changes during rapid and slower seated inversion.

8. RESPIRATORY SYSTEM

Head down tilt (HDT) position impairs functioning of the respiratory (Henderson et al.2006) and cardiovascular (Soubiran et al. 1996) systems. Aleksandrova et al. (2005) found that HDT posture decreases orthostatic stability and leads to contractile failure of the diaphragm musculature due to alteration in excitation- contraction coupling. In addition, impaired gaseous exchange (Prisk et al. 2002), decreased lung compliance (Donina et al. 2009), and increased airflow impedance of respiratory system (Donina et al. 2009) also contribute to the changes in the ventilatory system functioning during HDT. Furthermore, there is a possibility that inversion may lead to an augmentation of intrathoracic and/or intra-abdominal pressure, resulting in increased work for inspiratory and expiratory musculature followed by fatigue. These responses could lead to difficulties with breathing.

Lu et al. (2000) proposed that HDT might lead to a reduction in pulmonary ventilation and lung capacity, but an increase in pulmonary diffusion. They suggested that this rise in the pulmonary diffusion might be associated with the uniform distribution of the pulmonary blood flow and increased effectiveness of the pulmonary vascular bed. On the contrary, Hillebrecht et al. (1992) found alterations in the pulmonary blood flow due to HDT.

Acute HDT posture also causes compensatory increases in the inspiratory muscle contraction force (Aleksandrova et al. 2005). Reduction in oxygen supply may result in alterations in the force production capacity of the muscle due to reduction in levels of creatine phosphate (Brechue et al. 1995) and impaired excitation-contraction coupling (Aleksandrova et al. 2005). However, it is not known if the respiratory system responses could contribute to the changes in inversion-induced neuromuscular performance impairments with rapid and slower rotations to inversion.

CONCLUSION

This literature review has presented a number of mechanisms that may lead to alterations in both neuromuscular and cardiovascular functioning. All previous published inversion studies (Hearn et al. 2009; Paddock and Behm 2009; Neary et al. 2011*a*, 2011*b*) demonstrated the inversion-induced alterations in neuromuscular and cardiovascular response during upper limb and lower limb muscle activity. These studies suggested the involvement of central and peripheral factors in altering the muscle force, cardiac output, and arterial pressure changes during seated inversion.

In addition, there is evidence to show the probable decrease in baroreflex sensitivity and increase in hydrostatic pressure are associated with altered responses during inversion, due to excessive pooling of blood towards the brain. These can be considered as major contributing factors influencing changes in upper and lower limb muscle activity functioning during complete inversion.

Furthermore, inhibition of sympathetic nervous system and stimulation of vestibulosympathetic reflex are also strongly associated with reduction in neuromuscular system activity in both upper limb and lower limb during inversion. Both these factors also lead to a decrease in heart rate and blood pressure, resulting in less peripheral blood perfusion oxygen delivery, and ultimately low force output during contractions. Additionally, alterations in the respiratory system functioning during inversion also lead to reduced oxygen supply to the contracting muscles and may lead to impairments in neuromuscular performance.

Consequently, no research has been conducted to study the effectiveness of the above-mentioned mechanisms during seated inversion. However, it is speculated that these mechanisms play an important role when body is inverted. The rapidity of the response is an important question for basic physiology while there can be functional applications for sport, work and emergency environments. Therefore, the focus of the research portion of this thesis is to determine the changes in muscle force output, muscle activity, and heart rate and blood pressure during rapid and slower transition from upright to seated inversion at different rotational times.

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EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

by

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CO-AUTHORSHIP STATEMENT

Pramod Johar was involved in all aspects of the thesis including formulating the research idea and methodology; collecting, analyzing and interpreting all data; and writing the thesis. Dr. David Behm provided the genesis for the original research idea and guidance and input into the methodology, interpretation of data and revisions of the written thesis. Varun Grover and Mario DiSanto provided assistance with data collection.

ABSTRACT

The purpose of this study was to determine and compare the changes in neuromuscular and cardiovascular responses with rapid and slower transitions from upright to inverted seated positions. Twenty-two subjects performed concurrent unilateral biceps and quadriceps maximal voluntary contractions (MVCs) in the upright position, and when inverted within 1s and 3s. Ten of the 22 subjects also performed individual biceps and quadriceps MVCs in all three positions. Maximal force of biceps and quadriceps; muscle activation of biceps, triceps, quadriceps and hamstrings; and heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured. Whether the biceps or quadriceps was contracted concurrently or individually, significant ($p < 0.05$) decreases in MVC force were found when inverted within 1s and 3s rotations compared to the upright position. Similarly, biceps and quadriceps EMG activity with either concurrent or individual contractions significantly ($p < 0.05$) decreased when inverted within 1s and 3s rotations compared to the upright position. Quadriceps MVC demonstrated significant ($p < 0.05$) increase from the first second to 3-6s time period. Triceps and hamstrings EMG activity significantly ($p < 0.05$) decreased when inverted within 1s rotation compared to the upright position. HR, SBP, and DBP demonstrated significant ($p < 0.001$) decreases when inverted within 1s and 3s rotations compared to the upright position. In conclusion, similar to the slow and deliberate rotation of previous inversion studies, rapid and slower transitions from an upright to inverted seated positions also lead to neuromuscular impairments and decreases in HR and BP.

Key words: tilt, force, EMG, heart rate, blood pressure

INTRODUCTION

In day-to-day life, humans hardly perform any activities in which the body is inverted. To date, only two studies (Hearn et al. 2009 and Paddock and Behm 2009) have examined the level of muscle activation, force output, and changes in cardiovascular functioning during complete seated inversion compared to an upright body posture. Both studies demonstrated decreases in force production, muscle activation, heart rate, and blood pressure. In addition, two studies (Neary et al. 2011*a*, 2011*b*) also demonstrated a significant decrease in heart rate and cardiac output with inverted position as compared to upright position. They also found a tendency for quadriceps maximal voluntary contraction (MVC) to decrease in inverted position but no significant difference was found for biceps MVC between upright and inverted positions.

All the studies related to inverted seated posture (Hearn et al. 2009; Paddock and Behm 2009; Neary et al. 2011*a*, 2011*b*) have suggested inversion-induced inhibition of sympathetic nervous system activity as a rationale for decrease in neuromuscular and cardiovascular responses. A number of tilt studies have also supported this rationale. The most similar protocols to the inversion studies utilized head-down body tilt. Acute head-down body tilt inhibits sympathetic activity (Bosone et al. 2004; Cooke and Dowlyn 2000; Cooke et al. 2004; Fu et al. 2000), which is associated with decreased heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), total peripheral resistance (Goodman and LeSage 2002), and muscle blood flow (Thomas and Segal 2004). Other factors that could contribute to the decline in the muscle force output during inversion include an increase in hydrostatic pressure (Ranatunga and Geeves 1991), an increase in central venous pressure (CVP) (Charkoudian et al. 2004), and altered

functioning of the respiratory system (Henderson et al. 2006). Hence, it can be inferred that while an individual is inverted neuromuscular and cardiovascular systems may not function normally. In contrast to the above-mentioned studies, there are also head-down tilt studies, which suggest an increase in heart rate (Yao et al. 1999; Butler et al. 1991; Raffai et al. 2009) and arterial blood pressure (Wilkins et al. 1950). Furthermore, Hobbs and McCloskey (1987) found an increase in electromyographic (EMG) activity of soleus and medial gastrocnemius as the contracting muscles were raised above the heart level.

It is known that when an individual encounters a vulnerable situation, the activation of the sympathetic nervous system prepares the individual to cope via flight or fight reactions. Stimulation of the sympathetic system results in increased heart rate and blood pressure (Guyton and Hall 2006). Since the previously published seated inversion and head-tilt studies were conducted with slow rotation speeds, it is not known whether the typical inversion-induced responses (i.e. impaired force, decreased heart rate and blood pressure) found in these studies would be offset during a rapid rate of inversion by possible stimulation of the sympathetic system.

Accordingly, it is important to know the alterations in human body systems due to encounter of inversion-induced situations. To our knowledge no research has been published examining the changes in neuromuscular and cardiovascular systems and their related responses during rapid and slower inversion of human body posture. The purpose of the study was to determine the rapidity of changes in force output, muscle activation and cardiovascular functioning due to seated inversion at different rotation times. It was hypothesized that inversion of the body position within 1-3 seconds would initially

increase force production, muscle activation, heart rate and blood pressure subsequently followed by reductions over 3-6 seconds.

METHODOLOGY

1. Subjects

Twenty-two (24.2 $\pm$ 7.1 yrs., 76.5 $\pm$ 19.9 kg, 167.5 $\pm$ 10.6 cm) healthy and physically active subjects from Memorial University of Newfoundland volunteered for the study. All twenty-two subjects did simultaneous unilateral biceps and quadriceps contraction. Ten of the twenty-two subjects also performed unilateral biceps and quadriceps contraction both individually and concurrently. This was done to compare the effects of rapid and slower inversion rates on both unilateral concurrent and individual contractions. No participant had previous history of any hypertensive or cerebral related condition or serious injury. All subjects were verbally informed of the procedure of study and read and signed a consent form and Physical Activity Readiness Questionnaire (Health Canada, Canadian Society for Exercise Physiology 2004) prior to participation. The study was approved by Memorial University of Newfoundland Human Investigation Committee.

2. Experimental Design

2.1 Protocol

Subjects were instructed to not eat food for at least 2 h prior to testing and to not smoke, drink alcohol, or exercise at least 6 h prior to testing (Health Canada, Canadian Society for Exercise Physiology 2004). An initial orientation session was given to all subjects to allow them to become familiar with the protocol under both upright and inverted seated position. Prior to testing, subjects performed a 5 min warm up on a cycle ergometer set at an intensity of 1 kp and 70 rpm. All subjects were tested in both upright

and inverted seated positions. Among the twenty-two subjects, twelve subjects performed only concurrent unilateral contractions of biceps and quadriceps in upright and inverted positions within 1s and 3s rotations. Ten other subjects performed unilateral biceps and quadriceps contractions, concurrently and individually in upright and inverted positions within 1s and 3s rotations. The conditions (upright, inverted within 1s, and inverted within 3s rotations) were randomly allocated during the experiment.

All subjects were rotated from a seated upright to a seated inverted position by the primary investigator within 1s and 3s via a manual wheel attached to one side of the rotational chair. During data collection (experimental trials), a research assistant timed the manual rotation and any rotations that deviated by more than 0.3 seconds were not included in the data analysis.

Changes in neuromuscular activation were tested for a period of 6s for each trial. All participants were tested for right elbow flexors and right knee extensors force and activation in both upright and inverted positions. During upright and inverted positions within 1s and 3s rotations, all subjects performed 2 isometric MVCs of 6s duration for each condition.

The subjects started the muscle contraction at the initiation of inversion rotation for both 1s and 3s. The time when all subjects initiated muscle contraction for both upright and inverted seated rotations is defined as time zero. To prevent the discomfort related to an increase in pressure around head and eyes during seated inversion, a 3 min rest period was provided to every subject between each voluntary contraction. The 3 min rest period allowed the cardiovascular system to adjust to the upright posture and blood pressure (BP) and heart rate (HR) to return to baseline in < 1 min (information obtained

from pilot studies). Both upright and inverted positions were tested in the same experimental session. In the present study, rotation in 1s was considered rapid and rotation in 3s was described as slow in comparison to 1s rotation. For the purpose of analysis, the MVC force and EMG activity recorded over a period of 6s was divided into three phases – the first second, the first three seconds, and 3-6s. The first second provided information regarding the effect of rapid rotation, the second phase (0-3 seconds) provided information regarding the effect of slower rotation, whereas the third phase (3-6s) provided information regarding the effect of inversion on the dependent variables. Consequently, the significant changes were determined by comparing these three phases for upright position, and inverted within 1s and 3s rotations.

2.2 Apparatus

The subjects sat in a specially constructed rotational chair (Technical Services: Memorial University of Newfoundland) capable of being rotated over a 360° range. All subjects were rotated from an upright to an inverted position within 1s and 3s via a manual wheel attached to one side of the rotational chair. Subjects sat in an upright position with hips, knees and elbows flexed at 90° with forearms supinated and resting on padded support. The Velcro straps were secured to the upper arms at biceps (mid-belly). The upper torso rested against the backrest and was secured via straps around the waist, shoulder, and groin. Both legs were secured using a padded attachment placed over the thighs. The non-contracting leg and forearm were also placed in a strap so that it would not dangle while inverted. The right wrist and the right ankle were inserted into the padded straps attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.) to measure the force output during the isometric

elbow flexion and knee extension MVCs. During data analysis, the mass of the resting arm was subtracted from the force output readings of the inverted MVC since in the upright position the elbow flexors had to overcome the mass of the arm associated with the pull of gravity. The mass of the resting arm in the inverted position was measured by inverting the subject 180° with arm hanging in a padded strap attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.). The mean mass of the arm when hanging inverted was 39.26 N $\pm$ 17.32. All forces detected by the strain gauge were amplified (Biopac Systems Inc. DA 100 and analog to digital (A/D) converter MP100WSW; Holliston, MA) and monitored on computer (Dell Inspiron 6000, St. John's, Newfoundland) at a sampling rate of 2000 Hz. Data was analog to digitally converted and was stored on a computer for further analysis on a commercially designed software program (Acqknowlegde 4.1, Biopac Systems Inc., Holliston, MA).

3. Dependent Variables

3.1 MVC Force

For all subjects, MVC trials were recorded for upright as well as 1s and 3s rotations to an inverted position. During testing, subjects contracted biceps and quadriceps concurrently or individually at least twice in each position. Each contraction lasted 6s. A six-second MVC duration was chosen since from previous experience from this laboratory (Button and Behm 2008); this duration was the maximum that could be endured without eliciting a fatigue response (decrease in force). If more than 5% difference was found between the first two MVCs, a third trial was performed. Three-minute rest periods were allocated between each MVC to diminish the effects of fatigue.

To collect MVC data for biceps and quadriceps the padded velcro straps holding right wrist and right ankle were attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.). When performing individual contractions, the non-contracting right forearm and right leg were secured using different velcro straps to avoid dangling while inverted. All participants were provided verbal motivation to push as hard and fast as possible, to promote the maximal response. The highest difference between the baseline value and the greatest force amplitude was considered as peak force.

3.2 Electromyography

Muscle activation of the right knee extensors and right elbow flexors were recorded during concurrent and individual voluntary contractions. Thorough skin preparation for all electrodes included shaving of hair, removal of dead epithelial cells with an abrasive sand paper around the designated areas followed by cleansing with an isopropyl alcohol swab. Four pairs of surface EMG recording electrodes (Kendall Meditrace 100 series, Chikopee, Mass) were placed approximately 2 cm apart over the midbelly of the vastus lateralis, semitendinosis, mid-portion of biceps brachii (in alignment with the muscle fibers), and triceps with ground electrode placed on the fibular head. The electrodes were wrapped to ensure no movement during inversion. EMG activity was sampled at 2000 Hz, with a Blackman 61 dB band-pass filter between 10 and 500 Hz, amplified (Biopac Systems MEC 100 amplifier, Santa Barbara, Calif; input impedance = 2M, common mode rejection ratio > 100 dB (50/60 Hz); noise >5 UV), and analog to digitally converted (Biopac MP150) to be stored on a personal computer for further analysis (Dell Inspiron 6000). EMG data was integrated (rectified), averaged over

3 samples, and the root mean square (RMS) of the signal calculated using the software (AcqKnowledge 4.1, Biopac Systems Inc., Holliston, MA). From this transformation the rectified RMS mean amplitude of the signal was calculated by the software over the three segments. EMG was analyzed over 1s during the first phase, over 3s (0-3s) for the second phase and over 3s (3-6s) for the third phase. Co-contraction ratios were determined by dividing the antagonist (hamstrings and triceps) into the agonist (quadriceps and biceps) rectified RMS mean amplitude values.

4. Heart rate and blood pressure

Prior to testing, heart rate and blood pressure were monitored in the upright seated position and immediately after subjects were inverted within 1s and 3s rotations. Heart rate was monitored with a Polar A1 monitor (Woodbury, N.Y.). Blood pressure was measured with a battery operated A+ Med 7-62 pressure cuff (AMG Medical Inc., Montreal, Que.).

5. Statistical analysis

Two-way analysis of variance (ANOVA), (3x3) with repeated measures was conducted on force and EMG variables. The factors were body position (upright, inverted within 1s, and inverted within 3s), and time periods (first sec, 0-3s, and 3-6s). HR and BP data was analyzed with a 2 way ANOVA (3 x 2) with factors being body position and time (upright and completion of inversion). Data was analyzed using SPSS (SPSS for MS Windows, version 17.0, Polar Engineering and Consulting). Differences were considered significant when p values were below an alpha level of 0.05. A post hoc Bonferonni–

Dunn's procedure test was also utilized to determine the values of pair-wise comparisons and to detect the location of significant differences between upright and inverted positions. Data was reported as mean $\pm$ SD.

RESULTS

1. Force

When both biceps and quadriceps were contracted concurrently (n = 22), the average biceps MVC force significantly (F (2,189) = 15.01, $p < 0.05$) decreased by 35.4% when inverted within 1s and 15.9 % within 3s as compared to the upright position (Fig.1). Compared to the upright position, the average quadriceps MVC force was significantly (F (2,189) = 31.59, $p < 0.05$) lowered by 37.2% when inverted within 1s and 12.1% within 3s (Fig.2). Additionally, biceps and quadriceps MVC significantly ($p <$ 0.05) increased 30.1% and 39.8% respectively when inverted within a 3s rotation compared to inverted within a 1s.

When only the biceps was contracted (n = 10); the average biceps MVC force was significantly (F (2, 81) = 5.03, $p < 0.05$) lower by 21.1% and 18.9 % when inverted within 1s and 3s respectively as compared to the upright position (Fig.3). During quadriceps only contraction, MVC force significantly (F (2, 81) = 4.29, $p < 0.05$) decreased by 19.2% and 19.6% when inverted within 1s and 3s respectively as compared to the upright position (Fig.4).

Based on the analysis of the main effect of time when both biceps and quadriceps are contracted simultaneously (n = 22), the average quadriceps MVC force significantly (F (2, 189) = 4.25, $p < 0.05$) increased 16.9% from the first second to 3-6s time period, and demonstrated a tendency (F (2,189) = 4.25, $p = 0.06$) for a 14.7% increase from first second to the first three seconds time period (Fig. 11). Biceps MVC force demonstrated no significant main effect. No significant results were found with individual biceps and

quadriceps MVC contractions. Additionally, table 1 demonstrates average (n = 22) changes in the upper and lower limb MVC force values over the time period of the first second, 0-3s, and 3-6s for the upright position, inverted within 1s, and inverted within 3s of rotations.

2. Electromyography (EMG)

During simultaneous contraction of unilateral biceps and quadriceps (n = 22), the average biceps EMG activity demonstrated significant (F (2, 189) = 7.63, $p < 0.05$) decrease of 40.9% and 39.5% when inverted within 1s and 3s respectively as compared to the upright position (Fig.5). The average triceps EMG activity significantly (F (2, 189) = 3.80, $p < 0.05$) decreased by 43.9% when inverted within 1s compared to the upright position (Fig.6). The average quadriceps EMG activity significantly (F (2, 189) = 11.67, $p < 0.05$) decreased by 50.1% and 27.3% when inverted within 1s and 3s respectively as compared to the upright position (Fig.7). The average hamstrings EMG activity was significantly (F (2,189) = 6.23, $p < 0.05$) lowered by 44.1% when inverted within 1s compared to the upright position (Fig.8).

During individual biceps contraction (n = 10), the average biceps EMG activity was significantly (F (2, 81) = 3.51, $p < 0.05$) decreased by 21.7% when inverted within 1s and 35.9% lower when inverted within 3s compared to the upright position (Fig.9). When quadriceps was contracted individually, the average quadriceps EMG significantly (F (2, 81) = 6.91, $p < 0.05$) lowered by 39.1% and 40.2% when inverted within 1s and 3s respectively as compared to the upright position (Fig. 10).

No significant results were found for triceps to biceps and hamstrings to quadriceps co-contraction ratios for force and time when both biceps and quadriceps were contracted concurrently as well as individually. The average (n = 22) changes in the upper and lower limb EMG values over the time period of the first second, 0-3s, and 3-6s for the upright position, inverted within 1s, and inverted within 3s of rotations are illustrated in table 2.

3. Heart Rate and Blood Pressure

Heart rate significantly (F (2, 63) = 26.21, $p < 0.001$) decreased 16.8% and 21.1% when inverted within 1s and 3s respectively as compared to the upright position (Fig.12). Similarly, average (n = 22) systolic blood pressure significantly (F (2, 63) = 29.36, $p <$ 0.001) decreased by 10.8% when inverted within 1s and 12.4 % within 3s as compared to the upright position (Fig.13). Average (n = 22) diastolic blood pressure also significantly (F (2, 63) = 29.32, $p < 0.001$) decreased by 14.1% and 17.1% when inverted within 1s and 3s respectively as compared to the upright position (Fig.14).

DISCUSSION

This study investigated changes in neuromuscular and cardiovascular functioning with rapid and slower rotations from seated upright to seated inversion. Whether biceps and quadriceps were contracted concurrently or individually, MVC force and EMG decreased significantly when inverted within 1s and 3s compared to upright position. In addition, both biceps and quadriceps MVC increased significantly when inverted within 3s compared to 1s during concurrent contraction. Quadriceps MVC force subsequently increased from the first second to 3-6s time periods, but demonstrated a tendency for an increase from the first second to 0-3s time periods. No significant changes were found for elbow flexor MVC force for main effect for time. Triceps and hamstrings EMG activity significantly decreased when inverted within 1s as compared to upright position. Heart rate, systolic blood pressure, and diastolic blood pressure demonstrated significant decreases when inverted within 1s and 3s compared to upright position.

Neuromuscular impairments may be attributed to both central and peripheral factors with rapid and slower transitions from upright to inverted seated positions. When inverted within 1s and 3s both biceps and quadriceps MVC and EMG activity decreased suggesting the involvement of central mechanisms. The major possible central factors include inversion-induced increase in hydrostatic pressure (Parazynski et al. 1991) and decreased baroreflex activity (Charkoudian et al. 2004) due to elevated cerebral blood flow or intracranial pressure. However, the mechanisms underlying changes in force and

EMG during rapid and slower transitions to seated inversion are unknown. Further research is needed to determine these mechanisms.

It was hypothesized that rapid and slower transition to seated inversion would initially increase neuromuscular and cardiovascular responses followed by a drop-off. However, the results of this study demonstrated significant decreases in neuromuscular as well as cardiovascular responses suggesting rapid inversion-induced inhibition of sympathetic nervous system activity. Hearn et al. (2009), Paddock and Behm (2009), and Neary et al. (2011*a*, 2011*b*) exhibited similar responses with slow deliberate transitions to seated inversion compared to upright posture and proposed an inhibition of sympathetic nervous system activity. The significant decrease in heart rate and blood pressure (Bosone et al. 2004) and total peripheral resistance (Goodman and Lesage 2002) with head-down body tilt position also suggests a possible sympathetic system inhibition. Moreover, the adverse effects of sympathetic nervous system inhibition on muscle blood flow (Thomas and Segal 2004) and muscle force contractility (Martini and Nath 2008) might be related to a decrease in MVC force output and EMG activity with rapid movements at different rotational times from an upright to an inverted position. A decline in blood volume (Cerretelli et al. 1977) of upper and lower extremity working muscles, resulting in reduced oxygen and nutrient supply, may also be considered as a factor contributing to the lower force output and EMG activity with rapid and slower transitions to seated inversion.

Impairment of respiratory system functioning with head-down tilt (Henderson et al. 2006) might also contribute to inversion-induced neuromuscular deficit. Oxygen is necessary for the proper functioning of the skeletal muscles (Hepple et al. 2002). Head-

down tilt interferes with adequate gaseous exchange (Prisk et al. 2002), decreases pulmonary ventilation and lung capacity (Lu et al. 2000), and increases airflow impedance by decreasing lung compliance (Donina et al. 2009). Muscle hypoxia should have a greater detrimental effect upon prolonged muscle contractions, which have a greater reliance upon oxygen utilization. An altered oxygen supply to the contracting muscle during head-down tilt has been reported to alter muscle force output due to impaired excitation-contraction coupling (Aleksandrova et al. 2005). However, the very rapid response in the present study would suggest that the respiratory mechanisms would not have played a substantive role in neuromuscular impairments as the adverse effect on oxygen supply would in all probability need duration of greater than 3-6 seconds. Secondly, a brief MVC would not be as affected by a hypoxic environment as more prolonged contractions.

In contrast to the study of Hearn et al. (2009) and Paddock and Behm (2009), no changes were observed in upper extremity co-contraction (triceps to biceps) and lower extremity co-contraction (hamstrings to quadriceps) when biceps and quadriceps were contracted concurrently. Similar results were found with individual biceps and quadriceps contractions. Hence, the inversion-induced decreases in force could not be attributed to changes in motor control or inter-muscular co-ordination.

Quadriceps MVC force changed over different time periods (0-1s, 0-3s, and 3-6s) was independent of the condition (upright, inverted within 1s, and inverted within 3s). The force generated over a period of 6s reached its maximum value after three seconds. Button and Behm (2008) used 4s MVC to ensure maximum force was achieved. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated significant impairments in

neuromuscular responses using 4s MVCs in upright and inverted seated positions. Thus, it can be concluded that MVC forces need approximately 3 to less than 6s to reach maximum whether the individual is upright or in the process of being inverted.

The main limitation of the present study was that the subjects were manually inverted within 1s and 3s rotations via a detachable wheel attached to the rotational chair. Rotating manually with the help of a stopwatch to maintain 1s and 3s rotations made it difficult to attain exact rotation times for all the subjects. The variability in times was recorded for subjects when inverted within 1s and 3s rotations. The mean rotation times were 1.14s $\pm$ 0.07 when inverted within 1s and 3.13s $\pm$ 0.04 when inverted within 3s rotations. To overcome this limitation, future inversion-related research should use a motorized rotational chair. Additionally, the contraction of the biceps and quadriceps concurrently and unilaterally could lead to a disruptive torque to the trunk. However, the subjects were securely strapped into the chair so this possibility was minimal. There was also the possibility of a similar bilateral deficit mechanism whereby the contraction of the same two muscles bilaterally results in decreased force compared to the contraction of the two muscles individually. Since, no significant differences were found when upright, inverted within 1s, and inverted within 3s concurrent unilateral biceps and quadriceps contractions were respectively compared with upright, inverted within 1s, and inverted within 3s individual biceps and quadriceps contractions it was not considered a major limiting factor in the present study.

CONCLUSION

With rapid and slower transitions from upright to seated inversion, the biceps and quadriceps MVC force, EMG activity, heart rate, and blood pressure decreased for concurrent biceps and quadriceps contraction, as well as individual biceps and quadriceps contraction compared to the upright position. This inhibition of neuromuscular and cardiovascular measures occurred within approximately 1s of rotation to inversion. These results were in contradiction to the proposed hypothesis, which was based upon the activation of the flight or fight response of the sympathetic nervous system. The increase in sympathetic activity typically increases the heart rate and blood pressure, resulting in possible increased blood flow to the working muscles and the required force output. However, the expected increase in sympathetic nervous system activity seemed to be inhibited with rapid (1s) and slower (3s) transitions from upright to seated inversion. Another contributing factor could have been related to increased hydrostatic pressure. The aforementioned mechanism could immediately impact neuromuscular and cardiovascular responses when individuals are forced into inverted positions such as overturned helicopters or motor vehicle accidents. Further research is recommended to determine the effectiveness of these mechanisms and their practical implications.

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TABLES

Interactions with Concurrent Contractions		Upright	Inverted in 1s	Inverted in 3s
Biceps MVC Force (N)	1st sec	251.3263 ± 101.28*	152.6702 ± 62.87*	202.6819 ± 83.06*
	0-3s	261.9656 ± 112.56*	160.3608 ± 71.89*	215.6326 ± 100.03
	3-6s	258.0059 ± 119.06*	156.1803 ± 72.88*	217.5324 ± 97.49
Quadriceps MVC Force (N)	1st sec	467.3115 ± 161.65*	285.3885 ± 101.23*	400.8303 ± 135.30
	0-3s	527.8818 ± 170.38*	330.9764 ± 118.39*	464.7685 ± 153.76*
	3-6s	530.7031 ± 141.23*	342.6585 ± 117.41*	474.9801 ± 139.47*

Table 1. The interaction of time and condition for the changes in the upper and lower limb average (n = 22) MVC force (N) values over the time periods of the first second, 0-3s, and 3-6s in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations over the time periods of the first second, 0-3s, and 3-6s.

Biceps EMG (mv)	1st sec	1.3721 ± 1.06	0.7724 ± 0.54*	0.9005 ± 0.62
	0-3s	1.4174 ± 1.19	0.9438 ± 0.66	1.0899 ± 0.83
	3-6s	1.6852 ± 1.49*	0.8901 ± 0.64	1.1613 ± 0.96
Triceps EMG (mv)	1st sec	0.1330 ± 0.09	0.0707 ± 00.05	0.1695 ± 0.04
	0-3s	0.1572 ± 0.11	0.0908 ± 0.06	0.1182 ± 0.07
	3-6s	0.1752 ± 0.12	0.1000 ± 0.07	0.1358 ± 0.09
Quadriceps EMG (mv)	1st sec	0.5987 ± 0.51	0.2546 ± 0.21*	0.3736 ± 0.29
	0-3s	0.6561 ± 0.49*	0.3268 ± 0.25	0.4389 ± 0.31
	3-6s	0.5700 ± 0.42	0.3271 ± 0.28	0.5130 ± 0.37
Hamstrings EMG (mv)	1st sec	0.0539 ± 00.05	0.0281 ± 0.02	0.0370 ± 0.03
	0-3s	0.0603 ± 00.05	0.0319 ± 0.03	0.0538 ± 0.05
	3-6s	0.0614 ± 0.04	0.0399 ± 0.04	0.0411 ± 0.04

Table 2. The interaction of time and condition for the changes in the upper and lower limb average (n = 22) EMG (mv) values over the time periods of the first second, 0-3s, and 3-6s in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations over the time periods of the first second, 0-3s, and 3-6s.

Main Effect for Condition with Concurrent Contractions	Upright	Inverted in 1s	Inverted in 3s
Biceps MVC (N)	252.134 $\pm$ 134.49*	162.901 $\pm$ 62.94*	211.949 $\pm$ 92.93*
Biceps EMG (mv)	1.4916 $\pm$ 1.24*	0.8786 $\pm$ 0.60*	1.0506 $\pm$ 0.81*
Triceps EMG (mv)	0.1551 $\pm$ 0.10*	0.08716 $\pm$ 0.06*	0.1412 $\pm$ 0.08
Quadriceps MVC (N)	508.632 $\pm$ 158.53*	319.674 $\pm$ 113.63*	446.859 $\pm$ 114.67*
Quadriceps EMG (mv)	0.6083 $\pm$ 0.47*	0.3028 $\pm$ 0.25*	0.4418 $\pm$ 0.33*
Hamstrings EMG (mv)	0.0585 $\pm$ 0.049*	0.0333 $\pm$ 0.03*	0.04497 $\pm$ 0.04

Table 3. The main effect for condition for the changes in the upper and lower limb average (n = 22) MVC force (N) and EMG (mv) values in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps are contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

Main Effect for Time Concurrenrt Contractions	First second	0-3s	3-6s
Biceps MVC (N)	200.88 $\pm$ 91.57	213.58 $\pm$ 102.59	212.50 $\pm$ 103.42
Biceps EMG (mv)	1.0249 $\pm$ 0.80	1.1503 $\pm$ 0.93	1.2455 $\pm$ 0.99
Triceps EMG (mv)	0.1244 $\pm$ 0.10	0.1220 $\pm$ 0.09	0.1370 $\pm$ 0.09
Quadriceps MVC (N)	384.51 $\pm$ 152.98*	441.20 $\pm$ 168.49	449.44 $\pm$ 153.29*
Quadriceps EMG (mv)	0.4901 $\pm$ 0.38	0.4739 $\pm$ 0.39	0.4700 $\pm$ 0.37
Hamstrings EMG (mv)	0.0396 $\pm$ 0.02	0.0487 $\pm$ 0.03	0.0485 $\pm$ 0.03

Table 4. The main effect for time for the changes in the upper and lower limb average (n = 22) MVC force (N) and EMG (mv) values for the time periods of the first second, 0-3s, and 3-6s when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences for the time periods of the first second and 3-6s.

Main Effect for Condition with Individual Contractions	Upright	Inverted in 1s	Inverted in 3s
Biceps MVC (N)	318.675 + 94.39*	251.3507 + 78.23*	258.2243 + 89.988*
Biceps EMG (mv)	1.5719 + 0.98*	1.2303 + 0.8365*	1.007 + 0.59*
Triceps EMG (mv)	0.1592 + 0.0760	0.1371 + 0.3230	0.1462 + 0.0906
Quadriceps MVC (N)	551.8389 + 174.15*	446.0418 + 157.69*	443.750 + 150.26*
Quadriceps EMG (mv)	1.0002 + 0.60*	0.6092 + 0.40*	0.5984 + 0.37
Hamstrings EMG (mv)	0.0870 + 0.1206	0.0681 + 0.0381	0.0596 + 0.0464

Table 5. The changes in the upper and lower limb average (n =10) MVC force (N) and EMG (mv) values in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted individually. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

Main Effect for Condition	Upright	Inverted in 1s	Inverted in 3s
HR	82.0491 + 9.50*	68.5455 + 8.17*	65.0455 + 7.45*
SBP	130.1818 + 8.06*	116.0909 + 8.23*	113.9545 + 6.48*
DBP	78.6364 + 7.39*	67.5455 + 6.33*	65.1818 + 4.64*

Table 6. The main effect for condition with average (n = 22) values for the changes in heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) in the upright position, inverted within 1s and inverted with 3s rotations. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

FIGURES

1. Main effects for Condition: Force

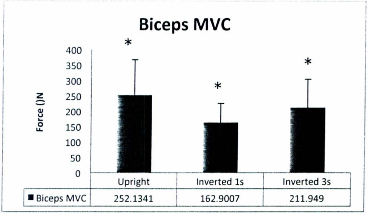


Fig.1. The average (n = 22) biceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

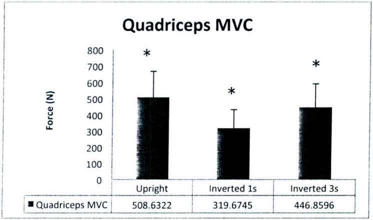


Fig.2. The average (n = 22) quadriceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

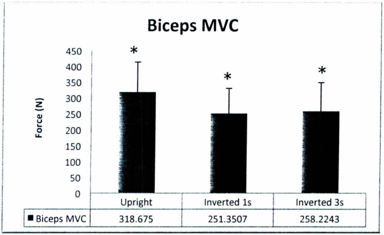


Fig.3. The average (n = 10) biceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps contracted individually. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

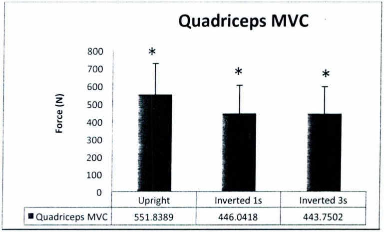


Fig.4. The average (n = 10) quadriceps MVC force (N) in the upright and inverted within 1s and 3s rotations when quadriceps contracted individually. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

2. **<u>Main effects for condition: Electromyography (EMG)</u>**

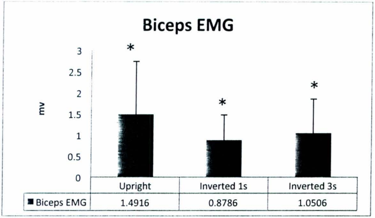


Fig.5. The average (n = 22) biceps EMG activity (mv) during the MVC of the biceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

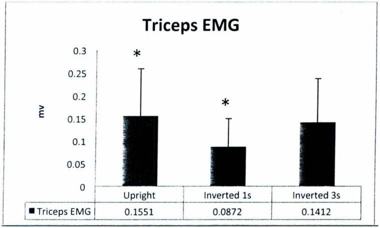


Fig.6. The average (n = 22) triceps EMG activity (mv) during the MVC of the biceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s rotations.

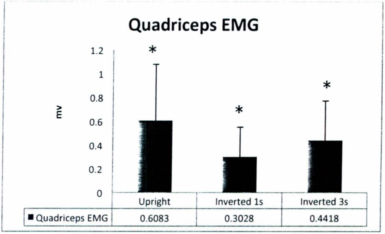


Fig.7. The average (n = 22) quadriceps EMG activity (mv) during the MVC of the quadriceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

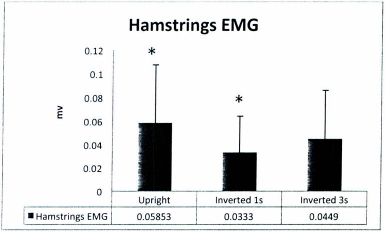


Fig.8. The average (n = 22) hamstrings EMG activity (mv) during the MVC of the quadriceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s rotations

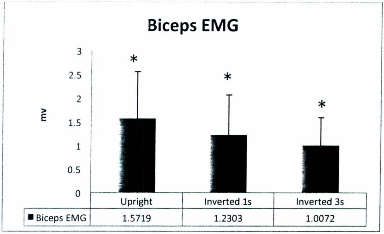


Fig.9. The average (n = 10) biceps EMG activity (mv) during the MVC of the biceps when biceps contracted individually in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

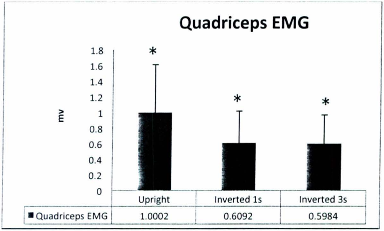


Fig.10. The average (n = 10) quadriceps EMG activity (mv) during the MVC of the quadriceps when quadriceps contracted individually in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

3. Main effects for Time: Force

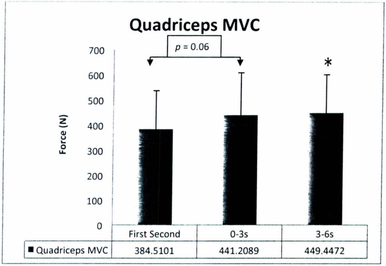


Fig.11. The average (n = 22) changes in quadriceps MVC force (N) in the first sec, 0-3s, and 3-6s time periods when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations ($\pm$ SD). Asterisk (*) sign denotes significant differences between the first second and 3-6s periods. A tendency ($p = 0.06$) was observed from the first second to 0-3s.

4. Heart Rate and Blood Pressure

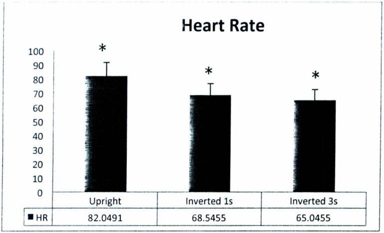


Fig.12. The average (n = 22) heart rate (beats/min) in the upright and inverted within 1s and 3s rotations. Columns represent average values of beats/min and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

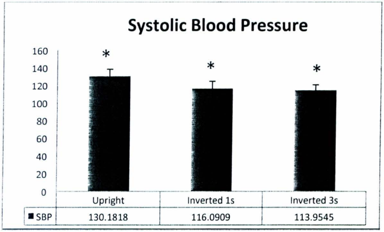


Fig.13. The average (n = 22) systolic blood pressure (mmHg) in the upright and inverted within 1s and 3s rotations. Columns represent average values of the pressure and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations

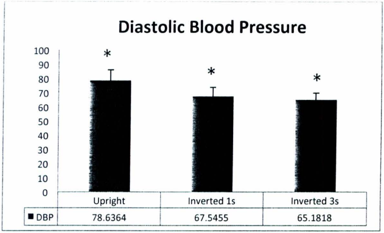


Fig.14. The average (n = 22) diastolic blood pressure (mmHg) in the upright and inverted within 1s and 3s rotations. Columns represent average values of the pressure and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations

5. Force Profiles

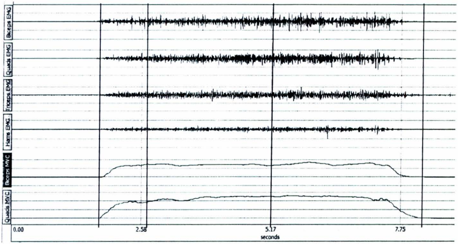


Fig. 15. Image represents the force profile when inverted within 1s rotation. The lines represent three different phases of analysis (0-1s, 0-3s, 3-6s).

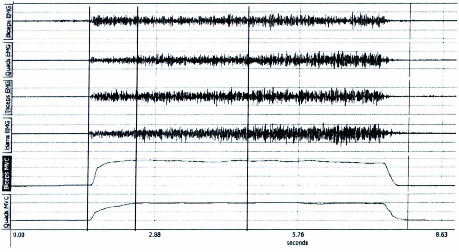


Fig. 16. Image represents the force profile when inverted within 3s rotation. The lines represent three different phases of analysis (0-1s, 0-3s, 3-6s).

APPENDICES

Variability in Rotation Times

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.12	3.07
Subject 2	1.23	3.21
Subject 3	1.09	3.14
Subject 4	1.11	3.11
Subject 5	1.17	3.17
Subject 6	1.21	3.01
Subject 7	1.08	3.26
Subject 8	1.19	3.04
Subject 9	1.14	3.12
Subject 10	1.02	3.13
Subject 11	1.17	3.00
Subject 12	1.00	3.22
Subject 13	1.24	3.03
Subject 14	1.16	3.19
Subject 15	1.19	3.14
Subject 16	1.23	3.17
Subject 17	1.12	3.26
Subject 18	1.27	3.08
Subject 19	1.05	3.20
Subject 20	1.14	3.16
Subject 21	1.11	3.21
Subject 22	1.02	3.02

Table 1. The variability in rotation times when subjects were inverted within 1s and 3s with concurrent biceps and quadriceps contraction.

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.15	3.01
Subject 2	1.09	3.20
Subject 3	1.21	3.16
Subject 4	1.17	3.11
Subject 5	1.23	3.11
Subject 6	1.07	3.09
Subject 7	1.19	3.19
Subject 8	1.02	3.05
Subject 9	1.11	3.16
Subject 10	1.06	3.18

Table 2. The variability in rotation times when subjects were inverted within 1s and 3s with individual biceps contraction.

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.13	3.23
Subject 2	1.11	3.02
Subject 3	1.24	3.19
Subject 4	1.07	3.14
Subject 5	1.19	3.18
Subject 6	1.15	3.11
Subject 7	1.17	3.00
Subject 8	1.05	3.13
Subject 9	1.22	3.05
Subject 10	1.04	3.17

Table 3. The variability in rotation times when subjects were inverted within 1s and 3s with individual quadriceps contraction.

Figure: Photo of rotational chair in upright position.

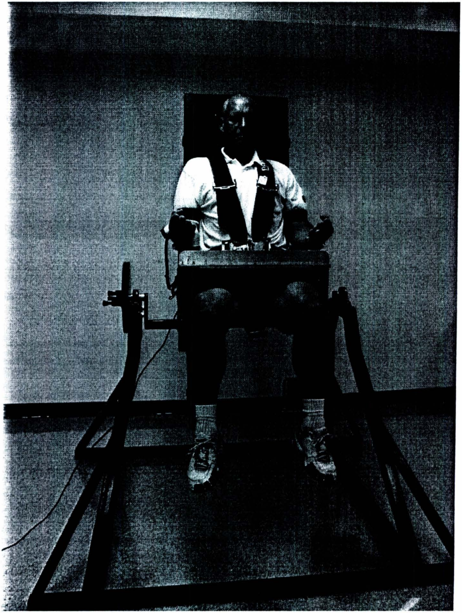
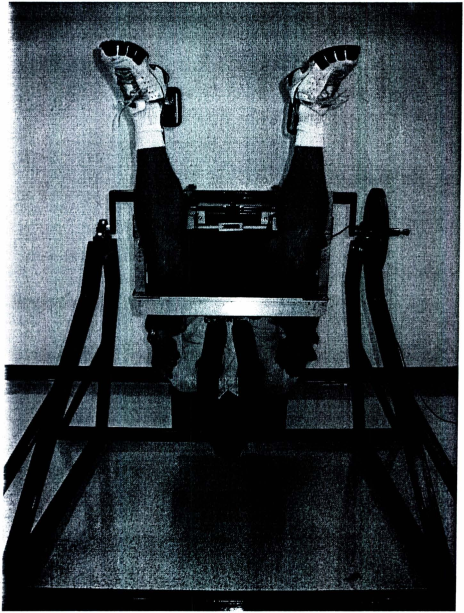


Figure: Photo of rotational chair in inverted position



EXPLORING THE ROLE OF DISCOURSE IN THE EMERGING IDENTITIES OF CHILDREN ENROLLED IN AN OBESITY TREATMENT PROGRAM

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EXPLORING THE ROLE OF DISCOURSE IN THE EMERGING IDENTITIES OF CHILDREN ENROLLED IN AN OBESITY TREATMENT PROGRAM

by

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A Dissertation submitted to the School of Graduate Studies

in partial fulfilment of the requirements for the

Degree of Doctor of Philosophy

Division of Community Health

and Humanities,

Faculty of Medicine, Memorial University of Newfoundland

May, 2012

St. John's Newfoundland

ABSTRACT

While there has been an abundance of research conducted in the area of obesity, the vast majority of studies have investigated the implications of obesity from a positivist perspective with attention to physical ramifications or potential burden to the healthcare system. Studies that examine the embodied experiences of children who are defined as obese are practically non-existent. Utilizing a multi-method qualitative approach informed by post-structural and feminist theory, this study was designed to examine how children enrolled in an obesity treatment program with a self-esteem focus both utilize and resist dominant discourses related to the body and health, and how they negotiate alternative discourses as introduced through the program. It provides a much-needed examination of how so-called 'obese' children navigate the dominant health and obesity discourses while trying to forge their sense of selves. Through interviews, focus groups and participant observations, I demonstrate how children in this study drew regularly upon the dominant messages in relation to weight and health to situate themselves on the periphery of social space, hence becoming the 'fat other'. Utilizing Foucauldian theory, I also demonstrate how governmental notions of risk and responsibility central to the obesity discourse serve to position 'obese' children as the 'ultimate at-risk' children, placing them in a position of constant scrutiny and surveillance. While I show that within the present healthist environment, these children are provided limited discursive resources to support a so-called 'healthy' identity, I also expose the fluid and contingent nature of identity formation. I illustrate how the children exercised agency through various resistive mechanisms upon entering the program, while also demonstrating this agency in drawing upon the alternative discourses as presented in the program in an effort to challenge the 'fat identity'. This research contributes to a growing body of critical obesity research that moves the concept obesity beyond a medical and social 'problem' to consider how such a concept is discursively constituted within the broader social, cultural, and political facets of contemporary society.

ACKNOWLEDGEMENTS

I would like to acknowledge my co-supervisors, Dr. Natalie Beausoleil and Dr. Olga Heath for helping to make this journey the greatest learning experience of my life.

To Dr. Beausoleil, I want to thank-you for introducing me to the fields of sociology and critical feminist studies. You have provided me with the tools to examine the world in a way I could not before. By encouraging me to question my own epistemological foundations you have enhanced my outlook as a health professional, a researcher, an educator, and a mother. You have provided me with a rich foundation from which I feel I can continue to learn and grow. Your constant support and pride in your students' accomplishments has been a source of strength for me throughout this process.

To Dr. Olga Heath, I thank you for your calm and fair approach to teaching and learning. You have taught me that collaborative practice and research are truly a possibility and something worth striving for. Your ongoing guidance throughout this process has been invaluable and your support unwavering. Your dedication to your work and your students has inspired me to be a better nurse, researcher, and educator.

I would also like to acknowledge the other members of my committee, Dr. Tracey Bridger and Dr. LeAnne Petherick. You have shown me that interprofessional collaboration is a realistic and worthwhile investment. Your expertise was invaluable in helping me complete this dissertation. To Dr. Bridger, your encouragement in my critique of the biomedical perspective speaks to your strength and character as a physician, researcher, and educator. You have made what could have been a very difficult process much more bearable and you have shown me that there are many health professionals who are open to exploring health and the body from different perspectives. To Dr. LeAnne Petherick, your knowledge, calm encouragement, and willingness to answer any question have provided me with the confidence I needed to pursue an area of study that I had little previous experience with.

Also, I must acknowledge the children, parents, and coordinators of the program outlined within my study. I thank you for allowing me to explore your world and the meaning you derive from it, if only for a brief time. Your willingness to share and talk to me means a great deal and it is my hope that your contribution will positively impact practice, research, and education.

To my colleagues at the Centre for Nursing Studies, your support throughout my studies has been very important to me. Specifically, I want to thank my two dear friends and colleagues Denise English And Kathleen Stevens. To Denise, for your continuous support throughout our committee work together, for keeping me on time and focussed, for reassuring me that my work will get done and for always caring about my wellbeing, I will be forever grateful. To Kathleen, who was always there to ask me about my progress, who was so patient in listening to me as I talked about my courses, my proposal, my comprehensive exams, and my writing while balancing work and family life, I thank you for your friendship, encouragement, and belief in me.

I must also acknowledge my dear friend, colleague, and fellow doctoral student Sue Ann Mandville-Anstey. For the friendship and support you have shown throughout our studies, from the late nights working on biostatistics, to the dinner and movie nights that were mixed with discussions of theoretical perspectives, research designs, and possible chapter titles, I thank you. I feel privileged to have had the opportunity to take this journey with you.

I would also like to acknowledge my parents, John and Vera Harte, for the constant love and support they have shown me throughout my studies and throughout my life. For the babysitting, the meals, the daily chats, and your unwavering belief in my ability to succeed, I thank you.

Finally, I want to acknowledge my wonderful husband Denis Ward and my two beautiful children Emma and Michael for their patience and the sacrifices they have made for me throughout my doctoral studies. For the love and support you have shown me, while

always reminding me that you are with me no matter what road I choose, I want to say I thank-you and I love you!

This dissertation is dedicated to the memory of my uncle and friend Dr. Austin J. Harte who showed me that although life may be fleeting, we should make every moment count and always strive to attain our goals. His pursuit of excellence in research and education inspired me to continue my graduate education and to never stop learning.

Table of Contents

List of Figures

List of Appendices

CHAPTER 1

INTRODUCTION

Power is not an institution, and not a structure; neither is it a certain strength we are endowed with; it is the name that one attributes to a complex strategical situation in a particular society. (Foucault, 1978, p.93)

How do we make meaning of the things around us that influence the way we live, the way we view life, and the ideas that shape, not only our attitudes, but also our identities? This is a question that often perplexes me. It is also a question from which I have framed my doctoral research. In the early phase of my doctoral program I had approached my supervisor with an idea to examine issues of body image with preteen girls. I was concerned about the dominant health discourses that conflate health and weight and the subsequent pressure this placed upon girls to fit the normative body ideal. I began reviewing the literature and developing ideas that I thought would bring me to the place I needed to be to begin developing a proposal for my doctoral research. As I reviewed the literature more in more depth, I was also intrigued by the growing body of research that highlights the increasing prominence of body image concerns in the male population (Cohane & Pope, 2001; Hargreaves & Tiggemann, 2006; Ricciardelli & McCabe, 2004). This led me to consider how children in general begin to shape their ideas about health and the body. How is it that we learn what it means to be healthy? How do we come to believe that the thin body equates with a healthy body and how has the imperative to maintain a so-called 'healthy weight status' become so ingrained in our practices of everyday life?

My research notion was solidified one day while visiting my children's school. Upon entering the school I noticed a large poster placed upon the entrance into the gymnasium that read, "Prevent Obesity". The poster was strategically placed so all people who passed through the door would see it. It was bright and colourful with smiling children and parents taking part in various physical activities. I was initially struck by the written message and subsequently struck by the pictures that served to reinforce this message. The message (Prevent Obesity) to me highlighted the negative connotations of obesity, as something that must be avoided. The position of this message in the gym entrance suggested that it was an important warning that children should pay attention to. The subjects of the pictures I noted were all a reflection of the normative thin body that has come to be not only desirable, but also required as the core characteristic of 'health'. The poster represented a very white middle class representation of what the healthy, active child should look like. While standing outside the threshold into the area where children are expected to be active and involved, where they are expected to learn to love being active in their bodies, I began to wonder what that message meant for children who were already categorized or labelled as obese. What did these children think of this message? How difficult is it to enter that gymnasium knowing that this is the place you should go to be someone unlike you? How difficult must it be when the healthy child is defined as somehow better than you are, someone thinner, someone fitter, the child in the poster? I began to wonder how these children in particular negotiate the anti-fat messages that are so pervasive in our society; the messages that are so uncritically endorsed within major institutions (schools as a primary example) that shape the way we live, the way we interact with others and effectively shape the messages that influence the identities we forge (Gard & Wright, 2005; Rail, Holmes, & Murray, 2010).

I thus returned to the literature in hopes that I would find something that would provide me with some insight into the issue at hand. While I found an abundance of literature that examined the physical and psychosocial implications of obesity for children, I found only two studies that utilized a qualitative approach in exploring the perceptions of obese children (Murtagh, Dixey, & Rudolf, 2006; Wills, Backett-Milburn, Gregory, & Lawton, 2006). Unfortunately, the initial study proved to be concerned more with the children's perceived barriers to weight loss than the embodied experiences of these children and the latter study considered children's opinions of overweight and obesity in children of various size categories. Neither of these studies provided an in-depth exploration of the experiences of the children defined as obese. From there, I drew on a number of studies that explored how youth utilize the discourses available to them in relation to health and the body and the impact these broad discourses have on the meanings they produce around health and the body (Burrows & Wright, 2004; George & Rail, 2006; Wright, O'Flynn, & MacDonald, 2006; Rail, 2009; Burrows, Wright, & Jungerson Smith, 2002). While these studies did not focus specifically on obese children, they were enlightening in that they provided a critical examination of the powerful dynamics at play that shape ideas and so-called knowledge related to health and the body. They also provided me with a reference point from which to begin. They further reinforced the significance of such exploration. It is from this point that I began to frame the research study I wanted to conduct with consideration to obesity as a social construct.

Obesity as a Contemporary Construct

Obesity is an issue that pervades many aspects of our lives in the 21st century. As citizens we are reminded on a regular basis of the so-called ‘obesity epidemic’ and the imminent threat that it poses to the health of individuals and the population as a whole (Evans, de Pian, Rich, & Davies, 2011; Rich & Evans, 2005; Saguy & Almeling, 2008). Throughout this dissertation I provide a critique of the notion of obesity as a contemporary health crisis. I see it not as a given reality but rather as a discursive social reality produced through powerful discourses. Considering obesity from a feminist poststructural perspective, I consider how we utilize discourses to navigate various subject positions, to consider how we fit within the discursive world that is available to us. I draw on the work of Foucault in considering how dominant discourses therefore serve as a repertoire from which we frame a sense of who we are and how we fit within the larger social structure. I consider how we, as Davies (2000) noted, “speak our selves into existence within the terms of available discourses” (p.55).

The current health and obesity discourses, I argue throughout this dissertation, provide limited resources for the acquisition of positive subject positions. These discourses, driven by healthist and individualist thinking, render health as an individual responsibility (Beausoleil, 2009; Rail & Beausoleil, 2003). Healthism, according to Crawford (1980), places health as the ultimate good in life, as a moral value or goal towards which all people should strive thus placing the responsibility for health at the individual level and reinforcing the concept of the individual as a consumer. This goal has been intertwined with an intense focus on the body (as the body has become a visual representation of health), resulting in what Dworkin & Wachs (2009) refer to as a ‘body panic'. This preoccupation with the body displaces " critiques of the social structure onto individual bodily failures and onto gender relations, while stigmatizing those who fail to participate and succeed in the existing system" (Dworkin & Wachs, p.104). Such panic has been perpetuated through media ads, health promotion material, and by many health professionals who consistently remind us of our responsibility as individuals to employ self-discipline to combat obesity through diet and exercise (Klacynski, Goold, & Mudry, 2004; Monaghan, 2007). Obesity therefore, within this healthist view, is perceived simply as the consequence of poor choices and unhealthy behaviours, with limited consideration to the multiple factors that serve to shape a person's weight status. Dominant health and obesity discourses have been implicated in the conflation of health and thinness, thus leaving obese people in a marginalized position within society, as they are considered to symbolize that which is undesirable and reflective of our overall moral decline (Gard & Wright, 2005; LeBesco, 2004; Jutel, 2005).

The construct of obesity has been widely discussed in the literature, given the notable increase in rates in both adults and children within Canada and globally. The rates of obesity today are reported as being markedly higher than they have been in previous decades, prompting the World Health Organization (2000), to constitute it as an epidemic. It has been noted that this trend applies to children as well as adults (Heingberg & Thompson, 2009; Wang & Lobstein, 2006). In a study by Tremblay and Willms (2003) for example, it was suggested that 33% of boys and 26% of girls in Canada fit into the category of overweight, while 10% of boys and 9% of girls were considered to be obese. While the issue of obesity is complex and greatly tied to social norms, the vast majority of obesity related literature arises from the positivist paradigm with little attention to the embodied realities of the people themselves. "Both the social sciences and the positivistic sciences tend to ignore how body weight is lived as an everyday reality. In other words, the lived realities, the voices of embodied subjects, are all but silenced in the "war on obesity" (Norman, 2009, p. 9). The studies focus predominantly on the physical ramifications of obesity and its impact upon the healthcare system with consideration to current and predicted trends, stating that obesity is linked to higher rates of heart disease, diabetes, hypertension and stroke (Eckel, 1997; Katzmarzyk & Adern, 2004; Peeters et al., 2003; Pietrobelli & Steinbeck, 2004; Reilley et al., 2003; Wang & Lobstein, 2006; World Health Organization, 2000). Other research has focused on the economic burden placed upon the system by those considered to be obese (Katzmarzyk & Janssen, 2004; Moodie & Carter, 2010; Wang & William, 2002). Childhood obesity has been an area of particular concern as it is suggested that of those children who present with a BMI greater than the 95^{th} percentile, upwards of 69% or greater will continue to be obese in adulthood (Ball & McCarger, 2003; Canning, Courage, & Frizzell, 2004; Shields, 2006; Heinberg & Thompson, 2009). Interestingly, recent research has suggested that overweight (BMI ranging from 25-29.9) and even class I obesity (BMI ranging from 30-34.9) may not result in increased risk of death and that they may in fact provide some level of protection (Orpana et al., 2010; Flegal, Graubard, Williamson, & Gail, 2007; Kuk et al., 2011). In a very recent study by Kuk et al. for example, the authors found that only some of the obese people in their study of the Edmonton Obesity Staging System identified as a greater mortality risk than more lean people. As they state,

> The finding that there were no differences in all-cause mortality risk between obese individuals in EOSS stage 0/1 and normal-weight individuals brings into question whether weight loss is beneficial for reducing health risk in this unique obese population. This is in contrast to the current U.S. obesity treatment guidelines, which suggest that obese individuals should be treated for their obesity, regardless of their overall risk profile (p.573).

It is interesting, given the notion that you can be 'fit and fat' (Gaesser, 2002) combined with the reports that state that death rates due to obesity have been overestimated (Flegal, Graubard, & Williamson, 2004; Flegal, Williamson, Pamuk, & Rosenberg, 2004), that alarming claims about the impending health crisis related to obesity continue to provide the backdrop to much of the obesity literature (Boero, 2007; Campos, 2004; Evans, & Rich, 2005). As stated by Lobstein, Baur, & Jackson-Leach (2010) childhood obesity "has been described by medical professionals as 'a public health disaster waiting to happen', 'a massive tsunami' and a 'health time bomb'" (p.3). This alarmist discourse originating from the scientific community that is so strongly endorsed through major social institutions through which we conduct our daily activities of life hence has resulted in what critical obesity researchers refer to as an 'obesity panic' (Beausoleil, 2009; Campos, Saguy, Ernsberger, Oliver, & Gaesser, 2006; Gard & Wright, 2005).

While health professionals cannot ignore the physical health consequences of extreme levels of weight in children and adolescents, it is also vital that we gain an understanding of how the obesity discourse is constructed, and the impact of the dominant messages surrounding obesity, particularly on those that fall into the obese category (Monaghan, Hollands, & Pritchard, 2010; Rice, 2007; Wright, 2000). Recent literature has begun to focus on the psychosocial impact of obesity on the wellbeing of these children. While obesity has been shown to have a negative impact on the physical health of some children, the impact on children's psychosocial wellbeing for many may be even greater and more damaging than the physical consequences (Flodmark, 2005; O'Dea, 2005; Larkin & Rice, 2005). This is of particular concern within programs designed to treat children who are considered obese as these children are in a particularly vulnerable position as they strive to function as marginalized bodies within the dominant discourse. It has been argued for example that while few obesity treatment programs have been found to be effective (Flynn et al., 2006; Summerbell, Ashton, Campbell, Edmunds, Kelly, & Waters, 2008), the reinforcement of dominant health discourses in many obesity prevention and treatment programs that conflate health and thinness and thus focus mainly on weight reduction or maintaining a specific weight status, may in fact serve to negatively influence the self-esteem and emerging identities of child participants (Cameron, 1999; O'Dea, 2005).

It is thus vital that we begin to explore the ways in which children negotiate the dominant health discourses, specifically the obesity discourse, and consider the impact of such discourses on the body image, self-esteem, and evolving identities of the children involved. While there have been a number of quantitative research studies that have provided some insight into the experiences of obese children with regard to body image, self-esteem and quality of life, research from a qualitative perspective is extremely limited. Although a number of authors have begun to question the role that obesity discourse plays in the way we view our bodies and the strategies designed to "combat" obesity in light of the so-called obesity epidemic, research that provides an exploration of the embodied experience of children within obesity treatment programs, with particular attention to obesity discourse and dominant health messages, is virtually non-existent. To my knowledge no other research studies have explored the role of discourse in non-measurement focused treatment programs that focus on building self-esteem.

This dissertation highlights a study in which I sought to examine how children enrolled in an obesity treatment program, with a self-esteem focus, both utilize and resist dominant discourses constructing the body and health and how they negotiate alternative discourses as introduced through the program. The proposed study was conducted within a treatment program for obese children within an Atlantic Province of Canada. While recognizing that the children who are referred to this program have been identified as obese and are often presenting with health threatening symptoms which must be addressed, the program coordinators also recognize that the dominant obesity discourse which is so pervasive both in medical and broader social environments may be having a negative impact on these very children. The treatment program has thus been designed using a multidisciplinary approach that promotes positive self-esteem and positive body image while avoiding focus on weight and measurement. Dominant beliefs about weight and health are challenged while acceptance of natural sizes is reinforced. Parents are also involved in the program because it has been recognized that they impact and are impacted by the concerns of their children and play a key role in their children's developing health beliefs and attitudes (McGarvey et al., 2004).

Considering the importance of the embodied experiences of children enrolled in obesity treatment programs, the overall objective of the proposed research study was to gain insight into how these children are learning to navigate a world which views fat as the enemy, to examine how they are constructing their sense of selves in and through their bodies and their daily experiences and to explore the introduction of alternative discourses through the Treatment Program. Drawing on the writing of Foucault, I work to make visible the power relations that privilege the obesity discourse over alternative discourses. Given that there has been very little research conducted that examines the experiences of obese children, particularly those in the treatment setting, this research has the potential to positively impact the design of programs and practice within the treatment setting as well as provide insight for health promoters, educators, policy makers, parents, and children in how to address and alter the dominant messages inherent in the current obesity discourse.

Purpose of the Study

The main purpose of this study was to explore the embodied experiences of children who have been defined as clinically obese and who have enrolled in a family centred obesity treatment program. This research will begin to fill an identified gap in research in relation to the embodied experiences of children defined as obese. As previously stated, the manner in which these children negotiate the obesity and dominant health discourses in light of their marginalized position within those discourses is of particular interest. Specifically this study examined the following questions:

1) How have children who epitomize what the dominant healthist view dictates as unhealthy and undesirable, taken up the messages that permeate the dominant obesity discourse?
2) Conversely, how do they resist these messages? What mechanisms do they utilize to maintain positive self-esteem and forge their identities?
3) What impact does the interplay of acceptance and resistance have on the self-esteem and evolving identity of the children?
4) How do parents negotiate the dominant health discourse? How is this reflected in discussions related their children's self-esteem and identity?
5) How do the children deal with alternative discourses introduced to them within the Treatment Program that serve to challenge the dominant messages?

While I recognize the complexity of the impact of discourse on identity, I also recognize that this can be explored through an examination of children's talk around their bodies, concepts of health and fitness, what they identify as their personal strengths, as well as friendships and other relationships. This impact can also be explored through the children's artwork that provides another outlet for the children to both express and examine the meanings they construct in relation to health and the body and where they fit within the dominant paradigm. Furthermore, this research provides a discussion into how we as health professionals, educators, and researchers can begin to effectively share our perspectives and open up to different ways of knowing that can serve to enhance our research, our health promotion initiatives, and ultimately improve the quality of life for children considered obese. Through exploring children's experiences with attention on how they utilize the discursive resources it is my hope that this research will serve as an impetus for change in the way we promote health and highlight the need for continuing research and education in this area.

Outline

This dissertation is organized to provide a thorough overview of the process I undertook to explore the embodied experiences of a group of children defined as obese. In the introduction I have provided rationale for why I chose this particular topic. I have also provided a background discussion highlighting the concept of obesity and how it has been constructed from a Foucauldian perspective to become a 'discourse of doom', which ultimately impacts on the way children view themselves and others. I discuss how I utilized a critical discursive approach to examine how identities are formed in light of powerful hegemonic or dominant discourses that frame the way we view health and the body and how children in this program both utilize and resist the discourses at their disposal.

In Chapter Two, the literature review, I provide an examination of the literature that frames the discursive production of obesity, obesity treatment, and the at-risk child. I highlight the feminist post-structural literature that provides a foundation for my critical examination of the discourse throughout this particular treatment program with specific reference to Foucault's conceptualization of discourse and the influence of feminist scholars who examine how the normative body is produced and monitored in our society. This discussion is presented with consideration to the power relations at play that render 'body work' as a prerequisite for health within an individualistic health paradigm. I provide an overview of mainstream obesity literature that warns of us of the impending threats related to obesity and the critical literature that serves to critique a number of the mainstreams claims. This literature provided me with the theoretical foundation from which I was able to contemplate and ultimately settle upon a research design that I felt would effectively address my research questions.

In Chapter Three I provide a discussion of the methodology utilized in this dissertation. I highlight the process of selection and recruitment within the obesity treatment program selected for the purposes of this research. I provide my rationale for the use of a critical discursive qualitative approach using multiple methods based both upon a feminist framework where researchers "bob and weave their threads of understanding, listening to the experiences of others" (Hesse-Biber, 2007, p. 3). I also demonstrate how researching *with* children rather than researching *on* children calls for diverse and creative data collection methods (Birbeck & Drummond, 2005). Finally, I provide an overview of the ethnographic approach utilized with descriptions of the methods used including participant observation, field notes, interviews, focus groups and an art project. Within this discussion I provide reflection upon the epistemological foundations of this methodology and the important function of reflexivity in considering my role in the co-construction of knowledge given my position as an adult, a mother, a health professional, an educator and a researcher.

Chapter Four, entitled "Discourse of Difference: "My Body Doesn't Fit" is the first of three chapters based upon my analysis of the data generated in this study. In this chapter I provide an analysis of the children's narratives relating to their constructions of health. I highlight how these constructions are very much framed by dominant discourses that define health in corporeal terms. I also provide a discussion about how these discourses serve to position the children on the periphery in terms of social space and the mechanisms the children utilize in striving toward a positive sense of self given in the context of where they are positioned. In this chapter I also highlight the importance of acknowledging the children's agency in relation to these discourses. I consider not just how they take up dominant discourses but also how they attempt to resist or subvert such discourses. In keeping with the theoretical underpinnings of my research I also integrate my reflections in relation to my position in the co-construction of knowledge at these particular junctures.

Chapter Five, entitled "Fatness, Risk, and the Responsible Child: "I Just Need More Willpower" explores the children's common experiences in living and learning health from a healthist perspective. In this chapter I examine how children utilize the neoliberal healthist discourse in their discussion of health as they struggle to achieve the status of worthy citizen. I discuss how, through the medicalization of obesity and a governmental approach to health, this discourse serves to construct the obese child as the 'ultimate at-risk child' and I consider the implications of such a construction in terms of the children's sense of self and responsibility. Within this chapter I also provide a discussion of how parents utilize the obesity and risk discourses in caring for their children and highlight the gendered nature of the healthist discourse in defining the promotion and maintenance of children's health as a motherly responsibility. I consider the mother's narratives as they struggle to achieve what they perceive as often contradictory tasks of helping their children achieve the prescribed health goals while simultaneously trying to promote positive self-esteem and identities. I demonstrate how the mothers utilize both the risk and obesity discourse in discussing their concerns for their children and the guilt and responsibility they feel in relation to their children and lifestyle issues. I also illustrate in this chapter how the common theme of will power consistently emerged as children often identified themselves as being weak and not having the strength to be good at the 'health thing'.

In chapter six, entitled "Alternative Messages and the Creation of a Safe Haven: "I Feel Safe Here", I explore issues that arose in relation to the Treatment Program itself. Within this chapter I provide an overview of the children's initial conceptualizations of the program that were drawn from dominant notions of obesity and medical intervention. I also consider how these conceptualizations changed through the course of the program as a result of the introduction of alternative messaging and program interactions. Through examination of the children's and program coordinators' narratives I illustrate how the program acted as a safe social space for the children where they felt secure in discussing and critiquing ideas of health and the body. I also highlight the challenges faced by the program coordinators in using an alternative framework within the dominant biomedical paradigm that produces obesity as disease.

In Chapter Seven, the final chapter, I provide a summary of the major findings discussed throughout this dissertation with consideration to their implications for health practice, education, and research. Based upon these findings I provide a number of recommendations for those in each of these fields with a specific focus on the integration of critical studies and appreciation for different 'ways of knowing'. Finally, I consider how this work contributes to the growing body of critical obesity studies work highlighting how it can be utilized and built upon in future research.

CHAPTER 2

LITERATURE REVIEW

There is no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not presuppose and constitute at the same time, power relations (Foucault, 1977, p.27).

Knowledge, from a Foucauldian perspective, is always viewed in connection with power. Knowledge is produced from power and can work to sustain and reinforce power. Knowledge, however, is not static and can change and alter the power relations at any given time. Thus any 'truth' can be contemplated and challenged, as 'truth' is very much based upon the perspective of the knower. "The claims of every knower reflect a particular perspective shaped by social, cultural, political, and personal factors" (Hawkesworth, 2007, p.485). We build our understanding of the world and frame our experiences around the knowledge that is available to us. Hence it is important that we look to the knowledge produced through the relevant literature in any given area when involved in the research process. The literature review therefore provides an important function. According to Boote and Biele (2005), the literature review "sets the broad context of the study, clearly demarcates what is and what is not within the scope of the investigation and justifies those decisions" (p.4).

In this chapter I provide a comprehensive review of the literature beginning with literature focussed on obesity treatment as this study was conducted within the context of an obesity treatment program. I move on to explore literature relating to the psychosocial ramifications of childhood obesity, as there is an ever-growing body of research in this area. While much of this literature is drawn from a positivist perspective of which I remain critical, many of the arguments within hold relevance and served to shape the context from which I began to conceptualize the issues central to my doctoral research. In this chapter I go on to provide an overview of the work of Michel Foucault, as his notions of truth, power, and knowledge provide the theoretical foundation from which I have framed this research. I also draw on the work of a number of feminist poststructural authors whose work on bodies, health, risk construction, and critique of the obesity epidemic were instrumental in both the design and analysis of this study.

Obesity Treatment

As discussed in chapter one of this dissertation, the issue of obesity is quite prevalent in the mainstream positivist literature with great emphasis placed on the physical consequences of living with what is considered excess body mass or weight and the medical treatment of obesity. For many years programs have been developed and implemented, most often with a focus on weight reduction as the goal. While a number of studies report on interventions that have lead to short-term weight loss and behaviour change, long-term maintenance has been difficult to attain and has not been accomplished in the vast majority of interventions (Caprio & Genel, 2005; Drohan, 2003; Flynn, McNeil, Mutasingwa, & Tough, 2006; Summerbell, Ashton, Campbell, Edmunds, Kelly, & Waters, 2008). According to Flynn et al. (2006) for example, "the fact that prevalence of childhood obesity has increased dramatically despite the numerous programmes and clinical interventions that have been undertaken over the last 20 years is a testament to the deficiency in obesity prevention and treatment approaches" (p.29). This statement is supported by the work of McGovern et al. (2008) who conducted a systematic review and meta-analysis of 61 non-surgical interventions for childhood obesity including the use of lifestyle interventions and medications to promote weight loss. Following this analysis the authors concluded that there was limited evidence to support the short-term efficacy of such interventions while the long-term efficacy remains unclear. Despite the lack of evidence to support the benefit of lifestyle and medication based treatments for weight reduction, practitioners in the midst of the moral panic over obesity continue to utilize this approach. As stated by ten Have, Beaufort, and Holm (2010),

> The view that "we have to do something now. Doing nothing is not an option" may blind us to the fact that doing something where we have very little evidence that is works is, apart from in a political sense, unlikely to be much better than doing nothing. And we also have to remember that doing something without sufficient evidence may later be proved to be a bad idea (p. 32).

It has been suggested in the literature that the rush to "do something", without specific attention to the complex nature of obesity and the lived experiences of those considered obese may enhance the potential for harm (Burns & Gavey, 2004; Gard & Wright, 2001; O'Dea, 2005; Rich & Evans, 2005). As far back as 1984, Brownell and Wadden recognized the limitations in treating obesity as simply an issue of altered energy balance. They emphasized the need for a broader approach to obesity treatment stating that "the professional community is concerned with the medical concomitants of obesity but the psychosocial and social perils are at least as important to those afflicted by the problem" (cited by Strauss, 2000). Interestingly, Stewart et al (2008) noted that while the motivating factor for many health professionals in obesity treatment is weight control, the motivating factors for children and parents tend to relate to self-esteem and social inclusion. Consequently, those programs that have been noted to be more successful were those focussed on self-esteem building including parental participation and group activities where socialization was fostered (Gruber & Haldeman, 2009; McLean, Griffin, Toney, & Hardeman, 2003; Walker-Lowry, Sallinen, & Janicke, 2007; Zametkin, Zoon, Klein, & Munson, 2004). As noted by Edwards et al. (2006), family-based treatment has been one of the only approaches that demonstrated both short and long-term efficacy. They argued therefore that it is incumbent upon those responsible for addressing weight concerns in youth to consider the importance of family presence and participation in treatment and to examine the implications of treatment on self-esteem and the importance of promoting positive body image and self-esteem.

Even with family involvement however, it has been argued that the focus on weight without consideration to the larger societal messages that are moderated by family, friends and the broader social environment may be greatly implicated in the failure of obesity treatment programs and there actually exists the potential for harm. O'Dea (2005), suggests that health professionals may unintentionally create body image concerns, disordered eating and eating disorders when focusing on the problems related to weight and the need for weight control. Youth, she suggests, might inadvertently conflate weight loss with the need to attain the thin ideal, which has the potential of negatively impacting already fragile levels of self-esteem. This is supported by Spear (2006) who states that youth may become preoccupied with dieting thus increasing the risk of body dissatisfaction and eating disorders. O'Dea goes on to say that a focus on self-esteem rather than weight loss may help reduce levels of body dissatisfaction and divert children and youth from unhealthy dieting practices. This argument is supported by Evans, Evans, Evans, and Evans (2002) who suggest that the focus on weight which has greatly impacted the direction of policy is self defeating, leading to pervasive levels of body dissatisfaction while in turn promoting destructive patterns of behaviour including disordered eating and weight control measures that negatively impact the lives of those involved.

Body dissatisfaction is an issue of great concern for children, particularly those that do not fit the prescribed norm (Gray et al., 2011; Jensen & Steele, 2009; Xanthopoulos et al., 2011). In fact it has been postulated that body dissatisfaction which is greatly implicated in dieting and other weight control behaviours may ultimately lead to weight gain, particularly in obese youth (Field et al., 2003; Neumark-Sztainer et al., 2002, 2006; Spear, 2006). It has also been noted that emphasis on "ideal weights" within the mainstream view, has resulted in a conflation of health with weight where health is seen to equate with thinness (Rail & Beausoleil, 2003; Wright, O'Flynn, & Macdonald, 2006). Children in western culture are growing up in an environment that places great value on what has been termed as the 'thin-ideal' which equates an ultra-thin appearance with beauty, success, happiness and a higher sense of self worth, while equating fat or larger body sizes with failure, lack of motivation and disease (Blood, 2005; Latner & Stunkard, 2003; Lebesco, 2004; Stice & Shaw, 2002). This message is introduced to children at a very young age and is often evident in health promotion messages which are endorsed through government sponsored programs, the school system and the broader social environment (Dixey et al., 2001; Gard & Kirk, 2007; Rich & Evans, 2005; Sands &

Wardle, 2003). Research has demonstrated that this message influences the way children view themselves and those around them and they are implicated in the rising rates of body image concerns and body dissatisfaction (Field et al., 2001; Martinez-Gonzalez et al., 2003; Shroff & Thompson, 2006).

Psychosocial Implications of Childhood Obesity

While preoccupation with weight that is evident in the medical, school and broader social environment exerts an obvious impact on children's view of fat (Larkin & Rice, 2005), a number of authors have noted that children defined as overweight and obese may be even more susceptible to these messages than children who fit into the so-called 'normal' weight category. For example, studies that elicited both child and parent reports have found that obese children are more likely to suffer from lower quality of life (Fallon et al., 2005; Friedlander et al., 2003; Griffiths, Parsons, & Hill, 2010; Janicke et al., 2007; Murtagh, Dixey, & Rudolf, 2006; Schwimmer, Berwinkle & Varni, 2003; Williams et al., 2005). In direct relation to this, it has also been noted that obese children are more likely to experience low self-esteem, low self-confidence, loneliness, sadness and are at higher risk for body dissatisfaction, disordered eating, eating disorders and suicide (Burrows & Cooper, 2002; Franklin, Denyer, Steinbeck, Caterson, & Hill, 2006; Goldfield et al., 2010; Klacynski, Goold, & Mudry, 2004; Robinson, Chang, Haydel, & Killen, 2001; Strauss, 2000; Wardle & Cooke, 2005; Whetstone, Morrissey, & Cummings, 2007). As noted in a study by Goldfield et al. for example, body dissatisfaction and weight loss attempts correlated with the youths' body size. Those youth defined as obese demonstrated greater dissatisfaction than those defined as overweight who in turn demonstrated greater dissatisfaction than those of so-called 'normal' weight.

A number of studies have also found that obese children are regularly faced with discrimination and peer victimization, often in the form of body-based harassment and social exclusion (Davison & Birch 2001; Haines, Neumark-Sztainer, Perry, Hannan, & Levine, 2006; Hesketh, K., Wake, M., & Waters, E., 2004; Janicke et al., 2007; Jansen et al., 2004; Latner & Stunkard, 2003; Larkin & Rice, 2005; Lumeng et al., 2010; Murtagh, Dixey, & Rudolf, 2006; Pesa et al., 2000; Sweeting, Wright & Minnis, 2005). In a study conducted with obese children, their teachers and peers for example, Zeller, Pertill and Ramey (2008) found that children characterised as obese were treated differently by classmates who described them as unattractive, sick, and less physically able, while teachers described these children as more withdrawn and lacking in leadership skills. This reflects the results of a study by Neumark-Sztainer, Story, and Harris (1999) that examined the beliefs and attitudes of schoolteachers and healthcare providers toward obesity. They found that attitudes toward obese people were generally negative with 28 % of respondents defining them as untidy, 27% viewing them as likely to have family problems and 28% stating that obesity is one of the worse things that can happen to a person. According to Rice (2007) "despite growing dialogue about body acceptance, overweight and obesity increasingly are interpreted as unattractive, downwardly mobile, not physically or emotionally healthy, and lacking in body and self -control" (p.158).

Paquette and Raine (2004) suggest that in order to address the issue of weight and body dissatisfaction in the population we must consider the sociocultural context in which our children are being raised. Body dissatisfaction, they argue, is occurring in an environment that promotes the over consumption of unhealthy food while simultaneously marketing the thin ideal and stigmatizing obesity. Children and the public at large are bombarded with images of ultra-thin models, and messages that suggest that beauty can be attained through dieting, the use of cosmetics, anti-aging remedies, the "right' clothes and a vast array of equipment that is designed to produce the "sculpted body" (Fitzgibbon & Stolley, 2006). This commercialized vision of health has become legitimized in our society and is contributing to a system that places blame on the individual (Guthman & DuPuis, 2006; Rail & Beausoleil, 2003). Evans et al. (2002) point to the role of discourse in dominant views on the body and state that this discourse must be examined to explore "how this imagery finds its way into the socio-cultural fabric of schools, into specific subject areas, as well as into other cultural terrain, how it is then interpreted by young people and commingles with other aspects of their lives" (p.192).

Foucauldian Theory and Obesity Discourse

As Evans et al. (2002) suggest, the discourse related to weight and obesity is seen to have a powerful impact on children and adults. If we are to consider how the dominant views of weight and health are communicated and reinforced it is important that we reflect upon the notion of discourse which is central to post-structural thinking. Michel Foucault, a French philosopher and social critic/theorist whose work challenged dominant views of knowledge, power, and truth, contested the notion that there exists some objective truth within our world to be revealed. He argues rather that subjects are constituted through dominant networks of discourses. As Foucault states:

> Truth is a thing of this world: it is produced only by virtue of multiple forms of constraint. And it induces regular effects of power. Each society has its regime of truth, its 'general politics' of truth: that is, the types of discourse which it accepts and makes function as true; the mechanisms and instances which enable one to distinguish true and false statements, the means by which each is sanctioned; the techniques and procedures accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true (Foucault, 1980, p.131).

Foucault suggests that our life views are very much influenced by discourse. He considers discourse to be comprised of the language we use for particular purposes to describe and communicate various topics that offer us ways to make meaning in the world. Discourses are seen to encompass not just the language that we use but also the meanings they entail within a given social and historical context. Through his genealogical work Foucault argues that discourses, constructed through certain relations of power, drive the way we view the world as they permeate many of the institutions through which we live and learn. They define what constitutes knowledge and who has the so-called expert authority to determine what is 'truth' within these dominant paradigms. Foucault (1972) defines discourse thus as "the practices that systematically form the objects of which they speak; they constitute them and in the practice of doing so conceal their own inventions" (p. 49). Truths, Foucault suggests, are constituted through the discourse that we draw upon to guide our life practices, those that are considered to be normal and politically neutral. In his works Foucault examines discourse in relation to power suggesting that discourses both create and transmit power. They are therefore never apolitical. They have the ability to produce, reinforce and sustain certain power relations that impact on people lives. Dominant or hegemonic discourses, discourses that hold more authority (the obesity discourse as one example), can serve to drive the way we define others, and ourselves, and ultimately frame the actions we take. “As legitimized and sanctioned knowledge, discourses are then able to feed back into regimes of power which made them possible and to enable power to operate in more subtle or systematic, more economical or vigilant forms” (Grosz, 1994, p.148).

Due to the powerful constitutive effect of discourse it is therefore an area of research that should be explored. According to Wright (2004), in contemplating discourse we can gain a greater understanding of how people use language to decipher the world around them and to function within that world. We therefore must consider discourse in our examination of issues that affect peoples’ lives. Wright (2000) argues that we must also consider the powerful forces at play that determine why some discourses are taken up while others are not. We must contemplate the site of operation, where power works upon those in their particular positions in life. This is particularly important when working with obese children given the often-powerless position they hold within society and the dominant healthist culture. As DeVault and Gross (2007) note, following the linguistic turn, exploring the discourse that people use particularly in a narrative sense provides us a window into exploring identity and how people make meaning within their own realities. This exploration “offers distinctive possibilities for maintaining the coherence of a person’s perspectives” (p.185). By examining the individual experience and then working to explore how this ‘talk’ is produced within the context of the larger discursive environment, we are able to gain a richer account of an individuals meaning making processes.

Power/knowledge

While discourses have a powerful impact on individuals and populations, the power they wield in the Foucauldian sense does not reside in one person or even one specific group but rather evolves from a number of discourses that shape the way we view the world, that produce what we consider to be 'knowledge'. Power and Knowledge therefore are inextricably linked and according to Foucault should be conceptualized as one inseparable unit (power-knowledge) as together they give rise to and constitute the discourse. Power is not overt; it resides in and through dominant discourses or knowledges referred to as 'Regimes of Truth' that are considered scientifically reputable and valid within contemporary institutions. These 'Regimes of Truth' as noted by Foucault are produced through circular relations of power. Also Foucault (1978) suggests that power is not always negative as is conceptualized in sovereign notions of power. He states:

> The analysis made in terms of power, must not assume that the sovereignty of the state, the form of law, or the over-all unity of a domination are given at the outset; rather, these are only the terminal forms power takes. It seems to me that power must be understood in the first instance as the multiplicity of force relations immanent in the sphere in which they operate and which constitute their own organization; as the process which through ceaseless struggles and confrontations, transforms strengthens, or reverses them; as the support which these force

> relations find in one another, thus forming a chain or system, or on the contrary, the disjunctions and contradictions which isolate them from one another; and lastly, as the strategies in which they take effect, whose general design or institutional crystallization is embodied in the state apparatus, in the formulation of the law, in the various social hegemonies (pp.92-93).

Power, therefore, from Foucault's perspective, is not a coercive force that is exerted upon people by a sovereign state. It is produced rather through the uptake of knowledges that are considered by people to be founded in 'truth'. "For Foucault, power is not primarily located in structures or in an all powerful state apparatus, rather institutions act as specific sites where particular techniques of power are channelled and brought to bear on individuals in specific ways" (Wright, 2000, p.21). The practices and knowledge transmitted through the various institutions to which we are exposed on a daily basis insert themselves into our daily practices and experiences. We therefore come to frame our thoughts and our beliefs about ourselves, others and life itself through the 'Regimes of Truth' that are supported and reinforced within these institutions. Hence, it is through the discourses that we are produced as subjects. This notion is supported by Lupton (1996) who states,

> Power is always present, inducing knowledge and understandings of the world… Given its inevitable presence in any social relationship and its highly contingent nature, power is not an entity that can be taken away from an individual or social group and given to another. Individuals and social groups are neither totally

> "powerless" nor "powerful"; their relationship to power depends on the historical and sociocultural context in which they are positioned as subjects (p.14).

Surveillance and The Contemporary Subject

Throughout his writing Foucault reiterates the connection between knowledge, power, the subject and surveillance through various institutions. In his work *Discipline and Punish (1977)*, Foucault draws on Bentham's Panopticon to explain the concept of surveillance. The panopticon is a prison structure constructed to allow for constant surveillance of inmates who are divided into individual cells. The cells are open to be visualized from a central tower that houses the guard or person in charge of surveillance. These cells also have a window in the back that allow the prisoner to be illuminated so the guard is always able to see them, their shadows and their movements. Prisoners, therefore, are always in a position where they can be observed. Given the central location of the prison tower and the division of prisoners (or as Foucault points out, this can be applied to the student, the worker or others) into discrete cells, prisoners come to learn that they are always in a position of being monitored.

> All that is needed then, is to place a supervisor in a central tower and to shut up in each cell a madman, a patient, a condemned man, a worker or a schoolboy. By the effect of backlighting, one can observe from the tower, standing out precisely against the light, the small captive shadows in the cells of the periphery. They are like so many cages, so many small theatres, in which each actor is alone, perfectly individualized and constantly visible (Foucault, 1977, p. 200).

Foucault goes on to say:

> He who is subjected to a field of visibility, and who knows it, assumes responsibility for the constraints of power; he makes them play spontaneously upon himself; he inscribes in himself the power relation in which he simultaneously plays both roles; he becomes the principle of his own subjection (1977, pp. 202-203).

Subjects therefore are produced through the process of monitoring themselves and working upon themselves to fall in line with the edicts of power. Interestingly, while many people perceive Foucault's work to be centred on the notion of power, Foucault in fact argued that his work was more about the subject than it was an analysis of power. As cited by Rabinow (1984), Foucault states:

> The goal of my work during the last twenty years has not been to analyze the phenomenon of power, nor to elaborate the foundations of such an analysis. My objective, instead, has been to create a history of the different modes by which, in our culture, human beings are made subjects" (p.7).

The subject, according to Foucault, is formed through discourses that both discipline and 'normalize'. The dominant discourses define what is normal, what one should be, while outlining the parameters of the 'normal' category. Thus they function within contemporary disciplinary societies (the modern panopticon) to provide the instructions upon which people construct their own subjectivities. People read and are read into these discourses as they are constructed as subjects. As stated by Cregan (2006), "the effect of the prison on criminal bodies is extended to the effects of power on and through the body in society. The carceral becomes a part of society in general, based in a new system of law, and a new system of general self- and other-control" (p.57). Foucault refers to the disciplines through which people are produced as subjects as '*technologies*'. According to Rabinow (1984), Foucault conceptualized subjects as being objectified through technologies in three distinct modes of objectification. Firstly, for example, in his work *Discipline and Punish: The Birth of the Prison,* Foucault conceptualized power as working on the subject to create what he referred to as 'docile bodies'. In this regard subjects were often considered passive victims of the power regime of that particular time. Subjects, Foucault argued may be objectified through "dividing practices". Such practices or '*techniques of domination*' alienate the subject from the social 'norm' in defining or marking the subject as different or 'abnormal'. As stated by Rabinow, "Essentially "dividing practices" are modes of manipulation that combine the mediation of a science (or pseudo-science) and the practice of exclusion-usually in a spatial sense but always in a social one" (p. 8). Foucault used examples such as the leper, the prisoner, or the madman to illustrate his point. People are thus categorized or assigned subject positions or identities that fit within or are in marked contrast to the ideals of the larger discursive structure. This in effect results in these people being pushed to the periphery either physically or socially through the exercise of exclusion. Obesity discourse, which is created and disseminated on the basis of objective science it is argued, functions to objectify in this manner (Evans & Rich, 2011; Gard & Wright, 2005; Murray, 2008; Rail, Holmes, & Murray, 2010). As argued by Jutel (2009), the medicalization of obesity and the alignment of obesity with a self-induced disease state leaves obese people open for public scrutiny as their bodies are seen to "reveal the nature of the individual" (p.63). Large people, she contends, are therefore expected to give themselves up to measurement. This measurement is understood to be "an objective means of assessment, and scales thus become more reliable than individuals in establishing truths" (p.64). Obesity discourses therefore serve to divide and alienate, to categorize and separate the normal from the abnormal.

Foucault's second mode of objectification, according to Rabinow, is "scientific classification". He cites Foucault (1982), who states that such classification emerges from "the modes of inquiry which try to give themselves the status of sciences"(p. 8). In his work *The Birth of The Clinic* for example, Foucault traces the evolution of modern medicine or the 'clinique' and the power of medical discourse in shaping our notions of disease and the body. Medicine, Foucault argues has asserted the power of the 'clinical gaze' in defining the normal. Once again, the contemporary 'science of obesity' that is portrayed as objective science provides an example of such objectification. It is argued that through the medicalization and legitimization of obesity and the discursive production of obesity as a disease or risk category, the prevailing obesity sciences further objectify obese people, ascribing them with a 'fat identity', marking them as pathological, abnormal and in need of bodily re-formation (Jutel, 2009; Murray, 2009).

In the third mode of objectification of the subject Foucault moves away from the notion of '*technologies of domination*' to consider '*technologies of the self*'. Within this mode of objectification the subject is conceptualized not as a passive victim of dominant discursive forces but rather is viewed as an active subject who constructs oneself albeit through discourses that may be hegemonic. Through the process of 'subjectification' we construct ourselves as subjects. In this process we utilize the discursive resources available to us that emerge from or are filtered through institutional processes. As Smith (1999) posits, from a poststructural perspective the subject is an 'effect of discourse'. Discourse she argues "constitutes subjects, subduing them to the diffuse, decentred processes of power that it articulates" (p.105). For Foucault (1988), the '*technologies of the self*' function as the mechanisms that,

> permit individuals to effect by their own means or with the help of others a certain number of operations on their own bodies and souls, thoughts, conduct, and way of being, so as to transform themselves in order to attain a certain state of happiness, purity, wisdom, perfection, or immortality (p. 18).

Thus, as Foucault argues, through modern processes of power, people have come to monitor and control themselves within the parameters set out by dominant discourses. The control of the body is one primary example. People strive to shape and tone the body by following the dictates of contemporary discourse relating to the thin sculpted body that are delivered through what Pronger (2002) refers to as an "intertextual ensemble" (science articles and books, text books, magazines, television shows, exercise videos, and infomercials as examples). As Pronger notes, by relying on the power of modern technology and science people come to utilize the prescriptive 'science' of the body in striving to sculpt themselves into 'normal' healthy subjects.

As stated previously however, the subject is not viewed as one who is completely passive. There is room within Foucault's conceptualization of the subject for resistance and agency. Foucault moves beyond Althusser's notion of the subject as one who "is produced and subjected to ideology" (Wetherell, Taylor, & Yates, 2001, p.209), to acknowledge the agency that people possess in negotiating and resisting discourses. People take up and utilize discourses in different ways with the capacity to actively affect their own subjectivities. As stated by Foucault (1980), "there are no relations of power without resistances; the latter are all the more real and effective because they are formed right at the point where relations of power are exercised" (p. 142). This resistance, although arising within the dominant discursive environment Foucault argued, has the capacity to disrupt hegemonic discourses, making visible their exclusionary mechanisms. This is supported by McLaren (2002), who states, "Practices of freedom do not take place outside of normalizing discourses of social practices, but they may reveal their contingent character and, in turn, allow for new possibilities" (p.166). Thus, as subjectivities are constructed, they can also be deconstructed. As Weedon (1987) points out, we can deconstruct our subjectivity, examine how it is discursively produced and in doing so reposition ourselves into more positive positions that open up new experiences for us. Resistance can change the way we conceptualize and speak of various notions and hence change our subjective experiences.

While subjects possess agency and may exercise their resistance, it is still argued however that the dominant discourses provide us with a limited set of discursive 'subject positions' or "identities made relevant by specific ways of talking" (Wetherell, Taylor, & Yates, 2001, p. 210). As Hall (1997) explains:

> But the discourse also produces a place for the subject (i.e. the reader or viewer, who is also 'subjected' to discourse) from which its particular knowledge and

> meaning most makes sense. It is not inevitable that all individuals in a particular period will become the subjects of a particular discourse in this sense, and thus the bearers of its power/knowledge. But for them -us- to do so, they -we- must locate themselves/ourselves in the position from which the discourse makes the most sense, and thus become its 'subjects' by subjecting ourselves to its meanings, power, and regulation. All discourses then construct subject positions, from which alone they make sense (p.56).

People utilize *technologies of the self* to move themselves into certain 'subject positions' or categories created and delineated within the dominant discourse. As Davies and Harre (1990) point out, in developing an emerging sense of self we learn what characteristics fit with particular subject positions including "a conceptual repertoire and a location for persons within the structure of rights for those that use that repertoire" (p.46). We learn what makes one subject position different from another and the limits of such positions. We then become involved in discursive practices that further reinforce the meaning derived from such categories. We see "the world from the vantage point of that position and in terms of the particular images, metaphors, storylines and concepts which are made relevant within the particular discursive practice in which they are positioned" (Davies & Harre, p. 46).

We learn about and adopt certain subject positions in and through our bodies and such processes therefore cannot be seen to occur in isolation of the body. The body, as noted by Grosz (1994), is significant and central to the lived experience. Grosz contends that we must move away from the notion of body mind dualism. The idea that the body is in some way subordinate to the mind, she argues, is merely a notion constructed in male terms which has historically considered the mind to be synonymous with maleness while the body is held as synonymous with femaleness. We must consider the body rather as the instrument by which we receive and transmit information and through which we actively experience the world. Our experiences in this sense are considered to be 'embodied'. Young (2005) notes the importance of recognizing the embodied experience, suggesting it is the lived body, "a unified idea of a physical body acting and experiencing in a specific sociocultural context; it is the body-in-situation" (p.16). The mind works in and through the body and therefore the body cannot be considered in a dualistic sense to be separate from the mind as it has the ability to sense and make meaning of objects around it.

> It is the condition and context through which I am able to have relations to objects. It is both immanent and transcendent. In so far as I live the body, it is a phenomenon experienced by me and thus provides the very horizon and perspectival point which places me in the world and makes relations between me, other objects and other subjects possible (Grosz, 1994, p. 86).

Exploration and examination of the subject therefore must consider the complexity of the embodied experiences and strive to recognize the participant as a unified subject that is defined and produced through complex social relations.

Gender, Fatness, and the Performative Subject

Butler (1990, 1993), drawing on Foucauldian theory in her writing on the politics of gender, sexuality, and the body, provides further insight into the notion of the subject. She argues that we must move beyond the essentialist view that there is 'some existing identity", contending that subjects are formed in and through the discursive social and historical practices and identities 'through certain exclusionary practices that do not "show" once the juridical structure of politics has been established" (Butler, 1990, p. 3). There is therefore no core essential self. In her work *Gender Trouble* for example, she contends that gender is performative, meaning that 'gender' does not exist in essence outside of the performed acts that represent gender.

> In other words, acts, gestures, and desire produce the effect of an internal core or substance, but produce this on the surface of the body, through the play of signifying absences that suggest, but never reveal, the organizing principle of identity as a cause. Such acts, gestures, enactments, generally construed, are performative in the sense that the essence or identity that they otherwise purport to express are fabrications manufactured and sustained through corporeal signs and other discursive means (p.185).

According to Butler, notions of gender, sex and sexuality are born out of discourses that support and reinforce heterosexuality as the 'norm'. Bodies, she argues, are materialized. "The regulatory norms of "sex" work in a performative fashion to constitute the materiality of bodies and, more specifically, to materialize the body's sex, to materialize sexual difference in the service of the consolidation of the heterosexual imperative" (Butler, 1993, p. 2). In keeping with Butler's argument this 'heterosexual imperative' is discussed frequently throughout the feminist literature. This literature suggests that the 'ideal' male or female identities are produced through an institutionalized heterosexual framework in which both boys and girls are expected to fit within 'mandatory' heterosexual categories (Jackson, 2006; Norman, 2011; Young, 2005; Thorne, 1993; Thorogood, 2000). Masculinity and femininity are produced in children through the regulation and performance of gender specific characteristics, tasks, and behaviours imbedded (often overtly) in dominant discourses. Gender and heterosexuality are conflated so the so-called normal male or female are expected to abide by the rules of normative heterosexuality. Those who do not fit these pre-described categories are hence labeled 'abnormal'. These categories are reproduced and reinforced through children's interactions with adults and their peers in the form of clothing, physical activities, relationships, and the discourses they take up (Renold, 2000).

Such discourse is central to identity formation. As Butler (1993) notes, female bodies are 'spoken' into femininity. This is supported by Young (2005) who (drawing upon the work of de Beauvoir) suggests that there is no natural 'feminine essence'. Consistent with Butler, the variations in the behaviour of males and females are based within the social, historical, cultural and economic circumstances in which their lives are situated and interactions take place. For example, girls who strive toward a thin so-called 'feminine' form are drawing upon dominant discourses that define what it means to be female; how one should look, how one should act and the boundaries that define the differences in the categories of 'male' and 'female' within a given time and sociocultural context. These discursive 'rules' of gender are read to be a 'natural' reflection of one's inner identity. Such is also the case within the lived experiences of boys. Boys who strive toward muscular bodies are pushing away from identification as the 'other', away from the emasculating effects of soft flesh (Pronger, 2002; Sykes, 2011) in reinforcing the masculine notion of a larger toned body. They are utilizing the process of identification to situate themselves within subject positions that are considered 'habitable' thus avoiding abjection. Identities, then, are constructed through the various subject positions that become available to us. These positions are also constrained or made less 'habitable' through discourses that privilege certain identities on the basis of age, race, gender, and sexuality. In Western society, for example, the young, thin, white female is constructed as the 'ideal' to the exclusion of those of a different age, race, ethnicity, and/or physical ability. "Those whose bodies are not white enough, not young enough, not thin enough or not able enough are considered flawed" (George & Rail, 2006, p. 47).

The current obesity panic has also been highlighted as a class issue. While blame is placed upon those who present as obese, there is little consideration given to their social circumstances and lived experiences (Guthman J, & DuPuis M, 2006; Hann & Peckham, 2010). Interestingly, while the rates of overweight and obesity are disproportionately higher within the lower socioeconomic bracket, obesity is consistently presented as a problem resulting from poor choices over which people have full control. The neoliberal healthist approach to obesity prevention and treatment fails to acknowledge the role of social inequalities and the limited choices available to those who are economically disadvantaged (Marsh, 2004). As stated by Gard and Wright (2005):

> what is even more noticeable is that researchers who find that poverty or low education levels are often (though not always) associated with obesity, inactivity, television watching and 'unhealthy diets' are prepared to advise poor parents about how they manage their children but rarely call for a reduction in poverty or more funds for school and university education (p.66).

The neoliberal assertion that body size is effectively within the control of the so-called responsible individual further serves to limit the possible subject positions for those considered obese. People are forced to maneuver through a variety of discursively produced meanings related to class, gender, sexuality, body size and so forth. For those people who are identified as overweight or obese the intersection of the various subject positions further limits the availability of positive identities and restricts them to a 'fat identity'.

According to Lebesco (2004), the fat identity, within the context of the present obesity discourse, has moved beyond Goffman's (1963) notion of the 'spoiled identity' to an 'uninhabitable' subject position in which there is no room for one to accept and appreciate her or his own body. Within the dominant obesity discourse people considered obese are positioned as the 'fat other' (Erdman-Farrell, 2011). The so-called 'fat' person is situated and examined in opposition to the 'thin' person. Within the realm of dualistic thinking the fat person is placed on a lower plane in opposition to the thin person because within this form of thinking, according to Grosz (1994), "either one or the other of the binary terms is "really" its opposite and can be explained by or translated into the terms of its other" (p.7). Considering the hierarchical nature of dualisms, with one category being positioned above the other, the 'fat other' is viewed then in opposition to the 'thin' healthy person. The fat/thin binary is aligned with other binaries such as active/sedentary, good/bad, motivated/lazy. The position of the 'fat other', therefore, is defined by characteristics that are seen in opposition to the thin, active, responsible healthy person. As LeBesco states, "fat is the antithesis of the beauty ideal of the day: tight, lean, and toned" (p.1).

Hall (2000) also highlights the role of 'othering' in contemplating the concept of identity. He draws on the work of Derrida (1981), Laclau (1990), and Butler (1993) for example in suggesting that one's identity can only be constructed "in relation to the Other, the relation of what it is not, to precisely what it lacks, to what has been called the *constitutive outside"* (p.4). He goes on to state, "identities can function as points of identification and attachment only because of their capacity to exclude, to leave out, to render 'outside', abjected" (p.5). Thus in constructing the obese person as at-risk, unhealthy or diseased, we are limiting the available subject positions of larger people. In the case of obese children they are rendered different and outside of the norm. They are ascribed the 'fat identity', an identity that is seen to lack the physical and moral aptitude to become healthy deserving citizens who 'practice' healthy lifestyles; (Gilman, 2004; Lebesco, 2004).

Rice (2007), in providing an account of women's narratives related to childhood experiences and acquiring the fat or unfit identity, provides some insight into how the obesity discourse impacts upon the so-called obese children through their lived experiences. Throughout the narratives, women consistently recount stories from their childhoods that served to shape their "fat-girl" identities. "For most participants, negative perception of fatness became increasingly commonplace as they moved through childhood, occurring at home, on the street and especially at school" (Rice, p. 164). For these women, the fat discourse may be seen as much more damaging to their health and emerging sense of self than the fat itself. Lebesco (2004) also spoke to the power of the fat identity, suggesting that people identified as fat often come to accept it and "abhor their own bodies" (p.3). When viewed as different and marginalized she suggests, one must negotiate the idea of being "abnormal". The concept of difference is therefore considered central to what we consider to be identity (Hall, 2000). Rice (2005) highlighted the role that difference plays identity formation. Identities, according to Rice, often depend on and evolve out of differences. Difference, she argues, is determined through the interplay of outward markers and the social context in which we live and interact. They are marked and reinforced, thus impacting on identity formation. In her research, she found that while the women she interviewed were negatively impacted by the marginalized position to which they were ascribed, they negotiated the messages they receive that serve to limit them and their identities. The women used a number of strategies of resistance to gain self-acceptance. Their stories, she argued, "reveal how they use strategies of opposition, evasion, concealment, reversal, transgression and conjunction to translate received differences into unique expressions of identity" (p.45). Sykes and McPhail (2008) also contend that identities, in particular fat identities, are not necessarily stable or fixed. Following their exploration of a group of adults' (who self-identified as fat or overweight) experiences in the realm of physical education, for example, Sykes and McPhail contend that fatness is a fluid subject position. The authors suggest that while participants in their study were restricted in terms of the availability of positive subject positions in physical education and experienced "numerous alienating and traumatic movement experiences" (p.68), they developed mechanisms to resist fat phobia and forge positive subjective experiences. The authors state, "The interviews reveal how fat and overweight students were able to form fluid identifications as fat, athletic, and healthy even within hostile educational climates" (p.68). This, they argue, illustrates the important role teachers and those in a position to influence the school and physical education environment play in the construction of "fat-positive" spaces.

A number of authors have suggested that the school environment may be the most influential setting in the development of children's identity as this is the place where they are faced with obvious differences and overt evaluation of those differences (Rich & Evans, 2009; Kirk, 1993; Rice, 2007; Wright & Dean, 2007). Evans et al. (2002) warned that when the obesity discourse is supported and permeated through the various institutions through which children are exposed, particularly schools, "they may do untold damage to the identities of children and young people" (p. 204). The school system, they argued, in upholding and promoting the healthist discourse may in fact be contributing to larger children's fat or unfit identity (Burrows & Wright, 2007; Evans, Rich, Davies, & Allwood, 2008; Evans & Rich, 2011; Kirk, 2006; Wright & Dean, 2007). According to Evans, Evans and Rich (2003), school systems, by rewarding "good food" and conflating weight and health, are potentially supporting a "pedagogy of degradation" (p.234). This is supported by Leahy (2009) who suggests that schools have become the central mechanism by which society is attempting to 'tackle' the so-called 'obesity problem. Because students are considered at risk of becoming overweight or obese, they argue, "school based health education is ideally positioned to provide students with relevant attitudes, knowledges and skills that can effectively contribute to reducing this risk" (p.174).

Governmentality, Healthism, and Risk

Regulation of the subject within the school and beyond, from a Foucauldian perspective, is tied to the notion of Governmentality. Governmentality or "the art of government" according to Foucault involves the political structure or type of governing that evolved out of a so-called growing interest in the welfare of populations. He views this structure or 'the state' as one that 'individualizes' at the same time that it 'totalizes'. The state, in this regard, is not merely the governing body but includes all of the authorities, institutions and mechanisms through which power is imbued upon people to regulate the processes or conduct of everyday life. According to Inda (2005), "it is those assemblages of authorities, knowledges, and techniques, that endeavour to shape the conduct of individuals and populations in order to effect individual and collective welfare" (p. 7). As Foucault (1978) contends, in the eighteenth and nineteenth centuries, the notions of state power transformed. There was a change from a coercive control, or domination of the 'individual' within the sovereign state, to a governing of 'populations' within a modern state. This, he postulated, broadened the reach of the state. While states no longer possessed an immediate power over life and death, they now possessed the power over the 'interests of people', the power to promote and preserve life. Such disciplinary power, Foucault argued, is exercised through surveillance of the population, a surveillance that is internalized so people come to monitor themselves.

> On the basis of the new governmental reason- and this is the point of separation between the old and the new, between raison d'états and reason of the least state- government must no longer intervene, and it no longer had a direct hold on things and people; it can only exert a hold, it is only legitimate, founded in law and reason, to intervene, insofar as interest, or interests, the interplay of interests, make a particular individual, thing, good, wealth, or process of interest for

> individuals, or for the set of individuals, or for the interest of a given individual faced with the interest of all, etcetera (Foucault, 2008, p.45).

The modern state, therefore, no longer exerted direct control over individuals, over their bodies and their lives through torture or threat of death. In the new government the state works through supposedly transparent institutions to affect the lives and activities of the populations, in essence controlling their 'conduct'. This power, that Foucault (1978) termed as 'biopower', involves strategies to preserve and promote life and is comprised of two poles; one that focuses on the individual and another that focuses on populations. While this may read as a gentler more humane form of governance, Foucault points out that this type of power is not necessarily an altruistic power. As Harwood (2009) states "this focus on life needs to be understood not as the heralding of some new caring and kinder age; but in terms of the aims of the state to solidify itself via the control of life (and hence strength, economic viability) of its population" (p. 16). Thus, through the use of disciplinary techniques, people come to frame their behaviours in a manner that falls in line with the objectives of the state that are said to promote the welfare of the population as a whole but which also serve to further strengthen state power.

> For the first time in history no doubt, biological existence was reflected in political existence; the fact of living was no longer an accessible substrate that only emerged from time to time, amid the randomness of death and its fatality; part of it passed into knowledge's field of control and power's sphere of intervention. Power would no longer be dealing simply with legal subjects over

> whom the ultimate domination was death, but with living beings, and the mastery it would be able to exercise over them would have to be applied at the level of life itself; it was the taking charge of life, more than the threat of death, that gave power its access even to the body.... One would have to speak of biopower to designate what brought life and its mechanisms into the realm of explicit calculations and made knowledge-power an agent of transformation of human life. (Foucault, 1978, pp. 142-143).

Through the modern science of epidemiology for example, governments have come to monitor the population through statistical measurements and calculations of prevalence of disease states, measurements of risk, and even surveillance of population through direct measurement of various bodily characteristics such as weight. In doing so they rely on the expert knowledge of epidemiologists, statisticians, and medical professionals who define and measure the 'normal' and in doing so draw attention to the 'abnormal'. As Lupton (1999a) suggests, expert knowledges are central to the power exerted through the modern state apparatus. They "are seen as pivotal to governmentality, providing the guidelines and advice by which populations are surveyed, compared against norms, trained to conform with the norms and rendered productive" (p.88). Thus it is the process of 'normalization' through which bio-power functions.

McDermott (2007) utilizes Turner's (1997) concept of 'normative coercion' in her discussion of strategies to promote the health of the population. She argues that health, like religious institutions, medicine and law, is a "critical contact point between government and the population" (p.308). The success of dominant health discourses in the normalization process, she argues, "lies in their ability to induce people to comply voluntarily" (p.308). Biopedagogies or 'body pedagogies' are viewed as mechanisms though which this compliance is sought and quite often accomplished. As the intense focus on the preservation of life has translated into an intense focus on the body, biopedagogies function to provide individuals and the population with the instructions and criteria through which we should work upon our bodies to achieve a prescribed level of health (Rail & LaFrance, 2009). According to Evans and Rich (2011), biopedagogies are those activities,

> occurring over multiple sites of practice, in and outside schools, they define the significance, value and potential of the body in time, place and space, producing particular, embodied subjectivities that are essentially corporeal orientations to self and others (p.376).

Working beyond the traditional boundaries of pedagogies, biopedagogies as suggested by Harwood (2009), work on both poles of biopower, "the individualized body and the species (the population)" (p. 21). They work through multiple sites on multiples levels targeting what Foucault (1979) refers to as 'interests of life'. According to Harwood, biopedagogies affect populations by transmitting knowledges. These knowledges are "attached to the shaping of identities and desires of life" (p.22). The contemporary mechanisms of health promotion, for example, that are taken up in every area of life utilize biopedagogies. With a focus on risk, lifestyle, and the responsible health conscious individual, they strive to regulate the population (Evans et al., 2008). According to Schilling (2008), 'body pedagogies' function to situate people into the 'health role'.

Within this role, Schilling argues, we are considered more productive and hence possessing more performative capacity. Such capacity is seen to enhance governmental power. As Schilling states:

> It is no longer just temporary or chronic illness preventing people from discharging their usual social roles that is deemed problematic but anything that interferes with individuals feeling, looking, and being at their best in a social milieu in which health is prized, expected and increasingly, demanded as a marker of productive efficiency (p. xii).

As sanctioned forms of regulating practices, biopedagogies, according to Wright (2009) push individuals and populations toward excessive surveillance and self-monitoring "often through increasing their *knowledge* around 'obesity' related risks, and 'instructing' them on how to eat healthily, and stay active" (p. 1). Within the present "totally pedagogical society" (Bernstein, 2001), Wright argues, biopedagogies are framed within the healthist perspective that emphasizes personal responsibility for health.

The term 'healthism' as coined by Crawford (1980) suggests that health, in contemporary society, has been positioned as a "supervalue" (p.365). Within the healthist paradigm, health is conceptualized as the ultimate goal in life that each individual is responsible to strive toward. Thus health has evolved into an ever-elusive target, what Crawford (2006) refers to as the "mirage of health", always visualized as something just beyond our reach. He argues that, "health may be reasonably described as a social cynosure, a meaningfully and emotionally charged fixation" (p.404). This fixation is centred on the individual. One can never be said to have achieved the 'healthy' status without significant work upon the body, work that is tied to notions of identity, risk, and citizenship (Gard & Wright, 2001). Thus within the present neoliberal healthist environment, we are expected as 'good citizens' to spend a substantial portion of our time and wealth in the 'pursuit of health'. This work is seen to bolster the power of a productive society (Elliott, 2007; MacDonald, Wright, & Abbott, 2010; Rawlins, 2008). Halse (2009) defines such a citizen as a 'bio-citizen', an active citizen whose identity "also derives from the disembodied, rational subject of liberal humanism a universal ethic of justice and a notion of the common good" (p. 51). One therefore is seen to have a moral and social responsibility toward working to develop and sustain a body that is representative of good health and hence the 'good citizen', one who works upon oneself in promotion of the common good (Guthman & DuPuis, 2006; MacKenzie, 2010; Share & Strain 2008). Those people whose bodies do not represent the 'disciplined' body (overweight or obese people as a primary example) are then marked as failed citizens (Elliott, 2007; Rawlins, 2008; Shugart, 2010). As LeBesco (2004) proposes, "Body type, citizenship, and moral type have been long linked: "beautiful" and "healthy" cluster to connote a "good " citizen, while "ill" and "ugly" put one in the citizenship doghouse" (p.55).

Utilizing this conceptualization of health, physical education and active living strategies are implemented within the school and broader environment to help 'produce' healthy citizens (MacNeill, 1999; Mc Dermott, 2007; Robertson, 1998; Kirk & Colquhoun, 1989, Macdonald, Wright, & Abbott, 2010). According to Petherick (2011), Health and Physical Education Curricula implemented in the school systems "incite particular modes of subjectification where students perform various practices of the self in becoming (or failing to become) good, self- governing biocitizens" (p. 14). Central to these strategies is the use of obesity discourse which positions obesity as being implicated as a central threat to the health of the population (Cliff & Wright, 2010; Jutel, 2005; Rail, Holmes, & Murray, 2010). As proposed by Wright and Dean (2007) for example, the obesity discourse functions within the healthist paradigm as a

> truth discourse which prompts strategies for intervention on populations and individuals. It also provides, through its manifestations in health promotion policies, the media and the school curriculum, instructions for the practices individuals need to engage in, the work they need to do on their-selves, in the name of their own and the life and health of the collective. (p. 80).

Strategies to promote the health of the population in effect are strategies that exert governmental control. As noted by Crawford (2004) control is largely exerted through the social construction of risk. Health risks he states expose the dangers of not acting in certain ways to achieve health. Thus as responsible citizens we are all charged with the responsibility of gaining 'knowledge' of health risks and hence gaining knowledge of what we can do to thwart such risks. Crawford states, "the constituting moment of health consciousness is acquiring or being exposed to information that conveys a sense of endangerment, along with a mandate to undertake instrumental actions for protection" (p. 507). The problem, according to Crawford, lies in the continual anxieties that such strategies and knowledge produce. For example, the more danger that is 'exposed', the harder we have to work to gain control over that danger and hence the more anxiety we feel in the possibilities of ill health. Control and anxiety therefore become "the twin siblings of health consciousness and action" (p. 506). One cannot be viewed to be health conscious without the accompanying health anxiety.

As Beck (1992) suggests, we are living in a 'contemporary risk society'. We are bombarded with information about health and other risks and our society is saturated with strategies to avoid and manage risk. In his discussion of the 'risk society', Beck distinguishes between the notions of risks and hazards. Hazards, according to Beck, arise out of natural occurrences that have the potential to do harm such as natural disasters (earthquakes, tornadoes etc.), whereas risks are viewed as social constructions evolving out of the process of industrialization. According to Beck, as our contemporary western society has moved into a position where the threat of natural hazards is viewed to be within our control, whether through early warning systems or quick response, we have moved on to the examination, calculation and attempted containment of man-made 'risk'. Risks, as Beck states:

> Induce systematic and often *irreversible* harm, generally remain *invisible,* are based upon causal *interpretations* and thus initially only exist in terms of the (scientific or anti-scientific) *knowledge* about them. They can thus be changed, magnified, dramatized or minimized within knowledge, and to that extent they are particularly *open to social definition and construction"* (p. 23).

While Beck highlights the uncertainty of knowledge in the area of risk he goes on to suggest that this knowledge has been constructed as certain through the use of 'expert knowledge'.

Giddens (as cited in Giddens & Pierson, 1998) supports this assertion, suggesting that risk is a form of "manufactured uncertainty" that "intrudes directly into personal and social life" (p. 210). Risk now permeates every facet of life and while we may work to confine risks, complete containment is never possible as risks are based upon controlling the future. The notion of risk sustains the contemporary neoliberal society because it works upon individuals. In this sense, behaviours can be measured and solutions or protective mechanisms can be prescribed. Through the medicalization of everyday life (Illich, 1975), we are taught to draw upon the expert knowledges about risk and to learn how we can work to negate threats to our health. Risks, in this sense are productive, as they constitute, "*a bottomless barrel of demands*, unsatisfiable, infinite, self producible" (Beck, 1992, p.23). This places those in a position to 'sell health' to prosper (Azzarito & Solomon, 2006; Heyes, 2006; Howell & Ingham, 2001; Moynihan, 2002; Rail & Beausoleil, 2003), thus bolstering the capitalist machine. Risk is also seen as a political issue as people become more sceptical of governments' use of expert advice and begin to questions and critique it (Gard & Wright, 2001). This questioning leaves people in a state of perpetual angst, as the limit of risk is never definitive.

Lupton (1999a) argues that through the practices of epidemiology (in which we draw upon so-called expert knowledge) and the creation of at-risk categories people no longer have to be examined as individuals to be considered at-risk. In the present risk society one only has to fit within the criteria that define an at-risk group to be considered at-risk. In being defined as members of this group "their future behaviour is gauged and the interventions that are judged to be required are based on the characteristics of the group" (p. 94). Obese people, for example, merely because of the assigned characteristics of the 'obese category', are judged to be inactive, overindulgent and in need of 'treatment' (Gard & Wright, 2001; O'Dea, 2005). They are viewed as 'risky bodies' who have not engaged in the proper behaviours that are conducive to the promotion of health and hence are viewed as moral failures. As Lupton (2006) states:

> As discourses on risk proliferate, more and more risk-avoiding practices are required of the 'good citizen'. Risk avoidance has become a moral enterprise relating to issues of self-control, self-knowledge and self-improvement. It is deemed people's own responsibility to take note of risk warnings and act on them accordingly. Those people who fail to engage in such behaviours may thus often find themselves stigmatized and subject to moral judgments (p.14).

Such classification, as Douglas (1992) argues, allows a community to maintain a certain degree of social order. When communities recognize and can articulate a specific threat based largely upon so-called 'expert knowledge' they can then work toward thwarting the source of risk. Blame, as Douglas asserts, is a consequence of the articulation of risk. She states, "danger is defined to protect the public good and the incidence of blame is a by-product of arrangements for persuading fellow members to contribute to it" (p.6). In the case of obesity, blame is placed upon the individual who stands out against the normative thin body. Blame is a direct impact of obesity discourse that places the responsibility of the body squarely upon the shoulders of the individual (Rail, Holmes, & Murray, 2010). It is thus vital in our consideration of the concept of obesity that we consider how the notions of risk and responsibility work upon people in their daily practices of life.

Fat Panic: The Obesity Epidemic as a Discursive Production

As noted throughout this literature review, Foucault's conceptualizations of power and the body are quite useful in examining the issue of obesity. As previously stated, while obesity is noted prominently within the positivist literature as representing a major threat to the health of the population (a theme that is reiterated through multiple social sites and institutions), there is also a growing body of literature that critiques this position. From a critical perspective it is argued that rather than viewing obesity and the physical ramifications as unproblematic 'truths', we must consider how this concept was forged through various social, historical and cultural relations (Beausoleil, 2009; Evans et al., 2008; Evans, 2010; Gard & Wright, 2001; LeBesco, 2004; Norman, 2009; Rail, 2009). We must explore how this notion is constituted through discursive practices, while exposing the role of hegemonic forces. We must also challenge the notion of obesity as 'scientific truth'. A number of authors, for example, have questioned the so-called 'scientific evidence' that suggests that overweight and obesity are greatly implicated in increased mortality rates (Boero, 2006; Evans & Colls, 2009; Gard & Wright, 2005; Campos, 2004; Campos et al., 2006; Gaesser, 2002). According to Campos et al. for example, obesity 'scientists' regularly blur the lines between overweight and obesity thus bolstering the statistics to support the notion of an 'epidemic'. They suggest that while people in higher obesity categories may have gained significant weight, "the vast majority of people in the 'overweight' and 'obese' categories are now at weight levels that are only slightly higher than they or their predecessors were maintaining a generation ago" (p.55). The authors contend that while there have been 'subtle' shifts in weight, the manipulation of the weight categories and the use of the Body Mass Index (BMI) as a measure of fatness have resulted in an over-exaggeration of heaviness of the population. This they argue functions to reinforce the dominant messages that equate health with body weight and bolsters the argument that obesity is literally a 'growing' problem. Interestingly, while it has been argued that 'fitness' is a better determinant of cardiovascular health than 'fatness' (Campos, 2004; Gaesser, 2002; Gaesser, 2003), the focus of public health efforts continue to be centred on the notions of obesity prevention and weight loss (Beausoleil & Ward, 2010; Fullagar, 2009; Rich & Evans, 2009).

Because of the intensity of the public health warnings related to obesity and the view of obesity as a self-induced, preventable disease within the individual's control, it is argued that we are now in the midst of a 'moral panic' (Campos et al., 2006; Rich & Evans, 2005; Saguy & Almeling, 2008). The use of alarmist discourse emanating from the field of obesity science, it is argued, has translated into an apocalyptic view of obesity that transcends medicine and injects itself into practices of everyday life (Boero, 2007; Gard & Wright, 2005). Within this view we are all called upon to battle the 'war on obesity' (Evans, 2010; Monaghan, 2008). As stated by Evans,

> The enemy – obesity (and by association overweight) – we are told (daily) is of epidemic (if not pandemic) proportions. Predictions for the future are therefore bleak and immediate dramatic action is presented as the only possible hope for the prevention of dystopian outcomes. These doomsday predictions are not just the stuff of shock journalism but they also pervade policy reports on obesity and shape policy action (p. 21).

Obesity is presented as a simple matter of excess energy intake on the part of individuals who are unwilling to expend the 'appropriate' amount of energy. Gard and Wright (2005) critique the common notion of weight regulation as a simple matter of balancing 'energy-in/energy out', stating that it utilizes the model of 'body as machine'. This model, they argue, is restrictive and short sighted in that it ignores the complexities of the human body and human experience. It also, they contend, ignores the effects of government and capitalism and it is "not so good at handling human differences such as cultural values, socio-economic class, ethnicity, gender, geographical location and age" (p.41). As noted by Rich and Evans (2005), such a model emphasizes thinness as a value and pushes people toward unrealistic weight loss goals. It places weight rather than health at the forefront and bolsters a system that produces fear of fat, the marginalization of fat people, and the exploitation of people for commercial gains (Gerbensky-Kerber, 2011; Jutel, 2009; Oliver, 2006). People who are viewed as being unable to achieve an appropriate energy balance (overweight and obese individuals) are considered to be at greater risk of disease and death and thus represent the future demise of the human population (Evans, 2010).

Intriguingly, while the majority of mainstream obesity studies continue to provide an alarmist view of weight in relation to energy imbalance and health risks, this contention has been called into question in a number of recent studies. In a longitudinal study by Orpana et al. (2010) for example, that measured the relative risk of mortality related to obesity in Canada, it was found that relative risk of mortality was increased only within the underweight and class II+ obesity categories, while overweight was actually considered to provide some level of protection against mortality. In other recent studies by Kuk et al. (2011) and Padwal, Pajewski, Allison, and Sharma (2011) utilizing the Edmonton Obesity Scaling System (EOSS), the authors have concluded that one can be obese and present with a 'normal' metabolism hence exhibiting no greater risk for morbidity or mortality than a person of so-called 'normal' weight. It was also noted that for these people, weight maintenance versus weight loss may be the preferred medical recommendation. Others have considered the impact of environment on the evolving issue of chronic disease. Egger and Dixon (2009) in their article entitled "*Should Obesity Be the Main Game?"*, for example contend that it may not be obesity per se that increases one's risk of disease, but rather an environment that promotes certain inflammatory processes. They state, "not all fatness indicates disease risk and not all leanness indicates lack of risk" (p. 239). The authors point to a modern lifestyle that implicates food, activity, stress, sleep and a variety of other factors in disease formation. While Egger and Dixon still contend that obesity is a problem, these authors also suggest that obesity may have become an outward marker of environmental changes that promote disease. This, they argue, explains why campaigns focussed on obesity are not serving to improve the health of the population. Interestingly, they contend that because of our intense focus on obesity, we may be neglecting a substantial portion of the population at-risk because they are represented within the normal weight category.

The use of the Body Mass Index (BMI) as a measure of fatness and hence a measure of health has also been critiqued by many critical obesity researchers (Evans & Colls, 2009; Gard & Wright, 2005; Jutel, 2011; Kirk, 2006; Monaghan, 2007). While recognized by the World Health Organization as a valuable tool in the measurement of obesity, the BMI, which is based upon the ratio of height to weight, has been critiqued as, in effect, it does not measure adiposity or fatness (Gaesser, 2002; Gard & Wright). Even though it is more suitable from an epidemiological standpoint as a population measure, it is consistently utilized as a means of measuring individual fatness and diagnosing the 'condition' of obesity. While even researchers within the realm of mainstream positivist obesity research acknowledge that BMI is not an ideal measure, it continues to be utilized as a measure of fatness upon which alarming claims about obesity are made (Jutel, 2011). It has also been argued that the BMI is particularly problematic in relation to childhood obesity, as BMI must also take into consideration the age of the child (Evans & Colls, 2009; Kirk, 2006). As stated by Gard and Wright, "it is not suitable for assessing body composition in children" and it "does not account for what seems to be natural age-related changes in body composition" (p.93).

Evans and Colls (2009), drawing upon the work of Foucault, contend that the BMI is a biopolitical tool that functions to simultaneously monitor the population and individuals, defining what constitutes 'normal'. They state "the surveillance of children's BMI can therefore be considered an example of a biopolitical mechanism fundamental to the governance of fatness" (p.1055). Hence, the BMI is utilized as a springboard from which the state can define what is normal and provide instruction on how to achieve that 'normal' or 'ideal' body weight. As Gaesser (2002) notes, for example, BMI cut-offs that determine what is defined as normal, overweight or obese are arbitrary, "refusing to take into account the considerable and natural variations in human body size and shape" (p.105). He goes on to argue that the height-weight tables which were introduced by a major insurance company to determine clients' level of insurability, in fact provide very little insight into the impact of weight on morbidity and mortality.

Jutel (2011) illustrates the arbitrary nature of weight standards in her discussion of how what is considered 'ideal weight' has changed over the years. For example she states, "from 1942 to 2000, no fewer than 18 different "ideal," "desirable," "normal," "suggested," "acceptable," or other categorical formulations for weight were implemented by a range of official classificatory documents" (p. 200). She goes on to state that even within the timeframe of the use of BMI the 'acceptable' categories continue to change. "From 1990 to 2000 the upper limit of healthy weights has changed from 27.8 kg/m2 to 24.9 kg/m2 and has variably modified its cut-off range for healthy weight on the basis of age and gender" (p.200). The continued use of the BMI, as argued by Evans (2010), remains a mechanism of governmental power to simultaneously control populations and individuals. The author suggests that the BMI is utilized as a measure to classify obesity as a "pre-emptive" or "virtual disease" (p. 21). This, she contends, allows large people to be classified as "asymptomatically ill" thus bolstering the power of governmental policies that employ notions of risk and insert themselves into people's everyday lives to provoke them to work upon their bodies to prevent 'future' illness. This argument is particularly pertinent in relation to childhood obesity as children are viewed as 'adults in the making' and they represent the future. This serves to intensify the present 'moral panic' around obesity as it provokes fear of future health ramifications and suggests that we need to act now to protect our future existence.

Gard (2009), while supporting the claim that we may be in the midst of a moral panic over obesity, contests Campos' view of the 'obesity epidemic', however, as a deliberate and in some ways corrupt production on the part of obesity scientists and those within the capitalist machine that may stand to profit. Rather than consider the obesity epidemic as an intentional fabrication Gard postulates that the 'panic' arises from scientists who may have good intentions. The knowledges that are produced he argues are developed by people within their own ideological perspectives. Thus they most often do not view the world or value the 'evidence' outside of these perspectives particularly those perspectives that have gained power within a particular 'Regime of Truth'. Researchers therefore draw upon evidence that is consistent with their own paradigms. They utilize this evidence in constructing their own arguments and in doing so they reinforce and maintain certain ideological positions. While Gard argues that the effects of the discursive construction of obesity may not always be intentional however, Rail, Holmes, and Murray (2010), question the intentionality and suggest that they do inflict harm. They state,

> the fabrication of 'evidence' in obesity research constitutes a good example of micro-fascism at play in the contemporary scientific arena. Favoring a particular ideology and excluding alternative forms of knowledge, obesity scientists have established a dominant 'obesity discourse' within which obese and 'at-risk' bodies are constructed as lazy and expensive bodies that should be submitted to disciplinary technologies (for example, surveillance), expert investigation and regulation (p.259).

Research that un-problematically emphasizes the alarming nature of the so-called 'obesity crisis' and calls for a 'war on obesity' positions fat as the enemy. It is argued that this invariably leads to a view of fat people as something to be scorned, ridiculed, and even hated and feared (Boero, 2007; Evans, 2006; LeBesco, 2004; Monaghan, 2007;

Rice, 2007). Obesity becomes an outward marker of a lack of control. As stated by Evans et al. (2008),

> in the blame the victim culture which this nurtures, fat is considered an outward sign of neglect of one's corporeal self; a condition considered either as shameful as being dirty, as irresponsibly ill, in effect, reinforcing and institutionalizing moral value beliefs about the body and citizens (p.38).

The fat body is thus open for visual appraisal. It is said to expose its own 'truth' and due to the nature of the obesity discourse, everyone is considered to possess knowledge related to obesity. "We read a fat body on the street, and believe we "know" its "truth"; just some of the characteristics we have come to assume define fatness are laziness, gluttony, poor personal hygiene and lack of fortitude" (Murray, 2005, p.154). While there is substantial evidence to suggest that thinness does not necessarily equate with 'good' health, this evidence is suppressed within a framework that glorifies the thin body (Jutel, 2005). Murray (2009) draws on the work of Grosz (1994) in highlighting how bodies are coded and read by others; how they are "marked as pathological" (p.74). The 'fat' body, she contends, because of the healthist obesity discourse, is read by others as weak, irresponsible, and morally lacking. It becomes a "virtual confessor" as this reading translates into the " "forced confession" of a deficient self residing in a 'fat' body" (p.75). The body she argues is considered to be a visual manifestation of one's "moral investment in 'health/morality'" (p.75). It is said to provide insight into a person's subjectivity.

In this way, the 'obese' subject is immediately 'known'; the 'fat' flesh of one's body has already silently performed a confession. This confession is one of necessary pathology, indulgence and excess, and before the 'fat' subject even speaks, this confession is produced as truth" (p.75).

Chapter Summary

While there are a multitude of factors that contribute to weight status and identity of 'obese' people including genetics, socioeconomic status, gender, and physical environment to name just a few, the present obesity discourse must also be implicated as it is explicitly linked to a dominant healthist view that suggests overweight or obese people are in some way failing themselves and society (Halse, 2009; LeBesco, 2004; O'Dea 2005). While researchers may not set out to intentionally reproduce or reinforce this view, it is argued that the present evidence-based approach to obesity research and practice has consistently marginalized overweight and obese people, producing both fear of and disdain for fat (McDermott, 2007; Moffat, 2010; Rail, Holmes, & Murray, 2010; Saguy & Ameling, 2008). Thus I conclude this chapter in much the same way that I introduced it, by recognizing that there are valuable insights to be drawn from various types of research but also recognizing that we must approach this research with a critical eye. I recognize that the literature that I have presented in this chapter was conducted and 'written up' by those not from a perspective of 'objectivity', but from the perspective in which they have been schooled. While research can inform our practices and the way we see the world, it can never be truly 'objective' (Harding, 2007). My presentation of the critical literature is not done in an attempt to negate the positivist obesity literature but rather to emphasize how we 'come to know' and how our own ideological foundations steer us in specific directions in terms of research and what we view as 'truth'. I contend that we rarely stop to contemplate how knowledge is produced in our given fields. We are provided with training and education that immerse us in the frameworks or perspectives from which we interpret the world and reproduce certain "Regimes of Truth". Murray, Holmes, and Rail (2008), for example point to Foucault's notion of '*episteme*', which they define as " the accepted and dominant manner of gaining and organizing knowledge in a given period" (p.274). Such ways of knowing determine how we come to view the world and hence how we analyse events within that world to draw conclusions; conclusions that impact directly on people's embodied experiences. Those paradigms that become dominant through mechanisms of history, culture, and various social relations are utilized and reinforced through the very institutions in which we are educated and cared for within our communities. They come to determine what constitutes 'knowledge' or 'evidence'. They provide systems under which we learn to examine the evidence and utilize it in our practices. Thus we have come to a point where often we cannot come to see the world outside of the parameters of our own epistemological position (Monaghan, 2010).

While the purpose of this dissertation is not to provide a critique of evidence-based practice, I do feel it is important to acknowledge and draw attention to the ways 'evidence' is produced and the implications such dynamics have on the embodied experiences of people in their everyday existences. I contend that knowledge production is never apolitical and is always grounded in the ideological perspectives of those conducting, funding, disseminating and utilizing research. It is therefore vital that we open up a conversation that allows us to question the evidence, not basing our practices on research 'findings' that we take at face value. We must not merely accept the literature as 'objective truth' that is not contestable, but we must examine it, consider how it is produced, to whose advantage and to whose disadvantage. As stated by Murray, Holmes, and Rail (2008), "in the face of a strategic fundamentalism that closes off debate, we must be mindful to resist in such a way that we open up critical debate and question those mechanisms that work to seduce us into complacency" (p.277).

While I have presented literature in this chapter that is derived from a number of fields including medicine, sociology, psychology, nursing, education, cultural studies and more, it is my hope that by considering them in light of their role in the production, examination and critique of obesity discourse that they illuminate the subject, they point to the diverse ways of examining the issue while also elucidating the restrictions produced by ideological constraints. As a nurse, I have become frustrated with the way that nursing, in striving toward recognition as a 'profession', is placing increasing emphasis on the notion of 'evidence based practice' and the intense focus on the production and utilization of scientific 'nursing knowledge', often to the exclusion of research from other fields (Gastaldo & Holmes, 1999). It is from reading outside of the realm of nursing literature, from practicing interprofessionally, and from my introduction to the poststructural perspective that I have come to appreciate different ways of knowing and have found the tools to critically examine my own conceptions of research, and human experience. While we may be constrained by our positions within certain regimes of truth, however, I must note that we also have the ability to resist and reposition ourselves in ways that allow us to reflectively critique our own positions. As stated by

Gastaldo and Holmes (1999), "the specificity of nurses' expertise is related to the production and dissemination of a regime of truth, but this same power/knowledge could be exercised to promote a different regime of truth for a community or a society" (p.238). It is from this perspective that I began to envision my doctoral research. Within the following chapter, I outline my research methodology that takes into consideration the role of the co-construction of knowledge in the research process while elucidating the important role that reflexive feminist research can play in exploring the embodied experiences of children defined as obese.

CHAPTER 3

METHODOLOGY

"Using a nontraditional method provides a way to see things that have been obscured by the repeated application of traditional methods- all ways of seeing are also ways of not seeing."- (Phillips & Hardy, 2002, p.16).

The ways our ideas about the world and the manner in which those ideas ultimately frame how we think and interact are complex and always evolving. The investigation or exploration of peoples' interactions and how we take up the more dominant or hegemonic messages in society that are forged through dynamic power relations is challenging, but as I have discovered, worthwhile. I entered into this research with the belief that my study would not necessarily reveal a "true" reality of the children involved but rather that I might gain insight into how language comes to constitute their reality. Using a qualitative feminist post-structural design, I was interested in how the children used the discourses at their disposal to forge social relations and a sense of self. Like other post-structural researchers I was interested in examining the text in its broadest sense including written, spoken and other expressions of the interplay of people and discourses and the manner in which they are utilized, negotiated and resisted by people in their daily experiences (Gannon & Davies, 2007). In keeping with this approach, I recognized the value of utilizing multiple research tools. The use of multiple research methods allowed me to reflexively explore the ways in which meaning is produced or shaped for these children through the lens of the social present that I recognize as being greatly influenced by the social history. It was important to me that this study was designed in a fashion that is sensitive to the experiences of the children while providing them with a comfortable means of sharing. Darbyshire, Macdougall and Schiller (2005) suggest that when researching children, the use of multiple methods is beneficial as they state such a design respects "children's agency as social actors and active participants in the creation of their own world of meanings" (p.430). As children are often silenced in our society, particularly children who do not fit the prescribed ideal, interviewing these children and allowing them to express themselves through various means including interviews, focus groups, and visual representation through art, I feel allowed their voices to be heard and hopefully reinforced the meaningfulness of their experiences. As Birbeck and Drummond (2005) argue, we should be open to the voices of children. "We must embrace what they have to say and find a better way to listen, understand and interpret their meanings. Ultimately children should be seen and heard" (p.595).

A qualitative approach was therefore essential in allowing me to explore the embodied experiences of my study participants. Qualitative research, according to Hesse-Biber and Leavy (2004), is a "distinct field of inquiry that encompasses both micro and marcoanalyses, drawing on historical, comparative, structural, observational, and interactional ways of knowing" (p.1). The use of a post-structural feminist approach with attention to the children's embodied experience allowed me to move beyond the description of how these children function in the midst of the so-called "obesity epidemic", to explore how they negotiate and resist dominant discourses that permeate every institution which influences their daily lives, and to examine how these discourses are produced, reproduced, and challenged. This type of research is particularly useful in studying the experiences of children as it provides the researcher with an opportunity to actively explore the meanings of social experiences with children, removing the assumption that as adults we can know for children (Darbyshire, MacDougall, & Schiller, 2007). From the feminist post-structural standpoint the researcher places emphasis on the "other" and the power relations at play that serve to oppress those in marginalized positions in society. The goal, as Aranda (2006) suggests, is to "create a space to allow the voices of marginalized groups to be heard" (p.8). It is my hope that my research has allowed such a space.

In this chapter, I will provide an overview of the research process undertaken in this study. I will describe how I employed an ethnographic approach within an obesity treatment program for children, utilizing multiple methods to explicate how children negotiate the messages that conflate health and thinness, and produce and promote a pervasive desire for the normative body. As post-structural and feminists researchers are concerned with the meaning that people derive from their lived experiences, they most often utilize multiple tools in exploring and challenging dominant or hegemonic discourses (Hesse-Biber, 2007). These methods do not have to be distinct to feminist research. Rather "what matters in defining feminist research methods is how feminists actually theorize, characterize, and depict research as a feminist activity and how they make the methods themselves integral to this research" (Moss, 2007, p.372). This is particularly important when researching children. Darbyshire, Macdougall, and Schiller (2005), for example, suggested when conducting research with children that multiple approaches complement the information being elicited while allowing the child to express their experiences with recognition that there are numerous and diverse ways of making meaning in the world. The data may be collected through the use of a number of diverse methods including interviews, focus groups, participant observation, writing, art, photo elicitation, dance and other sometimes unconventional modes of research. Within my research study a number of methods were utilized including: ethnography using participant observation and field notes, semi-structured interviews with the children and program coordinators, focus groups with the children and their parents, and an art project for the children. In this chapter, I will also highlight the important role of each of these methods and how they contribute to a broader understanding of how these children utilize and resist the dominant health discourses. Finally, I will emphasize how throughout the process I sought to acknowledge the meaning and importance of the children's experiences with ongoing reflection on my role in the co-construction of meaning.

Setting, Recruitment, and Selection

As discussed previously in my review of the literature, the majority of obesity treatment programs focus primarily on weight loss as the ultimate goal. When contemplating how I would design my study, I was intrigued by the approach to obesity treatment taken by the program utilized in this study. While recognizing that the children who are referred to this program have been identified as obese and are often presenting with health threatening symptoms which must be addressed, the program coordinators also recognize that the dominant obesity discourse, which is so pervasive both in medical and broader social environments, may be having a negative impact on these very children. The treatment program has thus been designed using a multidisciplinary approach that promotes positive self-esteem and body image while limiting focus on weight and measurement. Dominant beliefs about weight and health are challenged while an acceptance of natural sizes is reinforced. Parents are also involved in the program, as it has been recognized that they impact and are impacted by the concerns of their children and play a key role in their children's developing health attitudes (McGarvey et al., 2004). Considering this alternative approach to obesity treatment while also recognizing that from a critical perspective, the "treatment" of obesity is a more recent construct that has been forged within the dominant individualistic health driven paradigm, I felt this program was an appropriate setting for my research. Not only could I examine how these children negotiate the dominant discourses around health and the body but I could also examine the interplay of these discourses with alternative discourses that are introduced through the program. I also would have the opportunity to speak with the parents as they play a significant role in their children's lives and their evolving sense of self.

I approached the program coordinators (a clinical child psychologist and paediatric endocrinologist) and provided them with my perspective and rationale for the study. I met with both coordinators to discuss the study and its implications for their program. I received approval from the coordinators to conduct the study within the program with the expectation that full ethics approval would be achieved. There were 11 children enrolled in the program at the time of my study, ranging in ages from 10 to 16. The program activities took place in a number of settings. The primary setting was located within a children's hospital itself. Most weeks the participants and their parents/family members would meet in a designated room. This room was designed much like a classroom with chairs and a white board at the front of the room. It comfortably housed the children and their parents/ family members. The first portion (15 minutes to 30 minutes) of the 90 minute session would take place in this room. This usually consisted of a combined education period for parents and children conducted by one member of the facilitation team (psychologist, physician, dietician or social worker). Following the introduction to the session the group would split into a parent group and a children's group. I remained with the children's group throughout duration of the program with the exception of one session when I conducted the parent focus group. Activities did take place outside the hospital for two of the sessions. These sessions included outings to a wall climbing gym and a session at a local grocery store. On these particular days the families would meet at the facility in a designated area before the beginning of the session.

Once ethical approval was granted by both the University and hospital based ethics committees, parents of the children and the children themselves were provided with an overview of the study and given the opportunity to participate. This overview included a description of the background and rationale for the study along with a clear description of the study objectives and the type of data collection that was to take place. The program coordinators provided an introduction to the research to parents upon the first session. Following this brief introduction, I was given the opportunity to speak with parents and children and I provided them with time to answer questions related to the research. As well, parents and children were provided with my contact information, including phone number and email to allow them to ask questions outside of program allotted time. Prior to the following session parents and children were given the opportunity to sign consent forms for the interviews and focus group (see Appendix A for child consent form, Appendix B for parent consent form). One participant did not sign consent to be interviewed or participate in the focus groups. She did not, however attend, on the days of the focus groups and was absent for the majority of the sessions. I also provided a clear overview of the study with a description of study objectives to program coordinators and explained that they may also be interviewed in an effort to explore the meaning that they derive from their interaction with the children, and the way they utilize both dominant and alternative discourses with the children. Observation did not pose a barrier to data collection as permission was granted by the program coordinators and the ethics review committee. Since all participants involved in the program on the days of the focus groups provided consent, the focus groups were conducted during the program time. This was done with the permission of the program coordinators. Also some interviews were conducted during program time when independent activities were taking place. Other interviews that could not be facilitated during program time due to time constraints were conducted outside of the program timeframe.

Data Generation

Ethnography

From the post-structural perspective, data is not collected but generated (Aranda, 2006). This is reflected in the DeVault and Gross (2007) description of research as "an apparatus of knowledge production" (p. 192). In considering the role of discourse in the production of knowledge and the emerging identities of children enrolled in the treatment program, I felt I needed to bring myself closer to this discourse through active participation in the program. Through the application of an ethnographic approach, being present during the 11-week program and actually participating in the program activities, I gained further insight into how these children not only negotiated the broader discourse but how they brought their knowledge of the discourse into this particular setting and the interactions that took place there. I took the opportunity to observe, participate and dialogue not only with the children but also with the parents and program facilitators. Delamount (2004) described ethnography as a qualitative method in which participant observation and fieldwork are integral modes of data collection utilized to gain insight into the lived world of the participants. The ethnography itself, according to Delamount is a written reflection of the culmination of observations and experiences within the particular field of research.

> The ethnographer participates, overtly or covertly, in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions; in fact, collecting whatever data are available to throw light on the issues with which he or she is concerned (Hammersley & Atkinson, 1983, p. 2).

By immersing myself in the program, I hoped to forge relationships with the participants to effectively begin to learn about the embodied experiences of these children given their position within the dominant discourses around health and the body. Feminist research is unique in the attention it pays to the researcher/participant relationship (Pillow & Mayo, 2007). The examination of the relationships becomes part of and integral to the research process. This is particularly pertinent when conducting ethnographic research. As Pillow and Mayo suggest, the examination of these relationships in ethnography when one is an observer and a participant "makes visible the questions, complexities, and processes of doing research" (p.163).

Participant Observation and Field Notes

Throughout the 11-week program, I participated in a number of program activities. At certain times I helped facilitate activities while at other points in time I completed the activities with the children. The children were open to my participation and seemed pleased when I completed the tasks they were assigned to do. Throughout the time I spent with them I asked questions and sometimes had the opportunity to guide discussions. At other times I listened to the children and did not interject in their conversations. I observed not only the conversations but also the nonverbal elements of the interactions. I struggled with what Emerson, Fretz, and Shaw (1995) refer to as the "active enterprise" of ethnographic research that incorporates the "dual impulses" of striving to forge relationships while learning how to fairly represent the experiences in written form (p.15). I chose not to take obvious notes during the sessions so as not to hinder the children in their activities. While they were reminded on occasions that I was observing them for the purposes of research, I felt the overt action of note taking might be intimidating and inhibiting to some. In the evenings and days following each session I would take extensive notes and while doing so I would reflect upon my position in the group and how that impacted upon the interactions and the knowledge produced. According to Emerson, Fretz and Shaw,

> producing a record of these activities as close to their occurrence as possible preserves the idiosyncratic, contingent character in the face of the homogenizing tendencies of retrospective recall. In immediately written fieldnotes, distinctive qualities and features are sharply drawn and will elicit vivid memories

and images when the ethnographer rereads notes for coding and analysis (p.14).

The following excerpt from my fieldnotes illustrates how reflections upon my emotions leading into the initial focus group with the children, as well as detailed description of the room and the children's position served to enhance my memories of the interactions and fill in spaces (the gestures, the body language, the environment) that the audio recordings leave void.

> *Preparing for the initial focus group I was a little nervous as I was unsure whether the kids involved would be prepared to have an open discussion with me. I entered the room painfully aware that I was a middle-aged woman who the children already identified as a health professional and mother to whom the children were only briefly introduced in the previous session. They looked at me with expressions of curiosity while I described what would be involved in the focus group session as I had done last week... I suggested that we all sit in a semi-circle. Most agreed and moved their chairs closer to me and to the white board which we would use for the desert island activity which I had planned. One boy – Pete sat reclined in a chair with his legs over another chair forming a boundary between himself and the remainder of the group. Three other boys clustered together chatting while two girls sat to themselves in the opposite corner.*

The use of detailed notes such as these provided me with a vivid recollection of the events as they had taken place. The description of the room, the position of the people and a written reflection of my thoughts at that time helped when I returned to the text. In describing my feelings upon entering the focus group session, for example I can further consider how these feelings served to frame how I lead that particular session. As Emerson, Fretz, and Shaw (1995) suggest, the ethnographer should "document her own activities, circumstances, and emotional responses as these factors shape the process of observing and recording others' lives (p. 11). The ethnographer they argue should not separate what she says and does from the observations as such separation "distorts processes of inquiry and the meaning of the field 'data" and treats the data as "objective information" (pp. 11-12).

Interviews

As a component of the research study I also chose to conduct semi-structured interviews with a smaller number of the children and the program coordinators. While interview guides were developed for these interviews and I had a general idea as to what I wanted to explore, I entered into this process with the recognition that the interview process is not simply a process of discovery. As a researcher I am always aware that the information recorded during an interview or focus group session is a co-construction of knowledge between the interviewees and me. As Rapley (2004) points out, we may never be able to know the real experience of people. Interviews, however, do provide the opportunity to explore how people experience their lives and allow the researcher to become an active participant in the co-construction of knowledge. The researcher in this context must be open to the "flexibility and productive powers of language; the subtle shades of meaning conveyed through the nuances of speech, gesture, and ... the ineluctable locatedness of any moment or stretch of talk" (DeVault & Gross, 2007, p.173). With this in mind I was able to conduct a total of 7 interviews with the children.

As with other the forms of data generation within this study, the children were informed that they would not be identified and that I would use pseudonyms (which I defined for them and gave them the opportunity to choose). Also, in an effort to ensure that children were not identifiable, some of the specific sports and activities discussed were slightly altered. As these children are in a vulnerable position it was important to them and to me as a researcher that anonymity was preserved. Four of the children were interviewed within the first 2 weeks of the program and three of those four were interviewed following the completion of the program. One of those participants did not return my request for a follow-up interview. The interviews took between 30-45 minutes and were framed upon a number of open-ended questions as outlined in the interview schedules (see Appendices C and D). The follow-up interview provided an opportunity to revisit some of the issues that arose in the first interview and an exploration of the various facets of the 11-week program including the introduction of alternative health discourses. Although I did not manage to complete a follow-up interview with one child, Jordan, she was present and quite vocal at the final focus group session. This allowed some insight into her feelings in relation to the program and her ideas about health and the body upon completion of the program. I do recognize that this discussion occurred in a group environment and thus what was produced may have been quite different than that produced from a one on one interview.

Each interview was digitally recorded and transcribed. Although as Patton (2002) suggests, the recorder is an indispensable tool for evaluators using qualitative methods as it allows the interviewer to be more attentive to the interviewee, I do recognize that it does not replace good notes. Within the interview I took minimal notes so as not to detract from the interaction with the interviewee. Immediately following each interview I wrote detailed reflections of the interviews. Also, Diamond, as cited by Devault and McCoy (2002) posits that interview texts, although important to the research process, should not be considered in isolation of the presence of the person. The notes therefore were taken with specific attention to body language and eye contact that cannot be captured by voice recorder. Field notes were kept throughout the duration of the program with an effort, as Green and Thorogood (2004) suggest, to describe what is happening, who is involved and how meaning is being produced through interactions within the given setting and social context.

Focus Groups

Each child also had the opportunity to participate in two focus group discussions related to their ideas of health, weight, fitness, the body, and other issues they felt were pertinent to their experiences (one early in the program and one later in the program). Wilkinson (2004) suggests that focus groups are effective when the researcher is interested in investigating people's beliefs or opinions because they allow the researcher to both observe and participate in the co-construction of knowledge as this co-construction is reflective of the way people interact to construct knowledge in their everyday lives. While focus groups have not been used with children until recent years, "the development of this type of methodology can be seen as part of a process of trying to research with children rather than on children" (Dixey, Sahota, Atwal, & Turner, 2001, pp.208-209). Dixey et al. also note that children are aware of the power relationship between adults and children. The researcher therefore must remain cognizant of this relationship and foster an open comfortable space for the children while recognizing that a natural setting can never truly be realized in focus group research as the participants are aware that the discussion is happening for a prescribed purpose in a situation that can never be perfectly natural (Green & Thorogood, 2006; Kirk, 2007). While the children appeared comfortable in the focus group sessions, I did remind them of the reason for my presence, that the discussion was completely confidential and their names would not be attached to the transcripts. I explained to them that pseudonyms would be used and gave them the opportunity to choose the name they would like to see associated with them. I also reassured them that they could withdraw from the sessions at any point and did not have to discuss anything that made them feel uncomfortable.

It is important to create a comfortable environment for the children. Following a suggestion by Gibson (2007), I began the first group discussion with an icebreaker activity. During this time I engaged the children in an activity which was designed to get them thinking and moving. This activity, according to Gibson, does not have to be directly related to the research but can include elements of things to be explored. I thus began the first focus group with a "desert island" scenario. The participants were asked to list three things they would need to feel good and healthy if trapped on a desert island. They were also asked to write these down on a whiteboard and come to some agreement about what they should take as a group. This type of activity, as Gibson suggests, can enhance comfort levels and participation as it allows all participants the opportunity to speak in the group setting while promoting cooperation and sharing. The children were very receptive to this activity and seemed to enjoy the interaction and challenge inherent in it. To my surprise, they began to discuss some of the things I had outlined in my interview schedule, often without prompting. For example, the children in considering what they would need to be healthy if stranded on a desert island began a discussion about 'junk' food versus 'healthy' food. Nicholas suggested for example that they would have to follow Canada's Food Guide stating "*I do want healthy food there*" while Pete suggested there was room for both types of food stating "*I'd probably like healthy food and junk food... I'd definitely want meat. If you're stranded, you kinda want to put on the calories a bit*". The desert island scenario thus prompted them to begin a discussion about what constitutes healthy or unhealthy foods and the role the concepts of fat and calories play in the drive to be healthy.

Parents were also provided with the opportunity to participate in a focus group session toward the end of the program to provide feedback that highlighted their perceptions of their children's self esteem, and identity, and how they and their children negotiate both dominant and alternative health discourses. Parents are in a distinctly important position as they have the ability to provide great insight into the experiences of the child, the child's view toward themselves and others, and how they grapple with the obesity and health discourses. Also, in sharing information on the experiences in the treatment program, they may provide insights into the impact of the program. As it has been noted that programs that demonstrate positive outcomes in relation to self-concept and self-esteem most often are those that have parental involvement (Edwards et al., 2006), it was important to gain information regarding the parents' experiences. The focus group took approximately 1 hour and was framed upon a number of open ended questions as outlined in the interview schedule (see Appendix G). It consisted of all mothers which was reflective of the program attendance overall and illustrated the gendered nature of supporting and promoting healthy lifestyles for children and the responsibilities that are placed upon mothers (I provide a discussion of biopedagogies and the mothering experience in Chapter 5 of this dissertation).

The mothers were very receptive to discussion and eager to talk about their children, their experiences as women and mothers, and their children's experiences of living in a so-called "larger body". I found this experience to some degree more challenging than the focus group with the children in that I found it easier to instruct the children to "take turns" than I did the parents; a point I had to reflect upon during and following the session. I recognized that the power positions at play are different than with the child group. It may be that the children recognized my position as the adult in the room who was in 'control' of the session and thus the sessions functioned much like other classroom type situations in which they have learned to take turns and defer to the adult who is directing the session. I also considered the fact that the mothers rarely have the opportunity to speak openly about their children's experiences in a group of people with similar experiences. The focus group provided an outlet for which they have not had that opportunity previously. The eagerness to speak therefore was evident as they often interrupted and spoke over one another during the session. This speaks to the need for more research in the area of mothering and biopedagogies, particularly for the mothers of children who do not fit the desired health related norms.

While the experiences of facilitating the focus groups were very different and ultimately the data generated was very different, I did recognize that I must consider these experiences within the context of which they were produced (Green & Thorogood, 2004). I paid specific attention to the dynamic in the room and how the participants interacted with me, and the fellow participants. I tried to remain cognizant of my position and how that may be interpreted. This I knew would be important in the process of data analysis. I needed to be concerned with not just what the words in the final transcripts reflected but what they produced, and how the mothers in the room constructed themselves and their children in relation to the dominant discourse and the program.

Art Project

Given the value of using multiple methods with children, as previously discussed, I also asked the children to participate in an art project. Art as a research technique has gained recognition within recent years (Barker & Weller, 2003). As Levick and Wheeler (cited by Van Tilburg, 1987) state " anything created by someone - a drawing, a painting, a piece of sculpture-is a nonverbal message from the creator about the inner self and that artist's world" (p.1). Art, therefore, may be viewed as another expression of meaning through experience and was helpful in eliciting ideas from the participants on their experiences as 'large' children. "This is important, as art-based techniques and activities can be a powerful medium through which children can express their views across a wide range of the developmental continuum" (Coad, 2007, p.487). The children also had the opportunity to display and discuss these projects within the group. A discussion of the art project was also integrated into the final focus group that occurred the following week.

For the purpose of this project the children were given the opportunity to create a collage or a drawing. I allowed the children a choice of art techniques as some children may not feel skilled at drawing or they may feel this is a task for younger children and this can introduce pressures and unintended stress. According to Coad (2007), the researcher does not have to be particularly skilled in art but must instead be cognizant of the critical elements of art-based research and ensure the task is well planned in advance of implementation. I reviewed a number of articles in relation to art-based research and consulted with the program psychologist who is experienced in this type of activity with children. She was available throughout the activity should children have questions or if the art should elicit any upsetting emotional response. While this was an opportunity to create comfort between the researcher and participant it must be recognized that while the researcher should be present to monitor and guide the activity, the control should lie in the hands of the children. I purchased a large array of materials that would allow the children to explore their ideas in an artistic manner. The children were provided with all materials and allowed independence in creating their artwork. Materials included magazines, markers, paints, colouring pencils, coloured Bristol board, regular scissors, edging scissors, glue sticks and sketch paper. I moved throughout the room and spoke to the children while they were creating their projects. They were eager to discuss their methods and the messages behind the art. Deacon (2000) suggests that the researcher should become involved in the project as well stating that "the purpose behind many of these methods is to find ways to make living systems actually come alive; to not only hear, but to see the stories behind the participant's perception and experiences; to not only observe, but to actually become a part of that which we as researchers are studying" (p.2).

Data Analysis

Data analysis in qualitative research is concerned with more than an 'objective' reporting of data, rather it is concerned with telling the story of participants and extrapolating meaning from those stories with a recognition that the stories are produced within a broader social context (Green & Thorogood, 2004). Analytic techniques are influenced by the research questions as well as the epistemological standpoint of the researcher. Considering the methodological underpinnings of this research, I began my analysis with the perspective that the discourse highlighted within the research was constitutive of the social world known to the participants. As stated earlier, I was not seeking to reveal the 'truth' in relation to the children's experiences but rather I wanted to explore how their reality or 'truth' was constructed through their interaction with the discursive resources available to them. From a poststructural perspective, these resources open up various subject positions in which the children can locate themselves. I was concerned with examining the text to explicate how the participants used language to construct their ideas of health and sense of self within the context of broader social phenomena related to health, and the regulation and surveillance of the body. With this in mind I felt it was appropriate to utilize critical discourse analysis as a means of analysis. This analysis, as noted by Baxter (2002), is not merely about deconstructing discourse, it is about releasing " the words of marginalized or minority speakers in order to achieve the richness and diversity of textual play that only emerges from the expression of different and competing points of view" (p.9). This form of analysis, as noted by Flairclough (2001),

> provides a way of moving between close analysis of texts and interaction, and social analysis of various types. Its objective is to show how language figures in social processes. It is critical in the sense that it aims to show non-obvious way in which language is involved in social relations of power and domination, and in ideology (p.229).

I was concerned with how the language of health, fitness and the body serve to frame the ways these children view themselves and those around them and how these views impact the way they live and interact with others. Derived from poststructural and feminist theory, such analysis is "the process of capturing regularities of meaning (patterns in language use) as these are 'constitutive of discourses, and to show how discourses in turn constitute aspects of society and the people within it" (Taylor, 2001 as cited by Wright 2004, p.40). As Phillips and Hardy (2002) suggest, it

> focuses on the distal context -how it privileges some actors at the expense of others and how broad changes in the discourse result in different constellations of advantage and disadvantage, particularly within the Foucauldian tradition (p.25).

Critical discourse analysis hence helped me within this research to examine how subjectivities are formed in and through the discourse while simultaneously making visible the power relations that make such discourses workable and apparently 'natural'.

Using the description by Rail (2009), this type of analysis allowed me to explore how these children constructed their own identities within both "dominant and resistant discourses" (p. 144), with consideration to obesity discourse and the binaries at play that position large children as 'the other' in a world preoccupied with thinness. It was an iterative process that I entered into with a "certain blind faith" (Taylor, 2001, p.38). The data in such a process must be read and re-read until themes are derived with specific attention to the subject positions made available in and through the discourse and the ultimate effects (Wright, 2000).

> The discourse analyst needs to simultaneously identify what subject positions are available in a given conversation, how these subject positions function within that conversational context, and determine what the availability or existence of these subject positions tells us about the broader conditions of possibility at a particular socio-historic moment (Norman, 2009, p. 120).

According to Norman (2009), in conducting critical discourse analysis the researcher must examine the discourse with consideration to the local context in which this discourse is produced and utilized and then move beyond this examination to consider the broader social historical context. In my examination of the children's narratives, for example, I began by considering the context in which the interviews, interactions or focus groups took place. For example, I sought to acknowledge that the language utilized by the children was done so in the context of a group situation, most often in the program common room but at other times outside in 'public' areas'. This I reflected upon during my analysis.

As I have learned, analysis is not a discrete process that happens in a sequential manner following the collection of data. "The process of analysis includes transcription and to some extent also the definition and selection of data" (Wetherell, Taylor & Yates, 2001, p.38). The researcher should not enter the research process with the assumption that data collection and analysis are separate entities. Analysis within my research study in fact began when I began to collect the data. The interview and focus group recordings were digitally transcribed verbatim and compared with notes taken during the interview process. Transcripts were analyzed to reveal how the children in this particular obesity treatment program are utilizing discourses around health and the body. I returned regularly to the literature to consider how these discourses are both produced and taken up within different contexts by different people. The theory allowed me to consider how the children utilized discursive resources in the construction of meaning within the interview and focus group contexts. My exploration of theoretical conceptualizations of difference and the constructive nature of people's embodied experiences informed my reading of the transcripts and fieldnotes. I continued to read and reread the transcripts and fieldnotes until I identified certain regularities; themes that were consistently apparent to me each time I contemplated the narratives. I began by coding theses themes while again returning to the recordings, transcripts, and field notes. These themes were then examined in relation to both dominant and alternative health discourses. Talk that arose as inconsistent with dominant discourse was also compared to the alternative discourse as presented in the treatment program. Data was coded to allow consideration for individual changes in specific children's talk and issues of difference such as age and gender.

In analyzing the following excerpt for example, I illustrate how Summer utilizes the dominant discourse while she simultaneously struggles to reconcile this discourse with her need to feel good about herself. This was a consistent theme that arose from the children's talk.

> **Pam:** Are there any times when you don't feel good about yourself?
>
> **Summer:** I guess sometimes everybody does…
>
> **Pam:** Do you have any concerns about that?
>
> **Summer:** Ah, no not really. I don't really care what everybody else thinks. I'm happy the way I am. I think I am stronger than my friends.

Pam: And you're happy to be strong?

Summer: I'm not *really* strong, like I can lift stuff, and my friend, she finds it hard to lift her book bag for school. She finds that a problem.

Pam: So do you find that in ways, you might be more fit than they are?- or healthier than they are?

Summer: I guess sometimes- I mean, this friend I'm talking about, comes home everyday, pigs out for like an hour, and she's still like 98lbs. I guess it all depends on her metabolism. She's in skating too so…

Pam: It sounds like that may frustrate you?

Summer: Yeah sometimes. When I'm sitting down watching her, I'm like, that's just not right and there's so many people out there that can't eat anything without putting on a couple of pounds.

When analysing this portion of Summer's talk I highlighted words and phrases that were consistent with the dominant discourse and then contrasted them with other points Summer makes about weight and health. In analyzing the text and considering conversations I had with Summer, I noted that Summer is often resistive to the dominant discourses but still struggles with some issues of weight and the body. In this excerpt she suggests that she is happy with herself yet she struggles when I ask her if she may be healthier or more fit than her smaller friends as this concept is in direct opposition to the obesity discourse that equates thinness with health. She draws upon the mainstream discourse of diet and weight maintenance, for example, when she talks about metabolism and weight, suggesting that her small friend can eat more because her metabolism is higher. Given that the dominant discourse is replete with medical jargon including discussions around metabolism, this was not particularly surprising to me. In her use of the term 'pig out', Summer is again drawing upon the obesity discourse that equates eating with gluttony. Given that within the dominant discourse that gluttony is considered morally deficient and is most often a term that is paired with obesity, she voices her frustration that someone could 'pig out' and still remain small stating "*that's just not right*". The fact that someone can eat large amounts of food and remain thin is inconsistent with the biopedegogies that Summer has been schooled in which suggest that one's weight is a consequence of the balance of energy in/energy out. In utilizing this equation, Summer goes on to consider the fact that "she's in skating too", so that may contribute to her increased metabolism. This type of reasoning therefore falls in line with the energy in/energy out equation.

Summer's talk was also compared to her talk in a final interview with her conducted at the end of the 11-week program. In this interview we again had a discussion about what it means to be healthy.

> **Pam:** Tell me a little bit about what you think healthy means.
>
> **Summer:** Well… eating right, mentally-good self-esteem and body image. And well you don't have to be skinny to be healthy. I guess that's basically it…you need a good body image, so you need to think good things about yourself, socialize…be.. um.. happy.

While Summer again spoke of the need to eat healthy in this interview she also discussed the need to feel good about yourself. This talk including the phrase "*well you don't have* *to be skinny to be healthy"* is consistent with the alternative messages that were emphasized in the treatment program. Summer's talk therefore provides me as a researcher a glimpse of how she is creating meaning through the discursive resources available to her. Through she demonstrated a resistance to the dominant discourses upon entering the program, she at times had difficulty articulating her rationale as the dominant discourse provided her little room to resist. By examining her talk upon entering the program and upon completion I was able to note how she drew upon new discursive resources to help her resist the dominant messages to position herself in a more positive space.

Reflexivity

Ethnography, from a post-structural feminist perspective, "is a critical and self-reflexive ethnography and a literature on the inherent, but often unacknowledged hierarchical and power laden relations" (Stacey, 1988, p.24). Power imbalances should be acknowledged when conducting research. The researcher is always in a position of power given that she or he is in control of the research project and is the one who interprets the data. As Eder and Fingerson (2002) suggest, the power imbalance may be more accentuated when researching with children because of "inherent power differences between adult and child in addition to those between the researcher and participant" (p.197). In an effort to acknowledge the power difference I regularly reflected upon my role and the power relations at play in the group and took the opportunity to remind the children of the purpose of my presence. I recognize that while the children were aware that I was a researcher and not a member of the staff, that I was an adult health professional in a position of power relative to their own. I also considered how my past work in health promotion and my own beliefs and experiences regarding health and the body served to influence my interactions with the children, the parents and the program facilitators.

While the poststructural perspective does not clearly define the methods to be used, the concept of reflexivity in any mode of research is considered to be vitally important. Reflexivity is defined by Green and Thorogood (2004) as "the recognition that the researcher is part of the process of producing the data and their meanings, and conscious reflection on that process" (p.194). From a constructivist standpoint, it is argued that the researcher can never be removed from the data that is produced during the course of the research and it is incumbent upon the researcher to explore her role in the relations that are taking place with consideration to the immediate social setting and the wider social milieu. As a researcher therefore, I entered into the research process with an understanding that reflexivity involves a level of critical self-reflection in which differences and power are acknowledged and knowledge is recognized as fluid, depending upon the social context and the position of the observer and the observed (DeVault & Gross, 2007; Hesse- Biber & Piatelli, 2007). This is of particular importance when working with children. According to Darbyshire, Macdougall, and Schiller (2005) adults often assume that we have an understanding of the experiences and needs of children and conduct research without giving children a voice. They suggest that researchers remain cognizant of the tendency to assume they "know what childhood is all about" (p.419). In exploring experiences with children, Punch (2002) suggests the researcher must be sensitive to the position of children in the social structure. According to the author, this requires a reflexive and critical awareness of the how research is different with children while paying attention to the children's abilities and competencies in sharing their experiences. I was both intrigued and enlightened by the way these children interacted with and utilized the discourse around health and the body. While I entered the process with the intent of recognizing both my role and the ability of the children in knowing themselves, I was surprised at the level of insight and ability to critically evaluate the discourse that these children displayed. I recognized that the children were not blindly 'buying into' the discourse but that they were active players. For example, while the children demonstrated how they could easily articulate the main tenants of the present biopedagogies such as eating well and exercising they questioned on many occasions what the concept of "good for you" really means. One discussion regarding video game playing illustrates my point. Ethan, in considering things that are healthy or 'good for you', drew on the discourse of video gaming as being an activity detrimental to the health of children stating "*sitting around playing video games makes you fat*". In evaluating this statement however Pete replied by stating "*that is entertainment though. It's important to be entertained because depression is not good for your health either…entertainment and music is important*". While Pete was aware of the negative implications of video gaming in relation to obesity as outlined in the dominant discourse he also was able to utilize alternate perspectives on health beyond the physical to consider what things are 'good for you'. Focussing on the importance of feeling mentally well, Pete was able to put forth a sound argument that outlined the 'good' aspects of video gaming.

While I entered into this process determined to remind myself of how my various roles served to influence not only my interactions with the children and parents but also their interactions with each other, I became aware on many instances that as part of the interaction, I would get lost in the process. Only on later reflection in some instance did I see how my identity as a mother influenced my interactions. While being critical of the obesity discourse myself, I found myself empathising with parents of children with regards to their concerns about their children's weight. While having studied the discourse and the role it plays in constructing our realities, I realized that I am influenced by the power of these discourses. At times I became aware that the way I was communicating with the children was reflective of the way I communicate with my own children and this communication was certain to influence my interaction with the children. In certain ways this helped me as I felt I could utilize my familiarity with the issues of this age group to allow them to speak. I also recognized how my roles intertwine. The fact that I identify as a nurse, for example, often frames my interactions with others. While I empathized with the experiences of the children in the group, there were certain children who I did feel the need to take care of. As a mother, educator and health professional, I found that certain health messages and my resistance to others did creep into conversations. For example, the following excerpt points to my need to teach and support the children in recognizing the subjectivity inherent in the discourse:

Pam: So do you think that when I look at you, I'd think "oh, he's not healthy"?

Joel: Uh, I don't really know what other people think of me but… yeah probably.

Pam: Because I wouldn't look at you and think "he doesn't look healthy". I would think you look healthy.

Joel: Thank you

Pam: Yeah, so you obviously think of healthy as a good thing, right? It's a positive thing, but I just find it interesting how we look at people. You might look at yourself and think 'gosh, I'm not healthy', but someone else might look at you and say 'that looks like a healthy person to me'. Right? So it's all very subjective, and it's all influenced by so many different things. It's not simple right?

While it was not my intention entering into the interview process to guide the children in terms of recognizing the complexity of health discourse, I found that I was compelled to do so in some instances. In the previous excerpt, for example, my emotional response to Joel's suggestion that he doesn't look healthy was to reinforce that I would regard him as healthy. I wanted to help him feel good about himself while also encouraging a critique of the dominant discourse.

The need to 'teach' became something I tried to make myself explicitly aware of. I reminded myself that I was not responsible for simply eliciting information out of these children but that I was providing them with a forum in which to discuss their issues with guidance, not strict direction. The use of ethnography in this instance was appropriate and I believe it served to enrich my research. Not only did I learn more about the children but I learned about myself, how I have been affected by health messaging, how I utilize it and integrate it into my interactions with others. I do agree with Stacey (1988) who suggests that while the research must recognize the role of self within the research and the limitations that exist within participant research, feminist ethnography has the potential to construct cultural accounts that achieve a depth that cannot be achieved through other research methods. When the researcher is open to her role in the co-construction of meaning in the research process we have the potential to see things in ways we have not seen them before, we have the ability to move into places that we have not moved before. While my presence and contribution to the group for example would certainly affect the children in some way, these effects are meaningful and they contribute to a greater understanding of the children's experiences.

Crystallization

This research moves beyond the concerns of positivist research that seeks to provide an objective depiction of a given 'truth'. If our lived realities are to be considered products of competing discourses that give meaning to our daily experiences, then it is impossible to reveal an objective truth, as no objective truth actually exists. Truths are fluid and ever changing depending on the discourses available in given times and contexts. "The purpose of research is not to validate a Truth, but to enable different forms of knowledge to challenge power" (Hesse-Biber & Piatelli, 2007, p.498). While many qualitative researchers employ Denzin's (1978) notion of triangulation, "the combination of methodologies in the study of the same phenomenon" (p.291), in an attempt to enhance the accuracy of research findings, the use of triangulation has been criticized as it draws upon many of the principles established within the positivist paradigm that call for validity, reliability and generalizability of the research (Tobin & Begley, 2004). Within this research I draw upon Richardson's (2000) concept of crystallization to provide a rich multilayered examination of the experiences of the child participants. As stated by

Richardson, using crystallization " we recognize that there are far more than "three sides" from which to approach the world" (p. 934). The triangle as argued by Richardson represents as rigid structure that does not reflect the complexity of people's experiences. Crystals in contrast, represent something dynamic that is multidimensional.

> Crystals grow, change, alter, but are not amorphous. Crystals are prisms that reflect externalities *and* refract within themselves, creating different colors, patterns and arrays, casting off in different directions. What we see depends on our angle of repose (Richardson, 2000, p. 934).

Utilizing multiple methods, therefore, allows us to explore the various dimensions of peoples' experiences with the recognition that these experiences are ever changing and that interpretations fluctuate depending upon our epistemological underpinnings and the positions from which we examine them. It acknowledges that "our descriptions of social realities then cannot be separated from the objects, persons, or circumstances that describe or the language we use to describe them" (Miller & Fox, 2004, p.36). By exploring the children's experiences through the use of ethnography with interviews, focus groups and participant observation I was able to build "a rich account of a phenomenon that problematizes its own construction" (Ellingson, 2009, p.4). It is my hope that such an exploration will highlight the complexity of socially constructed concepts of health and the body and how these constructs weave their way into the social fabric that shapes our lives and daily experiences. By recognizing the multiplicity of experiences and the positionality of the researcher we open up ways of knowing that may have been previously closed to us.

CHAPTER 4

DISCOURSE OF DIFFERENCE: "MY BODY DOESN'T FIT"

What does it mean to fit the social norm and what are the implications of not being able to do so? These are questions that underlie much of the discussion in this chapter. Throughout this chapter I provide an examination of the dominant discourses around health and the body and how children within my research utilized these discourses in deriving meaning from the world around them. I explore how these children are struggling with emerging identities that are constructed in and through their embodied experiences. I also consider the cultural context in which these experiences are created. " From a post-structuralist vantage point, cultural meanings given to bodies also become a basis of identity" (Rice, 2007, p.159). From this point I consider how the knowledge of health and the body is generated and how that in turn impacts the way we view and relate to the world. I begin with a discussion of how health is constructed in our society and how in turn the normative body is both defined and promoted through discourses that serve to shape our views and regulate our activities. Fatness, from this perspective, is seen as a lack of control and bodily discipline that serves to define a healthy person (Evans, 2009; Gard & Wright, 2005; LeBesco, 2004; Monaghan, 2007; Throsby, 2007). I consider the constructivist perspective that suggests language is the conduit through which things and experiences are given meaning. Within this perspective we draw upon language in our everyday interactions to make meaning of the world around us and to function in a way that we can most effectively relate to others. Thus when exploring the experiences of others from this perspective it is important that we consider not just the local context from which these people derive meaning, but also the larger context in which knowledge is produced and gains power. I consider power in this regard from the Foucauldian perspective that suggests it is both created and sustained through discourses that permeate our most influential institutions. Power, according to Foucault (1980), is not an entity that is exerted overtly upon a group of people. Power is exercised through relationships, whether they are relationships of knowledge, sex, or government. Those hegemonic discourses that are taken up and endorsed through powerful social institutions that regulate and monitor social activity become entrenched in our everyday lives and thus become central to the meaning making process.

I begin my discussion with attention to the children's use of language as it constructs power relations. Within this chapter I explore the thematic narratives of the children provided through interviews, focus groups and field notes derived from the day-to-day interactions in the treatment program. I consider how their words are a product not only of the specific circumstances in which they live but how they are derived from a broader perspective in a society that values and rewards thinness while perpetuating a fear of fat and often stigmatizing those who fall into the overweight or obese categories (Beausoleil, 2009; Gard & Wright, 2005; LeBesco, 2004; Murray, 2009; Puhl & Brownell, 2001; Puhl & Heuer, 2009). I also reflect upon how these words produce the subject and how they grapple with the position of the "fat other" which Throsby (2007) describes as a 'spoiled' or 'discredited' identity. I attempt to move beyond the more traditional view of the individual participant as the knowing subject from which we as researchers can draw "scientific data" to a view of the subject as being enmeshed in social relations that serve to create and define meaning for them. This social life according to Prior (2004),

> is established on forms of collective activity or praxis, and if that is so then it must follow that social science research has to confront a dimension of human activity that cannot be contained in the consciousness of the isolated subject. In short it has to look at something that lies beyond the world of atomistic individuals (p.318).

Throughout this chapter I will provide examples from my interactions with the children that highlight how they grapple with the dominant discourses while striving to maintain a positive sense of self. In an effort to explicate the manner in which these children negotiate the dominant discourse, I will also draw attention to the children's moments of resistance in which they contest the dominant messages. These moments of resistance, I will argue, demonstrate the resilience of these children and the power that they begin to assert in striving to forge a positive fat subjectivity. I argue that there is room for alternative discourses and that these children actively seek out this space to accommodate their evolving identities.

As this study was undertaken using a poststructural feminist approach, I was interested in how the body is discursively produced through processes that define and regulate the body and how differences are articulated and reinforced as these processes intersect with constructions of gender, sexuality, age, class, race and space. It should be noted that the children in this study were relatively homogenous in terms of race and ethnicity, all coming from white lower to middle class families. Hence, racialized differences did not emerge from the data. While there was some variation in terms of social class, this was not clearly established upon entry to the study and no distinct differences in terms of discourse became evident through the narratives. As will be illustrated through a discussion of narratives, the children's discussions quite often reflected a white middle-class gendered heterosexual approach to health and the body. Children in the study regularly drew upon health and obesity discourses in describing themselves and others in terms of bodies, activities, likes, dislikes, strengths and weaknesses. The discourse has positioned these children on the periphery in terms of social space: a position in which they have to struggle to maintain a positive sense of self. This chapter provides the reader with an examination of three themes that arose from the narratives and are pertinent to the discussion at hand. Firstly, in order to bring myself closer to an understanding of the children's embodied experiences I felt I needed to explore their constructions of health. Following Rail (2009), I wanted to examine the "discursive effects" of the obesity discourse considering that such discourse is being perpetuated and legitimized in the majority of the settings to which children are exposed and in which they live their lives. In this section I provide examples of the children's narratives highlighting how they draw upon institutional concepts of health that are argued by many to be healthist and fat phobic (Beausoleil, 2009; Burrows, Wright, & Jungerson-Smith, 2002; Rail, 2009; Wright, O'Flynn, & MacDonald, 2006). These narratives also reflect the struggles the children encounter in light of where they are positioned in dominant health and beauty discourses, particularly the obesity discourse.

Also, I felt I must explore the concept of social space, as this was a theme that arose out of a number of my interactions with the children. Through the narratives I provide examples of how the children have been situated on the periphery in terms of social space in what Lebesco (2004) refers to as an "uninhabitable subjectivity" (p. 3). Through exploration of the obesity discourse, I consider how the children are subjectively positioned as 'the other' in terms of body size and the responsible healthy child (Fullagar, 2009). Within this exploration of the subject I move beyond the concept of the knowing subject to consider how the embodied experiences of these children are produced through their interactions with those in their immediate environment, social life and the broader societal context. I also explore, through the children's words and observation of interactions, how the normative thin subject is positioned as one who gets to make the 'social rules'. I go on to consider the concept of biopower and reveal through the narratives how regulation of the body and the marginalized location of these children in particular, places them in a position of constant scrutiny, a position of which they are brutally aware. Finally, in this section I will provide examples of how the children articulate their need to hide from this scrutiny, to become less noticeable, less visible. The children provide examples of how they detract from the visible differences between themselves and those who they felt were spared such scrutiny as those children fit into what they consider a 'normal' weight category.

Obesity Discourse and the Children's Constructions of Health

It has been argued by many critical scholars that language is instrumental in the way we view health and the body (Beausoleil, 2009; Burrows & Wright 2004; Gard & Wright, 2001; Grosz 1994; LeBesco, 2004; Murray, 2009; Norman, 2009; Petherick, 2008; Rail, 2009; Rail & Beausoleil, 2003; Wright, 2009). As I have discussed previously, this notion of discourse is central to the post-structural perspective in that it is through discourse that our ideas about life are formed. Wright (2004) suggests however that while these discourses provide us with something to draw on in terms of making meaning of the world and how we fit in it, the concept of discourse per se does not explain why some discourses are taken up or how people utilize them in different ways. She suggests,

> Part of the answer lies in the relation between power and discourse. Some discourses have more power to persuade than others and are reiterated more often across a wide range of sites and/or by those who are believable and understood to be expert (p. 20).

The present health discourses are no exception. While health is a concept that is continuously changing and shifting depending upon the discourses that are available to us at a given time, more recently it has been argued that health has been constituted as an individual good to which all people must strive. This particular "Regime of Truth" (Foucault, 1973) implies that in order to be considered healthy, one must work upon the body. The disciplined body according to Foucault (1977) is created through what he refers to as the "machinery of power" that determines how a body should be defined, exercised and manipulated to serve the "political anatomy". This in turn produces what Foucault refers to as "subjected and practiced bodies" or "docile bodies" (p. 138). Such discipline he argues,

> increases the forces of the body (in economic terms of utility) and diminishes these same forces (in political terms of obedience). In short, it dissociates power

> from the body; on the one hand it turns it into "aptitude", a "capacity", which seeks to increase; on the other hand, it reverses the course of the energy, the power that might result from it, and turns it into a relation of strict subjection (p.138).

The discourse of individual responsibility for maintaining a healthy disciplined body is also compounded by another discourse that suggests that thinness and the so-called 'toned' body are necessary for health and it is these very attributes that constitute beauty. These 'normalizing' discourses suggest that the body is a constant work in progress. It "provides a powerful set of imperatives for the ways people should live their lives and construct their identities" (Wright, O'Flynn, & MacDonald, 2006, p.707). These messages are regularly disseminated through health promotion discourses that permeate the school system, the realm of recreational and competitive sports, and the broader media. The discourses have seeped into the very fabric of our social environment. According to Burrows, Wright, and Jungerson-Smith (2002), if we look to the discourses within the current domain of health promotion and health practices which are encouraged and endorsed as healthy, specific constructions of health are seen to override others. The notion of the healthy thin body is no exception.

The children in my study are drawing upon such discourses. As previously suggested, many of the discourses that have gained greater power in recent years define health as an individual responsibility (Crawford, 1980; Crawford 2006; Rail & Beausoleil, 2003). Children, like adults, are expected to strive toward meeting the health ideals. They are taught that one's responsibility with regards to caring for one's body is also a social responsibility; as healthy individuals we must work on our corporeal selves to create a healthy society. These discourses have also privileged the lean toned body over all other bodies, conflating this body and the practices utilized to attain such a body with health. The narratives of the children in this study highlight the complex relationship between food, activity, the body, and health, and the prescriptive nature of the dominant discourses in supporting and maintaining the notion that health is directly linked to weight which is in turn a simple matter of energy balance; food as energy in-exercise as energy out (Evans, 2009). Throughout our interactions, children regularly utilized dominant health discourses in their discussions of health, the body and food. Even within discussions that were not overtly related to health, students utilized elements of obesity and beauty discourses.

Consistent with the work of other authors such as Beausoleil (2009), Burrows, Wright, and Jengerson-Smith (2002), Rail (2009), and Wright, O'Flynn, and Macdonald, (2006), the children drew regularly on the dominant health discourses that define health through the individual activities of eating well and exercising. While later discussions revealed moments of marked resistance to the dominant pedagogical messages, the participants initially answered the questions of 'what does it mean to be healthy or what does a healthy person look like?' in ways that reflected the dominant discourse to which they have been schooled. This was reflective of other studies such as one conducted by Rail, Beausoleil, MacNeill, Burrows and Wright as cited in Beausoleil (2009), Rail (2009), and MacNeill and Rail (2010), in which the youth regularly drew upon the discourses of health and the body. As Rail stated, health for their participants "was mostly constructed in bodily terms and was either associated with things that are done to the body (e.g. being physically active, eating well, avoiding bad habits) or that are associated with the body (e.g. being neither too fat or too skinny, having physical qualities, not being sick)" (p.145). This was reflected in my research as well.

The following excerpt from the initial focus group with the children highlights how they negotiated the dominant obesity discourse. As previously stated, while the children regularly drew upon health and body discourses, there were moments of resistance when the children worked against the dominant messages to describe how they 'think it should be'. These moments were sometimes highlighted with anger and frustration on the part of the children that things are 'the way they are'. As the program progressed they continued to utilize these discourses to define themselves as subjects and to define health in general. I did note that the children began to integrate some of the alternate discourses as introduced throughout the treatment program as time progressed. (While I allude to this in chapters four and five, a more in-depth discussion of the impact of alternative messaging is provided in chapter six entitled: "Alternative Messages and the Creation of a Safe Haven"). These new messages, however, were in constant competition with the dominant messages that permeated many of the discussions during the course of the study. In this initial excerpt from the first focus group with the children (Adam-an 11 year old boy, Ethan- an 11 year old boy, Pete-an 11 year old boy, Nicholas – a 12 year old boy and Jordan- a 12 year old girl) are involved in a discussion of what it means to be healthy. They draw upon the more dominant discourses of health and fitness. This is reminiscent of other studies mentioned above in which the participants begin by utilizing the dominant messages that conflate health, fitness, and thinness. The children drew upon the dominant language of health.

Throughout this focus group session, I was cognizant of the fact that I was a stranger to these children. While I reminded them that I was a researcher who was only interested in their feelings and ideas in relation to the subject, I also recognized that the children were aware that I was an adult, a nurse, a mother and someone who teaches in the health realm. It is certainly possible that the children in this situation provided me with information that they thought I wanted to hear. I also had to consider how my positioning in this group impacted the children. Was I conducting the session, for example, in what Darbyshire, MacDougall, and Schiller (2005) refer to as an 'adultist' approach: one that assumes I know more than the children, that presumes the ways they will react and behave in the session. I considered this in my analysis of this interaction and how it impacted on the meaning making process. I attempted to allow the children the freedom to speak and explore the concepts we were engaged in throughout the session. The children appeared comfortable in the group even though they had only known each other and me for a short period of time. There were a few children, however, who were more eager to join in the conversation while others sat back and watched the interaction. Interestingly, aside from one girl, it was the boys who became very engaged in this particular conversation.

> **Pam**: Can you describe to me a healthy person? If you think of a healthy person what do you see?
>
> **Jordan**: Someone that's fit.
>
> **Pam**: Someone that's fit? Can you explain to me what you mean by that?

Jordan: Ah, fit means exercising, eating the right foods, and being healthy and stuff.

Pam: Okay

Pete: Someone who doesn't get stoned on drugs and doesn't drink too much alcohol because that gets you drunk. Who wouldn't eat chips; a moderately active person that eats enough healthy foods and…that's basically it.

Adam: I was going to say someone who eats healthy and follows Canada's Food Guide and don't [sic] try to overeat all the time…

Pam: Okay, how about you? Do you have an idea you want to share?

Ethan: Someone who runs everyday and who does not, I repeat does NOT eat too much junk food. Well, not eating out…

Pete: Not big.

Pam: Okay, so do you think a healthy person would not be big?

Pete: Well, not that big?

Pam: Can you explain to me what you mean by big? Big as in tall? Big as in fat?

Pete: Not fat. Extra weight.

Nicholas: I say that a healthy person looks like a regular person, doesn't matter what they look like, as not long[sic] as they're overweight and…I don't really know.

Adam: Just a regular person, I guess.

Entering into the focus group session with a number of guiding questions in mind I was aware of the power of the dominant health discourses and cognizant of how these discourses present us with the tools we use to make meaning of ourselves, others and our relational experiences. It was not a great surprise that the children drew upon the discourses which hold a privileged position within school curriculum, the media and hence, often the family and broader social environment. For example, when asked to describe a healthy person Jordan began by responding "*someone who's fit*". When asked to explain this further, she drew upon the familiar discourse of eating right and exercising. In stating, "*eating the right foods*", Jordan is utilizing what she assumes to be a common understanding amongst the group of what eating right actually is. The 'right' foods or 'correct' foods as it might be are those foods that are viewed to be consistent with maintaining a healthy body. Adam, in keeping with this understanding refers to Canada's Food Guide with the assumption that those in the room were familiar with this text and how it is utilized in everyday life. Canada's Food Guide is seen as the guiding document that provides us with 'directions' as to how to eat right. The food guide is introduced through the school system and health promotion programs as a guide to healthy eating. I noted throughout the discussion that children were well aware of the food guide and the food groups and recommendations contained within. All children readily accepted the argument that in order to be healthy one must follow the criteria outlined in the Food Guide. This was taken for granted as an imperative for healthy living.

The children's constructions of healthy foods are also illustrated in the reference to junk food. When Ethan suggests that someone who is healthy is someone who "*I repeat does NOT eat too much junk food. Well, not eating out…*", he is drawing on the shared conceptualization of junk food as food without nutritional value, that does not contribute to good health and in fact that is seen to contribute to poor health. The children's statements also reflect an overarching moral imperative that is linked with food choice and consumption in the dominant health discourse. Pete states that a healthy person is a person "*who wouldn't eat chips …… that eats enough healthy food*". This statement reflects a widely held binary assumption that food is either good or bad. It highlights a set of values transmitted through present health promotion discourse in which food in itself has been ascribed certain values based upon the desired lifestyle of a health driven population. This is reflected in the work of McPhail, Chapman, and Beagan (2011) for example who noted that youth must negotiate the values placed upon so called good and bad food in defining themselves as either good or bad people. Within their study the notion of food as either good or bad was pervasive among youth regardless of social positioning or whether they lived in rural or urban settings. This is consistent with the results of a study by Wright, O'Flynn, and MacDonald (2006), who stated "our participants told us that 'healthy' food is eaten for nutritional reasons because it is "good for you". 'Bad food', such as chocolate and chips, were more likely to be associated with pleasure (and guilt)" (p.709). Like the participants in the previously cited studies, the youth in my study demonstrate a common conception that junk food is a bad thing which is not only associated with guilt but which contributes to fatness. Hence discourse around fatness and guilt become intertwined. According to Evans, Evans, and Rich (2003), "Cleary there is a hierarchy of good and bad food, with some, like chips- a metonym/metaphor for fat-laden food…There is also a hierarchy of good and bad ethnic lifestyles that generate allegiances to the right or wrong kind of food" (p.233).

As previously discussed, the children's constructions of health and fitness arising from the narratives are greatly tied to food choice and how the body looks. The narratives in my study are reflective of those highlighted in other studies of youth and constructions of health as discussed earlier in which fitness is greatly conflated with thinness (Beausoleil, 2009; Burrows, Wright, & Jengerson-Smith, 2002; Rail, 2009; Wills, Backett-Milburn, Gregory, & Lawton, 2006; Wright, O'Flynn, & Macdonald, 2006). For example, while the participants struggled with accepting that they in fact could be healthy in their non-normative bodies, they continued to return to defining fitness as a descriptor of how a person's body looks; that look having been derived from some level of personal effort. The children's description of health was invariably tied to the corporeal self, how the person looked to them. In keeping with the obesity discourse in which health is repeatedly conflated with thinness, the healthy person was considered to be one who was not big or who did not appear to be overweight. As Adam suggested, a fit person is one who is "*not too big*". Adam in this instance was utilizing the broadly accepted definition of the acceptable, normative size. The emphasis in this statement was on not being "*too*" big. From my interpretation of Adam's statement I took this to mean there were acceptable sizes and that there was a point when one surpassed what is desirable, '*too big'* being beyond this threshold. These notions are tied to the construction of obesity as being determined by preset measurements. While in the clinical sense what is considered 'too big' is defined according to the BMI (Evans, 2009; Gaesser, 2002; Gard & Wright, 2005), this conceptualization of acceptable sizes and the knowledge of when and how someone falls outside of the acceptable range is very much grounded in the aesthetics of the thin ideal. "According to the medically ratified view, levels of body mass judged "too fat" constitute a personal and social liability that must be tackled by those who are responsible to themselves and responsible to others" (Monaghan, 2007, p.585).

As a society we regularly evaluate people based upon their size and draw conclusions about whether they fall into a 'healthy weight range' simply by looking at them. Their fatness is read as an outward marker of moral deficiency (Murray, 2009). This provides others who place themselves on a higher moral plain, permission to follow through with opinions on what the 'fat other' should do to solve the perceived problem, what Murray (2005) refers to as "a negative culture of collective 'knowingness' about fatness" (p.154). The children in my study were quite aware of this phenomenon. While Nicholas engages in the conversation to challenge the concept of health as being defined by weight stating "*I say that a healthy person looks like a regular person, doesn't matter what they look like*", he continues on to say "*as not long[sic] as they're overweight*". It is quite apparent in this exchange that Nicholas is struggling to resist the so-called 'unhealthy' fat subjectivity. He further qualifies his position by pausing and stating "*I don't really know*". This is reflective of the conflicting messages children receive. On the one hand they are schooled in the acceptance of difference and the detrimental impact of bullying, while simultaneously being presented with a narrow category of fitness that defines body shape and size. Nicholas remains confused as to what actually defines 'healthy'.

While the message of acceptance of various body sizes is appealing to the children, the determination of health and the gauging of health according to body size is hard to resist. It is thus inevitable that they use this gauge as a measurement of their own health. For example, when I asked Adam to clarify what he meant by big he stated "*not fat; no extra weight*", he points to his abdomen, making circling motions to imply girth, holding himself up as an example of someone does not fit the 'healthy' or 'acceptable' category. The children regularly compared their bodies to the ideal standard and the bodies of others around them. According to Rice (2007), participants in her study in reflecting upon their childhoods in larger bodies "tell how critical comparisons and comments were the most memorable sources of cultural knowledge about body size binaries" (p.164). This, according to Rice, occurred through family comparisons, health promotion campaigns, and the broader environment. While the children in this study compared themselves to the ideal, this was often reinforced in school, home and their broader social environment.

Weight, in my discussions with and observations of the children, was directly linked with food consumption. As previously stated, a healthy person to them was a thin or '*not too big*' person, who does not "*eat too much*", "*does not eat takeout*" and "*does not eat junk food*". Emerging from these narratives is a theme that highlights the prescriptive nature of the obesity discourse. There are certain foods and practices that must be exercised to maintain a healthy body in keeping with Foucault's notion of 'technologies of the self'. The children draw on common conceptualizations of food as good or bad and consider "*takeout food*" as being detrimental to your health. They categorize food as bad in relation to the amount, the nature of the food (junk or takeout), and the impact that this food has on body weight.

The participants talked about the relationship of bodies to food intake and spoke in relation to the balance between food intake, body size, and exercise. This concept of energy balance is widely discussed as an integral concept in relation to obesity in the scientific literature (Campos, 2004; Evans, 2009; Gard & Wright, 2005). One is expected to balance the amount of food consumed with the amount of energy utilized in the body.

This notion is grounded in the assumption that all bodies respond to energy in the same way. According to Gard and Wright, this concept of the 'body as machine' is flawed at best and restrictive in the sense that it ignores issues of individual biology and social circumstance. This model according to the authors,

> assumes that all human bodies adhere to the same mechanical law, it is not good at handling human differences such as cultural values, socio-economic class, ethnicity gender, geographical location and age. Moving our lens out even wider, this model also tends not to have much to say about the decisions of governments, the workings of capitalism or the actions of large institutions such as corporations (p. 41).

Throughout the course of the program, the children regularly referred to this model in describing their relationships with food, exercise and their bodies. Throughout my interactions with and observation of the children, I was surprised at how well versed the children appeared to be in with the language of weight and the body, utilizing such terms as anorexic, overweight, and obesity. I was particularly intrigued by Pete, an 11-year old boy who would be considered substantially overweight in the mainstream clinical sense. During one particular discussion around health, body image and self-esteem that occurred in a regular program group session, Pete stated: "*If you have low self esteem you can eat yourself to death*". When I asked him to clarify what he meant he stated "*I mean like they would eat so much that they would get morbidly obese and would die because they would like just keep stuffing food into them…they like wouldn't care if they died so they would just eat and eat until it killed them*". Pete in this instance is drawing upon the popular construction of obesity as unhealthy, dangerous and life threatening. This message is pervasive in the mainstream literature (Campos, 2004; Gard & Wright, 2005). He also utilizes the messages that obesity is related to a lack of caring for the self, as loathing and apathy toward the corporeal self. There are numerous references in the literature to the moral underpinnings of the obesity discourse (Evans, 2009; LeBesco, 2004; Murray, 2009; Rich & Evans, 2005; Throsby, 2007). According to Gard and Wright, the disdain and lack of tolerance of fat in our society is reflective of the moral worth that is placed upon the corporeal self. Those who are obese therefore possess the outward markings of what our society deems a lazy gluttonous lifestyle. Pete's reference to the morbidly obese person as one who would "*keep stuffing food into them*" is reflective of this vision of the obese person as gluttonous and out of control. The use of the word "*stuffing*" carries with it images such as those that are pervasive in the media; a large person overeating in what is considered to be a voracious or insatiable manner.

I was intrigued by Pete's reference to the term 'morbidly obese'. This term is widely used within the mainstream scientific literature. As a function of the obesity discourse and the blurriness that has been created between the lines of scientific literature and the dominant healthist views, such terms are widely utilized. The fact that the children are utilizing, what Gard and Wright (2005) refer to as the "science for the people discourse" when discussing their ideas of health, reflects the power of such discourse. Recognizing that children, like adults utilize the discourse to create their own meanings based upon the information available to them, I felt the need to explore what Pete's conceptualization of 'morbidly obese' was. When asked what he meant by morbidly obese, Pete responded by saying "*when someone eats and eats until they get fat enough* *that it can kill them*". From Pete's perspective this happens when a person gives up and overindulges in a way that suggests they are no longer in control of their appetite or that they do not care enough about themselves to slow down or stop eating. This is reflected in a number of interactions with Pete throughout the program. On a number of occasions including a wall-climbing session and group art session, he referred to himself as a cow. When asked if he would elaborate, he would just reply, "*I am a cow*". Pete, in constructing his meaning around obesity, regularly utilized terms that are pervasive in the broader discourse that often support society's disdain for larger people and ultimately disdain for his own body. He felt the need to voice this throughout our interactions within the program, most often at times when he was not directly asked about himself. Pete's definition of morbid obesity, along with his reference to being a cow, is reflective of the medicalization or pathologization of fatness intertwined with a healthist moral imperative of maintaining the corporeal self. In his definition Pete acknowledges that gaining too much weight can be deadly. It also follows that being 'a cow' is not only deadly but socially unacceptable. As Murray (2008) states "a medico-moral discourse has inf(l)ected popular understandings of fatness as an affront to health that gives way to more fundamental social concerns and anxieties about normalization and normal appearance" (p. 7). Pete's identity is greatly tied to his conceptualization of fat and what that means for him in the broader context. Despite the fact that obesity is a complex issue tied to a myriad of factors, "obesity is popularly attributed to gluttony and lack of exercise, both things related to the individual's lack of control" (LeBesco, 2004, p. 30).

The gendered aspect of Pete's reference to being 'a cow' also intrigued me. This reference has gendered connotations as this term is often used as a derogatory term to define the women's body and is used by many women in a self-deprecating fashion. As suggested by Martin (2005), who draws upon the work of Friedan (1963) in her concept of the feminine mystique, the fat cow terminology is reflected in what she refers to as a 'famine mystique' in which women are continually in a position of self-evaluation and loathing of one's corporeal self. Woman's bodies are seen as soft, with boundaries that are less controlled than those of men (Hatcher, 2011). The fact that Pete speaks of himself in relation to 'a cow' speaks to the feminization of fatness. He is drawing upon this discourse because this is one of the few that is available to him, one that is continually reinforced in our society.

Gendered Constructions of Health

As I continued to contemplate during my interactions with Pete and the other children, our constructions of health are complex and certainly not fixed. They are forged through the intersection of social, historical, and cultural contexts and are negotiated through racial and gendered lenses. While recognizing that discourse is central to the meaning making process, it has been noted by many authors however that males and females tend to take up the dominant health discourses in different ways (Bordo, 1993; Monaghan, 2007; Rice 2007; Wright, O'Flynn, & MacDonald, 2006). There is a large body of feminist literature that explores issues of body and body dissatisfaction in women and the impact of discourse driven by historically patriarchal systems that endorse the thin ideal (Blood, 2005; Bordo, 1993; Butler, 1990; Grosz, 1994; Young, 2005; Wykes & Gunter, 2005). More recently however a number of researchers have examined the gendered constructions of health in terms of embodied experiences of males (Bell & McNaughton, 2007; Monaghan, 2007; Monaghan, 2008; Norman, 2009; Norman, 2011;

Pronger, 2002). Unlike previous research that argued that males are less concerned with appearances than they are with the masculine performative nature of health, more recent research has highlighted how boys and men are in fact concerned with how they look and this directly impacts how they function on a social level. Norman (2009) for example, states, " The emerging representational context that situates the male body as a surface to be gazed upon and desired means that men are increasingly judged by how their bodies *look* as opposed to what they *do*" (p.6). He goes on to argue that men are also in a position in which they must negotiate the obesity discourse and that the moral imperatives inherent in this discourse also apply to males. His study provides an in-depth analysis of the embodied experiences of boys that highlights the role discourses play in shaping not only beliefs, but also behaviours in relation to health, the body and broader social relationships.

Consistent with Norman (2009), boys within my study did express concern about the way they look and their health for them was very much reflected in their appearance. The internal struggle of recognizing the inherent flaws in the dominant messages and yet wanting to strive toward the ideal were evident. They frequently talked about the frustration of being expected to attain what they viewed as an unrealistic ideal of the chiselled male body while at the same time expressing the desire to achieve such a body type. In describing the healthy or fit body, the boys in the participant group were very vocal about what a healthy body looked like. This healthy body was often described as the chiselled muscular body type that is quite dominant within Western culture today where fat is considered by many to be a feminine trait (Dworkin & Wachs, 2009; Monaghan, 2008). I found it intriguing how the boys and only a couple of the girls utilized terms such as *chiselled abs, six pack abs,* and *cheese grater abs* to define what they saw as attributes of the healthy male. The following excerpt from focus group # 1 provides some insight into how the boys utilized this language in their description of the healthy body:

> **Pam**: What does a healthy person look like?
>
> **Pete**: Someone with chiselled abs.
>
> **Pam**: So you think someone who's healthy has chiselled abs? Do you have to have chiselled abs?
>
> **Ethan**: For a healthy heart and stuff
>
> **Pam**: Okay, do you think you have to have chiselled abs to be healthy?
>
> **Jordan**: No, not really. But if you're fit and healthy, you might be able to have chiselled abs.
>
> **Pam**: Can you be fit and not have chiselled abs?
>
> **Ethan**: Yes, but that's probably impossible.
>
> **Nicholas**: I don't think it's impossible.
>
> **Ethan**: It's probably impossible because you have to be fit and exercise and if you exercise, you have chiselled abs
>
> **Nicholas**: Well, if you're going to exercise, you might walk 30 minutes every day
>
> **Ethan**: Yeah, but you'll probably get chiselled abs.

In this excerpt Ethan equates fitness with a hard toned body. When asked if you can be fit in the absence of chiselled abs, Ethan suggests that it is probably not possible. In keeping with earlier statements, Nicholas challenges this dominant assumption. He provides further explanation that suggests that fitness can be about activity not about the way your body looks. Ethan, in this instance, insists however that chiselled abs are the product of such work. From a Foucauldian perspective, work upon the body or the 'technologies of the self' function to discipline the un-toned, undisciplined body. Considering that structures of power and knowledge work in and through the body, one must seek to define or produce the body utilizing the discursive resources that emerge from various structures of power and knowledge. A healthy body therefore is seen as a body that must be produced through a certain amount of personal effort or work. As Foucault (1988) stated technologies of the self

> permit individuals to effect by their own means or with the help of others a certain number of operations on their own bodies and souls, thoughts, conduct, and way of being, so as to transform themselves in order to attain a certain state of happiness, purity, wisdom, perfection, or immortality (p.18).

The concern with muscularity appeared in many of my interactions with the boys throughout the program. In a later discussion within a program group session regarding what is means to have a healthy body, Joel (a 16 year old boy, the oldest in the group) stated that he felt a healthy person was "*someone with a good complexion, shiny hair and a toned body*". Again this reflects what Norman (2011), drawing on the work of Bordo, refers to as a double-bind for males in our contemporary fat phobic society. This double bind according to the author, finds men in a position of desiring a nice body which for Joel is signified by "good complexion, shiny hair, and toned body", while at the same time striving to remain distanced from their bodies. Joel simultaneously views health as being related to the way one looks and being strong and toned. To him, softness and '*flab*', as he put it, were not masculine. The desire for muscle therefore is eclipsed with the desire to lose fat. As often is the case within the obesity discourse one assumes that weight concerns are synonymous with fat concerns. In articulating what it means to be healthy, Joel, in his first interview, with me describes personally what it means for him. While he states that he is not worried much about weight, he goes on to say that he is concerned about the amount of fat on his body and he wishes he could convert that fat into muscle. He described to me how he had lost weight, but that the weight loss was difficult to maintain. He has subsequently regained the weight and more. He stated:

> *Well, I've always just wanted to be strong – strongest of pretty much anybody I know. I don't know if it's a machismo thing, or if it's just whatever, I've just always wanted to be stronger, desire to be the best, be the strongest, the fastest. And for a while there, out of my friends, I was. Then I kind of gained weight and became the slowest.*

Interestingly while Joel is open in talking about his desire to lose weight, he utilizes and reinforces the dominant heterosexual discourse of masculinity to justify his desire suggesting it is a "*machismo thing*", wanting to "*be the best, be the strongest, the fastest*". As noted by Renold (2008), boys are regularly incited to utilize heterosexual discourses of masculinity to define and situate themselves and reinforce their masculine identities. Fat flesh is viewed then in opposition to masculinity. Fat for males "is deemed corporally polluting and emasculating.

It spoils men's appearance, identities, and like a cancerous growth, poses a life-threatening risk for the unaware male" (Monaghan, 2008, p.4). When asked if he felt he was healthy Joel replied "*no, not really. As long as this jiggles [grabs his belly], I will not be happy*". Joel suggested that if he had more control over his body, he would be firmer and ultimately healthier. As illustrated in the examples from the narratives, weight and body dissatisfaction that have traditionally been considered a female issue, are a lived reality for many boys and men. Males, now like females, are bombarded with messages that portray the ideal male body as lean and muscular.

> Research across disciplines finds that men are in fact more concerned than ever about their physical appearances. Focus group research on men underscores the importance of being muscular, acritical conflations of muscularity and health, fears of being fat, social pressure to be slender and muscular and links between looking good and feeling powerful in social situations (Dworkin & Wachs, 2009, p.8).

According to Norman (2009), the examination of this issue with consideration to males has traditionally been oversimplified. While the boys in my study did not necessarily want to be smaller or skinny as was often the desire for the girls, they talked about being stronger and bigger in terms of muscularity. A common theme that arose out of the narratives with the boys was also a concern with softness. They struggle with wanting to lose fat while gaining muscle. Softness was viewed as undesirable trait. This, according to the boys, reflected a feminine trait that deviated from their desire to look and feel more masculine. They therefore 'performed' their masculinity through regular discussions of sports, weight lifting and ways to accomplish a 'ripped' look. As Renold (2008) noted in her study on children and the impact of compulsory heterosexuality, boys are forced to demonstrate and maintain a heterosexual identity in an effort not to be defined as the 'other'. Boys who did not demonstrate these characteristics were considered girlish and less masculine.

In contrast to the boys and consistent with the literature, the girls' constructions of health and what constitutes a healthy body were very much tied to the thin ideal and the social struggle that this ideal ultimately produces (Andrist, 2003; Gerner & Wilson, 2005; Kelly, Wall, Eisenberg, Story, & Neumark-Sztainer, 2005; Neumark-Sztainer, Paxton, Hannan, Haines, & Story, 2006; Spear, 2006; Wykes & Gunter, 2005). While their language was often resistant and reflected a comprehension of the inherent flaws in the 'thin to be healthy' paradigm, they recognized that although the strict health and beauty standards are not realistic, that they would often continue to strive toward them. This was often discussed in relation to direct peer pressure and broader cultural norms. Such pressure to conform to the thin ideal is seen to be a driving force for girls with great pressure arising out of the school setting (Evans et al., 2002; Larkin & Rice, 2005; Rice, 2007; Wardle & Watters, 2004). As suggested by Evans et al. (2008), girls are expected to abide by certain performance and perfection codes that saturate the school curriculum. These codes serve to create a hierarchical social structure based upon body size. They determine:

> What bodily acts, shapes and forms are permitted and forbidden, the positive and the negative values of different possible behaviours of, and on, the body. They

> simultaneously determine and define what 'the body' is and ideally what it ought to be, and provide the ground rules for sifting and sorting those who can from those who cannot either aspire to or achieve appropriate corporeal ideals (Evans et al., p.98).

According to Evans, Rich, and Davies (2004), perfection codes consider the body to be imperfect, unfinished, and at risk and hence they call for responsibility and self-control with an emphasis on striving for perfection. Schoolgirls must then live and work on a daily basis through these structures, navigating an environment that is both oppressive and damaging yet one that stipulates these criteria in the name of health. For larger girls this is particularly problematic as they are viewed to be farthest from that ideal and thus in need of the most work. They become the reference point for the unhealthy and undesirable. "Clearly, when obesity narratives are recontextualized as a discourse of certainty about exercise, food and diet are taken up within formal and informal school cultures, they may have powerful bearing on individuals' developing sense of wellbeing and self" (Evans et al., 2008, p. 104). Rice (2007) supports this assertion suggesting that the practices imbedded in the school environment set up a mode of comparison that ultimately diminish and preclude specific body types. She states, "Children who diverge from cultural standards often experience devaluation of physical differences as a result of stereotyping and stigma. This includes fat girls, who may be marginalized by cultural messages about the abject female body interwoven throughout their everyday interactions" (p. 159).

On more than one occasion the girls in my study referred to the cheerleaders as representing the health and beauty ideal. The cheerleaders were seen as healthy as they were thin, active and fit the prescribed definition of attractiveness. Foods for the girls were tied to whether one achieved this ideal or not. While the dominant messages related to 'good' food and exercise, were routinely touted by the girls, a more complex relationship between food, intervening social pressures, and the body emerged. In the following interaction between me, Jenny, a 12 year-old girl and Jordan, another 12 year-old female participant during a regular program session, this complex relationship is highlighted:

> **Jordan:** And like the cheerleader group-after they become cheerleaders, a few people in that group are anorexic, right after they became cheerleaders, and I asked them why, and they said because all other people in the group, the cheerleading squad, including the captain does it, so…they don't eat.
>
> **Pam:** So do you think that is healthy?
>
> **Jordan:** No… probably not… but they look healthy.
>
> **Jenny:** We have people in our school who are anorexic. They don't eat their lunches.
>
> **Jordan:** Yeah… sometimes they eat but then stick their fingers down their throat and throw it up.
>
> **Jenny:** Yeah, they're anorexic and they bully other people. Like my best friend in the whole world, she became a cheerleader, but then she started bullying other people, and then started bullying me.

Pam: So, does she expect you to do the same things that she does, in terms of…

Jenny: Yeah… sort of, because I still hang out with her when she's not with her friends, but when she goes down there, she doesn't eat anything, so I'm there with a bag of chips or something, she has nothing in her hands. I offer her some money, she says no so I feel right bad, so I throw everything in the garbage.

Jordan: They know it's not healthy but they look healthy so that's what important. Like the cheerleaders they are super skinny and they will not pick you if you look like me… they think you got to look like the cheerleaders.

Jenny: …but you can't make everyone look like you.

Throughout this conversation Jenny and Jordan explore the meaning of their experiences in the peer environment. The pressures to be thin are clearly in line with findings throughout the research (Andrist, 2003; Blowers et al., 2003; Byely, Archibald, Graber, & Brooks-Gunn, 2000; Evans et al, 2008; Gerner & Wilson, 2005; Thompson & Stice, 2001). Interestingly, they recognize that the eating behaviour they are describing is not 'healthy' but they also go on to assert that the ultimate outcome of the behaviour, the lower weight status, is viewed to be healthy and desirable. This is reflected in Jenny's statement "*They know it's not healthy but they look healthy so that's what important*". As noted by Evans et al. (2008),

> health itself becomes a performance, a process of constant comparison and competition both with one's own embodied self and with those of others, of striving for 'gold standards' with respect to eating and exercise that are

> themselves volatile, ever changing, never attainable and over which they have little control (p.106).

The girls are very much caught in a complex 'storm' of social dynamics and interactions they must navigate in striving to achieve a balanced sense of self. As Young (2005) suggests, their lived bodies, their gendered experiences are a function of these interactions.

> Contexts of discourse and interaction position persons in systems of evaluation and expectations that often implicate their embodied being; the person experiences herself as looked at in certain ways, described in her physical being in certain ways, she experiences the bodily reactions of others to her and she reacts to them (p.17).

While Young argues that in contemplating the lived body, a person's subjective position is very much influenced by the sociocultural context that may not be within her control, she does go on to argue that a person can control the way she interacts with and takes up the messages dominant in that context. Whereas the girls' struggle with the social tension that is exacerbated by their physical positioning on the body hierarchy, they do strive to resist. Even after explaining how she submitted to the pressure of not eating, Jenny reasserts herself to argue "*but you can't make everyone look like you*". This resistance is further highlighted in a later discussion with Jenny in the program when she states, "*I like who I am. I am good at music and I am a good friend. There's no way that we can all be the same... man, I think that would make life very boring*". Jenny highlights the positive aspects of her own identity that are not tied to how she looks. She then goes on to articulate how difference can be a positive thing.

Such resistance was relatively consistent in my observations of and my interactions with Summer, a 15 year-old girl who remained quite shy and reserved throughout the duration of the 11-week program. Summer consistently resisted the messages toward the thin ideal. While she did draw on the dominant messages of eating right and being active, she most often focused on health in relation to the inside of the body. She stated in her first interview " *it's not health on the outside, it's health on the inside, if their organs are all healthy, then they're pretty much alright*". She contests the healthist discourse that suggests she cannot be healthy in a larger body. Health for her is about having internal organs which function properly. This is consistent with the Health At Every Size Paradigm (HAES) that suggests fitness is a much better marker of health than fatness (Gagnon-Girouard et al 2010; Miller, 2005). She later (in her second interview) went on to critique the media messages about the female body challenging the assumption that thinness equates with health stating:

> " *I guess the messages like, on TV, like if you're watching shows like America's Top Model- they're all like sticks. It's kinda like, you have to be this small to be a model, and it's the wrong message- it's not good for people's minds…it's not healthy*".

Summer struggles to position herself in the midst of the competing discourses however. While she recognizes the problems inherent in the dominant messages, she is still functioning on a day-to-day basis in an environment that endorses and idealizes the normative body type. While Summer, in her first interview, contests the healthist discourse that suggests that she cannot be healthy in her larger body she simultaneously desires to lose weight.

> **Pam:** So, it's just that you're looking at healthy-but you don't feel the pressure to lose weight?
>
> **Summer:** I would like to, but I'm not really pressured into it or anything, but I'd like to…it'd be alright. I mean it's healthier… I don't think I'd like to lose that much- I don't want to be really skinny. Like, I find that a lot of my really skinny friends they can't lift anything. Like, they're weak.

Art as a Representation of Self

The gendered nature of health and beauty discourses and the dominant themes that arose out of the children's narratives were also evident in the children's artwork. The narratives, as highlighted throughout this dissertation, have provided me with a glimpse into their meaning making processes with regard to the body, social relationships and the evolving sense of self. Through the use of multiple methods however, I was able to further explicate how they utilized the discourse in constructing their meanings around health and the body. While the use of observation, focus groups, and individual interviews within this study provided me with a rich view into the children's perspectives, the exploration of meaning through their art added another layer of richness. The children's artwork provided another glimpse into their lived worlds and elucidated further how they utilized and resisted broader social messages about health. According to Deacon

(2000) creative methods help to "encapsulate the multidimensionality of the human experience" (p. 1). It was my hope that engaging the children through the means of artistic expression would help facilitate a joint exploration of meaning around the body and health.

While I had planned to conduct my own art project with the children, this project was ultimately integrated into a regular group session as it reflected work that had been normally done within the program and time was a factor for the children and program coordinators. This was an interesting experience for me as it allowed me the time to circulate amongst the children as they worked through their pieces and view how they interacted with one another, the program staff and myself. Later, in a focus group session independent of the program facilitators, I was able to further explore their meanings in relation to the artwork. In the art session as described in the methodology chapter of this dissertation, the children were asked to create a piece of art that reflected what they felt it means to be healthy. During the art session I noticed the boys and girls moved to separate areas of the room and worked in smaller groups on their projects. One boy worked alone. Although they were given a choice of drawing or collage, all children chose collage. They seemed eager to review the magazines they were provided with and actively engaged in discussions around the pictures they were looking at.

The collages that developed out of the session were in many ways reflective of their earlier discussions of health. While the magazines were chosen by me to allow for representation of a variety of normative and non-normative body types, the children predominantly chose to use images that reflected the dominant body ideal. I was intrigued that most of the participants utilized both words and pictures highlighting the power that both images and words carry for them. When asked why they chose to use words as well as pictures one boy, Joel stated "because it helps explain what I am trying to say". The combination of words and pictures helped to explicate the meanings they were trying to represent. Throughout this process I was cognizant of how meanings are produced through visual media in social life and reminded myself, as Harrison (2002) suggests, that modes of representation are not merely a reflection of the children's knowledge or experiences but they are "an act of construction which involves the interpreter as much as the maker of the representation" (p. 867). Being in a position where I could ask them to further explain and elaborate on their pictures also provided me with a richer appreciation for their perspectives. Considering the work of Thorne (1993), I worked to see myself not as the adult in control who 'studies down' to children but as to one who strives to learn 'from children' with "an assumption that kids are competent social actors who take an active role in shaping their daily experiences" (p. 12). I purposefully tried to open myself up to respect their way of knowing. Once again the idealized body became the central focus for most. The children utilized the pictures to articulate and emphasize some of the points they had made earlier. Joel for example, created a collage that consisted of a variety of muscular men in typical 'masculine' poses, each with what he called 'ripped' abs. Central to that the piece was the word 'truth' in large print. Other phrases such as 'your best' and 'gain muscle, lose pounds' were interspersed with the pictures along with a picture of a protein drink (See Fig 1. below).

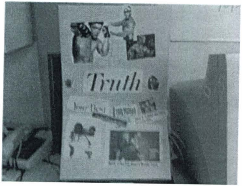

Fig 4.1. Joel, age 16. Collage depicting 'what does health mean to you?'

This was consistent with the discussions I had previously had with Joel throughout the program. When asked about their collages in the final focus group session, Joel spoke up to say, "*mine's the one with the muscle bound men*". When asked if this reflected what he thought of as healthy, the following exchange emerged:

> **Joel**: I think ripped guys are healthy.
>
> **Pam**: You think about ripped guys? So, yeah, you think about that when you think about healthy? Some of those guys up there on that picture?
>
> **Joel**: Or like, strong man shows.
>
> **Billy**: That's probably not healthy.
>
> **Joel**: They're healthy, they're just a little.. excessively healthy.
>
> **Adam**: In the case of this.. it's probably not overly healthy, it's obsession with muscle and physique, it's not necessarily being too healthy.

Joel continues to argue that more muscle is consistent with increased fitness, which ultimately is aligned with enhanced health. The resistance to that dominant message is evident in the statements of both Billy and Adam who argue that the practice of building large amounts of muscles may be more obsessive than healthy. I was intrigued by the phrase '*excessively healthy*' utilized by Joel in response to the resistive argument. This is reflected in the work of Pronger (2002) who explored the power of the exercise sciences in framing the way we view health fitness and in particular, the sculpted, toned, exercised body, and the way in which the healthy body is thus 'produced' in our so-called modern society. According to Pronger, the intertextual ensemble produced through the broader media and society provides us with the resources from which we read the body. These powerful messages he argues lead to subjectification, which instead of freeing the body in terms of healthy possibilities, actually limits the body to a prescribed definition and predetermined practices. The prescriptive nature of this "Regime of Truth" brings with it the assumption that you cannot be too fit. The push toward the 'perfect' body cannot be too focussed. Joel's expression of how he views health and fitness are in line with Pronger's contentions. Joel, throughout our conversations, continued to describe the building of muscles as a healthy activity. When asked at what point you need to stop Joel replied: "*I hate to sound like a broken record, about the cheese grater abs- if abs can-if like, if you can keep a Twix bar in between your abs (laughter) you should stop*". He continued to struggle with the concept of healthy and continued to see healthy as a reflection of how the body looked. When asked again later if he thought the very muscular man was healthy he stated: "*No, it's cool though*". Again the gendered nature of the health and beauty discourse was evident in Joel's responses " *it's a machismo thing, guys want to be big and ripped, usually more manly or muscular*". To Joel, the disciplined body is more worthy of attention and acceptance. The 'ripped' body was seen as a marker of control and ultimate triumph over his struggles around what he referred to as his "*soft jiggly body*".

It has been argued that the gendered nature of the dominant health and beauty discourses place women and more recently men in a position of constant surveillance. Women in particular become subject to the male gaze. When I asked the group in general whether they thought the excessive muscles looked good, the girls stated no while the boys agreed. Interestingly, Billy, a 13-year old boy, chose to focus his collage on what he considered to be health for females. His collage illustrated the idealized female form. There were three pictures of conventionally 'beautiful' female celebrities with a number of descriptors surrounding the pictures (see fig. 2). He utilized words that very much reflect the male gaze. The words 'sexy', 'beauty', 'perfect' and 'hot' were underscored by the phrase, 'we couldn't take our eyes off'. His concept of health and women is very much caught up in the act of looking. A healthy woman was seen as one who would draw his attention. When asked about his collage, Billy stated, that in order to look like these women you would have to lead a healthy lifestyle and this is what would appeal to him as a 'guy'. He stated "*it's what you see in the magazines..uh.. if you're going to look like that then you have to take care of yourself*". This statement was met with a number of resistive statements from the girls in the group. Jenny for example stated: "*Some people get skinny and get an eating disorder, so some of that isn't like.. the natural look they were born with*". When asked why someone would want to look like that Jordan went on to state:

> "*it's because it's the small percentage of people that can pull it off, and they're famous because they're something more exceptional than the average person, and*

they're put in the limelight, and they got that look and then everyone wants that look but they can't have it, because only a small percentage of society can look like that."

Fig 4.2 Billy (age- 13). Collage depicting 'what does health mean to you?'

Summer, a 15 year old participant, provided a different perspective in her artistic portrayal of what she considered to represent health. In keeping with earlier discussions, her collage highlighted her struggle with how health, beauty, and weight are conflated in the present cultural climate. Her collage (See Fig 3. below) in comparison to others was predominantly comprised of words. While no pictures of people were exhibited in the piece she utilized aspects of dominant messages around female beauty including high heels shoes and plump red lips. Pictures of food that fall into the healthy food category were also interspersed with words that reflect the messages prevalent in the healthy lifestyle discourse such as 'walk', 'get milk' and 'health'. These terms were intermingled with such terms as 'courage is beautiful', 'brave', 'artist', 'truth' and 'lucky'. When asked about her project, Summer stated that she knew it was important to practice a healthy lifestyle hence her placement of healthy foods. She also felt it was important to not be tied to all the rules in relation to health and beauty. For that reason she did not place pictures of so-called healthy beautiful women in her collage. In some ways she was conflicted as while she wanted to be brave and be her own person she stated it was difficult to resist the allure of shoes that heighten the female form. As noted by Azzarito and Solmon (2009), girls must consistently negotiate gendered discourses. These discourses according to the authors, intersect with discourses of race, lifestyle and physical activity. Girls, therefore, may draw upon some and utilize others in their constructions of health and identity.

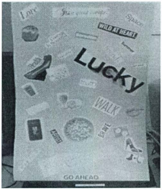

Fig 4.3. Summer (age- 15). Collage depicting 'what does health mean to you?'

Through the narratives and the artwork produced by the children in the program the struggles to negotiate the unrealistic and often conflicting messages that arise out of the current discursive milieu have been illustrated. While the themes that arose provide us some insight into the ways in which these children take up the dominant messages about health and the body, it must also be recognized this is a complex process which involves the day to day interactions that shape our lived realities. Hence it also becomes important to explore with the children how these ideas are both produced and utilized in their lives.

Living on the Periphery of Social Space

Becoming 'The Other'

The social space in which we function on a daily basis is central to the meaning we make and the identities that we ultimately forge (Gupta & Ferguson, 1992). The children's position on the periphery of social space was a theme that emerged through the narratives and interactions with the children throughout the 11 weeks of my study. The children were keenly aware of their social position as being outside of the norm. Through their talk, their interactions and their artwork the children were able to effectively articulate the meaning they derived from their ongoing social interactions as so-called obese children. Given this, I continue to recognize that my interpretations to these articulations are interwoven in this thesis. Drawing upon Carla Rice's (2007) work in "Becoming the fat girl", this section highlights the children's growing awareness of their status as the 'fat other'. On numerous occasions throughout the research children provided accounts of their positioning in terms of social space. This positioning as highlighted in the children's narratives took place largely in the school environment and served to solidify their identities as being outside the norm and in need of some kind of re-formation. This was reminiscent of the work of Rice, who through narratives explored the experiences of larger women as they reflected on childhood experiences that served to shape their identities. Rice highlights the school environment as being an integral component of these women's development of the 'fat girl' identity. She states " in our society, one location that may be more generative of identity than other social spaces is school, a place where perceptions of appearance and difference shape children's sense of belonging and standing" (p. 159).

Jordan, a 12- year old girl in my study, illustrated this point very well. Jordan explains on a number of occasions how she has been socially excluded in the school environment because her body did not fit the prescribed norm of the group. She would be described as being very tall and large for her age so that she is seen to 'tower' over her friends. In this excerpt from my first interview with Jordan, she describes how she is defined and labelled according to her size and how this has impacted the activities she participates in and how she relates to others. She is aware of her difference and that this difference places her in a marginalized position where she is likely to be judged or scrutinized.

Pam: Jordan, can you tell me a little about the things you enjoy doing?

Jordan: I like swimming, hanging out with my friends, and like dancing and singing-ALONE, because I can't do it in public.

Pam: Why not?

Jordan: Because when I sing and dance, I worry about what people are going to think, and I don't know if I'm good… because kids can be really, like, judgive[sic]-judged of another person.

Pam: Yeah, and have you experienced that?

Jordan: Yes, 'cause of my height and my weight since grade 2 and it keeps going on.

Pam: Yeah?, would you like to tell me what kind of things?

Jordan: Like they call me names and all that. Like, they call me Bigfoot, Godzilla-all that.

Pam: Do you find that hurtful?

Jordan: Well, I don't really mind it anymore. I just ignore it.

In this excerpt Jordan demonstrates her awareness of the broader societal desire for the normative body and the impact this has on those who do not fit. In stating " *kids can be really, like, judgive[sic]-judged of another person*", Jordan underscores the social pressure in the school and broader setting to fit the social norm. Those seen to be outside that norm are placed in a position of being subject to bullying and ridicule. According to Evans (2009), the ways in which we approach health and obesity sets up a dualistic form of thinking. This thinking, Bethany Evans argues, is reinforced through the school system. Food is viewed as either the right food or the wrong food, thinness is viewed as good and fatness is viewed as bad (Schilling, 1993). It is thus argued that once binaries are established that there is a hierarchy inherent that is inevitably produced. "Dichotomous thinking necessarily hierarchizes and ranks the two polarized terms so that one becomes the privileged term and the other its suppressed, subordinated, negative counterpart" (Grosz, 1994, p.3). The children who fall into the obese category in this case become the 'fat other'. As Grosz goes on to state, " the primary term defines itself by expelling its other and in this process establishes its own boundaries and borders to create an identity for itself" (p.3). The 'other' identity is thus formed upon the basis of what it is not in terms of the primary identity. The 'fat other' is the antithesis of the thin, healthy, and desirable form. This binary I argue allows the thin subject to exist on a perceived higher social and moral plain where he or she is given the social permission to cast off the 'fat other'. As suggested by Evans, the reinforcement of such binaries does not allow for anything in between and in doing so justifies the social exclusion.

Jordan goes on to describe how the school environment functions in terms of cliques. She provides an elaborate explanation of how the social culture of junior high functions in terms of belonging and social inclusion or exclusion as it may be. She draws upon concepts that are derived from broader culture in terms of cliques. When asked by the coordinator in the group "does it matter what you look like or what your friends looks like?" Jordan replied:

> "*well like, it is a thing at school because like it is a bullying thing...*
> *it all goes back to the bullying thing... it's about fitting in and like,*
> *the group who are the leaders, they decide who fits in and who doesn't and like to*
> *them it's all about looks. I'm the offbeat, I don't look the*
> *way they think I should look. My body doesn't fit so I don't fit...I am*
> *not someone they would admire*".

Jordan clearly exposes the power of dominant discourses in the normalizing process. As Foucault noted, the power exerted by hegemonic forces through institutions (both governmental and others which permeate societal relationships) seeks to normalize. Normality in this sense is a construction. The normality of the thin controlled body is produced in opposition to the fat body out of control body. The power of this process leads us to work upon the body or constantly seek to discipline the body that is always in fear of loss of control. Thus power resides in the body that fits the pre-described norm. As Bordo (1993) suggests, cultural representations of beauty both homogenize and normalize. They homogenize in the sense that "they will smooth out all racial, ethnic, and sexual "differences" that disturb Anglo-Saxon, heterosexual expectations and identifications" and they normalize in that "they function as models against which the self continuously measures, judges, "disciplines" and "corrects" itself" (p.25). Jordan clearly feels that her body does not fit the norm, that it is not worthy of admiration, and this hence leaves her on the periphery in terms of being accepted into the desirable social category. In removing herself from the "gaze" of others she is saving herself from the scrutiny and what she sees as the ultimate rejection of her 'otherness'. There are resistive moments however where Jordan asserts her sense of satisfaction and acceptance of herself. According to Sykes and McPhail (2008), people are not necessarily constrained to accept the 'fat other' identity. Through their research that involved interviews with 15 adults who identified as fat or overweight, they explored the meanings derived from these peoples' experiences with physical education in a fat phobic environment. While many of the participants recalled the experiences in physical education as repressive and degrading, some were able to resist the negative forces through either avoidance of sport or working to surpass the expectations of others by excelling at sport.

Jordan again returns to the discussion of how roles are defined in the school setting. She draws upon the familiar term "bullying", which has become a common discourse within the school setting. In defining herself as the offbeat she is drawing on language that is commonly used through the media and literature to categorize people into social groups. Websites, television shows and teen magazines are replete with advice on how to be popular and avoid being categorized as the offbeat.

Pam: So you said earlier that you are happy with who you are but you did have some concerns about clothes and fitting in. Would you like to tell me more about that. In terms of clothing and that kind of stuff?

Jordan: Oh, well. I don't really have any, I won't say- good clothes- but like good fitting clothes because in junior high people make fun of your clothes, and most of my clothes are not fit for junior high. I can't fit in a lot of that stuff- so I wear mostly, like three things…

Pam: So you said earlier they make fun of your clothes?

Jordan: You know, it's a junior high thing. There's A LOT of cliques.

Pam: Yeah, you mentioned that in our earlier discussion. Can you remind me what you said about the cliques and fitting in?

Jordan: Oh, yeah, I said that I fit in the offbeat- it's like a different person, and we have this whole group, well, we're all different in our own way. Me… my body doesn't fit… I'm tall, which makes me different. I'd prefer to be in the popular clique, but most of the people in that group are trying to be like that- actually fake. So, I wouldn't want to be that… but I like being tall…. Like they don't choose anyone over 65lbs or anything, which is a weight problem and they don't like people who wear their comfort, their comfy sort of pretty clothes, because they don't like the clothes they wear.

Pam: Where do you think that idea is coming from?

> **Jordan**: The idea is coming from –well, like I said, the leaders decide everything. Like, if one of the persons, the people in the group, came up to the leader and said" We should have this person and they didn't fit in, into anywhere, the leader would say, "well what does she look like?"

The need for social acceptance in this environment cannot be underestimated. In this excerpt Jordan notes the importance of wearing the 'proper' clothes which are tighter fitting and thus not necessarily comfortable for her. She claims that the popular kids do not like people larger people who wear their "*comfy sort of pretty clothes*". Clothing for girls that is tight and form fitting becomes a signifier of the femininity toward which girls are expected to strive and, as noted by Renolds (2008), is clearly linked with the heterosexual imperative. This also emphasizes the link between consumerism and childhood identity. It illustrates how children utilize clothing in their identity construction and reinforces the choice of clothing as a socially significant practice (Boden, Pole, Pilcher, & Edwards, 2004). When kids are produced as subjects outside of the norm who don't fit with the 'accepted social' practices, this can impact negatively on their quality of life. As McElhaney, Antonishal, and Allen (2008) stated, "their tendency to not be included in peer interactions at school may foster a self-fulfilling prophecy of sorts, in which these teens begin to decrease their bids for inclusion in peer activities over time" (p. 728). Throughout my discussions with Jordan and subsequent reading and rereading of the transcripts, I reflected on the impact of the dominant messages in relation to health and social positioning. While recognizing that these messages were influencing the children's views of themselves and others in relation to their bodies and health I also had to recognize that as Foucault suggested, these children are not passive dupes who blindly follow this particular regime of truth. The children regularly negotiated the discourses and while they drew consistently upon the dominant healthist discourse they did resist in many ways. This struggle was evident in my discussions with Jordan. She grappled with many of the messages she discussed in the previous excerpts. Resistance to the dominant discourses was evident in her speech as she tried to work through the messages that she is receiving from her friends, her family, her schoolmates, through broader contexts and through the program itself. While she recognizes what she perceives as the criteria are for fitting into the popular group and she still would like to fit there, she strives to focus on what she views as positive aspects of herself.

> **Pam:** So why do you think you fit into the offbeat, rather than the popular clique?
>
> **Jordan:** I fit into the offbeat because I am proud about myself and I don't have any…Like, I get along with everyone, and I'm big and tall, which makes me different and same with all my other friends. And the populars don't really care, they care about their appearances and …
>
> **Pam:** Right yeah, are there other things that make you feel good about yourself?
>
> **Jordan**: Ah.. well, I like getting good marks on tests and …well, I just like being tall.

Jordan, while recognizing that she would like to fit in the popular group, reasserts herself and suggests that she would not want to be 'fake'. She challenges the dominant messages by stating she is proud of herself for remaining true to who she is and not bending to the pressure to conform. When asked if she is concerned if the bullying affects how she feels about herself she states "*Um, not really, I see myself as the same person- I do NOT mind what they say*". Later however when asked about whether she worries about her weight she states "*Yeah... Well, I'm not really concerned... well I am concerned, because some days I eat a lot and other days I eat nothing .. I'm actually more worried about the future*". She goes on to say however that she likes herself.

This struggle; the need to fit in, the resistance to conformity, the tensions that arise out of wanting to be unique and to shun the dominant messages while remaining tied to them in many ways was evident throughout many of the conversations and interactions I had with the children. Their position in the social space was important to them. While often they identified with being on the periphery, they did articulate their desire to normalize or be "normal". At the same time the children were striving to assert themselves as normal in their own bodies: challenging the ideas of what normal is. This I argue, is the point at which the introduction of alternative messages may be most effective as the children demonstrated a readiness to challenge the status quo. The children are grasping for resources and new discourses that reinforce their need to feel 'normal'. While this may not, or quite possibly cannot be achieved in a timely manner, it is certainly a possibility. As Rich and Evans (2005) state:

> Offering alternative narratives on the obesity discourse may not only assist those who are labelled as overweight to re(position) themselves in alternative discourses, but also contribute to wider political, social and cultural discussion on how we are to make sense of obesity (p. 355).

While power can constrain it can also be utilized and transformed or converted. "Dominant forms and institutions are continually being penetrated and reconstructed by values, styles, and knowledges that have been developing and gathering strength, energy, and distinctiveness at the margins" (Bordo, 1993, p. 27-28).

Becoming Less Visible

In keeping with the concept of normalization as presented by Foucault (1977), power is seen to imbed itself and work not only through the exertion of external physical power but through the panoptic power of surveillance and monitoring. The narratives highlight how the hegemonic health and obesity discourses place the children in a position where they are open to constant surveillance and monitoring by others resulting in the feeling of always being "on view" for others to evaluate. The discourse not only permits such scrutiny but I would argue it also promotes this form of evaluation as a form of social regulation. For example, in teaching health in the school curriculum, utilizing disgust as a means of appraising the fat or abject other is commonplace (Evans et al., 2008; Leahy, 2009). The school curriculum, in doing this, places those who fit the prescribed norm in a position of power in relation to the fat "other". This is clearly evident in the children's narratives.

The marginalized position in which the participants of this study find themselves functions to make them less visible in the sense of being socially undesirable and pushed to the margins while at the same time serves to place them in a position of scrutiny due to the commonly held perception of fat people as unhealthy and unmotivated in terms of practicing so-called 'healthy lifestyles'. It has been noted within the literature that the obesity discourse carries with it a certain set of moral imperatives (Evans, 2009; Jutel, 2009; Murray, 2009). Those who do not fit the normative body type therefore are subjected to scrutiny and the gaze of those who feel they are in position to evaluate and lay judgement (LeBesco, 2004). Their bodies become "virtual confessors" in which outward body markings are read by others to interpret their internal psyche (Grosz, 1994; Murray, 2009). Grosz states:

> Visible body markers (such as fat flesh) are read in ways that position subjects on either the "acceptable" or "unacceptable" side of the normal/ pathological binary equation that signify subjects as either adhering to the requirements of "healthy' ethical living, or as engaging in "unhealthy" behaviours that position one as a moral or aesthetic failure (p.74).

It can also be argued then that the fat body which is held up as the symbol of what as a society 'we should not be', has become an entity to be gazed upon; to be evaluated in terms of it's deviation from the norm. The construction of the normal body as thin and the abnormal body as fat has resulted in cultural meanings around the body that permeate activities of everyday life. The 'fat abnormal body', within the modern healthist view, is aligned with attributes that signify a lack of care for the corporeal self such as gluttony, laziness and apathy regarding health and appearance in general. This has occurred in part as a result of the conceptualization of obesity as a disease. As Murray (2008) suggests, the medicalization of obesity "has entailed a collapsing of medical narrative/imperatives and historicultural discursive formations of fatness as a moral failing and as an aesthetic affront" (p.8). She argues that the authority of medicine in determining which bodies are morally acceptable has moved beyond the medical community into the broader community where people feel they are in a position to evaluate people according to their weight, size and shape. This view has thus become mainstream. These constructions are then utilized in the production of knowledge in relation to bodies and the formation of identities. The participants in this study were keenly aware of this gaze and demonstrated knowledge of the moral underpinnings inherent in it as well. They were aware that they were being evaluated based upon their bodies within various facets of their lives including physical education, organized sport, fashion, and daily interactions with those around them. As a result of this gaze they described instances where they felt they needed to withdraw, hide or become less visible so as not to be 'on view'.

This gaze is a product of the power that is exerted upon individuals and populations to be responsible healthy citizens. This power is exercised by governments through health strategies that shape our views of what a healthy person is. According to Foucault (1984), power in this regard, no longer reflects the sovereign power of the 18th and 19th century in which governments had the authority to take life. Power in the 21st century is a form of biopower: the power to give or preserve life. Governments now focus their strategies on monitoring and maintaining the life of the population. A healthy population is viewed thus as more productive and economically viable. While surveillance of the population and the implementation of strategies to enhance the health of the population may have some positive impacts one must also question how certain knowledge is produced, who is in a position to propagate this knowledge and to whose disadvantage. According to Harwood (2009), "this focus on life needs to be understood not as the heralding of some new caring and kinder age: but in terms of the aims of the state to solidify itself via the control of life (and hence strength, economic viability) of its population" (p.16). Efforts in this regard must be exerted to preserve and lengthen life. These efforts or biopedagogies therefore centre on the body, which can be worked upon to sustain life. Biopedagogies function as culturally situated practices and systems that create and convey knowledge and provide the instructive framework from which populations can be monitored and regulated in the name of health. They involve certain 'regimes of truth', which ultimately permeate the institutions and border social environments in which we are socialized.

The conceptualization of obesity as disease is one of these 'regimes of truth' that was socially constructed in an era of intense scrutiny. This has led therefore to a multitude of biopedagogies or the 'techniques of biopower' as Foucault (1978) referred to them. As reflected in Foucault's use of Bentham's panopticon, people are aware that they are being monitored and surveyed. The discipline that arises out of this surveillance becomes self-enforced and I would argue provides others who fit within the socially constructed category of 'normal' with sense of moral authority in which they feel they can monitor those considered abnormal within this paradigm.

Through the narratives the children articulated how they felt they were being observed and judged based upon their appearance. They expressed how they strove to become less visible in a number of different instances. This was most often elicited in discussions of activities and the things that the children liked to do. Jenny, a 12- year old girl, for example, highlighted in the first focus group how she does not like to be the centre of attention. It is easier to participate according to Jenny if you hide within the crowd.

Pam: Do you get involved in activities at school? Is there anything you avoid?

Jenny: I don't like to do soccer, volleyball or hockey…but I'm in drama, but I'm crowded by a whole bunch of my friends so it doesn't matter who's in front of me. I'm not out front.

Pam: So you find that when you're with a group, your group of friends, that feels safer?

Jenny: I'll do it with them I just don't want to be the centre of attention. I don't like people looking at me.

Concern in relation to participation in sport and evaluation of the body also arose out of the narratives. The boys in particular spoke about sports in terms of 'measuring up'. While the discussions reflected a gendered construction of sport as the performative demonstration of the powerful/ strong male body (Pronger, 2002), the body concerns highlighted by the boys transcended the performative aspect of the body. They highlighted concerns about how they looked in relation to clothes and concerns regarding the perceptions of others. This was in keeping with the work of Norman (2009) who suggests that the constructions of the healthy male body go beyond the performative nature of sport and the physical capacity one can demonstrate. He argues that the ways in which boys take up the obesity messages have been underestimated and are more complex than reflected in previous literature. As discussed earlier in this chapter, while appearance has often been considered to be less important to males than females, boys are concerned about the way they look and ultimately they are concerned about how others evaluate their bodies. As Norman states, in his study,

> The size and shape of the body—its appearance—proved to be a crucial marker of self for this group of men, as the obese body was talked about as not only an *unhealthy* body, but a body that was "looked down on" (p. 277).

This was consistent with the data generated in my study. For the male participants, there was an expectation that to be accepted one must achieve a certain level of physical health that was reflected not only in the way one performed and the way one looked.

The performative aspect of sport and the importance the boys placed upon how they looked were intertwined. While throughout the discussions the boys often paired body type with athletic achievement and noted how they could not measure up in terms of sport, they were also greatly concerned with how people evaluated how their bodies looked. Sport provided an opportunity for this evaluation to take place. They discussed how they felt they were being held in constant comparison to the boys who fit the normative body ideal and who were high achievers in the realm of sport and athletics. As they considered achievement in sport as reflective of the 'healthy male', they describe their experiences in relation to sport as inhibiting and often humiliating. Often they spoke of choosing activities that were not competitive. In seeking out individual type activities or avoiding physical activities they in turn avoided the scrutiny that accompanies such endeavours. In the following excerpt, for example, from our first interview, Adam discusses his experiences with sport. He suggests that certain sports place you in position where you can more easily be evaluated by other players and those watching the game. The gaze of the others according to Adam is inhibiting and functions to remind him that he does not "measure up" both performatively and aesthetically. In finding resistive ways of dealing with this position, he goes on to describe how through avoidance of one activity and his participation in another activity that provides him some 'cover', he is able to participate in sport.

Pam: You said you have been playing hockey and you feel okay out there. Like you're sticking to it?

Adam: Yeah oh yeah

Pam: Are there activities that you prefer not to be involved in?

Adam: Baseball, I DON'T like baseball.

Pam: No, why not?

Adam: Uh, I don't know. You're just standing up out there and then …then you got all these guys that are really awesome and I'm not very good at sports. When you're just standing there they just look at you and you wonder what they're thinking. I don't measure up so I wonder.

Pam: Right. So you don't like to stand and you don't like the comparison, is that what you mean? You don't want people comparing you to them?

Adam: Yeah, exactly. I hate being compared to other people. I don't like them looking down on me – like ah- you know you...

Pam: And so have you experienced that? Do you want to tell me a bit about that?

Adam: I Dunno- when you're standing still they look you up and down…some guys on my team were like, when I was playing baseball, some guys on my team were comparing me to another bad playing and I came out as the less person. He came out as the greater, and that made me the worst person on the team. In hockey

> though I still find it kind of weird because I'm still a sore thumb out on the ice because I'm not a very good skater....when I'm moving I don't stand out though... I keep moving and I have all that gear on so it's not like baseball.

In recounting his experiences with baseball and hockey Adam highlights his feelings of being evaluated. He talks about how he feels he is being compared. This comparison can be understood to mean a comparison to the norm or that, which is held to be the desired athletic type. To Adam, standing still in baseball provides others the opportunity to gaze upon him and allow them time to evaluate his body. His concerns regarding what they think is a reflection of Adam's knowledge of the permissibility of the evaluation of the body based upon size and performative ability. Adam is aware of the performative ideal and the ideal athletic body type. He thus feels inhibited, as he is not seen to, in his words, "*measure up*" to this ideal. While Adam possesses a desire to be involved in sport he is inhibited by the evaluative component. Adam has utilized hockey as a way of usurping the evaluative aspect of sport. In hockey he has the ability to move and become less visible in terms of his body makeup. The athletic equipment required to play hockey allows Adam to cover his body so that it becomes more difficult for others to scrutinize his fatness. This is reflected in his statement "*when I'm moving I don't stand out though... I keep moving and I have all that gear on so it's not like baseball*". The equipment combined with the movement eases the burden of the appraisal of others and provides him with some form of protection that helps him to enjoy the activity. As suggested by Sykes and McPhail (2008), the fat phobia evident in organized sport and physical education can have a profound effect on those who must negotiate the fat identity. While some, like Adam, may strive or resist this phobia and the constraining implications of the obesity discourse, "this involved confronting and resisting fat-phobic assumptions and practices through emotionally draining and intricate social, psychic and kinesthetic maneuvers" (p.89).

Billy, a 13-year old boy in my study in the first focus group, illustrates how concerns regarding the male body go beyond the sports arena. Throughout our interactions he discussed the pressures that boys also feel in relation to the body and being accepted in the peer context. As the following excerpt illustrates, while Billy felt a greater acceptance in the safety of his family, acceptance from his peers he suggests is greatly tied to how one looks. For Billy, the opportunity to cover his body, to become less visible provides him with some relief from the evaluative gaze of others and the pressures that that entails.

> **Billy:** Fitting in is about style and what you look like and who wears what and who looks the right way.
>
> **Pam:** What way is that?
>
> **Billy:** the right clothes, hang out with the right people… I don't worry about what I look like at home because the people at home are my family, like, they don't care how I look. I can go around in pyjamas all day, like they [family] don't care but when I go out I have to look different because people judge you… I like winter cuz like when you go out you wear big puffy winter coats and no one really knows what you look like.
>
> **Pam:** Do you mean what your body looks like?

Billy: Yeah, no one can really tell what your body looks like because it's kinda hidden. I don't have to think about what they're thinking.

Chapter Summary

The embodied experiences of children are often taken for granted in a society where, as adults we assume we possess a full understanding of the nature and experiences of the child simply because we were once children ourselves (Thorne, 1993). Throughout this chapter I have attempted to move beyond this assumption. Entering into my exploration of childhood experience, I was cognizant that the experiences of these children are not reflective of my experiences that have been tempered by a multitude of factors including, my own body, my education, gender, relationships, time, culture, and differing contexts. I reminded myself that their experiences are forged through their daily interactions and the resources they draw upon to make sense of themselves and others. I have provided in this chapter a discussion of themes that emerged as significant in the co-construction of knowledge that occurred through the multiple modes of data generation employed in this study. These themes are all distinctly and intricately linked to one larger overriding theme: discourse of difference. I argue that discourse is central to the meaning making processes of our everyday existence and the power of this discourse (how it produces knowledge, and how this discourse serves to shape and produce subjectivities) should never be underestimated. The obesity discourse sits as an example of this power. Such discourse, I argue, arising out of a neoliberal health driven society, has served to limit the opportunities of larger people in terms of social acceptance and positive body experiences. In examining these themes I have strived to consider them not only from the perspective of the child and her or his individual experience but I also have attempted to consider these experiences within the context of our broader social world.

As a means of gaining a better appreciation of the embodied experiences of these children I began with a discussion of their constructions of health. These constructions, I argue, are forged through a constant and complex negotiation with dominant and alternative discourses. I have demonstrated that the meanings that these children produce are greatly tied to contemporary discourses of health, obesity, beauty and the body that are endorsed through a number of powerful institutions in which the promotion of health has become synonymous with the promotion of the lean toned body ideal. Like other authors who have explored the ways in which children and youth take up the dominant discourses that conflate health and thinness (Beausoleil, 2009; Burrows, Wright, & Jungerson-Smith, 2002; Rail, 2009; Wright, O'Flynn, & MacDonald, 2006), I have argued that while these children are met with powerful forces that guide their beliefs about the body, they are not necessarily tied to the fat subjectivity. The children regularly resisted the dominant messages in striving toward positive or 'habitable' identities and presented as active agents in the production of their own identities. I have demonstrated how the children seek out ways of belonging, ways of feeling healthy and acting in healthy ways within bodies that are marked by society as 'unhealthy'.

Along with the examination of the children's constructions of health, in this chapter I have demonstrated how their words, their art and their interactions highlight the role that obesity discourse and other dominant health discourses play in the social positioning of these children. I have also drawn attention to the binaries established by the prevailing messages of health and the body that position the fat body as 'the other' and categorize it as something to be despised. Such binaries, I have demonstrated, situate these children on the periphery of social space making their subjectivities, if not uninhabitable, certainly less inhabitable. Throughout this chapter I have drawn upon the work of Foucault in the discussion of power and how the obesity discourse as a 'Regime of Truth' has positioned these children in a location of constant scrutiny in which the gaze of others has impacted not only how they monitor their own behaviours but the behaviours of others toward them. In keeping with Murray (2009) who defines the obesity discourse as a 'medico-moral discourse', I argue that such discourse which has served to define obesity as a threat, not just to our collective physical health but the very moral fabric of our society, not only provides us with social permission to openly gaze upon the fat body but also with permission to make open judgement about that body. This I contend has impacted greatly upon the emerging identities of the children in my study. The excerpts from the narratives provided in this chapter highlighted the articulate manner in which the children describe themselves, their social relationships and their choice of clothes and activities within the context of this discourse.

Finally, in explicating the manner in which these children navigate the present 'obesity storm', I have in this chapter brought to light the complex nature of the interplay of discourse, the search for a socially acceptable identity, and social positioning. The narratives demonstrate the astute manner in which these children negotiate the discourse and create and assess meanings around health and the body. This research illustrates how researching 'with' children rather than 'on' children and acknowledging their agency and strengths, can provide great insights into the embodied experiences of children while informing the way we conceptualize health.

CHAPTER 5

FATNESS, RISK, AND THE RESPONSIBLE CHILD: "I JUST NEED MORE WILLPOWER"

In the previous chapter I delved into the ways in which the children in my study construct health and their bodies given the discursive resources available to them. The discourses, I argued, that reflect the contemporary health promotion milieu are powerful in the ways they shape our beliefs around health and the body and are implicated in the positioning of larger children on the periphery of social space. In this chapter I move on to further explore issues of identity that arose out of the narratives with attention to the children's utilization of neoliberal heathist discourses that frame health as an individual responsibility that can only be achieved through some amount of work or personal effort (Crawford, 1980; Elliott, 2007; Rail & Beausoleil, 2003). From this perspective I highlight the role of risk in the production of the so-called 'responsible healthy citizen', as the concept of risk is central to this contemporary health consciousness. I draw on the work of authors such as Lupton (1993,1995, 1999a,b), Beck (1992) and Crawford (1980, 2006) in examining the role of risk in the production of the health conscious at- risk self. Within the neoliberal setting I argue, we are all produced as subjects who are responsible for acquiring 'knowledge' of health risks and consequently we are expected to utilize this knowledge in our work to avoid, reduce, or address these identified risks.

Considering that within the context of the current obesity panic health is measured in relation to the thin body ideal (Gard & Wright, 2005; Guthman, 2009; Jutel, 2009; Rich & Evans, 2005; Saguy & Almeling, 2008), within this chapter I postulate that the body becomes a visual representation of the degree to which one works towards and hence is seen to deserve the 'healthy' status. Health is considered something that is earned (Guthman & DuPuis, 2006). Thus, the body that is seen to deviate from the ideal representation is held up as morally deficient, corrupt or lacking in 'health' related work ethic (Guthman & Dupuis; LeBesco, 2004; Rail, Holmes, & Murray, 2010; Rawlins, 2008). Such people I argue are hence viewed as 'failed citizens'.

I begin this chapter with a discussion of risk as a means of regulation and go on to discuss the concept of governmentality and the production of the healthy neoliberal subject in general. I explore the relationship between knowledge, power and the at-risk identity. I consider how through the present healthist risk discourse, the child who is held up to symbolically represent the future of the human race is constructed as at-risk and therefore in need of intervention in order to ensure a safe healthy future for all. Within the chapter, I go further to discuss how the medicalization of obesity and the production of obesity as the ultimate risk factor leading to disease and death further function to restrict larger children in terms of achieving a healthy identity. I argue, given this medicalization of obesity and dire warnings that suggest that weight in excess of the prescribed norm could result in a shorter lifespan for larger children (Daniels, 2006; Ludwig, 2007; Peeters et al., 2003), that these children are constructed as the 'ultimate at-risk' children. The image of the obese child as increasingly sedentary intermingled with the representation of the larger child as gluttonous and lacking in self-control, as highlighted within the dominant discourse, reinforce this construction and are used to justify a call to action on the part of responsible adults including parents, teachers, researchers and legislators.

Given, as Crawford (2006) argues that those qualities which signify healthy living, come to produce our identities, this chapter provides a discussion of my exploration of how the children in my study have both taken up the messages of self-responsibility and how they integrated these into their own identities. This integration I argue ultimately serves to frame their relationships with other people and with food and activity. Through the narratives I explicate how the children negotiate both the overt and implied messages in the obesity discourse. I provide examples that highlight the guilt the children feel in relation to certain foods and activity and how though self-denial and the attempted mastery of avoidance of certain 'pleasures' they attempt to achieve 'healthy' identities and avoid the 'failure' status.

Finally in this chapter, I explore the role the parent plays in the construction of the ultimate at-risk child and through exploration of parent narratives how they both conceptualize their children in terms of risk and simultaneously function to address the risk. I highlight the gendered nature of health and lifestyle discourses in exploring the narratives of mothers to elucidate the meaning they derive from dominant messages. I consider how biopedagogies directed at mothers promote guilt in relation to their ability to succeed in the prescribed criteria of healthy living. I provide examples from a parent focus group that illustrate the guilt that mothers feel, the fear they possess for their children's future health and wellbeing and how this has impacted on their interactions with their children. I also examine how both the children and parents strive to withstand the messaging. While being absorbed and framed within the contemporary health paradigm, they find moments where they challenge the dominant messages and voice their resistance to elements of it.

Risk as a Means of Regulation

Risk is a concept that, in recent years, has come to pervade many aspects of our lives, leading to what Beck (1992) refers to as a contemporary 'risk society'. Along with Beck, a number of authors have argued that risk and the evaluation of risk have become the basis upon which we structure our daily activities in the ever-elusive search for 'health' (Crawford, 2004; Evans & Davies, 2004; Lupton, 1993,1995, 1999a,b; McDermott, 2007; Moynihan, Heath, & Henry, 2002). The concept of risk has been endorsed through the health promotion realm that permeates the institutions to which we are exposed on a daily basis. Risk consciousness is also evident in the broader social environment through media and strategically marketed health promotion campaigns (Rail, Holmes, & Murray, 2010). Through the medicalization of life, we have come to view life as a series of threats to our physical wellbeing and thus have become reliant on the medical establishment for guidance on how to live (Illich, 1975). Given that the present social environment is laden with neoliberal healthist values (Crawford, 1980, 2006; Monaghan, 2005; Rail & Beausoleil, 2003; Rawlins, 2008; Rich & Evans, 2005), we are expected as good citizens to work upon our bodies to produce a product that represents health (Evans et al., 2002; Guthman & Dupuis, 2006; Macdonald, Wright, & Abbott, 2010). As noted by Howell and Ingham (2001), the lifestyle movement calls upon us to utilize individual health strategies and products to find our 'true' selves. The search for the 'self' becomes a goal that is progressively tied to individual responsibility and thus justifies a focus on the individual within public policy. Thus within the context of the current health panic around obesity as discussed throughout this dissertation, it is no surprise that the discussion of risk and the so-called alarming consequences of overweight and obesity has reached what many would argue to be a fevered pitch (Campos 2004, Gaesser, 2002, Gard & Wright, 2004).

Risk is seen to heighten our awareness of our impending death and thus functions to restrict or police the activities that may contribute to ill health or death (Lupton, 1999). As suggested by Barsky (1988), this awareness, which supposedly serves to enhance health, in fact may function to increase our anxieties around health. As health risks are limitless and often times out of our control, the threats remain ever present and vigilance becomes a preoccupation (Crawford, 2006). This phenomenon is enmeshed within a neoliberal healthist approach to living that presumes the individual to be responsible for one's own health (Crawford, 1980). Within this approach one is expected to utilize the abounding scientific knowledge that drives our knew-found health consciousness in working upon the body to reduce risks and improve health status. Health becomes a moral or virtuous goal that one must strive to achieve (Halse, 2009). As Fox (1999) states in a discussion of risk and life choices,

> such moral positions are political, in that they ascribe rights and responsibilities to those subjected to them, and require actions in line with these rights or responsibilities. The human subject of risk analysis is drawn into a subjectivity as 'risky' and perhaps culpable" (p.22).

Given that obesity in our contemporary society is constructed as the ultimate risk factor for disease and something that can be prevented or controlled, those who are obese or outside of the normative body size become marked as 'abnormal' and come to represent the fear of impending doom that is permeated in many of the health messages.

As Murray (2009) suggests, these deviant bodies are virtual confessors. The 'risky' fat body becomes a visual representation of risk. "We read a fat body on the street, and believe we 'know' its 'truth': just some of the characteristics we have come to assume define fatness are laziness, gluttony, poor personal hygiene, and lack of fortitude" (p.154). Such discourse serves to frame the embodied experiences of the children in this study.

The 'Ultimate at-Risk' Child

In order to fully explore how the children in my study utilized the risk discourse, I felt it was important to consider how the concept of childhood in general is constructed in the present risk society. According to Burrows and Wright (2004), childhood is a construct that is continually being produced and amended based upon the particular social climate of that time. The child, according to the authors, has been traditionally produced in Western society in opposition to the adult. Children have been constructed as possessing an innocence that must be moulded, nurtured, and ultimately protected. Simultaneously, as Burrows and Wright point out however, the child is constructed as reckless and in need of protection and instruction on safe and proper behaviour. The child is an 'incomplete subject' within the neoliberal context who must be normalized to become a healthy 'governmental subject' (Norman, 2009). According to Jackson and Scott (1999), childhood is produced within the context of risk anxiety in which parents and society at large are bound to protect the child from anything that serves to threaten the childhood status. They state:

> Because children are thus constituted as a protected species and childhood as a protected state, both become loci of risk anxiety; safeguarding children entails keeping danger at bay; preserving childhood entails guarding against anything that threatens it. Conversely, risk anxiety helps construct childhood and maintain its boundaries (p. 86).

This conceptualization of childhood is a pertinent point in the examination of the social construction of the obese child. Within the current obesity panic, all children are constructed as at-risk. Scientific and mainstream articles regularly report on the growing concerns of childhood obesity, suggesting that all children are at-risk as long as we continue to function within the present obesogenic environment which encourages sedentary behaviour and the consumption of energy dense foods (Ball & McCarger, 2003; Canning, Courage, & Frizzell, 2004). The obesity discourse therefore is coupled with a discourse of risk. Discursive practices construct obesity as a "killer" therefore the need to identify and protect the children at risk operationalizes as a series of surveillance mechanisms. Consequently, I argue, those children who fall into weight categories above the norm are constructed as the 'ultimate at-risk children' giving rise to organizations, government departments, and research groups devoted entirely to the issue of childhood obesity and the components of risk which it entails. This conceptualization of risk is regularly reinforced to children and parents through risk messages imbedded in the biopedagogies that permeate the school system, the broader media and social environments (Evans et al., 2008; McDermott, 2007; Saguy & Almeling, 2008).

The children in my study were very much in tune with the discourse of risk that produces them as subjects of risk. This 'knowledge' of risk was evident in the children's talk. They regularly drew on concepts of risk and utilized the risk discourse on numerous occasions throughout our interactions. For example, on one occasion, when provided with a scenario in which they are stranded on a desert island, the discussion that ensued focused more on risk avoidance and the prevention of disease than on mere survival as I expected. In discussing what they felt they would need on that island to stay healthy for instance, the children provided examples such as sunscreen to prevent skin cancer, 'good' food to ensure (as Ethan put it) "*a healthy heart and stuff*", and regular exercise as articulated by Nicholas who stated "*30 minutes of exercise everyday*". These statements all reflect the growing awareness of risk in children that is permeated through the broader health discourses. I noted that throughout the discussions, the notion of risk in relation to cardiovascular health was particularly prominent. The children regularly spoke of heart health, cholesterol and the implications of inactivity and 'fatty' or 'bad' foods. The following excerpt provides an example of such talk. This interaction took place during a regular program activity as Billy explained to me why he came to the program in the first place.

Pam: Why do you think you are here in the program?

Billy: Well, I suppose it's because of my weight… I went to the doctor with pain in my knee and the doctor said I gotta lose weight.

Pam: Do you mean the doctor said your bad knee was due to your weight?

Billy: Yeah, the doctor said I need to work on eating healthy and moving around more.

Pam: Do you think you're active?

> **Billy:** Well, I play hockey and I go out and around with my friends a lot but I play a lot of video games like 'Call of Duty' and I like to watch TV so... I know I need to exercise and eat right if I don't want to end up with clogged arteries and stuff… or a heart attack or stuff like that.

Billy in this instance drew upon the dominant risk discourse in discussing his increased risk for cardiovascular disease. He demonstrates his knowledge of the discourse through directly associating activity levels and eating with *"clogged arteries"* and *"heart attack or stuff like that"*. He also utilizes the pervasive message that playing video games and watching TV are risk factors in the development of coronary artery disease. What I found particularly intriguing in this instance is that Billy seems to downplay the fact that he plays hockey and spends time being active with his friends by qualifying his initial statement with *"but I play a lot of video games…"*. The act of playing video games or participating in behaviour not considered conducive to health in this instance is seen to negate his more active endeavours. I argue that the obesity discourse in this sense does not provide room for children, particularly obese children, to engage in pleasurable sedentary activities even though they may be physically active. The negative consequences of media engagement as underscored in the obesity discourse completely outweigh any pleasure derived from such activities. While Gard and Wright (2005) argue that the research that suggests "that the relationship between television watching and overweight is at best complicated or at worst tenuous" (p.60), larger children in the media are regularly portrayed sitting lazily in front of the television set, quite often with 'junk' food in hand. The pervasiveness of the message of videos games and TV watching as 'bad' along with the association of these activities with fatness and hence illness, I argue restricts these children in terms of the opportunities for a balanced identity. The social construction of media use as detrimental to the health of children and adolescents and as representative of the growing apathy toward corporeal wellbeing, I assert, serves to shape the way children view themselves. While researchers and the broader media frame media use as a major risk factor in the growing rates of childhood obesity (Vandewater, Shim, & Caplovitz, 2004; Yang, Smith, & Graham, 2008), researchers, it is argued, are entering this realm with preconceived socially constructed notions of children as passive dupes who fall victim to the ill effects of a progressively sedentary self-indulgent society (Vander Schee & Boyles, 2010). However, as stated by Monaghan (2010):

> Just as young people's health and illness experiences are socially constructed states, intersected by experiences of class, gender, ethnicity, socioeconomic status, and expert discourses on what it is to be healthy, judgments on media risk are always grounded in the social locations of the expert (p. 129).

I argue that as researchers we need to consider other ways of examining issues such as media use that impact upon children and are implicated as risks to health. We must openly explore and critique the ideological foundations of research on children, risk, and media use. In moving beyond the 'adult knows best' perspective and being open to children as active agents in the use of video gaming we move beyond the restrictive and simplistic notion of video gaming as a 'useless activity' that leads to sedentary habits to consider how children utilize media and how this intersects with their daily activities and contributes to their emerging identities.

Governmentality, Risk, and the 'Body Project'

As noted in the previous section, risk functions to regulate behaviour. Within the risk discourse children, in order to achieve a healthy identity, are expected to deny the pleasures of sedentary activities in favour of what Foucault refers to as the 'project of the self' that involves working upon the body in a more physical manner to produce the 'healthy subject'. It is also interesting to note that while Billy (in the previous excerpt) presented to his physician with knee pain, that his fatness and the need to lose weight became the focus of the visit. The assumption is that his knee pain is a direct product of his fatness and therefore something to be worked upon. As Jutel and Buetow (2007) argue, appearance plays a large role in how obese individuals are assessed and treated by health professionals. This assessment they argue while not always inaccurate often results in a misinterpretation of the reality of a person's health. Patients' symptoms are often dismissed as a by-product of their weight and they are encouraged to work on their bodies to reduce the weight in an effort to relieve the symptoms.

This 'project of the self' is grounded in the notions of governmentality, knowledge, power, and control as conceptualized by Foucault. According to Foucault (1993), governmentality does not merely represent the power that a government exerts over a population but rather reflects the dynamic ways in which power is exerted through both 'technologies of domination' and 'technologies of the self'. The examination of discourse leads us to consider how people take up a discourse that is not violently forced upon them but rather a discourse which serves to shape subjects and their activities through hegemonic forces resulting from varying relationships of power. The question becomes 'why do people choose to take up discourses that may serve to shape their embodied experiences in negative if not harmful ways?' As Foucault (1980) stated:

> I think that if one wants to analyze the genealogy of the subject in Western civilization, one has to take into account not only techniques of domination but techniques of the self. Let's say: one has to take into account the interaction between these two types of techniques – techniques of domination and techniques of the self. One has to take into account the points where the technologies of domination of individuals over one another have recourse to processes by which the individual acts upon himself. And conversely, one has to take into account the points where the techniques of the self are integrated into structures of coercion or domination. The contact point, where the individuals are driven [and known] by others is tied to the way they conduct themselves [and know themselves], in what we can call, I think, government. Governing people, in the broad meaning of the word, governing people is not a way to force people to do what the governor wants; it is always a versatile equilibrium, with complementarity and conflicts between techniques which assure coercion and processes through which the self is constructed and modified by oneself (p. 203-204).

Governments, in providing the repertoire of resources and biopedagogies upon which citizens can work upon themselves in effect gain power over their citizens through the direction of their activities and hence, mark their identities. Through the use of what is considered objective scientific research, governments utilize epidemiology in contemporary society by providing the population with the indicators of health (or disease as it may be) that are ultimately translated into tangible risks. McDermott (2007) for example cites Dean (1999) who states " Risk is a way… of ordering reality, of rendering it into a calculable form. It is a way of representing events so they might be made governable in particular ways, with particular techniques, and for particular goals" (p.311). As McDermott suggests, a risk vocabulary works well within the obesity discourse. It provides the population with the clear markers of disease that call for action. If governments are to gain power in relation to people's lives through shaping their health related activities, risk is a logical place to begin (Leahy & Harrison, 2004).

It has thus been argued that through biopedagogies and providing people with resources that promote life, governments are implicated in shaping subjects through impacting how they shape themselves. Knowledge of health threats and so-called proper health practices serve to direct our activities while marking our degree of success in achieving a 'healthy lifestyle'. The obesity discourse is a pertinent example here. It functions to permit surveillance and monitoring of the population in terms of BMI and other weight based statistics that supposedly provide us with a measure of health. The ongoing surveillance of body anthropometric measurements across segments of the population is justified as a means of public health promotion and protection (Evans & Colls, 2009). At the same time this discourse serves to draw attention to and heighten our awareness of our own so-called deficiencies. We are regularly reminded how we as a population are falling short of the ideal or desired measure of health. In this environment people come to measure themselves and others by the degree to which they are seen to abide by the prevailing health guidelines. Through the conflation of health and the thin body ideal, those who do not reflect that ideal body type (that suggests they have achieved a healthy status) are viewed as a burden to the system and I argue as 'failed citizens'. The lean body is regarded as somehow more worthy, whereas the obese body is presumed to be unhealthy, and stands out as representative of a 'lesser citizen'" (Elliott, 2007, p.139). This I argue has implications for how children come to measure themselves and form their sense of belonging within the social context. As Crawford, (2006) states:

> In the health-valuing culture, people are come to define themselves in part by how well they succeed or fail in adopting healthy practices and by the qualities of the character or personality believed to support healthy behaviors. They assess others by the same criteria" (p.402).

Success in the adoption of healthy practices presupposes a certain level of responsibility. Through the scientific and governmental legitimization of a healthist neoliberal discourse, marketers abound who can sell sickness and hence the products that are designed to address or reduce the risk of sickness (Rail & Beausoleil, 2003). As stated by Moynihan and Cassels (2005) in the preface to their book, "at a time when many of us are leading longer, healthier and more vital lives than our ancestors saturation advertising and slick "awareness raising" campaigns are turning the worried well into the worried sick" (p.x). Given that children today are often considered 'adults in the making' (Jackson & Scott, 1999) who are being shaped toward healthy living for healthy futures, marketing is very much focused on the child and the family. Children, who in contemporary society are viewed as vulnerable and simultaneously viewed as a risk to the moral fabric of society, have become the target of consumer marketing and life shaping biopedagogies (James & James, 2004).

Throughout my interactions with the children in this study the concept of responsibility arose on numerous occasions both within the interviews and the broader program setting. The participants were acutely aware of how weight categories are defined as a measure of success and responsibility and articulated some of the widely held beliefs around the implications of body weight. They drew regularly upon common discourses of weight that infuse the school, home and leisure environments. In the following excerpt for example, during a discussion within a regular program session of their experiences with the Wii Fit gaming system, the children discuss the concept of obesity, the negative connotations that it entails and how this impacted their initial perceptions and expectations of the treatment program. The Wii system is marketed to children and parents as an alternative gaming format that addresses the so-called problem of sedentary video game playing and hence an undesirable level of energy expenditure, which has been implicated in the production and maintenance of childhood obesity (Graves, Stratton, Ridgers, & Cable, 2008; Robinson, 1999; Tremblay & Willms, 2003). Simultaneously however it also serves as a source of measurement and surveillance (Seung-A, 2009). The Wii Fit game, I argue, reinforces the broader obesity discourse by introducing the game player (in most cases children) to body measurement and monitoring in an effort to help 'solve' the problem of obesity. Each player is also given the opportunity to create their own avatar or Mii character which one can adjust to visually represent a certain height and weight. Gamers are then provided with regular opportunities to measure their BMI, which is charted on a graph to enable regular self-surveillance. Through this system that is customized to each player, the player is provided with regular unsolicited 'encouragement' to work harder to achieve an ideal BMI. The children in this excerpt discuss the Wii Fit messages:

> **Jenny**: I have Wii Fit …it's not very nice at all. My mom knows this person who got on it and it said 'you're too heavy, get off'.
>
> **Joel**: Wii fit called me obese.
>
> **Pete:** Yeah, I'm obese too apparently.
>
> **Billy:** But it's only telling the truth.
>
> **Jordan:** It told me to lower my BMI. I tried to lose weight before but it didn't work.
>
> **Ethan:** I don't like to be called obese.
>
> **Billy:** But you are…we all are or we wouldn't be here.
>
> **Pam:** And do you think that there is a problem with the categories we put for obese and overweight?
>
> **Jordan:** Yeah but… you can be healthy and be bigger.
>
> **Joel:** Obese is actually 20 lbs overweight, and depending on your body frame, that could actually be healthy. I can't get much under 200…
>
> **Billy:** Like I said weight is a problem or we wouldn't be here.

The children struggle with the measure of weight as a reflection of who they are. They recognize how the negative ways in which obesity is represented in society serves to diminish their positive sense of self as reflected in Ethan's statement "*I don't like to be called obese*". As discussed previously, the children implicate the video gaming system Wii in reinforcing the negative nature of the broader obesity discourse as Jordan suggests that Wii "*is not very nice at all*". While they voice their discomfort with being categorized as obese, Billy reminds them that whether they like it or not they do fit into that category and that their presence in the program reinforces this fact. Simultaneously, others like Jordan and Joel actively resist this message, suggesting that the way weight is defined and categorized is problematic. Billy again emphasizes the obesity discourse in stating, "*Like I said weight is a problem or we wouldn't be here*". The obesity discourse, as previously discussed, reinforces a knowledge of weight categories, the social values placed upon these categories and the imperative that states we are responsible for doing something about it (Evans et al., 2008). The children in the previous discussion highlighted their knowledge of the categories and also their recognition of the negative connotations of the category in which they fit. They recognize as well that they are expected to act upon it as reflected in Jordan's statement, "*It told me to lower my BMI. I tried to lose weight before but it didn't work*". While they highlight their discomfort with the category of obese, Billy reasserts the broader discourse as part of their lived reality and ultimately their identities.

I argue that the heightened awareness of BMI and its corresponding level of acceptability may negatively impact the emerging identities of children who do not fit the prescribed norm. Instead of becoming an incentive for improved health, it serves to further marginalize a segment of the population and inhibit participation in and enjoyment of activity that positively impacts on health as it increases concerns about fitting in or feeling abnormal (Evans & Colls, 2009). As Evans and Colls argue, the use of the BMI in the surveillance of children "ensures children (and parents) remain in a state of anxiety about the possibility of their (or their children's) bodies being revealed to be abnormal" (p.1077). The children in my study discuss how through the Wii system they are reminded of where they stand with regards to the norm, in a position of 'abnormality'. They also reiterate the discourse that suggests that they are in a position where they can control their BMI. While there is research that suggests that by allowing children to create their ideal avatar in the Wii system there is more motivation for change (Seung-A, 2009), it has also been argued that exergaming endorses a commercialized focus on the body (Schee & Boyles, 2010). I found no research that directly explores the impact of the Wii Fit or others games of that nature on children's body image and self-esteem. This is an important area of exploration as much research in this area is conducted from a positivist ideological perspective that often neglects the lived experiences of participants. As stated by Monaghan (2010), "as health researchers we must be wary of our tendency to overlay conceptual or heuristic categories of analysis in a manner that serves to define the experiences, and mute the voices, of the people we are studying" (p.128).

Self-Responsibility and the 'Failed Citizen'

As previously discussed the oversimplified view of health as being within the individual's control is the hallmark of the neoliberal approach and this is particularly pertinent to those marked as obese who display their so-called weakness via their non-normative bodies. The children in this study drew regularly on this naïve view of health and the body in the construction of their own identities. For example, in our discussion (during our first focus group session) of what they would need to be healthy on a stranded island , the children focused predominantly on food and exercise as a means to attain health. For example, Nicholas stated: *"I would say* [we would need] *some kind of exercise machine, or something like that to keep healthy".* When asked about the need for a machine on an island Nicholas responded by saying that by using a machine you are doing the "*right work*" needed to achieve a healthy body. Given that in the scenario, the children would be in an environment that would facilitate exercise (i.e. on a warm, tropical island with trees and beaches), the children still viewed the healthy body as something that needed to be produced through work. Nicholas in this instance drew upon the commonly held belief that the ideal body should be produced and disciplined through modern fitness equipment. This message is broadly reflected in contemporary discourses through media ads and even within modern school gymnasiums that are increasingly incorporating various exercise apparatus in an attempt to improve the physical fitness of the youth. As noted by Pronger (2002), exercise equipment is just one component of an intertextual ensemble that serves to produce the idealized fit body. He states:

> At most facilities, exercise machines have pictures that portray how the body is to be inserted into the machines, as well as written texts on how to use them. The machines are calibrated so that the user can set its functions to a selected intensity. Computerized aerobic training machines such as stair climbers, treadmills, stationary bicycles, and rowing ergometers invite the user to key in his or her age, weight, and preference for style and length of workout, and they will program a workout of varying intensities, inform the user when he or she is not working hard enough, record the number of calories burned and so on… (p. 140).

As Pronger (2002) highlights, exercise technology has infiltrated mainstream society on the pretext of scientific rationality. As noted in the previous discussion on the Wii Fit, the body is to be worked upon and disciplined according to prescribed texts that render the body an entity that can be objectively measured and managed. He goes on to state:

> while each textual field and indeed different texts within each field represent the technology of physical fitness in somewhat different ways, throughout the ensemble there is a common, essential (in Heidegger's sense) reading and writing of the body, of its future, and of its place in the political and ecological scheme of things (p.145).

Within the discourse of the disciplined body the effort that is exerted is seen to correspond with the level of 'health achieved'. As self-responsibility is central to this paradigm, those who are said to possess the qualities of willpower, self-control, and perseverance are rewarded with good health and in doing so become righteous or deserving citizens, contributing to the positive health of the collective whole (Elliott, 2007; Fullagar, 2009; Guthman & Depuis, 2006; McDermott, 2007; Rawlins, 2008). This concept of citizenship is thus tied to the corporeal self, suggesting that people have a duty to their nation to work to maintain the health of the entire population to keep a nation strong. As Evans et al., (2008) suggest, the pressures to abide by the so-called weight rules "are intensely visceral because the sort of 'responsibility' invoked by the instructional elements of obesity discourse signal not only that individuals should be responsible for themselves but should look after themselves *for the sake of others*" (p. 57). The individual body comes to represent the social body. This, they argue, exerts pressure on those who do not conform. The failure to comply to the bodily norms outlined in biopedagogies hence quite often results in a sense of failure, guilt which I assert, ultimately impacts negatively on evolving identities. As Rail, Holmes, and Murray (2010) state:

> The construction of health as a moral responsibility leads to the construction of illness and obesity as a personal failure in character, thus blaming the individual who falls short of maintaining health or weight…for so called 'obese' youth or youth with a disability who are stereotyped and constructed as being 'unhealthy', this is particularly problematic (p.273).

As Brownell and Puhl (2003) highlighted, people considered obese who suffer from stigmatization may come to accept the stereotypes placed upon them as a means of coping. Taking on the identity of the 'failed citizen' has numerous implications for the embodied experiences of these individuals as this identity transcends the many realms in which we live. This is highlighted in the following example from my research. During one regular program session, the children were provided with a large piece of paper with a non-descript outline of a body form. The children were asked to use the form to represent themselves. They could write their characteristics on the form or draw anything on the form that felt represented themselves. The children worked on the project: some together and some individually. I took note of one particular boy, Nicholas, in the process of the session, who carried out his project in the corner facing away from the other participants. When I approached him and asked him if I could view his work he obliged. He refused when I asked if I could take a picture of the piece for my research but did state that he had no problem if I wrote about it. He had written words in large uppercase letters with marker on various body parts that reflected how he felt about himself. On the right leg he had written '*lazy*' while on the left leg he had written '*couch potato*'. On one arm he wrote 'unpopular' while on the torso of the body he had written the word 'unhealthy' in large letters. When asked to explain these things he stated matter-of-factly that he was not popular and that he thought he was unfit and unhealthy because he was fat and lazy. He stated he considered himself a couch potato because he loved playing video games and could sit for a long time doing that. He stated he was lazy and was not very active. In exploring his meaning of active I asked him what activities he was involved in. He stated he played rugby twice a week and he regularly walked and participated in cross country skiing activities. I was intrigued that even while being involved in such activities that he still considered himself a couch potato. Nicholas in this instance is drawing upon the broader conceptualization of the at-risk child, particularly the 'ultimate at-risk' child as lazy and inactive. While he can articulate that he has a perceivably high or socially acceptable level of physical activity, he simultaneously categorizes himself as a '*couch potato'*. As Hann and Peckham (2010) state, "The alleged generation of couch potatoes is accused of watching too much television, playing too many computer games and not doing enough sport" (p.123). The children ultimately draw on this pervasive message in forging their identities in relation to broader social desires. Hann and Peckham go on to say "the couch potato accusation is also not universally supported by the empirical evidence"(p.123).

Later in an interview when I asked him to elaborate on why he felt he was unfit and unhealthy he stated "*ah, I dunno (laughs).. I don't have enough willpower to stop eating and stuff. I love eating, I just don't know why... I just need more willpower*". In this instance Nicholas was drawing on the neoliberal public health imperative that we are all responsible for our own health and that we must demonstrate a certain level of fortitude, strength of character, or 'willpower' that allows us to deny certain pleasures (food as one example). As stated by Evans et al. (2008), "In the disciplined world of 'healthy eating' they learn that health, goodness and moral virtue lie not in what they eat but in what and how much they can 'resist' " (p. 59). Nicholas, through his experiences with the new health 'knowledge', struggles with the fact that he cannot overcome the pleasure of eating to attain a disciplined diet. In keeping with the current obesity discourse, the suggestion that he needs more willpower points to what he views as a flaw or weakness in his character. He recognizes the mandate inherent in the health promotion messages that suggests that behaviours that produce pleasure are subordinate to those that produce health; that those people who can control their hunger for pleasurable food and activity are more deserving of good health (Guthman & Depuis, 2006). The role of pleasure in relation to food and leisure "are secondary concerns in an economy of risk structured through the metaphor of balancing energy 'inputs and outputs' " (Fullagar, 2009, p.111).

The tension between the pleasure and the ever-present pressure to avoid certain risky food and leisure behaviours such as television and video games is apparent in the children's talk. The children simultaneously talk about the pleasure they receive from so-called risky behaviours, the negative impact of such behaviours, and the need to deny the pleasures in the name of health. The tension between the pleasure derived from certain foods, the activities highlighted as risky and the guilt that arises out of 'giving in' to those pleasures is apparent. Focusing on the rules of healthy living, Coveney (2006) suggests that nutrition in this era is problematic in the sense that it is presented as science without recognition of the moral and ethical imperatives imbedded in it. The author states "nutrition is not only a science but also an ethos which presents a problem for modern individuals in regard to their food choices and pleasure" (p. xvi).

In the following excerpt from the second focus group for example, the children have a discussion of take-out or fast food that has been implicated in the increase in weights across contemporary populations. Within this excerpt, the children articulate both the pleasure they derive from the food produced by these franchises and the feelings of guilt it produces:

Nicholas: I miss McDonald's.

Pam: You miss McDonald's?

Adam: I miss Wendy's for lunch.

Pam: Did you cut out McDonald's?

Nicholas: Yeah

Pam: So why did you cut out McDonald's? Why did you cut it out?

Nicholas: Well, I didn't- mom did.

Pam: Your mom did?

Billy: I love Wendy's. But I can't have it because it's bad for me…But I miss it …I really love it… especially the Baconator

Jordan: We've been doing that too –we had McDonald's last week, I think but I felt a bit guilty…it was so good though.

Joel: Man…We haven't had McDonald's in over two months.

Pam: So why do you think your parents made that decision?

Jordan: Because we joined the group.

Pam: Because you joined the group?

Joel: Yeah…Mom has this big thing on the go, she had to measure everything out.

Pete: Because I am a cow.

Jenny: There's enough carbs and calories in McDonalds to kill a cow…so I don't see why we should be eating it.

I noted that the children very eagerly talked about the food they enjoyed at the various fast food restaurants and of the children who had eaten there during the course of the program, they qualified the fact that they had eaten there with statements of how their parents now regulated the frequency at which they eat at such establishments. A number of the children stated that they were no longer allowed to eat fast food but as Billy highlighted in his statement, "*I love Wendy's…*", there was definite pleasure derived from eating such food. The tension between the enjoyment of fast food and the guilt related to indulging in food in direct opposition to those dictated in the biopedagogies is highlighted in Jordan's statement: "*we had McDonald's last week, I think but I felt a bit guilty…it was so good though*". The children recognized that they are not only expected to deny themselves the pleasure of such food because the food is considered bad or unhealthy but also because they are obese. This is reflected in Pete's response to my question regarding why he no longer visited McDonald's stating *"Because I am a cow"*, a response that Pete gave during a number of our conversations throughout the duration of the program. In response to the discussion about how they miss this sort of food, Jenny draws on her knowledge of what constitutes unhealthy foods by highlighting that there are *"enough carbs and calories in McDonalds to kill a cow…so I don't see why we should be eating* *it"*. This statement falls in line with dominant messages that urge us to control our hunger and consider health before pleasure This is consistent with the findings of Shea and Beausoleil (2012) who noted that youth within their study, while identifying fast food as unhealthy also spoke of their how they enjoyed this type of food. They also linked fast food with heavier or unhealthy weight. It also reflects a moralistic view of fast food consumption that depicts fat people as indulgent and lacking control (Braziel & LeBesco, 2001). These findings are also consistent with those highlighted by McPhail, Chapman, and Beagan (2011), who, in interviews with 132 teenagers, found that youth conceptualized fast food as unhealthy and 'bad'. Drawing on Lamont's (1992, 2000) notion of 'moral boundary work', the authors concluded that the youths' formation of self was very much linked with the consumption of what is perceived as 'good' and 'bad' foods. As the authors state:

> Teens from all classes in our study positioned themselves within moralist narratives of healthy eating by reciting three basic fast food-related narratives: teens believed fast food to be unhealthy, and claimed to completely avoid fast food for health reasons; teens regarded fast food as unhealthy, and claimed to consume fast food but feel guilty and bad for doing so; and less often, teens claimed to consume and enjoy fast food without feel- ings of guilt or concerns for health, even while knowing fast food was bad and unhealthy (p. 306).

While there remains a general assumption within the mainstream literature that children and youth are not cognizant of the consequences of food choice and consumption and therefore must be educated about nutrition, this research illustrates the complex relationship that exists for children and food. It is essential that we continue to explore the ways in which children negotiate lifestyle and discourse and how these messages serve to shape the way they conceptualize food, themselves and those around them. As will be discussed in the following chapter which examines the messages delivered within the treatment program, although the children were taught within the program that there is room for fast food in their diets and that they should not feel guilty about it, the children's views of food while impacted by the program are very much informed and shaped by the dominant discourses.

Biopedagogies and the Mothering Experience

Earlier in this chapter I explored the manner in which the children in my study grappled with the regulation of behaviour with attention to neo-liberal healthist messages that suggest we must learn to control our desires as a component of the work we do to maintain health. In this section I consider the experiences of parents in relation to their children's health and how they themselves utilize the discursive resources available to them in striving to promote the health of their children. This, I argue, is a pertinent exploration as parents are viewed as integral role models in terms of the values, beliefs and behaviours of their children (Golan & Crow, 2009). In this section I also consider how within the dominant health paradigm, parents and families become the focus of the various biopedagogies that serve to guide and instruct us on how to live properly (Burrows, 2009; Fullagar, 2009). Through these biopedagogies families are forced to negotiate discourses that although provide instruction, may simultaneously function to "mobilize emotion, or affect, through 'fear' of bodily decline and 'guilt' about a lack of self-discipline" (Fullagar, p.113). Throughout this discussion I argue that the responsibility placed upon parents in relation to healthy lifestyles, is a gendered issue. There is much literature to support this contention considering the ideological foundations of motherhood and how mothers are positioned as being responsible for the care and nurturance of the child and in most instances carry the burden of blame (Arendell, 2000; Elvin-Nowa & Thomsson, 2001; Henderson, Harmon, & Houser, 2010; Jackson & Mannix, 2004; Nakano Glenn, 1994; Singh, 2004). This is a particularly salient argument with respect to obesity where mothers are regularly blamed for their children's weight status and health related behaviours (Herndon, 2010; Maher, Fraser, & Wright, 2010; Warin, Turner, Moore, & Davies, 2008). Given this line of reasoning and the fact that the mothers were the predominant presence in the program and the ones who chose to participate in the focus group, I chose to utilize the term 'mother' in the remainder of this dissertation. This is by no means an attempt to undermine the fathers and their familial contributions, as fathers did attend the program periodically, but rather it is an acknowledgement of the gendered nature of healthy lifestyle discourse and biopedagogies as taken up in families and society in general. As Jackson and Mannix (2004) suggest, while there has been a "call for the word 'parent' to replace 'mother' in research practice, …this perhaps could present the reader with an incomplete and imprecise picture" (p. 157). Only through acknowledging the gendered aspect they contend can we fully appreciate the gendered nature of people's experiences.

The mothers in my study were eager to talk and share. Also, as is largely the case within western and global societies, mothers within the program took on the bulk of responsibility for the promotion of healthy behaviours with their children. Like other mothers in our society, they are the ones who bear the responsibility for their children's food intake and ultimately are the one's who are blamed when children are identified as obese and not in keeping an acceptable bodily standard (Gard & Wright, 2005; Mannix & Jackson, 2004; Warin et al., 2004). "As mothers, the behaviours and actions of women are subject to scrutiny in ways that fathers are not, and these behaviours are often linked to family and child health outcomes in ways male activities are not" (Jackson & Mannix, p.150). As noted by Maher, Fraser, and Wright (2010), the obesity related literature is replete with research that examines everything from maternal employment, to the mother's role in the 'lost family meal', to mothers' perceptions related to feeding overweight or obese children. They also argue that maternal responsibility is a notable theme arising from media coverage of the obesity epidemic. The expectations, according to the authors, are that mothers are responsible for ensuring the health of their children through the regulation of their own bodily activities during pregnancy and beyond, as well as in the preparation and coordination of family meals and regulation of their children's eating behaviour within and outside the home.

It is recognized that while the social construction of motherhood is contingent upon social and cultural ideologies of a given time, the vision of the mother as the life giving nurturer responsible for the growth and wellbeing of her children has endured (Nakano Glenn, 1994). As suggested by DeVault (1991), despite changes in structures and division of labour, mothers are still constructed as the nurturers. She states:

> In spite of some recent change, the ideology of the family is still gendered and class biased. Women are still expected to take primary responsibility for the

> caring part of family life, and social discourse continues to emphasize a model of family life that assumes and builds upon a gendered based division of labour (p.16).

Even as mothers have moved outside of the home for work and leisure, they are still regarded as primarily responsible for their children's health promoting behaviours and hence carry the burden of the contemporary at-risk child identity. Gard and Wright (2005), for example, highlight the work of Eberstadt (2003), who suggests that as mothers have moved into the workforce and left the home, children are forced to spend more time in front of the television and are left to their own devices as 'latch-key children'. This notion of gendered responsibility is highlighted by Fullagar (2009), in her work on families embodied experiences of healthy lifestyle discourses. She states:

> Women in particular identified gendered difference in terms of the responsibility for undertaking the emotional work that informs the relational basis of family life and also conduct the healthy lifestyle practices (planning meals, organizing activities, negotiating with others and planning time (p.123).

Beyond the concept of maternal responsibility is the realization that the push toward thinness is, in itself, a gendered issue. Women regularly deal with the pressure to prevent obesity in their children while simultaneously negotiating discourses that suggest successful healthy women should be thin. As stated by Maher, Fraser, and Wright (2010), "childhood obesity offers a unique location where women's flesh, women's engagement in the issues of ideal weight, and their socially generated responsibilities for mothering can be combined" (p. 243). As a component of normative female embodiment the authors argue that the bodies of women and children are thus 'interlinked'. Along with concerns regarding one's own appearance and how one should 'present' herself to the world, mothers also take on concerns about their children's appearance as this appearance is often seen to reflect their identities as 'good mothers' (Collett, 2005). Throughout my conversations and interactions with the mothers within the course of my study, I noted that they are caught in a paradoxical quandary. On the one hand they are sensitive to the moral imperatives inherent in the contemporary health discourses that define a responsible and loving parent as one who follows the health promotion dictates of a 'healthy lifestyle'. These dictates call for an awareness of weight related risk factors as well as the consistent monitoring of their children's eating and activity habits in order to control their children's weight. On the other hand the mothers, being large women themselves, are sensitive to the impact of such monitoring on their children's body image, and self-esteem with consideration to the already marginalized position in which they are socially located. This is consistent with the findings of a qualitative study by Jackson, Wilkes, and McDonald (2007) in which they examined women's experiences of mothering overweight or obese children. The authors state:

> As mothers, they experienced tension between trying to promote a healthier lifestyle (for, example through supervision of diet and encouraging exercise) and being overly restrictive about food. They were concerned that monitoring too strictly could make their children rebel and be less willing to make better lifestyle choices (pp. 33-34).

Mothers in my study were very aware that they are held responsible for their children's health within the present social context where health is very much measured in terms of weight and how the body looks. They struggled with these pressures and the social responsibility to develop health-promoting skills in their children while grappling at the same time with their own health promoting behaviours. They also voiced frustration in relation to the social imperative to achieve lean bodies. They felt guilty about their children's size while simultaneously articulating the genetic component of weight reiterating that their children have a 'tendency' to be larger based upon family traits, something that is completely out of their control. This is supported by Gard and Wright (2005) who state:

> The imperatives to change lifestyle behaviours thus fall to parents (particularly mothers) and schools…The expectation that individuals will take responsibility for their own health, with respect to children, is handed over to parents. If children show signs of being overweight then parents are blamed and assumptions are made about the quality of parenting. Such an approach draws on particular ideas about parenting that again ignore the social contexts of children's and families lives and find it easier to hold mothers responsible (p.184).

The following excerpt from the parent focus group elucidates some of the concerns mothers voiced regarding the health risks for their children and explicates how mothers draw upon the discourse of risk in striving to ensure their children's health and wellbeing. The narratives underscore the pressures that these mothers feel in the present health conscious environment where they are produced through the risk discourse as being ultimately responsible for their child's visible measure of health: weight.

Pam: Are there any concerns right now, that you have, for your kids… are there any concerns that you have, in particular, for them? In terms of health, in terms of school?...

Mother #1: Adam's health issue is all around his middle. I brought it up to my doctor because I was concerned because they say in overweight people that's the dangerous weight – to carry around your middle. That's when you get risk of diabetes, which is in his family on his father's side, and high blood pressure, and stuff like that. To me, that was a growing concern, because I see Adam growing that way, right? And then the doctor referred us here.

Mother #2: Well, Joel's always eaten healthy, like you – salads – he has snacks, we eat out once a week, or every second week, you've got to live too, you can't withhold everything. But self esteem issues, and just to learn so that down the road, because there's a lot of everything arthritis, cholesterol, blood pressure, everything else …

Mother #3: So really, I never thought about it, he never thought about it. We never went looking, you know? I've always encouraged healthy eating, encouraged him to label read anyway, because it's just what I've always been doing, and just figured it was his genes.

In this exchange the mothers are drawing upon the dominant risk discourse that suggests that obesity is the ultimate risk factor for disease. Mother #1 for example in stating that her son's health issue "*is all around his middle*" is drawing on the widely touted scientific data that suggest that health risks increase as abdominal girth increases. As she refers to the science of obesity as she states: "*they say in overweight people that's the dangerous weight*". This is a clear example of what Gard and Wright (2005) refer to as 'obesity science for the people'. Conclusions based upon scientific data are regularly conveyed to the lay population in an effort to affect behavioural change. Such practices, according to the authors, serve to shape a knowledge base of obesity in the population that is based upon fragmented evidence and allow those in a position to sell quick solutions to act upon the population. Therefore while Mother #1 conceptualizes abdominal girth above the normative standard as *"dangerous"* and articulates how this may increase her son's health risk, the discourse also directs her to seek out help regarding how to correct it. This mother along with mother #2 noted distinct risk factors, including, hypertension or "*blood pressure*", high cholesterol, arthritis, and diabetes, when asked about their concerns for their children. Discussion of these risk factors is predominant in both lay and scientific articles about obesity, within the mainstream media, and population focused health promotion campaigns. The mothers' knowledge of the discourse and the way obesity is constructed within the discourse prompted some of them to seek medical attention for their children.

While two of the mothers in the previous exchange discussed risk as a concern for their children, the third mother emphasizes that she has always "*encouraged healthy eating, encouraged him to label read anyway*". This I argue reflects the mothers' need to defend their lifestyle practices and assert themselves as responsible caring parents. The discourse, I postulate necessitates such statements and defensive reactions as the parents of obese children are often positioned as irresponsible, indulgent, and lacking in restraint (Jackson & Mannix, 2004; Warin et. al., 2008). Mother # 3, in a resistive moment, goes on to assert that her son's weight is directly related to genetics that are out of his or her control. The mothers on a number of occasions attempted to resist the notion their children's size is merely a consequence of imbalance in the input of calories versus the output of energy; something which can be more clearly blamed upon the family. This is consistent with critiques within the literature that suggest such a conceptualization of obesity is short-sighted and over simplistic, negating the role of genetics and other factors that are out of a person's control (Campos, 2004; Campos et al., 2006; Evans & Colls, 2009; Gaesser, 2002; Gard & Wright, 2005). Interestingly, as noted by Saguy and Almeling (2007), in an examination of a large sample of scientific articles and news articles, while the complexity of the obesity issue in relation to genetics are limited in the scientific literature (20%), this aspect was almost non-existent in the news media articles (3%). This leaves few resistive discursive resources for parents to avail of.

I further argue that carrying the burden of producing the 'healthy' child, particularly for those mothers whose children are considered at 'ultimate risk', positions mothers in a location of continual stress and guilt. The mothers in this study were struggling to find balance in regulating their children's diet while simultaneously they were concerned about not inflicting harm on the children who they know are already impacted by their fat subjectivities. While they realize that they are charged with the responsibility of policing the food intake of their children they are also concerned about their children's self-esteem, body image and inflicting a diet mentality that could result is disordered eating and eating disorders. As Fullagar (2009) stated:

> Despite the seemingly neutral language of science that is deployed in health messages about reducing lifestyle risks, affect is evoked through fears about illness, incapacity, and death as well as the pleasures of family fun. Guilt also arises in relation to body size, appearance and parental decision making about children's wellbeing, while anger, frustration and despair can arise from the impossible demands of managing one's own, or one's family's health, as a rational self-resource project (p.122).

The mothers in this study articulated how they were continuously negotiating these elements of the obesity discourse in an effort to achieve some balance with regards to their children's wellbeing. This dynamic is exemplified again in the following excerpt from the parent focus group when the mothers were discussing their concerns for their children:

> **Mother # 1:** Just learning more about food
>
> **Mother #3:** …its hard, I think. So they don't forget.

Mother #4: Summer can very easily forget. She can go up to the store, buy the biggest kind of a junk lunch and go back to her room and forget everything, if I don't keep after her.

Mother #6: Then you have to look at the time factor.

Mother #2 : You're nagging at them then.

Mother #4 : You learn here, and they forget. And you have lives, because people all have busy lives, and then the time factor, trying to remind them, and then the arguments break out. Then you make a comment and her feelings gets involved, and it goes from just a simple comment that you make, to something bigger.

Pam: So do you find that you struggle with that though? How do you balance …

Mother #2: They'd rather that you not keep nagging them about it.. about eating right. They thinks that they know.

Mother #6 : But that's the way it is with kids anyway, I think. I'm just going from my thing – no matter what I say, you're going on..

Mother #2: … so what I've been saying to Joel, since we've been coming here, is that I'm trusting you to make the best choice. Because he went to Don Cherry's [local restaurant] Friday night with his friends and I said 'what are you going to order?' 'I really don't know. Now Mom, I'm not going up there with no salads', I said 'no, you don't have to have a salad, but I hope you make the best choice that you can make'.

The mothers in this discussion are struggling with their position in the surveillance of both the nature and amount of their children's food selection. They utilize terms such as *"reminding them"* and *"nagging at them"* to illustrate their continued roles in ensuring 'proper' food intake and helping them make *"the best choice"*. Again this reiterates to the child the responsibility in maintaining what is considered appropriate food intake within the dominant health discourse. The 'best choice' emphasizes firstly that the child should possess the knowledge of what is the most health conscious choice while simultaneously reaffirming that the child is in a position of control to make that choice. By conveying this information the mother may have the opportunity to alleviate some of the burden of maternal responsibility by responsibilizing the child. This also illustrates how the mother strives to meet the expectations placed upon a 'good' mother by teaching her child how to 'do the right thing' as is dictated within the dominant discourse (Evans et al., 2011).

The mothers also point to the pressures of family life in contemporary society with regards to the *"time factor"* and their lived realities of having "*busy lives*". These statements again reflect the complexities of the family embodied experiences that are most often not taken into consideration in the obesity science literature. The mothers also draw on discourses of healthy versus junk food in striving to promote a balance for their children. Again a tension arises between trying to change the children behaviours and hence the way they look and accepting them in the bodies they presently have. The following excerpt highlights the mothers' quandary:

> **Mother #4:** She's eating a lot less though, since she came here. She used to drink a two litre of pop and a big bag of chips, that was like a snack… But I think the weight bothers me more than my daughter.

Pam: Oh really?

Mother #4: Because I was afraid what might happen if I kept after her, because some girls 'well, I'm not eating that because I might gain' and all this, right? But she couldn't care less. 'If they don't like me, well, tough!" And that's a good attitude to have …

Pam: Well, that's a wonderful way to be.

Mother #4: But then, I'm just a bit scared for her, of she's going to continue eating, and then 'Mom, why didn't you stop me?'

Pam: So you're sort of caught?

Mother #4: Yeah, and I don't want to push it because I don't want to give her…

Mother #5: A bad image.

Mother #4: I'll worry that maybe she'll start not eating and get anorexic or something.

Interestingly, while the mainstream obesity literature often doesn't consider the association between obesity discourse and disordered eating and eating disorders (Cliff & Wright, 2010; Evans et al., 2002; Evans et al., 2008; Neumark- Sztainer, 2011), these mothers are sensitive to it. In keeping with how modern 'motherhood' is constructed through risk discourse, the mothers in my study strive to continually monitor and balance risks for their children. They recognize and fear the impact that discourses that endorse the thin ideal have, particularly on larger children like their own. As parent #4 noted she is concerned that if she pushes her daughter too hard in relation to her weight that she will *"start not eating and get anorexic or something"*. Cliff and Wright (2010) support this concern stating that body pedagogies "provide a set of resources through which individuals come to understand the relationship between bodies and health in relation to the social and cultural contexts in which they are mobilized" (p.222). This concern is supported in the literature as the pressure to be thin has been argued to increase levels of body dissatisfaction, disordered eating and eating disorders, particularly for children who are considered obese (Epstein et al., 2001; Latner & Stunkard, 2003; Rich & Evans, 2005; Vander Wal & Thelen, 2000).

While this study focused largely on the embodied experiences of the children, the experiences of the parents and in particular, the experience of mothers in relation to caring for and promoting health in their children, is an important avenue of exploration. While contemporary health promotion strategies are very much focused on the family, in recognition of family influence and the increased participation of fathers in the care of their children, women continue to carry the burden of blame that permeates from the healthist approach.

> Women are not the only ones who can perform the activities, but the concept of "family" (maintained over time in its shifting forms by a variety of interlocking discourses) incorporates a strong and relatively enduring association of caring activity with the woman's position in the household ("wife" or "mother")" (DeVault, 1991, p.12).

I argue that researchers need to acknowledge the gap in research in the exploration of the lived experiences of women in relation to the contemporary health promotion milieu. While exploration with the mothers consisted of only a small portion of my research, it illustrates the need for more qualitative research that considers how mothers negotiate the dominant health discourse. Further research into how risk and the neoliberal approach to health construct mothers and the concept of 'motherhood' is needed. Such research, that is sensitive to the embodied experiences of mothers, can help to inform present practice in an attempt to alter our present health ideologies.

Chapter Summary

In this chapter I moved beyond the examination of the children's constructions of health to consider how the children in my study shape their identities within a neoliberal healthist paradigm that teaches them that they are responsible for their own health outcomes. This paradigm I argue, suggests that those who follow a prescriptive approach to health and who fall in line with the dictates of this approach are held up as 'good' or 'deserving' citizens. Those people who deviate from the characteristics of the responsible healthy citizens are produced as 'failed citizens'. The measures of health I have asserted, within the context of the current obesity panic, are very much tied to the corporeal self. Given the conflation of health and weight and the hegemonic power of the thin ideal within the realm of health promotion, media, and broader society (Beausoleil, 2009; Burns & Gavey, 2004; Dwarkin & Wachs, 2009; Jutel & Buetow, 2007), I have argued within this chapter that weight has come to represent a significant marker of the level to which one deserves the 'healthy' status. Those who deviate from the ideal standard of weight/health are thus viewed as less deserving and in need of bodywork or re-formation.

In this chapter, I utilized examples from the children's narratives to draw attention to their attempts to negotiate this discourse and the implications of the dominant messages that mark obesity as a product of a flawed character (Brownell, 2005; Campos et al., 2006; Jutel, 2005; Lebesco, 2004; Murray, 2005; Sobal, 1999). The children, I have contended, are aware of the social implications of obesity as is explicated through our discussions. They drew regularly upon the discourse of personal responsibility for health in describing their embodied experiences. Throughout the chapter I have drawn on the work of Foucault, utilizing his conceptualization of governmentality. From this perspective I have argued that the so-called 'healthy' identity is very much tied to issues of power and control. While governments do not violently force the 'thin equals healthy' conflation upon children and their parents, biopedagogies which are endorsed through health promotion strategies that permeate the school system and broader society, call for people to work upon themselves to fall in line with what government dictates as healthy. These biopedagogies, as I have argued within this chapter, frame health as a virtuous goal to which all families should aspire (Burrows, 2009; Fullagar, 2009; Halse, 2009). These biopedagogies also provide the instructional criteria that guide families toward positively reinforced health behaviour. While they provide the resources for the parents and children, I also argue that these biopedagogies are value laden.

Throughout this chapter I provide excerpts from child and parent narratives that explicate the manner in which the techniques of domination, and the techniques of the self (which are articulated in the biopedgagoies) intersect. The children in this study utilized the biopedagogies to frame their ideas about how bodies should look, and the practices they need to undertake in order to attain a 'healthy' identity. They drew on the discourse of responsibility in voicing not only their conceptualizations of health, but also how they view themselves in light of the dominant messages. I have demonstrated within this chapter how they struggle in terms of where they fit in this paradigm that categorizes them as unfit and therefore not in keeping with the broader social ideal. I have also explicated how this discourse reinforces the concern with health risk that serves to shape the way they view their bodies and their relationships with activity and food.

The concept of risk is a significant element of this chapter. Within the chapter I have considered how risk discourse is central to the contemporary health promotion milieu and is pivotal in terms of defining the healthy responsible neoliberal subject. Healthy citizens, I argued, are defined by not only their knowledge of so-called risks but by the degree to which they act to contain or thwart those risks. Given that children in general are constructed in contemporary society as at-risk (Burrow & Wright, 2004), and given that obesity has been constructed as the ultimate risk (Campos, 2004; Gaesser, 2002; Gard & Wright, 2005), I contend in this chapter that obese children are produced as the 'ultimate at-risk' children. I have demonstrated here, with specific reference to the children's talk, how the children in my study both utilize the risk discourse and how they recognize how they are positioned in it. This I have argued serves to shape an identity that suggests a lack of willpower or a weakness in character. I have also highlighted how the children have taken up the notions of guilt and pleasure that are inherent in the dominant discourses, demonstrating how the children conceptualize health as being achieved through the denial of pleasure and how 'giving in' to those pleasures produces feelings of guilt and disappointment; the 'giving in' again representing a weakness or lack of fortitude.

In exploring the role of the healthist discourse in the emerging identities of the children in my study I also felt it was important to consider the experiences of the parents in light of the imperatives for family which are central to the biopedagogies (Fullagar, 2009). In this chapter I have demonstrated that the concept of lifestyle, particularly in relation to food and health, is a gendered issue. Mothers, I have argued, carry the burden of responsibility for following the health dictates of the responsible healthy lifestyle and in ensuring this lifestyle is practiced within the realm of the family. Within this chapter I expound upon the mothers' talk to describe how the mothers feel compelled to 'fall in line' with or follow the 'rules' of health eating. The narratives I have contended reveal how the mothers drew on the discourse of risk and responsibility in their approach to caring for their children. As highlighted in this chapter, the tensions between feeling responsible for directing their children's health promoting behaviours and functioning in a surveillance role was difficult for the mothers. The narratives expose the torment that these mothers endure in the struggle to promote and maintain health in their children while simultaneously trying to promote a positive sense of self. Through the use of risk rationalities mothers are responsibilised in relation to their children's lifestyle habits and hence their weight, leaving mothers in a position where they must continually negotiate the risk discourse in the care of their children. This experience of mothers, I argue, has implications for the emerging identities of their children and is an area that should be explored further.

Finally, this chapter has provided an examination of how the children navigate the often-confusing effects of this healthist neoliberal risk discourse. I have argued that this discourse is not only self-limiting but damaging to the emerging identities of the children in general and in particular the children in my study who are conceptualized as the 'ultimate at risk' children. I question, if children and parents are to accept the potential for harm that risk employs than how do they ever attain a satisfying level of health or enjoyment of living? As Hunt (2003) states:

> Everyday risks present us with the necessity of making a seemingly never-ending set of choices. The significance of these choices is compounded by the disparate pressures of the mechanisms of responsibilization that demand we make them in a context that requires us to treat out lives as a project over which we should exercise deliberate and long term calculative effort" (p.169).

I question therefore, if health is something to be achieved, then at what point do we succeed? If children and parents are positioned through the discourse as 'failed citizens' in the-ever elusive search for health, where does that leave them in terms of our societal possibilities? I explore these issues in the following chapter in considering the role of alternative discourses in moving beyond the present healthist discourse to consider different conceptualizations of health.

CHAPTER 6

ALTERNATIVE MESSAGES AND THE CREATION OF A SAFE HAVEN:

"I FEEL SAFE HERE"

In previous chapters I explored the ways in which the children in my study negotiate the contemporary health discourses that construct obesity as a controllable risk factor that is placing burden upon an already overburdened system. The large child, I argued, is in this context, discursively produced as unhealthy and undeserving, representing the ultimate risk and moral decline of contemporary western society. These constructions I contended function to frame the way these children are positioned in terms of social space and provide few discursive resources that support the development of positive self-esteem and identity. In this chapter I go on to explore the children's experiences within and opinions of the obesity treatment program in which the research took place. Given that this program, as outlined in the introductory chapter of this dissertation, focuses on the promotion of positive self esteem and not weight loss, while maintaining that health can be experienced in different sized bodies, I was curious about how the children negotiate messages that are in contrast to the dominant obesity messages they have been subjected to and how these alternative discourses were taken up by the children in their struggle towards achieving positive subjectivities.

Within this chapter I present examples from the narratives that provide insight into the children's initial impressions of the program and, given the broader discursive context, how they initially envisioned the program. Their familiarity with the dominant discourse is underscored by their descriptions of how they were surprised when introduced to the messaging of the program that suggested weight loss was not the goal or underlying intention. I also frame this chapter within the exploration of narratives elicited from interviews with the program coordinators that provide insight into their conceptualizations of obesity, obesity treatment, and their rationale for the program they have developed. These narratives helped me in exploring the conceptual foundations of the program and in explicating the manner in which the children produced meaning, as their constructions of health and the body intersected with messages that were not consistent with what they considered to be 'general knowledge'. Through the narratives, I highlight in this chapter, how the children, while at first hesitant, were drawn to discursive resources that allow them to experience their bodies in ways that represent health, as they are excluded from healthy subjectivities within the present biopedagogies. I provide examples of how the children began to utilize the alternative messages in discussion of health and the body. These messages that were endorsed by health professionals, provided the children some leverage to resist some of the dominant messages. I also consider the limitations of such an approach as these messages, provided in the context of a small social bubble, are tempered by the more powerful discourses of health and obesity that pervade our daily experiences, making it difficult for these children to utilize alternative ways of experiencing health and their bodies.

I also discuss in this chapter, how in my exploration of the discourse I came to recognize a dynamic produced within the program that was in many ways more meaningful to the children than the introduction of alternative messages alone. The safe social environment or 'safe haven' produced within the program emerged as a dominant theme. By removing the element of bodily comparison, bringing together children with similar experiences in a positive accepting environment, and in that context providing them with alternative discourses that suggest the possibility of establishing a 'healthy' identity in non-normative bodies, the children developed a sense of comfort that they themselves stated they often did not experience in other venues. The permission to exercise their agency and voice their resistance, I argue, served as a powerful tool for these children. Finally, within this chapter I examine the challenges of the treatment program utilized in this study and how it functions within a dominant medical paradigm that reinforces obesity discourses while simultaneously attempting to shift the dominant views, perceptions, and understandings of obesity. These challenges I argue when articulated provided impetus for further change, re-examination of the concept of obesity treatment, and program development that may serve to benefit the health of not only larger children but of the broader community.

Shifting Conceptualizations of Obesity Treatment

As outlined in the introduction of this dissertation, the treatment program utilized in this study, while functioning within the dominant health paradigm that produces overweight and obesity as major threats to one's health, adopted an alternative perspective that calls into question the effectiveness of weight loss as the answer to the so-called obesity epidemic. In keeping with a growing body of research, the program coordinators have suggested that the moral undertones inherent in the current obesity discourse may have dire implications when it comes to the children's growing sense of self and social inclusion (Burrows, Wright, & Jungerson-Smith, 2002; McDermott, 2007; Rail, Holmes, & Murray, 2009; Wright, 2009). The program, while still utilizing a health promotion approach in promoting healthy eating and activity, was developed with a self-esteem focus that, according to the coordinators (a psychologist and a physician), centres on activities that promote self-acceptance, the positive aspects of diversity, and the health-in-many sizes paradigm. The children upon entering the program, are informed that weight is not the concern of the program, nor that of the program facilitators. They are provided with messages related to health and weight that are often in direct opposition to many of the messages they receive in school and through the broader obesity discourse which suggests that a person's body size and shape are a direct reflection of health and that the thin body is one to aspire to. The program, while emphasizing balanced nutrition in a manner consistent with health promotion campaigns, does not focus on weight reduction and children in the program are weighed only in the clinical setting outside of the program as a component of the clinical physical assessment. They are reassured that weight loss is not the goal and that people can be healthy in non-normative bodies. While I remain critical of the ways in which the promotion of healthy eating and activity endorse a larger governmental framework, my intention here was not to critique the program itself but rather to provide an examination of how the messaging was negotiated by the children. Based upon this examination I will provide recommendations for the program coordinators that will be outlined in chapter 7 of this dissertation. The following excerpts from my interviews with each of the two program coordinators provide some insight into how the program coordinators conceptualize the program:

> **Pam**: So when they're coming to you, in terms of when they're coming to you, it's for all these various reasons, not necessarily one specific focus?

Coordinator #1[psychologist]: No, I think primarily though, the history of the program, and it really is, was born as an obesity program – so the issue is weight. That's not the take we take on it, that's not the way we look at it, but that is the identifying issue. The message should not be different for people who have the weight on than it is for people who struggle with an eating disorder, because otherwise, I think you will actually produce eating disorders, or vice versa. So we had to have the same message, that was the vitality message, it still is – we haven't changed the message, it's the foundation of the philosophy of the program. Things have changed other than that. At that point, there was no other program that I had read, or could see, that had that third pillar. So there was a lot about eating well, a lot about being active. The third pillar is to feel good about yourself and there was very few, if any, programs that actually included that within this field. And that's changing now, I think. But we started from that premise, now it seems that a lot of the obesity treatments are moving towards that - they're including body image, they're including self esteem and that sort of thing, as opposed to weight loss as their goal, which is not the goal for us. And if you're measuring weight loss as a measure of success of a program, then they're all failing.

Pam: Yes…

Coordinator #1: I think [the physician] is probably one of the biggest proponents of that - she's very clear that that's not the goal, and she's very committed to educating people about that, and to make sure that there's not prejudice – that we're not increasing prejudice, and that we're not increasing body image issues,

> or damaging kids in any way, I mean, that's absolutely the very first thing… we want to make sure that we're not hurting kids and we're not hurting their self esteem, and we're not hurting their body image. And if we are, then we need to change. But we've built it, trying to prevent that, as the first, the underlying philosophy.

The points raised by coordinator #1 in our interview were then reiterated by coordinator #2 in a separate interview:

> **Coordinator #2 [physician]:** The kids always come first, so our number one priority is that: helping them to become as healthy as they can and feel good about themselves. And if, at the end, they are feeling better, they're happier – for lack of a better word – and they are, you know, engaging in healthy behaviours, regardless of whether they've lost weight, most of the time they eat fairly well, and if they are doing activities end enjoy it, then I think we've done a good job.

The coordinators point out that while weight is the identifying issue or often the reason for referral, once the children become participants in the program the focus shifts from a weight focus to a health focus. Coordinator # 1 highlights their attention to the Vitality message. This message was introduced by Health Canada in 1990 with a shift in emphasis from weight loss to healthy living. "Rather than focusing on weight loss, VITALITY aims to enhance Canadians' physical, psychological and social well-being by encouraging them to enjoy eating well, being active and feeling good themselves" (Health Canada, 2000, p. 7). While this message has been criticized for being complicit in touting the same rhetoric as many other biopedagogies that endorse self surveillance and individual responsibility (Beausoleil, 2009; MacNeill, 1999), the coordinators emphasize that they place much emphasis on the third pillar, the promotion of feeling good about oneself. They stress that this focus is what initially made them much different than other obesity treatment programs, as coordinator #2 states "*so our number one priority is that: helping them to become as healthy as they can and feel good about themselves*". The focus therefore is largely on the promotion of healthy living rather than living to achieve a specific body type. The view of the program coordinators is consistent with the work of Neumark-Sztainer et al. (2007), who suggest that supporting people in the promotion of health rather than the promotion of weight loss for the sake of health may enhance the health of youth today. Like Neumark-Stzainer and her colleagues, the coordinators also draw on the notion that eating disorders, disordered eating and obesity all exist within the same realm and hence can be both examined and addressed in a unified approach. As coordinator # 1 states: "*The message should not be different for people who have the weight on then it is for people who struggle with an eating disorder, because otherwise, I think you will actually produce eating disorders, or vice versa*". The panic around obesity, it is argued, produces a disordered eating mentality that promotes the use of unhealthy diets, further glorification of the thin ideal (Campos et al., 2006; O'Hara & Gregg, 2010; Rich & Evans, 2005), and ultimately marginalization of those who are considered overweight or obese. It is argued that if the focus shifts from the need for the thin body to health in many different sizes then improvements may be seen in the rates of body dissatisfaction, unhealthy dieting, obesity and eating disorders (Gaesser, 2003; Miller, 2005).

The position in which the program coordinators find themselves is a difficult one to manoeuvre however. As noted by Beausoleil (2009) in her discussion of community action in the prevention of disordered eating, attempting to promote positive body image while simultaneously promoting healthy eating and activity is often complex and sometimes contradictory, leaving people working in this realm with what she proposes may be an "impossible task". She goes on to suggest, however, that working toward change is "worth attempting nonetheless" (p. 105). Shifting the focus from weight to health in general may be a place to begin (Burns & Gavey, 2004).

Given that the children are introduced to this conceptualization of obesity treatment that is not consistent with dominant messages the children receive on a regular basis through a myriad of sources, the program coordinators state that the children are often surprised and sometimes confused when they are informed that the focus of the program is not weight loss. The children, according to the coordinators, most often enter the program with the expectations that the program is a weight loss program in which they will be weighed and placed on restrictive diets. This is illustrated by the following exchange when I asked the physician about the children's first reaction to the program.

> **Coordinator # 2:** I think they're very surprised, actually… They're expecting to come and be weighed every week and be given a specific diet to follow, or … this is your exercise regime, or something like that. And I think too, that they're expecting, although they might not be verbalizing this, I think they're expecting to be in an atmosphere more of blame type of thing, where that it's all about them 'you're not doing this, you're not doing this' sort of thing …

Pam: Where do you think that comes from?

Coordinator # 2: I think it comes from society. And if you look at what a lot, when people talk about health, and especially body size and things like that, you know almost everything you read is all individually based. It's rare to talk about how society has changed things. It's all about this person's not eating well, and how can they do that?

The physician in this instance highlights the impact of the obesity discourse and the healthist approach that it engenders when she states, "*you know almost everything you read is all individually based*". Such an approach " promotes an individualistic conception of health, a view that health can be sustained and illness prevented through sheer effort of will and determination of individuals" (Kirk & Colquhoun, 1989, p.419). The children, she suggests, are surprised when they enter the program as they expect the program to be in keeping with the dominant health message to which they are so accustomed; that weight is indicative of health and that it is the sole responsibility of the individual. They are, she suggests, expecting to "*be weighed every week and be given a specific diet to follow*". I was intrigued that she also suggested that the children might expect to be introduced to an environment of blame and ridicule. This is consistent with much of the critical obesity literature that presents the argument that overweight and obese people are regularly ridiculed for being lazy, self- indulgent, and self-destructive in conducting a lifestyle that is not conducive to health (Guthman, 2009; Jutel, 2005; Rich & Evans, 2005;Tischner & Malson, 2010). As discussed in previous chapters, the children in this study were aware of these labels and in some cases had integrated these into their identities. Such attitudes unfortunately also exist in the health care realm (Persky & Eccleston, 2011; Puhl & Heuer, 2009; Schwartz, O'Neal Chambliss, Brownell, Blair, & Billington, 2003). As noted by Puhl and Brownell (2001), " very negative attitudes about overweight individuals have been reported in physicians, nurses, and medical students much the same as in general society" (p.800). This only serves to increase the challenge of a program that seeks to dispel and correct the negative conceptualizations of overweight and obesity.

Interestingly, the children's description of their expectations of the program, very much mirrored the words of coordinator #2. Not surprisingly, the children, drawing on the dominant discourses of weight loss and surveillance, assumed the program would focus on weight loss. They also voiced the expectation that they would have to offer themselves up regularly to specific forms of monitoring. As Nicholas stated for example, *"I thought they were inspecting our bodies over like.. a 12 month period*". This concept of inspection is one that is in keeping with the dominant paradigm. We are regularly bombarded with advertising that promotes the monitoring of our bodies. For example, we are reminded through the media and through health promotion strategies about the importance of monitoring our weight and BMI in an effort to remain within the recommended standards of weight (Evans, 2006; Evans & Colls, 2009; Gard & Wright, 2005; Gerbensky-Kerber, 2011; Murray, 2008). These 'technologies of the self', as central to Foucault's (1988) notion of Governmentality, also intersect with 'technologies of regulation and surveillance'. Thus there exists a subtle (and sometimes not so subtle) underlying imperative that people offer their bodies up for expert surveillance. It hence becomes 'normal' to expect to be measured and monitored in order to promote the health of a nation (Share & Strain, 2008). This form of 'normative coercion', as Turner (1997) describes, it serves to normalize the practice of medical surveillance. Each body is viewed as a component of the collective health of a population (Elliott, 2007; McDermott, 2007) and it becomes our duty as governmental citizens to subject ourselves to surveillance, as this is seen to contribute to the common good (Evans & Colls, 2009; Evans, 2005; Guthman, 2009; Murray, 2008; Rail, Holmes, & Murray, 2010). Moreover, given that within the context of the current obesity panic that obesity has been medicalized and constructed as a disease of epidemic proportions, those who present as overweight and obese, fall under medical authority and hence measurement of the so-called condition is an expectation (Evans & Rich, 2011; Jutel, 2009). It has thus, I argue, become taken for granted that larger people should give their bodies over to this authority for surveillance and treatment in our "totally pedagogised society" (Bernstein, 2001). This authority is considered to 'know' the truth of the person's body and is in a position to cast blame (Halse, 2009; Jutel, 2009; Jutel & Buetow, 2007; Murray, 2008). Unfortunately such practices often "focus on the viewed, measureable body and trivialize the lived – experience of an individual" (Jutel, 2005, p. 123). The program coordinators within my study suggested that they want to move beyond this mode of thinking to focus on the factors that influence health in the environment and what really represents health. As coordinator #2 states:

> *So there are certain things that I think are good for people to know. So one is… about the complexity of body sizes, and it's not about willpower and things like that. And how things have changed over the last few decades so that they can see*

more clearly' oh that there's a lot more technology now, for example, or maybe we're moving less as a population...and look at the strong influence genetics has on it and all those sort of things. It's not all about individual control. To have that sort of background is nice. I think it's really critical.

The children in this study were quite aware that there is a general expectation that larger people should submit themselves to medical monitoring. The clinical gaze is a powerful force in our contemporary health driven society. As noted by Foucault (1973) the clinical gaze encompasses the power ascribed to the physician who was seen to learn the 'truth' about the patient through the process of observing or gazing upon the visible. As Foucault stated:

> The clinician's gaze becomes the functional equivalent of fire in chemical combustion; it is through it that the essential purity of phenomena can emerge; it is separating the agent of truths... the clinical gaze is a gaze that burns things to their furthest truth (p. 147).

The expert reading of the body is seen to provide clarity, the ability to define disease and prescribe the solutions or remedies by which to fix the problem. This is in keeping with Foucault's later discussion of biopower. Clinicians from this perspective are afforded a substantial degree of power as society looks to them for guidance on 'how to live' and they are afforded the power of evaluating and defining 'truth' of health related phenomenon (Jutel & Buetow, 2007; Murray, 2009). The power of the clinical gaze and the permissions that are ascribed to the medical community in western society were reflected in the children's talk throughout this study. For example, as another participant, Jordan, described her expectations of the program, she stated "*I expected it to be more-okay so what's your waist size today? How much do you weigh today?*". This statement reflects Jordan's 'knowledge' of the medical or clinical gaze as a phenomenon that entails inquisition in an authoritative manner. She and the other children in the group were aware that the clinicians are the 'experts' who, because of their position in 'knowing the body', have the power and the right to inspect their bodies and monitor their bodily practices. Hence, this was the children's expectation of the program. This is reiterated in Nicholas's statement, "*I thought it was going to be like one of those programs ... like, oh look at you, you're fat. Let's weigh you now on a scale*". This is supported by Rail, Holmes, and Murray (2010) who state:

> As a discursive effect of obesity discourse and biopedagogies, obesity scientists and clinicians are presumed to know the 'truth' of obesity and to have the moral and intellectual authority to label it a disease and to prescribe treatment (p.261).

The children's expectations of the clinical approach were in keeping with the broader perceptions of overweight and obesity as existing as a consequence of behaviour. This conceptualization as discussed above provides the so-called expert with permission to interrogate the 'fat' person, to place moral judgment, and prescribe a solution. Given that the children's expectations of the program were very much tied to notions of monitoring and surveillance, they also expected to be placed upon a prescriptive diet regime as illustrated in the following statements from Adam and Nicholas respectively: "*I thought it* *was going to be like a diet plan too" and "and it's like, you have to go on diets and crap like that".* These notions are in keeping with the messages inherent in the obesity discourse that suggest that people, especially obese people are unable or unwilling to follow a well balanced diet and therefore need professional guidance and prescriptive programs to ensure they lose weight in an effort to enhance their health (Jutel, 2005). I was intrigued by Adam's use of the term 'diet plan'. This term is used so pervasively in our contemporary thin obsessed environment that this child could safely assume that everyone in the room understood what he was referring to. The children were generally well versed in the terminology that is reflected in what Kater, Rohwer, and Londre (2002) refer to as the 'diet mentality' that is so pervasive in western society today. These included ways to lose weight such as restricting carbohydrates or increasing water intake and an articulated knowledge of various diet programs such as Weight Watchers® and the Atkins Diet® and prescriptive food systems such as Nutrisystem® and Jenny Craig®. This reflects the extent to which this mentality has infiltrated our mechanisms of everyday living. As stated by Kater, Rowher, and Londre:

> The "diet mentality" generated the belief that calorie or nutrient-restrictive "dieting" provides an effective means by which all "can and should" achieve and maintain the desired thin body. While pervasive media glorifying a thin standard of beauty cultivated a preference for a slim physique, the diet mentality elevated this preference into a sociocultural mandate through the false belief that the "right" (fat-free) appearance can be achieved by anyone with "willpower." Thus, it is assumed that those who do not conform ***to*** the desired lean look are not

> "doing what it takes," and, therefore, deserve negative judgment and discrimination (p. 199).

The children in this study understood that they are in a position where judgment and discrimination are considered not only acceptable but also socially appropriate. As discussed in previous chapters, they regularly drew upon the messages that they interact with everyday, that weight is a health problem, that the individual is responsible for doing something about it, and that the health professional is present to remind you of what you are doing wrong and provide instruction to correct your poor behaviour. I argue that the underlying punitive and moral messages imbedded in biopedagogies are read by children who are exposed to them. In identifying 'fat' people as representing a threat to the health of a nation (a threat for which they are personally responsible) and positioning the health professional as an agent of authority, the children have come to expect an imbalanced relationship with the health professional that I argue does not serve to support or enhance their health. Given the fact that these children enter into an already unbalanced provider/patient relationship simply by virtue of their less powerful position as children, their position as obese children I argue serves to further complicate the development of a trusting relationship. By openly challenging dominant health beliefs and engaging children in discussions regarding alternative perspectives, I contend that health professionals may begin to open up avenues for change and hence positively impact the outcomes for children who are suffering from the social fallout of being considered 'fat'.

Challenging Dominant Discourse: Swimming Against the Current

As noted by Burrows, Wright, and Jungerson-Smith (2002), "analyses of health promotion discourses and practices in contemporary western society point to the power of certain constructions of health over others" (p. 41). While the obesity treatment program in this study provides room for the children to explore alternative messages that challenge traditional corporeal views of health, dominant health discourses, as discussed throughout this dissertation, are difficult to challenge, as they are powerful and deeply imbedded in the structures and practices of our everyday lives. Given that the program also functions within a health promotion paradigm that is often inconsistent with critical perspectives, the task of providing alternative messages becomes even more difficult. In order to begin to challenge such deep-rooted notions, it is recognized that we must be willing to critically examine people's present constructions of health (Burrows, Wright, & Jungerson-Smith; Rail, Holmes, & Murray, 2010; Rich & Evans, 2005). As noted by Lupton (2003), from a poststructural perspective, such notions should not be taken for granted as medical progress but rather should be critically examined through cultural and social lenses. Throughout my interactions with the coordinators of the program they discussed the challenges of addressing issues related to weight and health with the children. They suggested that in working with these children you must begin with some appreciation of or insight into the children's conceptualizations of health. In keeping with the discussion in chapter 4 regarding the children's constructions of health, the coordinators demonstrated sensitivity to the children's perspectives upon entering the program. As can be explicated from the following quotation from an interview with coordinator # 1 (Psychologist), the coordinators have demonstrated an appreciation for the ways in which children are constructing health and are sensitive to the ways in which health is represented and marked in corporeal terms. They noted that within the program they spend time talking about these notions with the children and they utilize various techniques in attempting to deconstruct these ideas.

> **Coordinator #1**: *Well, the boys are telling us that in order to be healthy, you have to have a six pack, and the girls are telling us that it's better to be anorexic than overweight, in order to be healthy. I like that they tell us, it means they're being honest, and what I do with that as a psychologist can help them explore that. We need somebody with expertise that can debunk some of that, which [coordinator #2] is lovely at doing that – very good at making it sensible to people.*

As highlighted in the previous excerpt, the coordinator speaks to the gendered nature of the obesity and dominant health discourses. She recognizes, from regular interactions with the children in the program, that the boys most often desire to be lean and muscular while the girls generally desire to be thin as reflected in the narrative examples discussed in Chapter 4 of this dissertation. Coordinator #1 suggested that this is where they need to begin. Within the program, the coordinators also demonstrated that, given the medicalization of obesity and authority which health care professionals are afforded from a societal perspective, that this authority can be utilized to challenge dominant messages as Coordinator# 1 states "*we need somebody with expertise that can debunk some of that*". She goes on to suggest that the physician given her position is "*very good at making it sensible to people*". By utilizing this authority, it is hoped that the program can provide opportunities for these children and their families where they begin to recognize alternative ways of viewing health and draw upon alternative discourses that allow them to identify as 'healthy' people. Offering up alternative discourses "may not only assist those who are labelled as 'overweight' to re(position) themselves in alternative discourses, but also contribute to wider political, social and cultural discussion on how we are to make sense of obesity" (Rich & Evans, 2005, p. 355).

The coordinators go on to say that it is not enough to simply teach the parents and the children more critical perspectives. As Rich and Evans (2005) emphasize, such discussions need to occur in larger forums that span the sociocultural environment that has embraced the obesity as disease concept. They describe how they are hoping to change perspectives on a wider level as illustrated in the following quotation.

> **Coordinator #1**:*So we're part of policy at the government, trying to guide the policies related to obesity in a positive direction because there is an obesity expert working group guiding policies around that with government. So we are part of that, In fact [coordinator #2] co-chairs it, so we can ensure that it goes in a positive direction to educate and be constructive in that message, rather than critical and blaming. As well, in terms of the [anti-bullying] Schools policy in the Department of Education, we've become a member of that, trying to educate teachers and school administrators around the issues. So we've done some of that as well, in general, like there's been a lot of media stuff-radio, television, whatever to try to change the message, it's not about weight, and to get people to question that.*

Given the fervour created within the current obesity panic, the coordinators continue to struggle with working within the dominant discourse. They recognize the division that exists between the dominant views of health and more critical perspectives and through our interactions demonstrated sensitivity to the negative implications of the current obesity discourse. As this quote from coordinator # 2 illustrates for example, even her younger patients are being impacted by this discourse.

> **Coordinator #2**: *With the very little kids, they might not be thinking about it as much – but I can't say that for every little kid! Because even some of the younger ones ... I was quite surprised last week in one of our follow up clinics, one of the younger girls, she is just starting the program now, telling me that she goes down (she's about 8 or 9 now), she goes downstairs all the time and weighs herself. We had a LONG discussion about that.*

Throughout the interviews the coordinators also discussed their desire to be open to alternative and more critical ways of defining health in relation to body size. They stated they have made an effort to draw upon those whose have the ability to provide them with alternative perspectives and the resources to utilize these perspectives.

> **Coordinator # 1:** *So, people from the critical side of things, we've invited them into the program, so we can learn from that. And we have learned and grown so much, and I want to hear those messages. I might not agree with them all, but a lot of them I have, and it's made a difference.*

While the coordinators point out that this can be a difficult position and they do not always agree with the philosophical position of critical theorists they did demonstrate an openness to other ways of knowing and a desire to challenge the status quo. As suggested by Moffat (2010), the recognition that obesity is a social construction may provide the middle ground that allows those from a biomedical perspective to change the way they view obesity and health.

Through our communications, the program coordinators also highlighted the ongoing challenges inherent in helping children recognize that there are other ways to 'think about' and 'do' health. While, as previously stated, they utilize their medical authority in the dissemination of some alternative messages they also recognize the power of the obesity discourse that is generally reinforced by the health care professionals and the broader society. As coordinator #1 illustrates in the following excerpt, it may be naïve on their part to assume that they can completely change the ways children conceptualize health. The goal therefore becomes the introduction of a critical perspective and permission to challenge dominant ways of thinking.

> **Coordinator# 1**: And I think that's a big key, actually, but in ten or eleven weeks, I don't think that there's any way we can change. They hear that message everywhere. All we can do is help them to question it. So we have a session on body image, and the focus of that session is to get them thinking and questioning – it's not to change their ideas about it, because I think that's unrealistic because there's too much coming at them, and at the end of the program, many of them, I believe, think that being healthy means being active, eating well and they believe

that, but their own practice, I don't know if they can apply that – it's just too much pressure outside. So it's an uphill battle.

Pam: So it's the thin equals healthy kind of concept?

Coordinator# 1: And even if thin doesn't equal healthy, they'd rather be thin than healthy.

Pam: Because that, I guess, is the ideal, what's accepted, what's pushed?

Coordinator# 1: What's accepted, what's popular.

The coordinator in this excerpt acknowledges the limitations of the program in terms of changing the children's constructions of health given the power of the dominant health messages. In stating, "*They hear that message everywhere*", the coordinator is acknowledging the pervasiveness of the dominant messages and the difficulty inherent in challenging a powerful discourse. This assertion is supported by Wright (2009), who draws on Bernstein's (2001) concept of a 'totally pedagogised society', stating:

> the discourse of the obesity epidemic are enacted on the bodies of children and young people in schools, in patient consultations in doctors' surgeries and by individuals on themselves via the mechanisms for self-monitoring offered on the web, in popular magazines and similar popular media sites " (p. 11).

The coordinator goes on to qualify that statement by suggesting, "*All we can do is help them to question it*". This emphasizes the power of a critical approach to knowledge formation. By offering the option of alternatives, recognizing their status as social agents and providing the children with the resources to question or challenge such ideas, we may support their agency in challenging discourses that limit their opportunities toward achieving healthy subjectivities (Rail, Holmes, & Murray, 2010). As suggested by Beausoleil (2009), young people's lack of power in relation to the dominant health messages "and their lack of power in general, may ironically position them particularly well for critical thinking about concrete obstacles to health in people's everyday lives" (p. 104). By considering the resistive powers of the children and directly focusing on how the concepts of health, fitness and the ideal body are constructed it is hoped children will have the opportunity to consider how they can begin to resist the dominant messages that restrict them in terms of healthy identities (Burrows, Wright, & Jungerson-Smith, 2002).

The children, throughout the program, were given some opportunity to critically examine the ways in which we conceptualize the body. They did begin to draw more upon alternatives ways of looking at the body. Within one group session in the 9th week of the program, for example, the group had the opportunity to talk about health, body image and self-esteem. In critiquing images that they see in the media and other places around them, one child raised the issue of mannequins. The following exchange illustrates their ongoing frustration with the thin ideal messages and their resistance to these messages. It also illustrates how the children, given the opportunity to vocalize their frustrations and challenge the status quo may gain a sense of empowerment:

> **Pete**: Like those mannequins in the store, they don't look like real people.. I'd like to steal them and burn them all. I think they should have mannequins that look like real people in the windows of the store.
>
> **Pam**: Do you mean that mannequins should look like people with different looks?

> **Pete**: Yeah, I think they should be different sizes and different looks… they should be like real people… real people… healthy people don't come in mannequin sizes. They should stand them there so they look real, then the person who goes in to try on the clothes will know what the clothes look like on real people not those stupid skinny mannequins.
>
> **Jenny**: Maybe you could just not shop at those stores…may be that would change it.

Pete notes within this narrative that *"healthy people don't come in mannequin sizes"*. This may illustrate some change in Pete's conceptualization of health as he stated in the first session that healthy people are "*skinny people who are all toned and ripped"*. He voices his frustration with the "skinny' ideal stating *"not those stupid skinny mannequins*". Jenny, in considering the situation, presents an option that would allow them to exercise some power over the storeowners who place the mannequins in the window. By choosing not to shop at these stores she may exert some resistance in two ways; by avoiding the issue of mannequins altogether and removing herself from having to deal with being influenced by the thin ideal or by choosing not to spend her money in an establishment that supports the promotion of a harmful body ideal.

Adam provides another example of the positive implications of the introduction of alternative messaging. In the final focus group toward the end of the program, for example, when the children had the opportunity to talk about health and the body once again, Adam stated, "*you shouldn't worry about your weight, it's not about how heavy you are*". This is in contrast to Adam's discussion of weight in the initial focus group when he stated he was not healthy because of the weight around his belly as he drew a wide ring around his belly with his hands to emphasize his abdominal girth.

Again, while these moments of apparent resistance to the dominant discourse were interspersed with moments where the children utilized the dominant discourse their potential for resistance, I argue, should not be underestimated. While the children do often 'speak the language' of the dominant health discourses and, as previously discussed, have integrated these discourses into their identity formation, we must consider, as Markula (2001) points, out that if the "panoptic grip" as she puts it were complete, people would not question or critique at all but would blindly follow. The fact that people utilize the discourse does not mean that they do not take opportunities to resist in different ways. "The relationships between individuals and the state, although mediated through institutional spaces such as the family home, the school and the community, still allows for agency of the individual in making certain decisions" (Rawlins, 2008, p.147). The ways people resist, I argue, depends upon a number of factors. One major factor I contend is whether they recognize the power or agency that they have to exercise and whether they have access to the resources to help facilitate this critical perspective. The children in this program, when provided with permission to be constructively critical, were eager to explore their ideas about health and the body.

While the children did utilize some of the alternative messages as introduced through the program, it is also important to acknowledge the agency exercised before they even entered the program. I draw from the work of Foucault in recognizing that these children were not 'passive dupes' upon entering the program. They were active agents in negotiating the dominant messages. Given the negative connotations of the obesity epidemic and the potential negative implications of this discourse on the psychosocial wellbeing of these children, they entered the program already employing mechanisms that demonstrate a degree of resistance; mechanisms that allowed them to seek stable identities. Consistent with the work of Sykes and McPhail (2008) in their study of a group of 'fat' or overweight people's experiences with physical education, even before entry into the program, the children in my study found ways to usurp the messages that served to limit their achievement of healthy identities even before the program began. Also in keeping with the findings of Rice (2005), the children were creative in establishing identities that were not tied to the fat body. Nicholas and Jenny, for instance, utilized their creative abilities in the musical arena to draw attention away from their bodies, refocusing attention on their musical skills. As Jenny stated, "*I am a good musician and a good friend and that's what's important*". Pete utilized a comedic approach that his mother (in a conversation during a regular program session) stated "*he uses to cope with his weight... he's the big funny guy*". Joel, on the other hand, describes how he created an intimidating persona that he felt would prevent him from being openly criticized or bullied. He describes to the other children how he wears a long black trench coat so other kids won't approach him. The following excerpt from the first focus group illustrates how Joel utilizes this persona to avoid the ridicule of others:

> **Joel:** Well, I have the privilege of being one of the creepy kids at school, that no one wants to, like mess with because they're afraid I'm going to stab them…so…it's all good. I have my friends, but then there's people that don't like me but that's O.K.

Pam: You don't strike me as the type of person who would stab somebody.

Joel: Of course not…There's this thing –Columbine- that happened down in the states, years ago, these guys came in with trench coats at school took shot guns and started blowing people away.

Pam: So that scares people?

Joel: That's the kind of coat I have. They had leather ones, I have a cloth one, but the point is, they don't say anything to me…they leave me alone…you know they're idiots.

I argue, that the children, even prior to the program, were seeking out ways to usurp the identities ascribed to them through the dominant messages in an effort to feel good about themselves. While the children were drawn to the alternative messages provided within the obesity treatment program and seemed to enjoy the opportunity to exercise their critical perspectives, I must also note however that these moments of resistance were tempered by instances where the children remained immersed in a weight centred paradigm and were ultimately framed by it. While they recognized that weight might not necessarily define health some of the children continued to focus on weight loss as a goal in an effort to fit the social norm.

The Program as a Safe Social Space

As highlighted in Chapter 4 of this dissertation, the children throughout the narratives alluded to their social positioning and drew regularly upon the obesity discourse which functioned to position them on the periphery of social space. While the children spoke regularly of their marginal social positioning within the school and social setting, I noted throughout my research, however, that the children appeared quite comfortable within the realm of the social space of the treatment program. Even early in the program, when I had the opportunity to speak with the children, they demonstrated a distinct level of comfort or ease. They spoke about their concerns regarding their weight, the program, and the impact of their position as so-called 'fat' children on their daily activity. Given that in my ongoing discussions with the parents that many of the children had been described as shy and not outgoing in a social setting, I was surprised by the children's eagerness to talk and share their beliefs and opinions on the topics brought about through the program. I felt it was important to explore this issue with the children in examining their views of the program and the social climate that was created within the boundaries of the program.

Throughout my interactions with the children it appeared to me that they considered the program a sort of 'safe social haven'. Within the context of the program they took on challenges and participated in activities that they stated they would not otherwise have participated in within the school or broader social settings such as rock climbing, group activities, and hiking. As one child stated *"I can be myself here"*. Drawing on the work of Goffman (1959) in which the author compares our social interactions to theatrical performances in which the character we present to the audience may not reflect the preparation or interactions that take place back stage, I was reminded that the children demonstrated that their performances did not have to be as orchestrated in the program setting. Goffman defines the performance as " all activity of an individual which occurs during a period marked by his continuous presence before a particular set of observers" (p.22). The performance that they carried out on a regular basis in an environment that is openly critical of their appearance, motivation and abilities was not always necessary in the program. They tried things that they admittedly had not tried before. The techniques that they used on a regular basis to 'perform' in the broader social setting such as humour, intimidation, or specific clothing to hide the body, were not as necessary in this setting. The comfort that developed within the group was reflected in their discussion of the program itself. The following excerpt illustrates the social safety that the children experienced in the program because, as many of them stated, they did not feel different in this setting.

Pam: How do you feel when you are here in the program?

Nicholas: Relaxed

Adam: Yes

Billy: Yeah

Joel: Incredibly so

Pam: Yeah? And why do you say incredibly so?

Joel: Well, I'm pretty much opening up to everyone here like it's absolutely nothing…

Adam: And it's extremely private

Billy: And you barely know us

Joel: Exactly! You guys are practically strangers and…

Pam: Why do you think that is? Why don't you do that elsewhere? What is it about this place that does that?

Nicholas: Cause by law you can't tell anyone else.

Jordan: We're all here for the same reason.

Adam: Pretty much

Pam: So you feel that you guys have the same sort of experiences?

Jordan: To some degree

Adam: Yeah

Pam: And do you think it is safe to talk here?

Jenny: Yes

Nicholas: Yes

Jenny: I feel safe here because I feel I can talk about what I want to talk about… Sometimes you can't talk to your friends at school because they don't know what it's like …they don't understand…they haven't had the same experiences and they don't understand.

Pam: So do you think that if you talked about the things you talked about here in other places, that that would be the case?

Joel: Where we're in a similar situation, people who haven't been in a similar situation won't sympathize the same way because they don't know what it's like… but people here have been in similar situations, and they can sympathize

> and see where you're coming from, they listen to you. They've probably been in the same situation.

The children in this excerpt emphasized that they feel comfortable within the confines of the program group. Nicholas, for example, states that he feels *"relaxed"*, while Joel emphasizes the point stating *"incredibly so"*. Throughout the program the children emphasized the fact that they did not often feel this comfort in other social settings and felt that others do not understand where they are coming from. This is reflected in Jenny's statement "*they don't know what it's like ...they don't understand...they haven't had the same experiences*". The marginalization and stigmatization (as highlighted in the children's narratives discussed throughout this dissertation) that often is inflicted upon those with non-normative bodies is reflected in the literature (Davison & Birch, 2001; Latner & Stunkard, 2003; Rice, 2007; Sykes & McPhail, 2008; ten Have, de Beaufort, & Holm, 2010). As stated by Puhl and Latner (2007),

> The stigmatization directed at obese children by their peers, parents, educators, and others is pervasive and unrelenting. It has been extensively documented across diverse samples of children using diverse research methods. As a result of weight bias and discrimination, obese children suffer psychological, social, and health related consequences (p.574).

Overweight and obese children for example have been seen to suffer from lower self-esteem and quality of life (Fallon et al., 2005; Janicke et al., 2007; Murtagh, Dixey, & Rudolf, 2006; Williams et al., 2005). They are ostracized, ridiculed and labelled as being lazy, stupid, less competent and unmotivated (Haines et al., 2006; Jansen et al., 2004; Latner & Stunkard, 2003; Larkin & Rice, 2005; Murtagh, Dixey, & Rudolf, 2006; Puhl & Heuer, 2009). Thus I argue, the children's embodied experiences impact how they relate to others, the trust they place in others, and the terms upon which they can feel free to be themselves and 'let down their guard' so to speak. The removal of scrutiny and the introduction of an environment that proves itself to be free from ridicule and the moral underpinnings of the obesity discourse, I contend, can provide a space where larger children can feel free to experience their bodies in positive ways so they can more easily come to identify themselves as healthy individuals.

Interestingly, in discussing the comfort that the participants experienced in the program, Nicholas drew on his knowledge of the medical environment and the notion of confidentiality in stating, "*Cause by law you can't tell anyone else*". The program, in this respect, can be conceptualized as a protected space. Nicholas recognized that according to the concept of confidentiality within the health care field, health professionals are legally bound to maintain the patient's privacy and are obligated not to share patient information. I had also previously explained to the children, that as a researcher, I am also bound to maintain confidentiality and that while the things they say may come up in the reporting of my research, their names would never be repeated or known. This provided a level of comfort for the children.

Also, as can be explicated from the previous excerpt, the children articulated how shared experiences and commonalities within the group permitted a sense of safety. As Jenny suggested, she felt she could talk more openly within the program because the people within the group would understand. Joel emphasizes this point when he states "*but* *people here have been in similar situations, and they can sympathize and see where you're coming from, they listen to you*". Such shared characteristics and experiences may, as noted by Puhl and Brownell (2003) provide a mechanism for coping for people experiencing stigmatization based upon their size. Drawing on the work of Levy (1993), the authors state that health care providers may "help their stigmatized clients participate in positive interactions with other members of the stigmatized group who can affirm their identity" (p. 59). It has also been suggested that consideration of the larger child's point of view as well as attention to individual difference can positively impact on the child's path toward achieving a positive sense of self (Bromfield, 2009). I argue here that the social safety that was produced within the program allowed the children an outlet to discuss their shared experiences and in doing so also share their resistive messages.

As the notion of social safety was a distinct characteristic of the program that the children were quite evidently drawn to, I decided to further explore this dynamic with the program coordinators in an interview. Coordinator # 1 in the following excerpt for example suggests that the social comfort created within the program is a key element that the children are drawn to.

> **Pam**: So that leads me back a bit, in terms of the concept of safety, and the kids in the program, and when they go consistently, so that eleven weeks when they're together each week, you know, you say they do develop that sense of cohesion, that sense of safety. Do you want to just comment on that?
>
> **Coordinator #1**: Sure. And I think that that's probably what you're asking …
>
> **Pam**: and I know we're deviating a bit, but as the issues come up

Coordinator #1: That's fine... Put that in! I think that's why people come. I think that parents may come for information, in terms of they're concerned about their kids health or whatever, I'm not sure the kids are quite as concerned about that. I think that what the kids get here, that they don't get other places, is they actually experience not being judged. And for many of them that's a unique and first time experience. And even having that feeling can help create that in other settings, and that is the hope. One kid said, when we did a body image session, I told you this before, that when we talked about body image and bodies, and situations where you feel good about your bodies, and the person that asked the question, it was one of the group leaders, he said, 'I feel good about my body around my family', and one kid said, 'well, I feel good about my body here'. And that was a powerful message for me, because kids are willing to try things that they normally will not try. If they feel that they could be ridiculed, they will not want to go rock climbing, but I think they've always felt, many of them felt insecure about trying that, because you're really being on display from a body perspective, but it's also harder, if you have weight on, to actually pull yourself up. But when they come with us, it's so encouraging, like all the other kids are grouping around, saying 'try this, try that one', and they love it. They want to go again and again, because they get to do it without worrying about their performance or their appearance. So it's a psychological safe space.

Pam: And have you seen where they have sort of started something in a comfortable, safe setting, and continued, been ready to do that outside of the program?

Coordinator #1: Oh yeah, definitely. Not every activity hooks every kid, but the goal, or what I would like to see, if we do a different activity, and we get one kid that enjoys it – because that's all it's about. If they enjoy it enough to do it again, and then they can get hooked on it. Because activity is about, when you're a kid, it's about being fun. It's not about having exercise. I mean, who wants to do that? I don't even want to do that, and I'm in my 40's. If I'm not having fun, I don't do it. So we'll try different things we'll try cross-country skiing, we'll try geocaching or [wall climbing], or drama, or we'll do music, or we'll do whatever. But we'll do different things because different things will hook different kids.

The previous narrative provides some insight into how this coordinator conceptualizes the program based upon her experiences with the children. Within the narrative she emphasizes the freedom from judgment that the children experience, pointing to this freedom as a key to enhancing the children's comfort levels and allowing them the freedom to explore being active and comfortable in their own bodies as she states: *"I think that what the kids get here, that they don't get other places, is they actually experience not being judged. And for many of them that's a unique and first time experience"*. The coordinator asserts that the freedom and comfort that comes from not feeling judged should be achievable when she states: *"And even having that feeling can help create that in other settings, and that is the hope"*. By opening up channels of conversation, recognizing that so-called health knowledge is contestable and that there are other ways of viewing health, it is possible to begin to change the present weight obsessed culture to which these children are exposed on a daily basis. By having the opportunity to consider the contradictions in the obesity discourse and given the permission to do so in a protected space can afford these children the room to explore their subjective positions. As noted by Rail, Holmes, and Murray (2010), who drew on the work of Butler (1997), identity is a fluid state. While, as in their study of youth, children in my study discursively produced their identities through utilization of the dominant discourses, they did utilize performative acts that created room for the introduction of more fluid transition into more positive healthy subjectivities.

Striving toward a Shared Vision of Health

While the goal of the obesity treatment program utilized within this study was to create a comfortable non-judgmental environment for the children to enhance the likelihood that they may engage in enjoyable activities and ultimately feel good about themselves (with the assumption that this will lead to good health), this vision is often contradictory to many of the messages endorsed through our contemporary biopedagogies. As discussed previously this can pose challenges for program coordinators who must combat these messages within the design and implementation of their program. The vast majority of health care professionals have been educated within the dominant health paradigm in which they are taught to monitor weight as an indicator of health and ultimately work to help people lose the weight in order to positively impact the health of the community. As this is a generally accepted conceptualization, the coordinators indicated that some issues do arise within the program with regard to both staff turnover and introducing staff to their more critical perspective. As the program is provided only a small budget and the coordinators have little control over who is hired, the introduction of a more critical approach to obesity treatment is both time consuming and at times frustrating. While some staff are naturally drawn to other ways of viewing health and body size, more ingrained attitudes in relation to body size are hard to overcome as many times even those who have education in the area still display negative attitudes toward obese people and continue to utilize a healthist approach of individual responsibility (Hebl & Xu, 2001; Schwartz et al., 2003; Wigton & McGaphie, 2001). As illustrated in the following excerpt the high number of staff changeovers continues to make the process difficult for the program coordinators.

> **Coordinator #1:** *But no, I think the other people on the team, as you know, part of our biggest struggle has been turnover in some of the other professions on the team, because we have part time positions, and we've had some maternity leaves, but the part time positions has a lot of problems, so we have had, in the four years probably had seven different dieticians and four different social workers, only two different physiotherapists. But it has a big impact when you're looking at fostering a sense of community. So everybody who comes in – I had one dietician say to me after being here for about three weeks 'oh my God, it's not about the food', and I think that's fairly common, and most of them get there, but I'm not sure that they all have the same understanding.*

As previously stated, the coordinators also voiced their concern with the focus on obesity in terms of health outcomes. They argued that many of the symptoms that their obese patients are presenting with are also symptoms that occur in people who do not fall within the parameters of obesity. This, they argue, suggests that obesity in and of itself is not the problem. Thus, the move toward the treatment of obesity itself may be contradictory to their own messages. Even though, as they state the program began as an obesity treatment program, they are now in the process of changing the perspective to a chronic disease perspective. In the following exchange, coordinator #2 explains her perspective.

> **Coordinator #2:** But it always started out as a being a management thing for kids with extra weight on. But it's become very clear to us over time, that it's not about weight, its about health… well lots more needs to be done, that's why we're involved in so many other things, initiatives at different levels of government, community, and things like that. But also that there are other – the messages that we say apply to everybody, and that there are kids out there who might really need our help, but because their weight isn't up, then they aren't hearing it. This is going to be more of a helping to prevent chronic disease sort of group, which is what we're going to be starting in the fall….And I think health care professionals really need to understand the complexity of it. It's one of those areas that even health care professionals think they know a lot about … which is a lot of the problem. Because there's so much written about it
>
> **Pam**: because when you read about it it's very interesting, everybody … it's like socially we've been given permission, because it's such a perceived problem that everybody can talk about it in an authoritative kind of way …
>
> **Coordinator #2:** And there's so much written about it in literature and … so everyone has an opinion about body size, about nutrition, about physical activity, about all that sort of stuff, so it's … um … anyway. It's interesting. And the health care professionals are no different. Sometimes they might know more, but

> they don't always know the right thing to say. You know, I hope they truly understand the complexity of it all, and that they don't use the word 'willpower' and things like that when they're talking to people, and they offer help that is appropriate, or know who to ask. Like, here's a good group, lets get them involved.

As previously stated, the coordinators made the determination that the program would no longer focus strictly on obesity but would rather take on a chronic disease prevention focus. In keeping with this the children who enter the program would no longer have to be those above the 95th percentile but rather any child who may be displaying negative health outcomes that may be improved through support and education. This focus is supported by Egger and Dixon (2009) who, although having written extensively on the negative repercussions of the so-called obesity epidemic and the 'obesogenic environment', are now beginning to question whether it is obesity per se that is leading to poorer health outcomes or whether there are other factors at play.

> It is proposed here that it is the environment driving modern lifestyles, which is the true cause of much chronic disease, rather than obesity per se, and that obesity may be a marker of environmental derangement, rather than the primary cause of the problem. Attempts to clinically manage obesity alone on a large scale are therefore unlikely to be successful at the population level without significant lifestyle or environmental change (Egger & Dixon, 2009, p. 237).

This approach is supported by a number of authors who suggest that in focusing on obesity we may be missing an entire segment of the population and creating a hostile environment toward larger people (Cooper, 2009; Gaesser, 2002; Robison, 2005).

While the move away from a focus strictly on obesity by the program coordinators may not be the most popular approach within the biomedical context of the present obesity panic, their acceptance of a more critical way of examining the issue may be promising in terms of promoting a more collaborative and progressive approach to supporting health in people of many sizes. As noted by Moffat (2010), a more collaborative approach that brings an appreciation of how childhood obesity is socially constructed is necessary. By utilizing the medical authority that comes along with their positions, the program coordinators have the opportunity to positively impact policy, to work collaboratively on research in this field to infiltrate the mainstream literature and disseminate a more progressive approach within the research and health care communities. While this move may prove beneficial in changing perspectives related to health and weight, there are a number of questions that the program coordinators must consider however. For example, if the program changes its format and opens up to children of all sizes, how will this impact upon the safe social space that has been established for the larger children? Also, in accepting the argument that health outcomes are not the repercussions of individual behaviour alone and that larger societal processes are at play, should the program continue to focus on the promotion of nutrition and health behaviour based upon individual behaviour? I will refer back to these questions in the concluding chapter.

Chapter Summary

In this chapter I have shifted away from my exploration of how the children in my study negotiate pervasive obesity discourses in general toward an investigation of the treatment program itself. Through an examination of the children's narratives and those of the program coordinators, I have provided some insight into how the program was both intended on the part of the coordinators and received from the children's perspective. Given that the interactions throughout the program point to the complex relationships of knowledge and power as articulated by Foucault, I thought it was important to explore how the children experienced the program, how they negotiated the alternative messages introduced and how ultimately this can inform further program development.

Based upon my exploration, I have discussed within this chapter how both the children and the program coordinators struggle with issues related to the dominant health paradigm. From the children's perspective I have illustrated how their initial views of the obesity treatment program and the meanings they derived were a product of their daily experiences with and knowledge of the dominant health messages. I have demonstrated how the children utilized this knowledge in forming their ideas about obesity treatment. These ideas, as I have expounded upon within this chapter, were very much tied to notions of weight reduction and individual responsibility. While I have demonstrated that the children did draw upon the alternative discourses and did integrate them to some degree into their conversations throughout the program, I have also noted within this chapter that the children continued to utilize dominant discourses as well. It would be, as I have argued throughout this dissertation, naïve to assume that the program messages will be fully integrated and utilized by the children given the powerful health messages that inform so many of their daily experiences. I have illustrated within this chapter however, that while the children are influenced by the dominant messages, the key here may be recognizing and fostering their agency. I have suggested that we must first consider the agency with which these children enter the program. The children entered with their own ideas about themselves and the world around them. As I have noted within this chapter, they utilized their agency in modes of self-expression that, for some, helped them cope with the negative repercussions of being obese in a thin obsessed society. Beyond the specific messages related to weight and obesity, the program as well played an important role in allowing the children the opportunity to exercise this agency. This, I argue, is an important point that should not be underestimated. While the program did not necessarily counteract the negative elements of the biopedagogies that endorse the thin ideal, it did provide the children with a safe space where they felt comfortable to talk about their experiences and share and challenge their ideas about health and the body.

In this chapter I have also pointed to the power of the clinical gaze as articulated by Foucault. I take the stance in the chapter that the authority granted to physicians may be utilized in a subversive manner to help children challenge dominant ideas. As I have argued within this chapter, the children eagerly utilized this permission to challenge a number of ideas about health and the body. While the coordinators hope to provide children and their families with helpful information, the opportunity to mobilize their agency may be more effective and in fact much more important in terms of establishing change within this field. While, as presented in this chapter, the coordinators have struggled with high staff turnover and a system that often contradicts their own messages, this element of the program may be instrumental in striving toward a shared vision of health.

In the following concluding chapter, I revisit this concept. I also provide an overview of other elements of my research discussed in this dissertation. I provide recommendations for future health care professionals and critical researchers alike with consideration to how we can begin to approach this issue in a manner that can result in positive outcomes for children of all sizes.

CHAPTER 7

CONCLUSION

"IT'S THAT RIPPLE EFFECT- ONE SMALL DROP CAN PRODUCE A HUGE CHANGE"

In this dissertation I have provided an overview of a research study in which I sought to explore the embodied experiences of a group of so-called 'obese' children that has not been seen before in the literature. It moves beyond the rhetoric that is produced through the obesity panic to consider how powerful discourses serve to influence and shape the experiences and subjectivities of children who have been marginalized due to their body size. Ironically, the mere fact that they have been referred to an obesity 'treatment' program illustrates how the biomedical approach to health produces such marginalization.

Throughout this dissertation I have drawn on the work of Foucault with consideration to the power of discourse and the complex relations that privilege certain discourses over others. The contemporary obesity and health discourses, I have argued, hold a privileged position that has allowed them to infiltrate the institutions to which children are exposed everyday and in doing so inhibit alternative discourses that allow for more positive healthy subjectivities. These discourses, I contend, are very much tied to the neoliberal healthist paradigm that has gained power in contemporary western society and is becoming more powerful worldwide as globalization has taken hold. The marketing of the thin ideal, I have argued, has transcended the business sector and the 'selling of health' as outlined by Moynihan, Heath, and Henry (2002) has become interwoven with expert discourse and mainstream obesity research (Campos, 2004; Gard & Wright, 2005; Oliver, 2006) that functions to guide the way people 'should' live (Burrows, 2009; Leahy, 2009; Wright, 2009). It is from this critical standpoint that, I contend, we must begin. It is the recognition and acknowledgement of the role and power of discourse, I argue, that may have the greatest impact in terms of changing the way we view the body in the health field and ultimately within the broader community in an effort to support people in achieving and maintaining what they consider to be a positive health status. I postulate that only when we can begin to scrutinize and critically examine our own practices, their origins, and their meanings, will we begin to come closer to the goal of health for all. As stated by Rail (2009):

> Unless subversive discourse about health and obesity are given a more prominent place, young people's acquisition of new subject positions will remain limited, and health will remain elusive particularly for marginalized youth. For progressive change, we need to raise awareness about obesity discourse, its problematic discursive effects, and particularly how and why it constructs particular subjects (p.152).

Reflections On My Research

This doctoral research arose out of my own discomfort with the status quo in relation to health and the intense focus on the normative body. I questioned how we could condone an approach to health promotion that marginalizes an entire segment of the population in the name of health while simultaneously fostering a pervasive and growing level of body dissatisfaction within the population (Evans et al., 2008). In examining the issue through a feminist lens I considered how the dualistic messages of 'thin is good' and 'fat is bad' are impacting our children, particularly those children who are discursively produced as fat, lazy, and ultimately unworthy. I have, in this dissertation, deconstructed these binaries in hopes of opening up our conversations about health and the body (within the field of health and beyond) drawing attention to how binaries, described as natural, "give us only one option- of mimicking one part and abjecting the other" (Gannon & Davies, 2007, p. 75). I have demonstrated that when provided with the social permission, social safety, the tools to critique the dominant messages, and alternative modes of conceptualizing the issues, that there is great potential for children to move beyond these binaries to manoeuvre within multiple discourses to forge positive identities, allowing them to be positioned as 'healthy'.

As discussed in my introduction, this research grew out of my concern for the children whose identities are shaped and influenced by a discourse that may be viewed as detrimental and not consistent with the promotion of overall health. As a health professional, I have been privy to and have taken part in many conversations and initiatives that have drawn on the main tenets that are so often perpetuated in the obesity panic messages. The concerns swirl around a society that is argued to be progressively more gluttonous and lazy, producing an environment that fosters inactivity and a generation of children who many have argued, will not outlive their parents (Cliff & Wright, 2010; Evans & Colls, 2009; Gaesser, 2003; Gard & Wright, 2005). As a professional, however, I have also become more discontent with the way we 'promote' health. I question whether we truly are concerned with people's everyday lives and the complexities of their embodied experiences. I agree with Kelly Monaghan (2010) in her reflection on health promotion documents:

> I failed to find any substantive elaboration of social or cultural theory; any interrogation of power dynamics in society, or the processes of engagement and knowledge co-creation; any reference to the epistemological debate waging elsewhere in social science; or any exploration or standpoint in regard to the structure/agency question or its platform for social change (p. 23).

As health professionals we often, with good intentions, make decisions for people. We decide how they should behave in terms of following specific diet, activity, and treatment regimens. We outline specific 'rules' to good health that we expect them to follow. We draw conclusions based upon what we consider reliable evidence often without consideration to who produced this so-called knowledge or the processes in place that may privilege one mode of thinking over another. We, ourselves, take up subject positions in which we utilize and reinforce the dominant discourses, only to enhance their power and in doing so, restrict and inhibit alternative perspectives. Also, as researchers and so-called experts in our given fields, we are often granted the authority to speak for given groups as we are considered to be in a position of 'knowing'. Throughout my initial exploration of the literature or the mainstream 'evidence', I recognized that it was the voice of the health professional or health researcher that I was hearing. I was not hearing the voice of the research participants. In fact, it was not until my introduction to the critical feminist literature that I began to hear that voice. Through this literature I found the resources through which I could effectively explore what I felt was missing in the mainstream obesity research, the voice of those most greatly impacted and framed by the present obesity discourse. I recognized how important that voice is and how as health researchers it is incumbent upon us to provide for research opportunities that allow that voice to be heard.

The overall purpose of my research, therefore, was to explore the embodied experiences of my participants, the children, through observation and direct interaction in a setting designed to be supportive, without judgment or ridicule. In exploring how the children interacted with the dominant health discourses, considering how they both utilized and resisted the discourse, I have demonstrated within this study how these children read the biopedagogies, how they integrate them into their evolving sense of self and also how they can exercise their own agency in finding ways to resist the dominant messages and be receptive to alternative ways of conceptualizing the body and health. As discussed throughout this dissertation I was not surprised that the children drew upon the dominant discourse to construct their ideas of health. As was consistent with other post structural studies on youth and constructions of health, health for them was constructed predominantly in corporeal terms (Beausoleil, 2009; Burrows, Wright, & Jungerson-Smith, 2002; Rail, 2009, Wright & Burrows, 2004). This focus on the body, as reflected in the dominant health discourses, was intertwined with a healthist moral imperative of personal responsibility that the children consistently struggled with. This imperative and the contemporary health promotion milieu, I have postulated, discursively produced these children as the ultimate at-risk children thus further limiting the availability of positive subject positions and alternate discursive resources. The voices of the mothers also pointed to the production of the ultimate at-risk child and further reinforced how mothers (particularly of larger children) struggle with their assigned responsibilities of ensuring a 'healthy lifestyle' for their children while simultaneously trying to promote positive self-esteem in their children. To accomplish both tasks, I argue, is extremely difficult in the context of the present health driven environment that limits the space for positive subjectivity in larger people and places them on the periphery of social space, a theme that I noted repeatedly throughout the narratives.

What did surprise me however in reflecting upon the narratives and my interactions with and observations of the children in this study, was the significant role that social safety played within the treatment program. As noted in chapter six, this was a consistent theme throughout the weeks I spent with the children. The children, when provided with safety from scrutiny and permission to examine and openly critique the dominant health messages, were very receptive and spoke of the comfort they felt. Through this study, therefore, I have demonstrated the significant role the immediate social environment plays in the utilization of the discourses and the exploration of subject positions. Such positions are always being negotiated and the comfort experienced by the children within the treatment program utilized in this study, I argue, allowed them to consider different subject positions and their ability to oppose or take on such positions. Like Rail, Holmes, and Stuart (2010) while I argue that the subjects in my study are shaped through the discursive resources available to them " they nonetheless exist as thinking, feeling subjects and social agents, capable of resistance and innovations produced out of the confrontation of contradictory subject positions" (p.274). When children in this study were provided with discursive resources (in addition to the resources they already possessed and utilized) and these resources were supplemented by a safe environment in which the resources could be utilized, the results (as highlighted in chapter 6) were quite positive. The significance of this point cannot be underestimated. It highlights the importance of an environment that provides room for open exploration of body issues and expression of self that is not limited by corporeal categories that define who we are in terms of dominant 'healthy living' goals. Given the safety that was produced within the program utilized in this study, the children were eager to voice their ideas about themselves, health, and the body. In the absence of the intense scrutiny produced by the predominant biopedagogies, with full endorsement of the medical authorities who can legitimize the alternative or resistive narratives, and when presented with alternative ways of considering health, the children took the opportunity to voice their opposition and discomfort with the dominant messages and take up positions that they previously had not.

While I do recognize and acknowledge the power of the dominant discourses and I am not naïve in my conclusions to assume that the children will take up and utilize all alternative discourses presented within the program or that all messages within the program were free from the imperatives that are dictated within the 'healthy lifestyle' approach, the issue of social safety is one to be further explored. By critically examining the social situations that we are creating through the present biopedagogies, we may begin to disrupt the current notions of health that foster a negative social environment for many people and begin to open up opportunities for the expression and appreciation of difference. In recognizing how the language we utilize in our so-called 'health' messages serves to shape the discursive environment we can begin to appreciate their impact and more carefully frame our health promotion initiatives with attention to the power of language.

> Once we let go of our desire for unitary subjectivity and acknowledge the constitutive roles of discourses, including those of finding the truth, achieving mastery, and "pinning down" the subject once and for all, we open up to interrogating the ways in which we have been producing knowledge (Barrett, 2005, p.89).

Reflexivity in the Research

This research has provided a snapshot of the experiences of one group of children in a brief period of time. While working toward a reflexive mode of research I remain cognizant of my role in the co-construction of knowledge as it relates to the children, their constructions of health and their negotiation of the dominant discourses. Through feminist poststructural research, it is the production of such knowledge that is my interest. My part in this construction therefore should be acknowledged and considered. While I reminded the children on a regular basis of my role and they appeared quite comfortable with my presence, they still may have conceptualized me as a health care professional. I recognize that their talk may be different without my presence, however, I also recognize that the building of knowledge and meaning occurs through the process of dialogue. I strove to integrate and appreciate how my presence and my participation in that dialogue interacted with the expression of their experiences moving beyond the notion of 'insider' and 'outsider' (Hesse-Biber & Piatelli, 2007). Thus, while I have attempted to grasp the true essence of the children's experiences, I recognize that this is not entirely possible. In keeping with the constructivist perspective I acknowledge that I have not been striving toward a truth (as reality in and of itself is a production) but rather I have sought to explore and give voice to the children's multiple realities that are constructed through complex processes.

Implications for Research, Education, and Clinical Practice

Health research, education, and clinical practice are interwoven, dynamic processes. As health researchers we often utilize the literature and conduct our research with attention to rigour and validity, in search of an attainable 'truth'. As health professionals, we draw regularly upon research findings to inform both our client teaching and practice. As educators, we consistently remind students of the importance of evidence-based practice suggesting that they can find the most reliable modes of thought and practice within the mainstream literature. I contend that within each of these realms, however, we rarely reflect upon our epistemological standpoints in critically examining what constitutes evidence, how knowledge is produced, or how or what voices are heard. We draw on the frameworks that we are taught, the frameworks that we know and assume to be 'correct', often without consideration of the fact that there are alternative ways of examining various issues that may provide us with greater insight into the subjective experiences of the people we are researching (Barrett, 2005; Gard, 2004; Kincheloe, 2008). In relying upon expert testimony for example do we stop to consider what defines 'expert'? It is with these considerations in mind that I make a number of recommendations. To begin, I contend that as health professionals, educators, and researchers, we must start to change the present health promotion milieu by recognizing the need for a more critical examination of the literature, by opening up our exploration of the literature to draw on research that provides attention to and room for the exploration of embodied experiences of those we are expected to 'teach', and by exploring new ways of 'doing' research. While this may be more challenging in the realm of present practice, I contend that through colleague presentations, through introducing our peers to more critical modes of thought, to new forms of research that span beyond the positivist camp, and through asking questions that explore the meanings we derive from so-called evidence-based practice, that we can begin to accomplish some change. "These questions attempt to open up discourses, making them and the power relations within them visible and thus accessible for examination and possible revision" (Barrett, 2005, p.84). This is supported by Morgan (2007) who drawing upon the work of Kuhn, notes that the boundaries that define paradigms are not definitive but rather may be negotiated through a process of communication that informs one party of the other party's epistemological perspective.

As illustrated by Neumark-Sztainer (2009), the work of health educators, researchers, and health professionals does not have to occur in separate philosophical silos. In her examination of weight related issues in the adolescent population, this author notes that we must work together by accepting a broader approach that incorporates different ways of researching that are sensitive to issues of stigmatization, body image dissatisfaction and the 'do no harm' approach. While the various approaches may in many ways appear in opposition to one another, there is great potential when they are utilized together in a manner that recognizes the strengths, limitations, and contributions of each one. While differences in these approaches may exist, and the positivist and constructivist perspectives may never be fully commensurable, they do have the capacity to inform one another and provide a more comprehensive examination of people's experiences when researchers are open to examining and challenging their own epistemological foundations.

Researchers, educators, and health professionals, I argue, are in a particularly good position to begin to implement change. As articulated in this dissertation, exploring alternative discourses with children is an exciting prospect. The children in this study were drawn to exercising their agency and displayed enthusiasm when given permission to critique the status quo. By providing children with the space and permission to examine their own beliefs and explore more critical ways of examining health and the body through alternative discourses, we (health professionals, researchers, and teachers) may allow them to see and do health in different ways. We can change the present environment that limits the children's possibilities in relation to positive identity formation. It is my contention that we can begin to accomplish this by working in a subversive manner within the very structures that produce and reinforce the present biopedagogies. By drawing attention to the way this knowledge is produced and reinforced and by challenging the present view of health and the programs that arise out of the present biomedical paradigm, we can begin to open up and make available a broader pool of discursive resources that do not limit people to narrow categories of discursive subject positions. To accomplish this it is important that such critical perspectives be addressed at the level of curriculum and resource development within the school system and at a broader community level with consideration to how "school based body pedagogies mediate, categorize and select on the basis of health discourse which has as its referent a normative vision of the ideal body" (Evans & Rich, 2011, p. 375). We must also continue to reinforce such perspectives and highlight the politics of pedagogy with the teachers and health professionals who utilize these resources through involvement with the employer driven continuing education workshops and through active involvement with the various professional associations through newsletters, journals, conferences, and professional development opportunities.

> This requires engagement in a politics of how 'we' (teachers, teacher educators, health workers and researchers) are to construct the experience of education for young people in a way that does not alienate them by separating 'body' from 'mind', 'subject' from 'object' or individuals from the communities and cultures to which they belong (Evans et al., 2008, p.129).

It is also vital that we consider the postsecondary environments in the education of our future teachers and health professionals in particular. Students at this stage need to be given the opportunities to critically analyze various perspectives. We must recognize, as illustrated by Kincheloe (2008), that students are most often denied an introduction to other ways of knowing through our restrictive curricula which is steeped within a positivist paradigm:

> In college their liberal arts and science courses many times simply delivered facts in biology, physics, sociology, psychology, or literature. The idea that these courses presented only one narrow perspective on the field in question, that they left out competing forms of knowledge produced by scholars from different

> schools of thought or from different cultures was never mentioned (Kincheloe, 2008, p. 9).

Through the introduction of critical perspectives we can allow students the opportunity to explore what constitutes knowledge. In doing so they will have the opportunity to examine their own beliefs and the discursive foundation of those beliefs. As Butler (2005) stated, "Thus, if I question the regime of truth, I question too, the regime through which being, and my own ontological status, is allocated" (p.23). Students need the space to consider how subjects are formed through the re-articulation of discourses that are embedded in cultural notions of health, gender, race, sexuality and so forth. This could be addressed through the introduction of a critical studies element in the students' curriculum through a specific critical studies course or integrated through courses such as research and professional issues. The importance of introducing students to the examination of varying perspectives is reiterated by Grix (2002) who argues that in order for students to become engaged in constructive dialogue and criticism of others work, they need to be schooled in the notions of ontology and epistemology so they are aware that people from different perspectives draw on different discursive resources.

> An understanding of ontology and epistemology is important for students because they need to understand the logic behind the approaches taken by others and they need to make their own approach very clear. This will allow them to defend their own positions, under- stand other researchers' positions and fully grasp the directional relationship of key components of the research process. The latter is essential if students wish to go on to engage properly in academic debate and

produce quality and transparent research projects (Grix, 2002, pp.184-185).

By introducing students to varied ways of knowing, educating them in the presence of other disciplines and introducing social theory informed by feminist and cultural studies, we can help students attain a broader view of the human experience. As stated by Gingras (2006), in reflecting upon the field of dietetics "One way to start is to create multidisciplinary learning environments for health profession students, including in the curricula knowledges from the domains of sociology, feminism, aboriginal studies, education, and anthropology" (p.204). It is the hope that through collaborative learning and exposure to other ways of knowing that students can recognize the constitutive power of language in their future careers while maintaining an open perspective in terms of resource and policy development and the practices that affect people in their everyday lives. We must recognize that these students will be the future researchers, educators, practitioners and policy makers and, like those before them, they will draw on the resources to which they have been schooled. While I recognize that dominant discourses are deeply embedded in powerful processes that span beyond the field of health, I am hopeful and optimistic that these processes can be interrupted and discourses can begin to be modified to allow for enhanced recognition of and sensitivity to people's lived experiences.

While education is vital, further research into the way subject positions are produced through health discourse is also essential. I am not arguing that poststructural feminist research is the only way to conduct research, as this contradicts many of the arguments I have made about the nature of knowledge production. It does, however, provide us with the means to disrupt certain notions, to break them down, to consider where they are situated in terms of power and privilege and how they impact on people's everyday lived experiences. It also allows us to consider the perspectives of others and the way 'science' is done. As Baxter (2002) states, "it provides a way of understanding the world through a rich plurality of voices and perspectives, which may lead to a greater recognition and connection between people of competing viewpoints and ultimately may prompt social and educational transformation" (p. 5).

I have demonstrated in this dissertation that this connection can be useful and productive. Working critically with those who work within the positivist biomedical framework is possible and can be beneficial.

> If we hope to develop a more equitable and engaged scholarship and practice to eliminate health disparities, we must promote a more inclusive intellectual landscape to support dialogue and collaboration across intersectional, critical public health and biomedically derived paradigms (Weber, 2007, p.675).

This type of work has provided me with further insights into the challenges of clinical practice within this framework and the possibilities when those within the health care system are open to other ways of 'knowing' and 'doing' research. The presence of critical researchers, therefore, on interprofessional research teams, working groups, and practice and policy committees is vital. Through collaborative efforts we may have the opportunity to "inject some critical reflection on the construction of the social problem of childhood obesity" (Moffat, 2010, p. 13). There are opportunities here to move beyond what Johnson and Onwuegbuzie (2004) refer to as the 'paradigm wars', to acknowledge the differences in paradigms while drawing upon the strengths of both in the interest of those we are researching. In valuing the positive aspects of the different paradigms and the valuable contributions they can make, I argue that we must also be open to the limitations of our own standpoints and be willing to recognize and engage in other ways of knowing.

I must note that the concept of obesity treatment, while contrary to many of the arguments I have made throughout this dissertation, is a reality for many and for some people such treatment may provide an avenue to help improve health outcomes. It is thus imperative that the research into this practice be broadened to consider the embodied experiences of those involved. In terms of the treatment program utilized within this study, I have a number of recommendations. An identified strength of this program that was elicited through this research was the level of involvement the children had in both the choices of activities and the space to explore their beliefs regarding health and the body. It is vital that the program coordinators continue to involve the children in this process. Given that the program coordinators (in recognizing the limitations of focusing on weight rather than health) are considering a change in the program philosophy from obesity treatment to chronic disease prevention in which children will be admitted to the program based upon health risks and existing concerns rather than body size, it is important that the children previously involved in the program be consulted. The children's input may help guide decisions regarding how the program should be further developed and provide professionals within the program with greater insight into the experiences and expressed needs of the program participants. This is supported by Schwartz et al. (2003), who state "interventions that enhance personal appreciation of the experiences of obese individuals may be useful in changing attitudes" (p.1039). While children are often not considered valuable contributors to the planning process, the children who have experienced this program (as articulated in this dissertation) can provide valuable and reflective feedback that may be quite helpful to the program coordinators.

The program coordinators should also examine the issue of social safety as discussed in this dissertation. It would be helpful to explore this issue with children who have previously been involved with the treatment program. Should the program philosophy change to incorporate children who are not considered obese, it would be important to evaluate how this change affects the dynamic produced when the children share experiences in relation to the body and social marginalization. As this appeared to be one of the most effective component of the program, it will be important to study how this dynamic changes as the program opens up to children of all sizes not just children with a BMI over the 95^{th} percentile. Will the children continue to feel safe to critique the dominant messages, will they continue to challenge specific subject positions in taking on roles that they had previously avoided, and will this setting continue to support the development and utilization of agency in marginalized children? Considering that research has found that larger children who have experienced stigmatization demonstrate improved outcomes when provided with social support and a non-judgemental environment (Haines & Neumark-Sztainer, 2009), I highlight the recommendations of Zeller, Reiter-Pertill, and Ramey (2008) here who state, "peer-based educational interventions are needed to increase acceptance of obese children and to reduce the negative attitudes and behaviors directed at them" (p.8). The coordinators should explore whether the integration of children of all sizes into the program will foster positive learning experiences that address issues of marginalization and enhance the acceptance of larger children. Finally, should this approach be developed and utilized with success, the coordinators should consider how it could be modified and integrated into the school setting to impact the broader community.

Also, given the challenges that the program coordinators have highlighted in terms of high staff turnover and working with messages that are often inconsistent with the dominant paradigm, it is important that program coordinators be provided input into the screening and selection of staff chosen to work within the program. As highlighted throughout the literature, many healthcare providers are not sensitive to the issues faced by those considered obese and are resistant to a 'health in many sizes' approach (Puhl & Brownell, 2003; Puhl & Latner, 2007). To ensure they 'do no harm' those working within such a setting must value the experiences of these children and recognize their potential for healthy identities outside of the culturally established binaries of 'thin' and 'fat'. Given that most health care providers have not been educated in a more critical paradigm, it is important that program coordinators be provided time and resources to educate and orientate facilitators in their alternative approach. This should include an introduction to and exploration of the critical literature in the areas of health promotion and body image. This orientation could be enhanced by working collaboratively with a person educated in the critical perspective. Also, drawing on recommendations outlined by Evans et al. (2008), both coordinators and staff could benefit from exercises that enhance awareness of body related issues, opportunities to examine their own body related experiences and how this impacts their behaviours and relations with the children, and opportunities to work collaboratively to integrate their knowledge and ideas into program related activities to benefit the children.

Also, while parents were not the intended focus of my research study, the narratives of the mothers illustrate the struggles these mothers experience and the guilt they feel in striving to support their in achieving healthy identities. Further research with parents, in particular mothers, is essential as feeding and nurturing of children has emerged as a gendered issue (Jackson & Mannix, 2004; Warin et al., 2008). Consideration in this research must be given to how mothers construct their own meanings of health and the body and how these meanings intersect with the various biopedagogies that produced their children as at-risk and unhealthy.

Finally, the positive critical aspects of this program should be disseminated through professional conferences, peer reviewed journals, health care forums, and professional association avenues. The quantitative data that is collected from all participants and parents upon admission into and completion of the program by the coordinators could be utilized in conjunction with qualitative methods to further explore the experiences of the children involved within this program. The examination of this data could serve to inform the researcher in areas not explored in the qualitative research and open up areas of exploration that have not been previously considered.

Contributions of This Research

This research fills a major gap in the literature in the exploration of children's embodied experiences within the current obesity panic that serves to marginalize children who do not fit the prescribed or desired norm. While there is an abundance of research studies that consider the physical or even psychosocial ramifications of obesity, this is the first study that considers the role of discourse and the production of health 'knowledge' in shaping the embodied experiences of children defined as 'obese'. It is also the first study of its kind to be conducted within an obesity treatment program. In this research I was not concerned with the exploration of barriers to weight loss (as noted in other studies) and I moved beyond the examination of psychosocial effects of obesity to consider how large children are positioned by and work with the broader discourses available to them. By acknowledging and working with the assumption that there is no defined truth to be revealed but rather exploring how discourse constitutes the social world for these children, this research contributes to a growing body of critical poststructural feminist research. It challenges current notions of health by drawing attention to the role discourse plays in how we shape our ideas about health, the body and our own identities. Through the use of multiple methods and the employment of an ethnographic approach I had the opportunity to share in the children's co-construction of meaning in exploring issues of health, the body, and subjectivity. The use of an ethnographic approach allowed me to consider discourses as they were enacted in the setting of the obesity treatment program. Through the use of interviews, focus groups and observations, and participation in regular program activities, I was able to question many of the notions that the children took to be normal as these notions were created in and through the discourses that produce their reality on a daily basis. The use of multiple methods within this research project highlights the strength of exploring people's experiences from various perspectives. As suggested by Hemming (2008), researching the experiences of children through a variety of methods including ethnography, interviews, and participant observation allows the researcher to gain a greater sensitivity to and understanding of children's lived experiences. Simultaneously the use of multiple methods or as Padgett (2008) refers to it, a 'family' of methods, also helps us to expose the often taken for granted roles of adults and children and consider the fluidity of identities within various settings. Finally, in examining the processes through which the 'healthy' subject is produced and reinforced and having done so within a program that works within the biomedical framework (while navigating a fine line, pushing boundaries and opening spaces for non-normative children to explore alternative ways of occupying their subject position), I have been able to disrupt and make visible some of the power relations that make them possible.

The work, therefore, may provide an impetus for change in the way we 'do' health promotion as it builds upon a growing body of research that illustrates the negative discursive effects of the broadly endorsed obesity discourse and the biopedagogies that utilize and simultaneously reinforce such discourse. This dissertation has also built upon previous studies that suggest that the present biopedagogies provide little room for the formation of positive identities and demonstrates how they function to restrict the enjoyment of activity in the non-normative body. It could be utilized in the fields of health and education, therefore, as a framework for examining how children draw upon specific discourses and how critical perspectives can be effectively integrated into program planning initiatives.

This dissertation also contributes to a growing body of literature in the examination of risk construction, healthism, and the neoliberal agenda. It highlights the construction of the at-risk child as a relevant and timely argument that must be addressed through further research with consideration to people's everyday lives. The data generated in this dissertation point to the negative implications of the ever-expanding risk categories. They reinforce the argument that the development of risk categories and notions of self-responsibility and the neoliberal citizen may in fact be counterproductive in promoting and fostering 'healthy' subjectivities. In an effort to control and prevent disease they simultaneously decrease room for discursively positive subject positions and enhance risk anxiety (Crawford, 2004). This research calls for us to move beyond the categorization of children in terms of obesity and risk. While using the children's narratives along with narratives from the mothers and the program coordinators, I have in this dissertation provided rationale for changing the emphasis on the thin body to promoting health in many sizes. It calls for a critical awareness of the implications of the use of risk as a health indicator and the implications of risk categorization in creating hostile social environments for those who do not fit the prescribed norm.

Hence, this research also emphasizes the importance of creating supportive social environments and, as Evans (2004) argues, moving beyond dualistic thinking in relation to children and health. This element of social safety should be further explored and could become a key consideration in the development of programs within the school system and in broader community programs. This study highlights the potential in creating safe body spaces that 'do no harm', that provide the discursive resources that allow children who do not fit the prescribed norm to seek and situate themselves in subject positions that can be considered 'healthy'. Further research is necessary to explore the degree to which such safe havens benefit the children involved and to consider the extent to which, what Lyons et al (1998) refer to as 'communal coping', may in fact reinforce the notion of being different and hence limit the child's perceived ability to 'fit in' within the broader social context.

Finally, in considering how this dissertation contributes to the field of health research, I must acknowledge that conducting a feminist poststructural study within the realm of an obesity treatment program was a worthwhile endeavour. Through this study I have exposed the challenges faced by those working within the biomedical paradigm that provides little room for the alternative discourses. While the study exposes the difficulties and frustrations of working from competing frameworks and epistemological standpoints, it also provides an example of how such work can be done. It opens up the discussion of working interprofessionally to utilize feminist research within a formally positivist environment. It points to the potential that exists when people from differing paradigms are open to new and different research that can help them explore the meanings of their clients/ patients/students' experiences. While I am not so naïve as to assume that feminist epistemologies and methodologies will be fully embraced, we must work with those who display an openness to such perspectives, as this has the potential to positively impact on practice and ultimately serve to enhance the lives of the people we choose to research.

Research in the field of obesity treatment has been primarily limited to quantitative research focused upon criteria to measure success; most often the main criterion being weight loss. This dissertation has illustrated the need for qualitative research in exploring the embodied experiences of participants. The utilization of a feminist poststructural framework goes further, moving beyond attention to the subject's social world to consider how that world is constituted through broader discourses. Such a framework can provide great insight into the way we 'treat' people. It functions to break down the notion of the clinician as the expert by allowing for recognition and examination of the clinical gaze and could be used further to provide practitioners the tools to examine their own constructions of health and wellbeing. While this research was conducted in one small treatment program it can inform those who are involved in future practice in supporting those referred for obesity treatment, in problematizing the mere notions of obesity and obesity treatment and ultimately in changing what constitutes 'success'.

Final Remarks

The writing of this dissertation has been a journey of exploration not only into the ways in which we as a society utilize discursive practices to take up subjective positions and frame our daily experiences, but also into implications of these practices in terms of the embodied experiences of those navigating such discourses. It has also provided me with a deeper understanding of how I as an individual contribute to a larger production of meaning through both my personal and professional interactions. This research has functioned for me as a means of self reflection while also providing the tools to make sense of how biopedagogies are produced and disseminated and the overarching consequences of the way we use language to guide our health teaching, research, and clinical practices. As this journey draws to a close I am more convinced that we have the capacity to produce change, to destabilize dominant discourses, and contribute to opportunities for opening up new subject positions that move health beyond a strict corporeal goal. The following quote from my interview with program coordinator #1 in my research setting reflects this point:

Yeah, I don't expect everything to change because of what we do, but it's that ripple effect, one small drop can produce a huge change... if other health professionals change how they think imagine what we can do.

It is my hope that this dissertation will serve as a valuable contribution not only to the field of critical obesity research but also to the fields of health education and practice. While the contemporary health ideals could leave one with a sense of discouragement, I look forward in optimism. I remind myself that as Foucault suggests, discourse is contestable. The mere nature of discourse means that hegemonic forces can be contested, they can be overturned and new more enriching ways of being and knowing can be realized. By examining such issues through a feminist lens I realize that I am in a position to contribute to an ongoing discussion that helps to break down hegemonic discourses, to dissect them and in doing so open up opportunities to insert discourses that provide room for positive embodied experiences.

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Appendix A

Consent Form- Parent/Child

Memorial University of Newfoundland, St. John's, NL
Consent to Take Part in Research
(Parents/Children)

TITLE: Exploring the Impact of Health Messages on Children Enrolled in a Lifestyle Program

INVESTIGATOR(S): Pamela Ward BN RN MEd

You have been invited to take part in a research study. It is up to you to decide whether to be in the study or not. Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This consent form explains the study.

The researcher will:

- **discuss the study with you**
- **answer your questions**
- **keep confidential any information which could identify you personally**
- **be available during the study to deal with problems and answer questions**

If you decide not to take part or to leave the study this will not affect your participation in the [redacted] Program

1. Introduction/Background:

Children are greatly impacted by the messages they receive regarding health, fitness, and their bodies or the way they should look. There are many powerful messages that tell us how we should look and act in order to fit into society. These messages can place great pressure on children and affect how they feel about themselves. Many of these issues are addressed within the [redacted] Program at the [redacted] Hospital. This program is designed to promote positive self-esteem and body image in the children involved with a focus on the child not on weight. A team of health care workers including doctors, psychologists, dietitians, occupational therapists and other health professionals work together to provide care for your child. It has been suggested that this model of care that focuses on the promotion of healthy behaviours, movement, the promotion of self-esteem and positive social relationships while limiting the focus on weight, can have a positive impact on the children involved.

2. **Purpose of study:**
   The purpose of this study is to learn more about the experiences of children who have been referred to a program as a result of weight and health concerns. The study will examine how these children take in the messages about health and body size and how they react to new messages introduced within the [redacted] Program.

3. **Description of the study procedures and tests:**
   This study is made up of a number of different elements. You and your child will be asked to participate. Your child may be asked to participate in two face to face interviews (one before or within the first 2 weeks of the program and one after the program is completed) which will take place at a time and location that is best for you and your child. Children will be asked about their ideas of health, fitness, and their feelings around their bodies. This interview will take approximately 45 minutes and will be audio-taped.

   The children will also be asked to participate in two focus groups (one within the first 2 weeks of the program and one at the end of the program). The focus groups will be held in a room at the [redacted] Hospital. Children again will be asked to discuss their ideas of health, fitness, and what makes them feel good about themselves. In the second focus group children will have the opportunity to create a piece of art that reflects the way they think about being healthy and feeling good about oneself. They may choose not to participate in this project. They will be asked not to place their names on their artwork as the art pieces will be photographed for later analysis. Your child will **not** be photographed. In the focus group, they may be asked again about things we discussed in the first focus group. They will be asked about their experiences in the [redacted] Program and if or how it has changed the way they think about themselves and others. These sessions will take approximately 60-90 minutes and will be audio-taped. They will be scheduled at a time that is as convenient as possible for most participants and the researcher.

Parents will also be requested to participate in one focus group session to discuss their ideas of health, the [redacted] Program and any concerns they may have for their children related to the program. This focus group will take place within the last 2 weeks of the program and will be held in a room at the [redacted] Hospital. This session will take approximately 60-90 minutes and will be audio-taped. Again, a time that is convenient for most will be arranged.

If you choose not to have your child participate or you choose not to participate yourself in this study this will in no way impact upon your child's participation in the [redacted] Program. While the principal investigator will be present at program activities for the purposes of observation, if you or your child chooses not to participate, no specific observation notes will be made on your child.

4. Length of time:

Interviews will take approximately 45 minutes. Focus groups will take 60-90 minutes.

5. Possible risks and discomforts:

You and/or your child may feel uncomfortable talking about your experiences. At any time you may decide to stop the interview and leave the study. You may also exclude yourself from a focus group at any point. [redacted], clinical psychologist, ([redacted] Hospital) will be available for immediate referral should this happen.

6. Benefits:

It is not known whether this study will benefit you.

7. Liability statement:

Signing this form gives us your consent to be in this study. It tells us that you understand the information about the research study. When you sign this form, you do not give up your legal rights. Researchers or agencies involved in this research study still have their legal and professional responsibilities.

8. What about my privacy and confidentiality?

Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made. However it cannot be guaranteed. For example we may be required by law to allow access to research records.

When you sign this consent form you give us permission to

- Collect information from you
- Share information with the people conducting the study
- Share information with the people responsible for protecting your safety

Access to records
The principal investigator will see study records that identify you by name.
Other people may need to look at the study records that identify you by name. This might include the research ethics board. You may ask to see the list of these people. They can look at your records only when the principal investigator is present.

Use of records
The researcher will collect and use only the information needed for this research study.
This information will include your
- date of birth
- sex
- information from study interviews and focus groups

Your name and contact information will be kept secure by the researcher in Newfoundland and Labrador. It will not be shared with others without your permission. Your name will not appear in any report or article published as a result of this study.

Information collected for this study will kept in a locked cabinet on the premises of the Centre for Nursing Studies for 5 years.

Information collected and used by the researcher will be stored by Pamela Ward in a locked cabinet in her office at the Centre for Nursing Studies.

Your access to records
You may ask the researcher to see the information that has been collected about you.

9. Questions:

If you have any questions about taking part in this study, you can meet with the investigator who is in charge of the study at this institution. That person is: Pamela Ward.

Principal Investigator's Name and Phone Number

Pamela Ward

777-8141 or

pward@cns.nf.ca

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through: Office of the Human Investigation Committee (HIC) at 709-777-6974 or Email: hic@mun.ca

After signing this consent you will be given a copy.

Signature Page (Parent/Child)

Study title: Exploring the Impact of Health Messages on Children Enrolled in a Lifestyle Program

Name of principal investigator: Pamela Ward

To be filled out and signed by the participant:

Please check as appropriate:

I have read the consent. Yes { } No { }

I have had the opportunity to ask questions/to discuss this study. Yes { } No { }

I have received satisfactory answers to all of my questions. Yes { } No { }

I have received enough information about the study. Yes { } No { }

I have spoken to Pamela Ward and she has answered my questions Yes { } No { }

I understand that I and my child/ward are free to withdraw

from the study Yes { } No { }

- at any time
- without having to give a reason
- without affecting my or my child/ward's future participation in the [redacted] Program

I understand that it is my choice to be in the study and that I may not benefit.

Yes { } No { }

I understand that it is my choice for my child/ward to be in the study and

he/she may not benefit. Yes { } No { }

I agree to be audio taped	Yes { }	No { }
I agree for my child/ward to be audio taped	Yes { }	No { }
I agree to take part in this study.	Yes { }	No { }
I agree for my child/ward to take part in this study	Yes { }	No { }

____________________________ ________________________

Signature of participant Date

___________________________________ ________________________

Signature of witness (if applicable) Date

<u>To be signed by the investigator or person obtaining consent</u>

I have explained this study to the best of my ability. I invited questions and gave answers. I believe that the participant fully understands what is involved in being in the study, any potential risks of the study and that he or she has freely chosen to be in the study.

____ ________________________

Signature of investigator/person obtaining consent Date

Telephone number: ________________________

<u>Assent of minor participant:</u>

____________________________ _________________________

Signature of minor participant *Date*

__________________________ _________________________

Relationship to participant named above *Age*

Appendix B

Consent Form- Program Coordinators/Facilitators

Memorial University of Newfoundland, St. John's, NL
Consent to Take Part in Research
(Program Facilitators)

TITLE: Exploring the Role of Discourse in the Emerging Identities of Children Enrolled in an Obesity Treatment Program

INVESTIGATOR(S): Pamela Ward BN RN MEd

You have been invited to take part in a research study. It is up to you to decide whether to be in the study or not. Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This consent form explains the study.

The researcher will:

- **discuss the study with you**
- **answer your questions**
- **keep confidential any information which could identify you personally**
- **be available during the study to deal with problems and answer questions**

If you decide not to take part or to leave the study this will not affect your work in the [redacted] Program

2. Introduction/Background:

Children are greatly impacted by the messages they receive regarding health, fitness, and their bodies or the way they should look. There are many dominant messages that dictate how we should look and act in order to fit into society that can place great pressure on children and how they view themselves. Many of these issues are addressed within the [redacted] Program at the [redacted] Hospital. This is a proactive program which has been designed using a multidisciplinary approach which promotes positive self esteem and body image and reinforces the acceptance of natural sizes. It has been suggested that this innovative model of care that focuses on the promotion of healthy behaviours, movement, the promotion of self-esteem and positive social relationships while limiting the focus on weight, can produce positive outcomes.

2. **Purpose of study:**
   The purpose of this study is to learn more about the experiences of children who have been referred to a program as a result of weight and health concerns. The study will examine how these children take in the messages about health and body size and how they react to new messages introduced within the [redacted] Program.

3. **Description of the study procedures and tests:**
   This study is made up of a number of different elements. The parents, the children, and the group facilitators will be asked to participate. The children may be asked to participate in a semi-structured face to face interview which will take place at a time and location that is best for the parent and child. Children will be asked about their ideas of health, fitness, and their feelings around their bodies. This interview will take approximately 45 minutes and will be audio-taped.

   The children will also be asked to participate in two focus groups. Children again will be asked to discuss their ideas of health, fitness, and what makes them feel good about themselves. In the second focus group children will have the opportunity to create a piece of art that reflects the way they think about being healthy and feeling good about oneself. They may choose not to participate in this project. They will be asked not to place their names on their artwork as the art pieces will be photographed for later analysis. The children will **not** be photographed. In the focus group, they may be asked again about things we discussed in the first focus group. They will be asked about their experiences in the [redacted] Program and if or how it has changed the way they think about themselves and others. These sessions will take approximately 60-90 minutes and will be audio-taped. They will be scheduled at a time that is as convenient as possible for most participants and the researcher.

Parents will also be requested to participate in one focus group session to discuss their ideas of health, the [redacted] Program and any concerns they may have for their children related to the program. This session will take approximately 60-90 minutes and will be audio-taped. Again, a time that is convenient for most will be arranged.

Finally, facilitators of the program will be asked to participate in a face to face interview to discuss the goals of the [redacted] Program and your ideas regarding the children`s participation.

If you choose not to participate in this study this will in no way impact upon your work in the [redacted] Program.

4. **Length of time:**
   Interviews will take approximately 45 minutes.

5. **Possible risks and discomforts:**

   You may feel uncomfortable talking about your experiences. At any time you may decide to stop the interview and leave the study. [redacted], clinical psychologist, ([redacted] Hospital) will be available for immediate referral should this happen.

6. **Benefits:**

   It is not known whether this study will benefit you.

7. **Liability statement:**

   Signing this form gives us your consent to be in this study. It tells us that you understand the information about the research study. When you sign this form, you do not give up your legal rights. Researchers or agencies involved in this research study still have their legal and professional responsibilities.

8. **What about my privacy and confidentiality?**

   Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made. However it cannot be guaranteed. For example we may be required by law to allow access to research records.

When you sign this consent form you give us permission to

- Collect information from you
- Share information with the people conducting the study
- Share information with the people responsible for protecting your safety

Access to records
The principal investigator will see study records that identify you by name.
Other people may need to look at the study records that identify you by name. This might include the research ethics board. You may ask to see the list of these people. They can look at your records only when the principal investigator is present.

Use of records
The researcher will collect and use only the information needed for this research study.
This information will include your

- sex
- information from study interviews

Your name and contact information will be kept secure by the researcher in Newfoundland and Labrador. It will not be shared with others without your permission. Your name will not appear in any report or article published as a result of this study.

Information collected for this study will kept in a locked cabinet on the premises of the Centre for Nursing Studies for 5 years.

Information collected and used by the researcher will be stored by Pamela Ward in a locked cabinet in her office at the Centre for Nursing Studies.

Your access to records
You may ask the researcher to see the information that has been collected about you.

9. Questions:

If you have any questions about taking part in this study, you can meet with the investigator who is in charge of the study at this institution. That person is: Pamela Ward.

<u>Principal Investigator's Name and Phone Number</u>

Pamela Ward

777-8141 or

pward@cns.nf.ca

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through: Office of the Human Investigation Committee (HIC) at 709-777-6974 or Email: hic@mun.ca

After signing this consent you will be given a copy.

Signature Page (Program Coordinators/Facilitators)

Study title: Exploring the Role of Discourse in the Emerging Identities of Children Enrolled in an Obesity Treatment Program

Name of principal investigator: Pamela Ward

To be filled out and signed by the participant:

Please check as appropriate:

I have read the consent.	Yes { }	No { }
I have had the opportunity to ask questions/to discuss this study.	Yes { }	No { }
I have received satisfactory answers to all of my questions.	Yes { }	No { }
I have received enough information about the study.	Yes { }	No { }
I have spoken to Pamela Ward and she has answered my questions	Yes { }	No { }
I understand that I am free to withdraw from the study	Yes { }	No { }

- at any time
- without having to give a reason
- without affecting my future work in the [redacted] Program

I understand that it is my choice to be in the study and that I may not benefit.	Yes { }	No { }
I agree to be audio taped	Yes { }	No { }
I agree to take part in this study.	Yes { }	No { }

_______________________________ _____________________

Signature of participant Date

_______________________________ _____________________

Signature of witness (if applicable) Date

<u>To be signed by the investigator or person obtaining consent</u>

I have explained this study to the best of my ability. I invited questions and gave answers. I believe that the participant fully understands what is involved in being in the study, any potential risks of the study and that he or she has freely chosen to be in the study.

_______________________________ _____________________

Signature of investigator/person obtaining consent Date

Telephone number: _____________________

Appendix C

Interview Guide (Interview #1)- Children

1. Can you tell me about the things you enjoy doing that make you feel good about yourself?
2. Can you describe for me what you like to do for fun?
3. Are there activities that you prefer not to be involved in? Why?
4. Are there times when you don't feel good about yourself/body? Why? How?
5. Describe for me what you think "healthy" means?
6. Can you describe for me what you think a healthy body looks like?
7. What are the things we need to do to feel or be healthy?
8. Where did you learn about the things you need to do to be healthy?-

    - School, Home, T.V, Internet, Other?
9. Can you tell me a little bit about school?

    -Do you enjoy it?

    -What are your favourite subjects? What do you enjoy most?

    -Do you have special friends who you hang out with in school? What do you like to do together? Are these your after school friends?

    -Are there things about school that you don't like? Can you tell me about them? Why do you not like them?
10. What do you hope to learn from the [redacted] Program? How do you think this program can help you?

Appendix D

Interview Guide (Interview #2)- Children

1. Can you tell me about the things you enjoy doing that make you feel good about yourself?
2. Have you found any new activities that you enjoy since we talked last? What are they? Why are they enjoyable?
3. Are there activities that you prefer not to be involved in? Why?
4. Are there times when you don't feel good about yourself/body? Why? How?
5. When do you feel good about yourself /body? Please explain.
6. Describe for me what you think "healthy" means?
7. Can you describe for me what you think a healthy body looks like?
8. What are the things we need to do to feel or be healthy?
9. What have you learned from the [redacted] Program? Do you think this program has helped you? If so how?
10. Has this program changed the way you feel about health, yourself, and your friends? If so how?
11. Would you recommend this program to other people? Why?

Appendix E

Focus Group Interview Guide (Focus Group #1)- Children

I will begin the first group discussion with an icebreaker activity as outline by Gibson (2007). During this time I will engage the children in an activity which is designed to get them thinking and moving. I will begin the first focus group with a "desert island" scenario. The participants will be asked to list three things they would need to feel good and healthy if trapped on a desert island. They will be asked to write these down or draw them on a whiteboard and come to some agreement about what they should take as a group.

Other guiding questions:

1. How would you describe a healthy person? What does a healthy person looks like?
2. What are the things we need to do to be healthy?
3. What do you like to do to have fun? Do you think these activities are healthy? Why or why not?
4. What activities do you prefer not to do? Why?
5. Are there activities you would like to try but have not? If so why not?
6. Where did you learn about the things you need to do to be healthy?
   - School, Home, T.V, Internet, Other?
7. Can you tell me a little bit about school-
   - Do you enjoy it?
   -What do you enjoy most? Why?
   -What do you enjoy least? Why?
8. What do you hope to learn from the [redacted] Program? How do you think this program can help you?

Appendix F

Focus Group Interview Guide (Focus Group #2)- Children

This focus group will begin with an art project. Participants will be given the option of opting out of the project if they prefer not to take part. The children will be provided with a choice of doing a drawing or collage. They may integrate words into the piece. They will then have the opportunity to display and discuss these projects within the group. They will be asked to create a piece that reflects the way they feel about themselves, their surroundings, the messages they receive about health, and what they have learned in the [redacted] Program.

Questions will be derived from the art pieces and the previous focus group?

1. What makes a person healthy? List some words that come to mind when you think of a healthy person.
2. What are the things we need to do to be healthy?
3. What are the things we need to feel good about ourselves?
4. Have you participated in any activities lately that you would describe as healthy? Can you describe them and tell me why they are good for your health?
5. What activities do you prefer not to do? Why?
6. Have you found any new activities that you like to do? What are they?

Artwork

7. Please explain what your artwork says about being healthy?
8. What other things does your artwork tell us? Please explain it to the group.
9. Has this been a fun activity? Why?

Program

10. How do you feel about being involved in the [redacted] program this fall? (e.g. has it made you happy, relaxed? Have you made friends? Has it made you feel good about yourself?
11. What have you learned?
12. Has this program changed the way you feel about health, yourself, and your friends? If so how?

Appendix G

Focus Group Interview Guide- Parents

1. What does the term "healthy" mean to you?
2. How do you think we can achieve health?
3. Can you describe your children for me?
4. What do you see as your children's strengths?
5. What types of activities do your children enjoy?
6. What types of activities do your children participate in?
7. Can you tell me about any concerns you have for your children?
8. Do you feel your children are healthy?
9. Can you tell me about your children's experiences in school? Are there concerns regarding school or friends?
10. Do you feel your children have concerns related to their bodies?
11. How do you know? E.g. –do your children talk about these concerns or have you observed this in your children?
12. If yes, can you tell me how you have addressed these concerns with/for your children?
13. What do you feel you and your children have achieved through the [redacted] Program?

Appendix H

Interview Guide- Program Coordinators/Facilitators

1. What are the goals of the [redacted] Program?
2. How does your approach compare to other obesity treatment programs?
3. What are the main issues that you address through this program?
4. How do you address these issues?
5. How do you feel children in the program conceptualize health and healthy bodies?
6. How do you feel they deal with dominant health messages regarding health, fitness and body size?
7. What do you hope that child participants will gain from this program?
8. Can you provide me with examples of how you feel this program has impacted on the way children view health and the body? (i.e. do you feel their ideas change?)
9. Can you explain your process for follow-up with these children?

EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

PRAMOD JOHAR

EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

by

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A thesis submitted to the

School of Graduate Studies

in partial fulfillment of the

requirements for the degree of

Master of Science in Kinesiology

School of Human Kinetics and Recreation

Memorial University of Newfoundland

27 May, 2012

St. John's Newfoundland

ABSTRACT

An inverted body posture is not common. During unusual situations (e.g. overturned helicopters or motor vehicle accidents) when the body is inverted, the neuromuscular responses can change. In order to manage these situations, it is necessary to examine changes in muscle force output and activation.

Although the exact mechanisms are unknown, it is believed that both central and peripheral factors can contribute to changes in muscle force output. Increase in cerebral blood pooling, increase in hydrostatic pressure, and decrease in sympathetic activity during rapid and slow transitions from upright to inverted seated position are considered to be the main central factors leading to decrease in inversion-induced muscle force output. Peripheral factors such as decreased blood flow to the contracting muscle resulting in decrease perfusion pressure and oxygen deficit within the muscle are most likely to summate along with central factors inducing neuromuscular impairments during rapid and slower inversion rotations.

There is no evidence examining possible impairments in neuromuscular functioning with more rapid versus slower inverted rotations as compared to an upright seated position. Maximal voluntary contraction (MVC) and electromyographic (EMG) activity were recorded and analyzed in biceps and quadriceps, concurrently and individually, for maximal force output and activation with upright seated position, and inverted within 1s and 3s rotations. It was anticipated that changes in muscle force and activation within 1s and 3s inversion rotations would suggest impairments in the functioning of neuromuscular system, as compared to the upright position. In addition,

ACKNOWLEDGEMENTS

On completing this thesis as I look back on the whole experience from its very inception, I feel humbled. All along I was assured of the presence of god to who goes all the glory and honor for the successful completion of this thesis.

I am very much grateful and indebted to my supervisor Dr. David Behm, who immensely helped and rendered his valuable advice, precious time, knowledge and relevant information regarding the collection of material and whose suggestions and guidance have enlightened me on this thesis. It has been a great experience working under his supervision.

My sincere thanks to Dr. Duane Button and Dr. Tim Alkanani for their kind professional help and cooperation.

I would be biased if I don't mention the name of Varun Grover and Mario DiSanto who really helped me while working on this thesis. It has been a great help and support to have them.

A special thanks to all the subjects whom I have worked with. I owe a special regard and gratitude to all of them. Lastly, thanks to all those whose names are not mentioned here, for their unrelenting encouragement.

PRAMOD JOHAR

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Main effects for Condition: MVC

2. Main effects for Condition: EMG

3. Main effects for Time: MVC

4. Heart Rate and Blood Pressure

5. Force Profiles

LIST OF ABBREVIATIONS

BP	Blood pressure
CVP	Central venous pressure
DBP	Diastolic blood pressure
EMG	Electromyography
HDT	Head-down tilt
HR	Heart rate
LBNP	Lower body negative pressure
MVC	Maximum voluntary contraction
SBP	Systolic blood pressure
SV	Stroke volume

LIST OF APPENDICES

Variability in Rotation Times

INTRODUCTION

The human body is adapted to work in an upright position. In situations when an individual is required to manage circumstances where the body is forced into inverted positions (e.g. completely overturned helicopter or motor vehicle accidents), physiological responses can change. It is important to know the neuromuscular and cardiovascular responses when a person is inverted from an upright position.

Only two studies have been published which examine the elbow flexion (Hearn et. al. 2009) and the knee extension (Paddock and Behm 2009) force and activation during inverted seated position. Both studies were performed to determine the changes in neuromuscular responses between upright and inverted seated positions. The results for both studies illustrated decreases in neuromuscular performance with an inverted seated posture. Also, both studies exhibited significant decreases in heart rate and blood pressure in the inverted position attributed to alterations of sympathetic nervous system stimulation. In addition, Neary et al. (2011*a*, 2011*b*) demonstrated a tendency for quadriceps maximal voluntary contraction (MVC) force to decrease in inverted position but no significant difference was found for biceps brachii MVC between upright and inverted positions. They also found a significant decrease in heart rate as well as cardiac output with inverted position as compared to upright position, which were in accordance with the results from Hearn et al. (2009) and Paddock and Behm (2009). Hence, it can be established that an inverted seated posture results in neuromuscular and cardiovascular system impairments.

There are a number of physiological mechanisms involved when the body responds to an inverted position. Hydrostatic pressure (pressure exerted by a fluid due to

the force of gravity) is considered as one of the major contributing factors related to the decline in the muscle force output during inversion. Mechanisms to reduce hydrostatic pressure in the lower body when upright, such as respiratory muscle pump (Miller et al. 2005), skeletal muscle pump (Delp and Laughlin 1998), and veno-vasoconstriction (Vissing et al. 1997) offset the effect of increased lower body hydrostatic pressure and ensure adequate venous return to the heart. Bosone et al. (2004) demonstrated ten minutes of 30^{o} head down tilt caused a significant increase in arterial pressure at the cranial level due to the development of the hydrostatic pressure gradient between the heart and brain levels. It is speculated that the inversion-induced increase in hydrostatic pressure could have a negative impact on the ability of the brain to function appropriately. This response could affect optimal performance during sport, and occupational tasks or emergency situations.

Furthermore, inhibition of sympathetic activity during head down body tilt (Bosone et al. 2004; Cooke and Dowlyn 2000; Cooke et al. 2004; Fu et al. 2000) is associated with decreased heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), and total peripheral resistance (Goodman and LeSage 2002). This inhibition of the sympathetic nervous system adversely affects the peripheral perfusion (Thomas and Segal 2004), resulting in decreased muscle force output. Head-down tilt postures also lead to decreased oxygen supply to the working muscle via compensatory increases in the inspiratory muscle contraction force (Aleksandrova et al. 2005), decreased lung compliance (Donina et al. 2009), impaired gaseous exchange (Prisk et al. 2002), and increased airflow impedance of the respiratory system (Donina et al. 2009), which further adds to the factors causing reduced muscle force output with inverted

position. However, all inversion studies to date have involved slow and deliberate transitions from upright to inverted positions. In most situations such as overturned vehicle accidents and ditched helicopters, these events will occur rapidly. Due to the rapid transition of the body from an upright to inverted position, there is the possibility that force output will be augmented abruptly due to the activation of the sympathetic nervous system (fight or flight phenomenon). However, it is unknown whether the typical inversion-induced decrements are more predominant than possible sympathetic system excitation.

Consequently, it is important to observe the changes in force output, muscle activation and cardiac functioning when inverted at different rotational times compared to an upright seated position. The following sections will provide a critical and in-depth evaluation of the physiological responses and underlying mechanisms related to inverted body posture.

1. EFFECTS OF INVERSION ON NEUROMUSCULAR PROPERTIES

An inverted seated position is not a common body posture. Neuromuscular responses change with an inverted position as compared to an upright position. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated decreases in force production and muscle activation. Hearn et al. (2009) found significant decreases in elbow flexor MVC force, voluntary rate of force development, and biceps electromyographic (EMG) activity with complete inversion. A similar study by Paddock and Behm (2009) focusing on lower limb quadriceps muscle activation, showed a significant reduction in maximal voluntary contraction force, rate of force development, and EMG activity with seated inversion. In

addition, Neary et al. (2011*a*, 2011*b*) also found a tendency for quadriceps MVC to decrease in inverted position but no significant difference was found for biceps MVC between upright and inverted positions. Hence, it can be inferred that the inverted position generally has a negative impact on an individual's neuromuscular functioning.

2. PERFUSION PRESSURE

Inversion-induced muscle performance impediments may be attributed to a number of mechanisms. Peripheral perfusion pressure; a graded difference between arterial blood pressure and venous pressure (Ganong 2003), is an important factor affecting muscle force output. During activity, regulation of blood pressure plays a vital role in optimizing perfusion to the working muscles and supplying essential nutrients and oxygen needed for proper functioning. Hobbs and McCloskey (1987) found a decrease in blood flow and force production near maximal workloads when an isolated cat soleus muscle was treated with a reduced mean blood pressure. This suggests that the amount of workload is associated with the alterations in the perfusion pressure and force production. Perfusion pressure in the muscle can increase or decrease depending upon the distance the muscle is from the heart. Raising the arm above the heart level leads to a decrease in the perfusion pressure in hand, resulting in lower force production (Fitzpatrick et al. 1996). Sundberg and Kaijser (1992) found the same effect in lower limbs. They found a decrease in muscle perfusion followed by a decrease in muscle force when a positive pressure of 50 mmHg was applied.

All the above-mentioned studies support the changes in neuromuscular responses demonstrated by Hearn et al. (2009) and Paddock and Behm (2009). These studies

exhibited decreased elbow flexion (Hearn et al. 2009) and knee extension (Paddock and Behm 2009) muscle force when upright seated position was compared with inverted seated posture. Both the studies attributed inversion-induced reduction in peripheral perfusion in contracting muscles as a major contributing peripheral factor.

3. HYDROSTATIC PRESSURE

Hydrostatic pressure is defined as a pressure change caused by fluid changes in the capillary network (Guyton and Hall 2006). A number of studies on animals and humans have demonstrated a significant effect on working capacity of the muscles due to alteration in hydrostatic pressure with or without changes in body position. The majority of the studies related to hydrostatic pressure are conducted on animals. Both rabbit psoas (Fortune et al. 1994) and rat extensor digitorum longus (Ranatunga and Geeves 1991) muscles have responded with decreased tetanic force when subjected to high hydrostatic pressure. Ranatunga and Geeves (1991) also found that the peak tension, the time to peak and the time to half-relaxation of a twitch contraction increased when the muscle fiber bundles isolated from the rat extensor digitorum longus of the rat were exposed to increasing hydrostatic pressures. However, when a maximally calcium activated rabbit psoas muscle fiber was subjected to high hydrostatic pressure, a 15% decrease in isometric active tension was reported (Geeves and Ranatunga 1987). It was hypothesized that a lower number of active-cross bridges or decrease in the force per cross-bridge was responsible for this impairment due to an increased pressure. Alternatively, twitch tension was potentiated with an increase in hydrostatic pressure in response to enhanced release of calcium (Vawda et al. 1996). High hydrostatic pressure causes pulsing acetylcholine

receptor release, decreasing muscle firing frequency (Heinman et al. 1987), and enzymatic activity of lactate dehydrogenase (Schmid et al. 1979). Therefore, based on animal research, the increased hydrostatic pressure can have adverse effects on neuromuscular performance.

In humans, a number of mechanisms work *in vivo* in upright position to compensate for the effect of increased hydrostatic pressure and consequent blood pooling in the lower limbs. These mechanisms, such as respiratory muscle pump (Miller et al. 2005), skeletal muscle pump (Delp & Laughlin 1998), and veno-vasoconstriction (Vissing et al.1997) ensure adequate venous return to the heart. In addition, vasoconstriction triggered by venous distension and a local neural veni-arteriolar response is important for counteracting increases in capillary hydrostatic pressure during upright posture or limb dependency (Henriksen 1991). Bosone et al. (2004) found that 10 min of 30° head down tilt caused significant increase in arterial pressure at the cranial level, due to the development of the hydrostatic pressure gradient between the heart and brain. Furthermore, minimal changes in hydrostatic pressure and perfusion pressure are observed in a supine position (Laughlin and Scharge 1999).

In conclusion, previous published studies related to complete seated inversion (Hearn et al. 2009; Paddock and Behm 2009) illustrated decreases in muscle activation and force production with an inverted body position. Neither of these studies investigated hydrostatic pressure directly, but suggested it may be an important central factor leading to impairments in neuromuscular system responses.

4. LOWER BODY NEGATIVE PRESSURE AND BARORECEPTOR REFLEXS

A lower body negative pressure (LBNP) is the application of an external negative pressure below the waist under well-controlled conditions. LBNP is most often used as a perturbation to the cardiovascular system and has been applied to simulate gravitational stress (Levine et al. 1991; Savard and Stonehouse 1995; Zhang et al. 1999). During upright body posture, vasomotor sympathetic activity plays an essential role in maintaining arterial pressure via the baroreceptor reflex mechanism (Fu et al. 2006). Baroreceptors are the stretch receptors that are located in the aortic arch and the carotid sinuses (Fox 2006). These receptors play a vital role in maintaining the blood pressure within limits. With the change in position from lying to standing there is a shift of blood from the veins in the thoracic cavity to the veins in the lower extremities. This results in lower blood pressure due to decreases in venous return and cardiac output, which is counteracted via activation of the baroreceptor reflex (Fox 2006). Thus, it helps in maintaining homeostasis by playing an important role during changes in body posture.

Hughson et al. (1993) investigated the effect of cycling exercise in upright and supine positions, and compared it with -40 mmHg lower body negative pressure in supine position. The baroreceptor reflex was activated during supine exercise, as LBNP caused more pooling of blood in lower extremities as compared to upright position. Cooper and Hainsworth (2001) determined that -40 mmHg LBNP has no effect on cardiac responses. However, they illustrated a significant increase in vascular resistance response during LBNP along with the increase in the peak gain of the baroreceptor reflex. They also suggested that an increase in baroreflex gain may help in maintenance of blood pressure during orthostatic stress.

Baroreceptor reflex also helps to maintain adequate cerebral perfusion (Ponte and Purves 1974). The sensitivity of the baroreflex control of sympathetic nerve activity decreases from upright to tilted position due to an increase in central venous pressure (CVP) (Charkoudian et al. 2004). Hearn et al. (2009) and Paddock and Behm (2009) have illustrated significant decreases in blood pressure, both systolic and diastolic with complete seated inversion. A subsequent study from the same laboratory reported similar inversion-induced decreases in mean arterial pressure and cardiac output (Neary et al. 2011*a*, 2011*b*). Thus, it can be hypothesized that with the increase in hydrostatic pressure during inversion, CVP may also increase, resulting in reduced sensitivity of the baroreceptor reflex with inverted body posture. However, no research has been conducted to determine the role of baroreceptors during complete seated inversion; therefore, the adjustments made by baroreceptors have not been fully clarified.

5. VESTIBULAR SYSTEM

The vestibular system assists with the control of balance and equilibrium. It accomplishes this function by assessing head and body movement and position in space, generating a neural code representing this information, and distributing this code to appropriate sites located throughout the central nervous system. Vestibular function is largely reflex and unconscious in nature (Ganong 2003). The otolith organs and semi-circular canals are the two main components of the vestibular system associated with postural adjustments. The semicircular canals respond to rotational movements of the head, whereas otolith organs sense linear motion (Ganong 2003).

Gravity also plays an important role with the vestibulosympathetic reflex. Tanaka et al. (2006) found that vestibular deficient rats are less able to regulate blood pressure as compared to gravitational stressed rats with the inner ear intact. Therefore, it can be proposed that the vestibulosympathetic reflex is vital to maintain homeostasis during gravity related changes with inversion. However, further research is necessary to determine the possible mechanisms and/or adjustments, and the role played by the vestibular system during complete inversion.

Ray (2000) found that the vestibulosympathetic reflex, via an increase in sympathetic outflow, plays an important role in maintaining orthostasis in humans. During upright standing, vestibulosympathetic reflex assists in regulating blood pressure changes in humans (Ray and Carter 2003). Kerman et al. (2000) also suggested that the vestibular system plays a role during postural adjustments by regulating autonomic outflow. They illustrated, that based upon the anatomical location and innervation target of a particular sympathetic nerve; the vestibular sympathetic reflexes may result in local blood flow changes. Though none of these studies were directly related to rapid and slow seated inversion of the human body, they would insinuate that changes occur in neuromuscular performance during downward rotation.

6. SYMPATHETIC NERVOUS SYSTEM

In order to maintain arterial blood pressure, sympathetic nerve activity decreases blood flow to the active muscles via vasoconstriction (Fox 2006). However, it has been noted that even though the sympathetic neural discharge increases with the increase in intensity of the activity, the muscle blood flow also increases, indicating a reduced

responsiveness to sympathetic activation (Thomas and Segal 2004). Wallin and Sundlof (1982) reported vasoconstriction in skeletal muscles during a standing upright posture. During standing, an increase in the sympathetic activity to the vessels is accompanied by an over-activity of the sympathetic system leading to an exaggerated increase in the heart rate (Furlan 2001). As the response of muscle nerve sympathetic activity is not directly studied in inversion, it is reasonable to expect the opposite (decreased heart rate) with an inverted body position.

The sympathetic nervous system also influences muscle force contractility, alertness through stimulation of the reticular activating system, glycogen utilization, and muscle tone (Martini and Nath 2008). Additionally, a decrease in heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), and total peripheral resistance (Goodman and LeSage 2002) are also attributed to inhibition of sympathetic nervous system activity. Significant increase in intracranial pressure and inhibition of sympathetic outflow (Bosone et al. 2004) may reduce the ability to sustain maximal force output by decreasing the neural outflow to the motor neurons.

Furthermore, tilt studies have also shown a decrease in sympathetic activity. Acute head down body tilt studies have reported lower sympathetic nervous activity (Cooke and Dowlyn 2000: Cooke et al. 2004), which could play a role in the ability of the central nervous system to adequately activate motor neuron activity (Roatta et al. 2008). During 6° head down tilt the muscle sympathetic nerve activity decreased by 27% (Fu et al. 2000). A recent study by Wang et al. (2011) also demonstrated that a 6° head-down bed rest decreased the working capacity of the muscle. Additionally, Bosone et al. (2004) have reported that 10 min of 30° head down tilt inhibit the sympathetic nervous

system response along with a decrease in heart rate and arterial blood pressure. Heart rate and cardiac output decreased significantly (Yao et al. 1999) with 24 h- 6° head down body tilt bed rest. Kawanokuchi et al. (2001) demonstrated that vestibulosympathetic reflex rather than cardiopulmonary baroreceptors suppress sympathetic outflow with 6-8° head down body-tilt with LBNP.

However, when encountering vulnerable situations in which the human body is forced to be inverted (e.g. overturned helicopters, motor vehicle accidents etc.), the sympathetic nervous system will typically be highly activated (fight or flight phenomenon) (Guyton and Hall 2006). Stimulation of the sympathetic system results in an increased heart rate and blood pressure to provide better perfusion of the vital organs and muscles, and decreases the threshold in the reticular formation, reinforcing the arousal and alert states (Ganong 2003). Hearn et al. (2009), Paddock and Behm (2009), and Neary et al. (2011*a*, 2011*b*) have illustrated significant decreases in heart rate, systolic, and diastolic blood pressure with complete seated inversion. They have suggested that changes in heart rate and blood pressure during inverted body posture are due to the alterations in sympathetic nervous system stimulation. Since seated inversion has shown significant reductions in cardiovascular activity, which have been proposed to be due to altered sympathetic activity, it would be of interest to examine the cardiovascular responses with rapid and slower transitions from upright to inverted positions to determine whether the more rapid and slower rotations elicit a sympathetic response that may overcome typical inversion-induced decrements.

7. HEART RATE AND BLOOD PRESSURE

An inverted seated posture alters the cardiovascular responses. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated significant decreases in heart rate, systolic and diastolic blood pressures with complete seated inversion. Furthermore, two published abstracts (Neary et al. 2011*a*, 2011*b*) also demonstrated significant decrease in heart rate and cardiac output with inverted position as compared to upright position. These studies attributed this decline in heart rate and blood pressure with reduction in sympathetic nervous system activity.

In addition to the studies performed with seated inversion, a number of studies have been performed to demonstrate the changes in cardiovascular responses with anti-orthostatic posture. Anti-orthostatic posture is defined as a posture in which the body is upside down or inverted at an angle with head down and feet unsupported. Anti-orthostatic posture has shown an association with alterations in systemic circulation in both humans (Gavrikov and Isupov 1999) as well as rats (Osadchii et al. 1997; Bychkova et al. 1990). In addition, Bychkova et al. (1990) have also illustrated changes in skeletal muscle blood flow during anti-orthostatic position.

Moreover, Balueva and Sergeev (2010) found that 45° head-down tilt decreases blood pressure and cardiac output in rats. Bosone et al. (2004) also illustrated decrease in heart rate and blood pressure during 10 min of 30° head down tilt, due to the inhibition of sympathetic nervous system. Vestibular system also plays an important role in maintaining arterial pressure during changes in body postures (Tanaka et al. 2009). During upright body posture, the baroreceptor reflex counteracts the decrease in blood pressure due to gravity and maintains adequate cerebral perfusion. However, it is still

unknown whether this reflex adequately regulates the changes in blood pressure during seated inversion.

In contrast to the aforementioned studies, Yao et al. (1999) and Butler et al. (1991) demonstrated an increase in cardiac output and decrease in stroke volume (SV) with head down tilt. Both these studies suggest an increase in heart rate, which proposes that some other cardiovascular mechanisms are also present which assist in regulating the changes during alterations in body position. Raffai et al. (2009) also showed an increase in heart rate and blood pressure after 45° head down tilt in rats. Therefore, it would be of interest to investigate the functioning of the cardiovascular system to respond to possible changes during rapid and slower seated inversion.

8. RESPIRATORY SYSTEM

Head down tilt (HDT) position impairs functioning of the respiratory (Henderson et al.2006) and cardiovascular (Soubiran et al. 1996) systems. Aleksandrova et al. (2005) found that HDT posture decreases orthostatic stability and leads to contractile failure of the diaphragm musculature due to alteration in excitation- contraction coupling. In addition, impaired gaseous exchange (Prisk et al. 2002), decreased lung compliance (Donina et al. 2009), and increased airflow impedance of respiratory system (Donina et al. 2009) also contribute to the changes in the ventilatory system functioning during HDT. Furthermore, there is a possibility that inversion may lead to an augmentation of intrathoracic and/or intra-abdominal pressure, resulting in increased work for inspiratory and expiratory musculature followed by fatigue. These responses could lead to difficulties with breathing.

Lu et al. (2000) proposed that HDT might lead to a reduction in pulmonary ventilation and lung capacity, but an increase in pulmonary diffusion. They suggested that this rise in the pulmonary diffusion might be associated with the uniform distribution of the pulmonary blood flow and increased effectiveness of the pulmonary vascular bed. On the contrary, Hillebrecht et al. (1992) found alterations in the pulmonary blood flow due to HDT.

Acute HDT posture also causes compensatory increases in the inspiratory muscle contraction force (Aleksandrova et al. 2005). Reduction in oxygen supply may result in alterations in the force production capacity of the muscle due to reduction in levels of creatine phosphate (Brechue et al. 1995) and impaired excitation-contraction coupling (Aleksandrova et al. 2005). However, it is not known if the respiratory system responses could contribute to the changes in inversion-induced neuromuscular performance impairments with rapid and slower rotations to inversion.

CONCLUSION

This literature review has presented a number of mechanisms that may lead to alterations in both neuromuscular and cardiovascular functioning. All previous published inversion studies (Hearn et al. 2009; Paddock and Behm 2009; Neary et al. 2011*a*, 2011*b*) demonstrated the inversion-induced alterations in neuromuscular and cardiovascular response during upper limb and lower limb muscle activity. These studies suggested the involvement of central and peripheral factors in altering the muscle force, cardiac output, and arterial pressure changes during seated inversion.

In addition, there is evidence to show the probable decrease in baroreflex sensitivity and increase in hydrostatic pressure are associated with altered responses during inversion, due to excessive pooling of blood towards the brain. These can be considered as major contributing factors influencing changes in upper and lower limb muscle activity functioning during complete inversion.

Furthermore, inhibition of sympathetic nervous system and stimulation of vestibulosympathetic reflex are also strongly associated with reduction in neuromuscular system activity in both upper limb and lower limb during inversion. Both these factors also lead to a decrease in heart rate and blood pressure, resulting in less peripheral blood perfusion oxygen delivery, and ultimately low force output during contractions. Additionally, alterations in the respiratory system functioning during inversion also lead to reduced oxygen supply to the contracting muscles and may lead to impairments in neuromuscular performance.

Consequently, no research has been conducted to study the effectiveness of the above-mentioned mechanisms during seated inversion. However, it is speculated that these mechanisms play an important role when body is inverted. The rapidity of the response is an important question for basic physiology while there can be functional applications for sport, work and emergency environments. Therefore, the focus of the research portion of this thesis is to determine the changes in muscle force output, muscle activity, and heart rate and blood pressure during rapid and slower transition from upright to seated inversion at different rotational times.

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EFFECTS OF RAPID AND SLOWER ROTATIONS TO AN INVERTED SEATED POSTURE ON HUMAN NEUROMUSCULAR AND CARDIOVASCULAR FUNCTIONS

by

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CO-AUTHORSHIP STATEMENT

Pramod Johar was involved in all aspects of the thesis including formulating the research idea and methodology; collecting, analyzing and interpreting all data; and writing the thesis. Dr. David Behm provided the genesis for the original research idea and guidance and input into the methodology, interpretation of data and revisions of the written thesis. Varun Grover and Mario DiSanto provided assistance with data collection.

ABSTRACT

The purpose of this study was to determine and compare the changes in neuromuscular and cardiovascular responses with rapid and slower transitions from upright to inverted seated positions. Twenty-two subjects performed concurrent unilateral biceps and quadriceps maximal voluntary contractions (MVCs) in the upright position, and when inverted within 1s and 3s. Ten of the 22 subjects also performed individual biceps and quadriceps MVCs in all three positions. Maximal force of biceps and quadriceps; muscle activation of biceps, triceps, quadriceps and hamstrings; and heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured. Whether the biceps or quadriceps was contracted concurrently or individually, significant ($p < 0.05$) decreases in MVC force were found when inverted within 1s and 3s rotations compared to the upright position. Similarly, biceps and quadriceps EMG activity with either concurrent or individual contractions significantly ($p < 0.05$) decreased when inverted within 1s and 3s rotations compared to the upright position. Quadriceps MVC demonstrated significant ($p < 0.05$) increase from the first second to 3-6s time period. Triceps and hamstrings EMG activity significantly ($p < 0.05$) decreased when inverted within 1s rotation compared to the upright position. HR, SBP, and DBP demonstrated significant ($p < 0.001$) decreases when inverted within 1s and 3s rotations compared to the upright position. In conclusion, similar to the slow and deliberate rotation of previous inversion studies, rapid and slower transitions from an upright to inverted seated positions also lead to neuromuscular impairments and decreases in HR and BP.

Key words: tilt, force, EMG, heart rate, blood pressure

INTRODUCTION

In day-to-day life, humans hardly perform any activities in which the body is inverted. To date, only two studies (Hearn et al. 2009 and Paddock and Behm 2009) have examined the level of muscle activation, force output, and changes in cardiovascular functioning during complete seated inversion compared to an upright body posture. Both studies demonstrated decreases in force production, muscle activation, heart rate, and blood pressure. In addition, two studies (Neary et al. 2011*a*, 2011*b*) also demonstrated a significant decrease in heart rate and cardiac output with inverted position as compared to upright position. They also found a tendency for quadriceps maximal voluntary contraction (MVC) to decrease in inverted position but no significant difference was found for biceps MVC between upright and inverted positions.

All the studies related to inverted seated posture (Hearn et al. 2009; Paddock and Behm 2009; Neary et al. 2011*a*, 2011*b*) have suggested inversion-induced inhibition of sympathetic nervous system activity as a rationale for decrease in neuromuscular and cardiovascular responses. A number of tilt studies have also supported this rationale. The most similar protocols to the inversion studies utilized head-down body tilt. Acute head-down body tilt inhibits sympathetic activity (Bosone et al. 2004; Cooke and Dowlyn 2000; Cooke et al. 2004; Fu et al. 2000), which is associated with decreased heart rate (Schneider and Chandler 1973), blood pressure (Bosone et al. 2004), total peripheral resistance (Goodman and LeSage 2002), and muscle blood flow (Thomas and Segal 2004). Other factors that could contribute to the decline in the muscle force output during inversion include an increase in hydrostatic pressure (Ranatunga and Geeves 1991), an increase in central venous pressure (CVP) (Charkoudian et al. 2004), and altered

functioning of the respiratory system (Henderson et al. 2006). Hence, it can be inferred that while an individual is inverted neuromuscular and cardiovascular systems may not function normally. In contrast to the above-mentioned studies, there are also head-down tilt studies, which suggest an increase in heart rate (Yao et al. 1999; Butler et al. 1991; Raffai et al. 2009) and arterial blood pressure (Wilkins et al. 1950). Furthermore, Hobbs and McCloskey (1987) found an increase in electromyographic (EMG) activity of soleus and medial gastrocnemius as the contracting muscles were raised above the heart level.

It is known that when an individual encounters a vulnerable situation, the activation of the sympathetic nervous system prepares the individual to cope via flight or fight reactions. Stimulation of the sympathetic system results in increased heart rate and blood pressure (Guyton and Hall 2006). Since the previously published seated inversion and head-tilt studies were conducted with slow rotation speeds, it is not known whether the typical inversion-induced responses (i.e. impaired force, decreased heart rate and blood pressure) found in these studies would be offset during a rapid rate of inversion by possible stimulation of the sympathetic system.

Accordingly, it is important to know the alterations in human body systems due to encounter of inversion-induced situations. To our knowledge no research has been published examining the changes in neuromuscular and cardiovascular systems and their related responses during rapid and slower inversion of human body posture. The purpose of the study was to determine the rapidity of changes in force output, muscle activation and cardiovascular functioning due to seated inversion at different rotation times. It was hypothesized that inversion of the body position within 1-3 seconds would initially

increase force production, muscle activation, heart rate and blood pressure subsequently followed by reductions over 3-6 seconds.

METHODOLOGY

1. Subjects

Twenty-two (24.2 ± 7.1 yrs., 76.5 ± 19.9 kg, 167.5 ± 10.6 cm) healthy and physically active subjects from Memorial University of Newfoundland volunteered for the study. All twenty-two subjects did simultaneous unilateral biceps and quadriceps contraction. Ten of the twenty-two subjects also performed unilateral biceps and quadriceps contraction both individually and concurrently. This was done to compare the effects of rapid and slower inversion rates on both unilateral concurrent and individual contractions. No participant had previous history of any hypertensive or cerebral related condition or serious injury. All subjects were verbally informed of the procedure of study and read and signed a consent form and Physical Activity Readiness Questionnaire (Health Canada, Canadian Society for Exercise Physiology 2004) prior to participation. The study was approved by Memorial University of Newfoundland Human Investigation Committee.

2. Experimental Design

2.1 Protocol

Subjects were instructed to not eat food for at least 2 h prior to testing and to not smoke, drink alcohol, or exercise at least 6 h prior to testing (Health Canada, Canadian Society for Exercise Physiology 2004). An initial orientation session was given to all subjects to allow them to become familiar with the protocol under both upright and inverted seated position. Prior to testing, subjects performed a 5 min warm up on a cycle ergometer set at an intensity of 1 kp and 70 rpm. All subjects were tested in both upright

and inverted seated positions. Among the twenty-two subjects, twelve subjects performed only concurrent unilateral contractions of biceps and quadriceps in upright and inverted positions within 1s and 3s rotations. Ten other subjects performed unilateral biceps and quadriceps contractions, concurrently and individually in upright and inverted positions within 1s and 3s rotations. The conditions (upright, inverted within 1s, and inverted within 3s rotations) were randomly allocated during the experiment.

All subjects were rotated from a seated upright to a seated inverted position by the primary investigator within 1s and 3s via a manual wheel attached to one side of the rotational chair. During data collection (experimental trials), a research assistant timed the manual rotation and any rotations that deviated by more than 0.3 seconds were not included in the data analysis.

Changes in neuromuscular activation were tested for a period of 6s for each trial. All participants were tested for right elbow flexors and right knee extensors force and activation in both upright and inverted positions. During upright and inverted positions within 1s and 3s rotations, all subjects performed 2 isometric MVCs of 6s duration for each condition.

The subjects started the muscle contraction at the initiation of inversion rotation for both 1s and 3s. The time when all subjects initiated muscle contraction for both upright and inverted seated rotations is defined as time zero. To prevent the discomfort related to an increase in pressure around head and eyes during seated inversion, a 3 min rest period was provided to every subject between each voluntary contraction. The 3 min rest period allowed the cardiovascular system to adjust to the upright posture and blood pressure (BP) and heart rate (HR) to return to baseline in < 1 min (information obtained

from pilot studies). Both upright and inverted positions were tested in the same experimental session. In the present study, rotation in 1s was considered rapid and rotation in 3s was described as slow in comparison to 1s rotation. For the purpose of analysis, the MVC force and EMG activity recorded over a period of 6s was divided into three phases – the first second, the first three seconds, and 3-6s. The first second provided information regarding the effect of rapid rotation, the second phase (0-3 seconds) provided information regarding the effect of slower rotation, whereas the third phase (3-6s) provided information regarding the effect of inversion on the dependent variables. Consequently, the significant changes were determined by comparing these three phases for upright position, and inverted within 1s and 3s rotations.

2.2 Apparatus

The subjects sat in a specially constructed rotational chair (Technical Services: Memorial University of Newfoundland) capable of being rotated over a 360° range. All subjects were rotated from an upright to an inverted position within 1s and 3s via a manual wheel attached to one side of the rotational chair. Subjects sat in an upright position with hips, knees and elbows flexed at 90° with forearms supinated and resting on padded support. The Velcro straps were secured to the upper arms at biceps (mid-belly). The upper torso rested against the backrest and was secured via straps around the waist, shoulder, and groin. Both legs were secured using a padded attachment placed over the thighs. The non-contracting leg and forearm were also placed in a strap so that it would not dangle while inverted. The right wrist and the right ankle were inserted into the padded straps attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.) to measure the force output during the isometric

elbow flexion and knee extension MVCs. During data analysis, the mass of the resting arm was subtracted from the force output readings of the inverted MVC since in the upright position the elbow flexors had to overcome the mass of the arm associated with the pull of gravity. The mass of the resting arm in the inverted position was measured by inverting the subject 180° with arm hanging in a padded strap attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.). The mean mass of the arm when hanging inverted was 39.26 N $\pm$ 17.32. All forces detected by the strain gauge were amplified (Biopac Systems Inc. DA 100 and analog to digital (A/D) converter MP100WSW; Holliston, MA) and monitored on computer (Dell Inspiron 6000, St. John's, Newfoundland) at a sampling rate of 2000 Hz. Data was analog to digitally converted and was stored on a computer for further analysis on a commercially designed software program (Acqknowlegde 4.1, Biopac Systems Inc., Holliston, MA).

3. Dependent Variables

3.1 MVC Force

For all subjects, MVC trials were recorded for upright as well as 1s and 3s rotations to an inverted position. During testing, subjects contracted biceps and quadriceps concurrently or individually at least twice in each position. Each contraction lasted 6s. A six-second MVC duration was chosen since from previous experience from this laboratory (Button and Behm 2008); this duration was the maximum that could be endured without eliciting a fatigue response (decrease in force). If more than 5% difference was found between the first two MVCs, a third trial was performed. Three-minute rest periods were allocated between each MVC to diminish the effects of fatigue.

To collect MVC data for biceps and quadriceps the padded velcro straps holding right wrist and right ankle were attached to a Wheatstone bridge configuration strain gauge (Omega Engineering Inc., Don Mills, Ont.). When performing individual contractions, the non-contracting right forearm and right leg were secured using different velcro straps to avoid dangling while inverted. All participants were provided verbal motivation to push as hard and fast as possible, to promote the maximal response. The highest difference between the baseline value and the greatest force amplitude was considered as peak force.

3.2 Electromyography

Muscle activation of the right knee extensors and right elbow flexors were recorded during concurrent and individual voluntary contractions. Thorough skin preparation for all electrodes included shaving of hair, removal of dead epithelial cells with an abrasive sand paper around the designated areas followed by cleansing with an isopropyl alcohol swab. Four pairs of surface EMG recording electrodes (Kendall Meditrace 100 series, Chikopee, Mass) were placed approximately 2 cm apart over the midbelly of the vastus lateralis, semitendinosis, mid-portion of biceps brachii (in alignment with the muscle fibers), and triceps with ground electrode placed on the fibular head. The electrodes were wrapped to ensure no movement during inversion. EMG activity was sampled at 2000 Hz, with a Blackman 61 dB band-pass filter between 10 and 500 Hz, amplified (Biopac Systems MEC 100 amplifier, Santa Barbara, Calif; input impedance = 2M, common mode rejection ratio > 100 dB (50/60 Hz); noise >5 UV), and analog to digitally converted (Biopac MP150) to be stored on a personal computer for further analysis (Dell Inspiron 6000). EMG data was integrated (rectified), averaged over

3 samples, and the root mean square (RMS) of the signal calculated using the software (AcqKnowledge 4.1, Biopac Systems Inc., Holliston, MA). From this transformation the rectified RMS mean amplitude of the signal was calculated by the software over the three segments. EMG was analyzed over 1s during the first phase, over 3s (0-3s) for the second phase and over 3s (3-6s) for the third phase. Co-contraction ratios were determined by dividing the antagonist (hamstrings and triceps) into the agonist (quadriceps and biceps) rectified RMS mean amplitude values.

4. Heart rate and blood pressure

Prior to testing, heart rate and blood pressure were monitored in the upright seated position and immediately after subjects were inverted within 1s and 3s rotations. Heart rate was monitored with a Polar A1 monitor (Woodbury, N.Y.). Blood pressure was measured with a battery operated A+ Med 7-62 pressure cuff (AMG Medical Inc., Montreal, Que.).

5. Statistical analysis

Two-way analysis of variance (ANOVA), (3x3) with repeated measures was conducted on force and EMG variables. The factors were body position (upright, inverted within 1s, and inverted within 3s), and time periods (first sec, 0-3s, and 3-6s). HR and BP data was analyzed with a 2 way ANOVA (3 x 2) with factors being body position and time (upright and completion of inversion). Data was analyzed using SPSS (SPSS for MS Windows, version 17.0, Polar Engineering and Consulting). Differences were considered significant when p values were below an alpha level of 0.05. A post hoc Bonferonni–

Dunn's procedure test was also utilized to determine the values of pair-wise comparisons and to detect the location of significant differences between upright and inverted positions. Data was reported as mean $\pm$ SD.

RESULTS

1. Force

When both biceps and quadriceps were contracted concurrently (n = 22), the average biceps MVC force significantly ($F\,(2,189) = 15.01$, $p < 0.05$) decreased by 35.4% when inverted within 1s and 15.9 % within 3s as compared to the upright position (Fig.1). Compared to the upright position, the average quadriceps MVC force was significantly ($F\,(2,189) = 31.59$, $p < 0.05$) lowered by 37.2% when inverted within 1s and 12.1% within 3s (Fig.2). Additionally, biceps and quadriceps MVC significantly ($p < 0.05$) increased 30.1% and 39.8% respectively when inverted within a 3s rotation compared to inverted within a 1s.

When only the biceps was contracted (n = 10); the average biceps MVC force was significantly ($F\,(2, 81) = 5.03$, $p < 0.05$) lower by 21.1% and 18.9 % when inverted within 1s and 3s respectively as compared to the upright position (Fig.3). During quadriceps only contraction, MVC force significantly ($F\,(2, 81) = 4.29$, $p < 0.05$) decreased by 19.2% and 19.6% when inverted within 1s and 3s respectively as compared to the upright position (Fig.4).

Based on the analysis of the main effect of time when both biceps and quadriceps are contracted simultaneously (n = 22), the average quadriceps MVC force significantly ($F\,(2, 189) = 4.25$, $p < 0.05$) increased 16.9% from the first second to 3-6s time period, and demonstrated a tendency ($F\,(2,189) = 4.25$, $p = 0.06$) for a 14.7% increase from first second to the first three seconds time period (Fig. 11). Biceps MVC force demonstrated no significant main effect. No significant results were found with individual biceps and quadriceps MVC contractions. Additionally, table 1 demonstrates average ($n = 22$) changes in the upper and lower limb MVC force values over the time period of the first second, 0-3s, and 3-6s for the upright position, inverted within 1s, and inverted within 3s of rotations.

2. Electromyography (EMG)

During simultaneous contraction of unilateral biceps and quadriceps ($n = 22$), the average biceps EMG activity demonstrated significant (F (2, 189) = 7.63, $p < 0.05$) decrease of 40.9% and 39.5% when inverted within 1s and 3s respectively as compared to the upright position (Fig.5). The average triceps EMG activity significantly (F (2, 189) = 3.80, $p < 0.05$) decreased by 43.9% when inverted within 1s compared to the upright position (Fig.6). The average quadriceps EMG activity significantly (F (2, 189) = 11.67, $p < 0.05$) decreased by 50.1% and 27.3% when inverted within 1s and 3s respectively as compared to the upright position (Fig.7). The average hamstrings EMG activity was significantly (F (2,189) = 6.23, $p < 0.05$) lowered by 44.1% when inverted within 1s compared to the upright position (Fig.8).

During individual biceps contraction ($n = 10$), the average biceps EMG activity was significantly (F (2, 81) = 3.51, $p < 0.05$) decreased by 21.7% when inverted within 1s and 35.9% lower when inverted within 3s compared to the upright position (Fig.9). When quadriceps was contracted individually, the average quadriceps EMG significantly (F (2, 81) = 6.91, $p < 0.05$) lowered by 39.1% and 40.2% when inverted within 1s and 3s respectively as compared to the upright position (Fig. 10).

No significant results were found for triceps to biceps and hamstrings to quadriceps co-contraction ratios for force and time when both biceps and quadriceps were contracted concurrently as well as individually. The average (n = 22) changes in the upper and lower limb EMG values over the time period of the first second, 0-3s, and 3-6s for the upright position, inverted within 1s, and inverted within 3s of rotations are illustrated in table 2.

3. Heart Rate and Blood Pressure

Heart rate significantly (F (2, 63) = 26.21, $p < 0.001$) decreased 16.8% and 21.1% when inverted within 1s and 3s respectively as compared to the upright position (Fig.12). Similarly, average (n = 22) systolic blood pressure significantly (F (2, 63) = 29.36, $p <$ 0.001) decreased by 10.8% when inverted within 1s and 12.4 % within 3s as compared to the upright position (Fig.13). Average (n = 22) diastolic blood pressure also significantly (F (2, 63) = 29.32, $p < 0.001$) decreased by 14.1% and 17.1% when inverted within 1s and 3s respectively as compared to the upright position (Fig.14).

DISCUSSION

This study investigated changes in neuromuscular and cardiovascular functioning with rapid and slower rotations from seated upright to seated inversion. Whether biceps and quadriceps were contracted concurrently or individually, MVC force and EMG decreased significantly when inverted within 1s and 3s compared to upright position. In addition, both biceps and quadriceps MVC increased significantly when inverted within 3s compared to 1s during concurrent contraction. Quadriceps MVC force subsequently increased from the first second to 3-6s time periods, but demonstrated a tendency for an increase from the first second to 0-3s time periods. No significant changes were found for elbow flexor MVC force for main effect for time. Triceps and hamstrings EMG activity significantly decreased when inverted within 1s as compared to upright position. Heart rate, systolic blood pressure, and diastolic blood pressure demonstrated significant decreases when inverted within 1s and 3s compared to upright position.

Neuromuscular impairments may be attributed to both central and peripheral factors with rapid and slower transitions from upright to inverted seated positions. When inverted within 1s and 3s both biceps and quadriceps MVC and EMG activity decreased suggesting the involvement of central mechanisms. The major possible central factors include inversion-induced increase in hydrostatic pressure (Parazynski et al. 1991) and decreased baroreflex activity (Charkoudian et al. 2004) due to elevated cerebral blood flow or intracranial pressure. However, the mechanisms underlying changes in force and

EMG during rapid and slower transitions to seated inversion are unknown. Further research is needed to determine these mechanisms.

It was hypothesized that rapid and slower transition to seated inversion would initially increase neuromuscular and cardiovascular responses followed by a drop-off. However, the results of this study demonstrated significant decreases in neuromuscular as well as cardiovascular responses suggesting rapid inversion-induced inhibition of sympathetic nervous system activity. Hearn et al. (2009), Paddock and Behm (2009), and Neary et al. (2011*a*, 2011*b*) exhibited similar responses with slow deliberate transitions to seated inversion compared to upright posture and proposed an inhibition of sympathetic nervous system activity. The significant decrease in heart rate and blood pressure (Bosone et al. 2004) and total peripheral resistance (Goodman and Lesage 2002) with head-down body tilt position also suggests a possible sympathetic system inhibition. Moreover, the adverse effects of sympathetic nervous system inhibition on muscle blood flow (Thomas and Segal 2004) and muscle force contractility (Martini and Nath 2008) might be related to a decrease in MVC force output and EMG activity with rapid movements at different rotational times from an upright to an inverted position. A decline in blood volume (Cerretelli et al. 1977) of upper and lower extremity working muscles, resulting in reduced oxygen and nutrient supply, may also be considered as a factor contributing to the lower force output and EMG activity with rapid and slower transitions to seated inversion.

Impairment of respiratory system functioning with head-down tilt (Henderson et al. 2006) might also contribute to inversion-induced neuromuscular deficit. Oxygen is necessary for the proper functioning of the skeletal muscles (Hepple et al. 2002). Head-

down tilt interferes with adequate gaseous exchange (Prisk et al. 2002), decreases pulmonary ventilation and lung capacity (Lu et al. 2000), and increases airflow impedance by decreasing lung compliance (Donina et al. 2009). Muscle hypoxia should have a greater detrimental effect upon prolonged muscle contractions, which have a greater reliance upon oxygen utilization. An altered oxygen supply to the contracting muscle during head-down tilt has been reported to alter muscle force output due to impaired excitation-contraction coupling (Aleksandrova et al. 2005). However, the very rapid response in the present study would suggest that the respiratory mechanisms would not have played a substantive role in neuromuscular impairments as the adverse effect on oxygen supply would in all probability need duration of greater than 3-6 seconds. Secondly, a brief MVC would not be as affected by a hypoxic environment as more prolonged contractions.

In contrast to the study of Hearn et al. (2009) and Paddock and Behm (2009), no changes were observed in upper extremity co-contraction (triceps to biceps) and lower extremity co-contraction (hamstrings to quadriceps) when biceps and quadriceps were contracted concurrently. Similar results were found with individual biceps and quadriceps contractions. Hence, the inversion-induced decreases in force could not be attributed to changes in motor control or inter-muscular co-ordination.

Quadriceps MVC force changed over different time periods (0-1s, 0-3s, and 3-6s) was independent of the condition (upright, inverted within 1s, and inverted within 3s). The force generated over a period of 6s reached its maximum value after three seconds. Button and Behm (2008) used 4s MVC to ensure maximum force was achieved. Hearn et al. (2009) and Paddock and Behm (2009) demonstrated significant impairments in

neuromuscular responses using 4s MVCs in upright and inverted seated positions. Thus, it can be concluded that MVC forces need approximately 3 to less than 6s to reach maximum whether the individual is upright or in the process of being inverted.

The main limitation of the present study was that the subjects were manually inverted within 1s and 3s rotations via a detachable wheel attached to the rotational chair. Rotating manually with the help of a stopwatch to maintain 1s and 3s rotations made it difficult to attain exact rotation times for all the subjects. The variability in times was recorded for subjects when inverted within 1s and 3s rotations. The mean rotation times were 1.14s $\pm$ 0.07 when inverted within 1s and 3.13s $\pm$ 0.04 when inverted within 3s rotations. To overcome this limitation, future inversion-related research should use a motorized rotational chair. Additionally, the contraction of the biceps and quadriceps concurrently and unilaterally could lead to a disruptive torque to the trunk. However, the subjects were securely strapped into the chair so this possibility was minimal. There was also the possibility of a similar bilateral deficit mechanism whereby the contraction of the same two muscles bilaterally results in decreased force compared to the contraction of the two muscles individually. Since, no significant differences were found when upright, inverted within 1s, and inverted within 3s concurrent unilateral biceps and quadriceps contractions were respectively compared with upright, inverted within 1s, and inverted within 3s individual biceps and quadriceps contractions it was not considered a major limiting factor in the present study.

CONCLUSION

With rapid and slower transitions from upright to seated inversion, the biceps and quadriceps MVC force, EMG activity, heart rate, and blood pressure decreased for concurrent biceps and quadriceps contraction, as well as individual biceps and quadriceps contraction compared to the upright position. This inhibition of neuromuscular and cardiovascular measures occurred within approximately 1s of rotation to inversion. These results were in contradiction to the proposed hypothesis, which was based upon the activation of the flight or fight response of the sympathetic nervous system. The increase in sympathetic activity typically increases the heart rate and blood pressure, resulting in possible increased blood flow to the working muscles and the required force output. However, the expected increase in sympathetic nervous system activity seemed to be inhibited with rapid (1s) and slower (3s) transitions from upright to seated inversion. Another contributing factor could have been related to increased hydrostatic pressure. The aforementioned mechanism could immediately impact neuromuscular and cardiovascular responses when individuals are forced into inverted positions such as overturned helicopters or motor vehicle accidents. Further research is recommended to determine the effectiveness of these mechanisms and their practical implications.

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TABLES

Interactions with Concurrent Contractions		Upright	Inverted in 1s	Inverted in 3s
Biceps MVC Force (N)	1^{st} sec	251.3263 ± 101.28*	152.6702 ± 62.87*	202.6819 ± 83.06*
	0-3s	261.9656 ± 112.56*	160.3608 ± 71.89*	215.6326 ± 100.03
	3-6s	258.0059 ± 119.06*	156.1803 ± 72.88*	217.5324 ± 97.49
Quadriceps MVC Force (N)	1^{st} sec	467.3115 ± 161.65*	285.3885 ± 101.23*	400.8303 ± 135.30
	0-3s	527.8818 ± 170.38*	330.9764 ± 118.39*	464.7685 ± 153.76*
	3-6s	530.7031 ± 141.23*	342.6585 ± 117.41*	474.9801 ± 139.47*

Table 1. The interaction of time and condition for the changes in the upper and lower limb average (n = 22) MVC force (N) values over the time periods of the first second, 0-3s, and 3-6s in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations over the time periods of the first second, 0-3s, and 3-6s.

Biceps EMG (mv)	1st sec	1.3721 ± 1.06	0.7724 ± 0.54*	0.9005 ± 0.62
	0-3s	1.4174 ± 1.19	0.9438 ± 0.66	1.0899 ± 0.83
	3-6s	1.6852 ± 1.49*	0.8901 ± 0.64	1.1613 ± 0.96
Triceps EMG (mv)	1st sec	0.1330 ± 0.09	0.0707 ± 00.05	0.1695 ± 0.04
	0-3s	0.1572 ± 0.11	0.0908 ± 0.06	0.1182 ± 0.07
	3-6s	0.1752 ± 0.12	0.1000 ± 0.07	0.1358 ± 0.09
Quadriceps EMG (mv)	1st sec	0.5987 ± 0.51	0.2546 ± 0.21*	0.3736 ± 0.29
	0-3s	0.6561 ± 0.49*	0.3268 ± 0.25	0.4389 ± 0.31
	3-6s	0.5700 ± 0.42	0.3271 ± 0.28	0.5130 ± 0.37
Hamstrings EMG (mv)	1st sec	0.0539 ± 00.05	0.0281 ± 0.02	0.0370 ± 0.03
	0-3s	0.0603 ± 00.05	0.0319 ± 0.03	0.0538 ± 0.05
	3-6s	0.0614 ± 0.04	0.0399 ± 0.04	0.0411 ± 0.04

Table 2. The interaction of time and condition for the changes in the upper and lower limb average (n = 22) EMG (mv) values over the time periods of the first second, 0-3s, and 3-6s in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations over the time periods of the first second, 0-3s, and 3-6s.

Main Effect for Condition with Concurrent Contractions	Upright	Inverted in 1s	Inverted in 3s
Biceps MVC (N)	252.134 + 134.49*	162.901 + 62.94*	211.949 + 92.93*
Biceps EMG (mv)	1.4916 + 1.24*	0.8786 + 0.60*	1.0506 + 0.81*
Triceps EMG (mv)	0.1551 + 0.10*	0.08716 + 0.06*	0.1412 + 0.08
Quadriceps MVC (N)	508.632 + 158.53*	319.674 + 113.63*	446.859 + 114.67*
Quadriceps EMG (mv)	0.6083 + 0.47*	0.3028 + 0.25*	0.4418 + 0.33*
Hamstrings EMG (mv)	0.0585 + 0.049*	0.0333 + 0.03*	0.04497 + 0.04

Table 3. The main effect for condition for the changes in the upper and lower limb average (n = 22) MVC force (N) and EMG (mv) values in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps are contracted together. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

Main Effect for Time Concurrenrt Contractions	First second	0-3s	3-6s
Biceps MVC (N)	200.88 + 91.57	213.58 + 102.59	212.50 + 103.42
Biceps EMG (mv)	1.0249 + 0.80	1.1503 + 0.93	1.2455 + 0.99
Triceps EMG (mv)	0.1244 + 0.10	0.1220 + 0.09	0.1370 + 0.09
Quadriceps MVC (N)	384.51 + 152.98*	441.20 + 168.49	449.44 + 153.29*
Quadriceps EMG (mv)	0.4901 + 0.38	0.4739 + 0.39	0.4700 + 0.37
Hamstrings EMG (mv)	0.0396 + 0.02	0.0487 + 0.03	0.0485 + 0.03

Table 4. The main effect for time for the changes in the upper and lower limb average (n = 22) MVC force (N) and EMG (mv) values for the time periods of the first second, 0-3s, and 3-6s when biceps and quadriceps contracted together. Asterisk (*) sign denotes significant differences for the time periods of the first second and 3-6s.

Main Effect for Condition with Individual Contractions	Upright	Inverted in 1s	Inverted in 3s
Biceps MVC (N)	318.675 + 94.39*	251.3507 + 78.23*	258.2243 + 89.988*
Biceps EMG (mv)	1.5719 + 0.98*	1.2303 + 0.8365*	1.007 + 0.59*
Triceps EMG (mv)	0.1592 + 0.0760	0.1371 + 0.3230	0.1462 + 0.0906
Quadriceps MVC (N)	551.8389 + 174.15*	446.0418 + 157.69*	443.750 + 150.26*
Quadriceps EMG (mv)	1.0002 + 0.60*	0.6092 + 0.40*	0.5984 + 0.37
Hamstrings EMG (mv)	0.0870 + 0.1206	0.0681 + 0.0381	0.0596 + 0.0464

Table 5. The changes in the upper and lower limb average (n =10) MVC force (N) and EMG (mv) values in the upright position, inverted within 1s and inverted within 3s rotations when biceps and quadriceps contracted individually. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

Main Effect for Condition	Upright	Inverted in 1s	Inverted in 3s
HR	82.0491 + 9.50*	68.5455 + 8.17*	65.0455 + 7.45*
SBP	130.1818 + 8.06*	116.0909 + 8.23*	113.9545 + 6.48*
DBP	78.6364 + 7.39*	67.5455 + 6.33*	65.1818 + 4.64*

Table 6. The main effect for condition with average (n = 22) values for the changes in heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) in the upright position, inverted within 1s and inverted with 3s rotations. Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

FIGURES

1. Main effects for Condition: Force

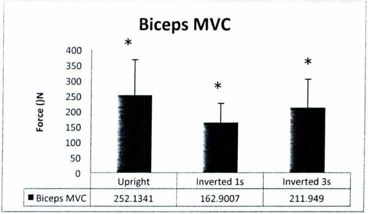


Fig.1. The average (n = 22) biceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

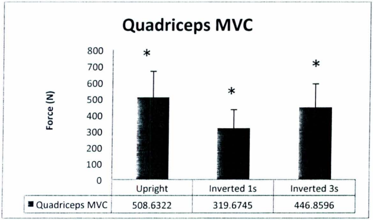


Fig.2. The average (n = 22) quadriceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

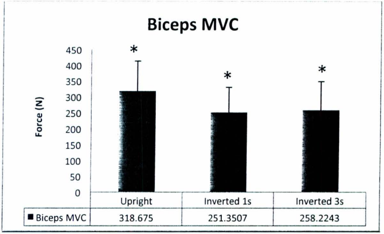


Fig.3. The average (n = 10) biceps MVC force (N) in the upright and inverted within 1s and 3s rotations when biceps contracted individually. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

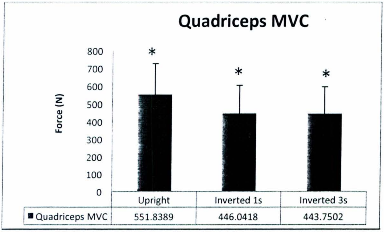


Fig.4. The average (n = 10) quadriceps MVC force (N) in the upright and inverted within 1s and 3s rotations when quadriceps contracted individually. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

2. **Main effects for condition: Electromyography (EMG)**

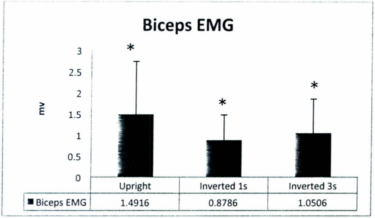


Fig.5. The average (n = 22) biceps EMG activity (mv) during the MVC of the biceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

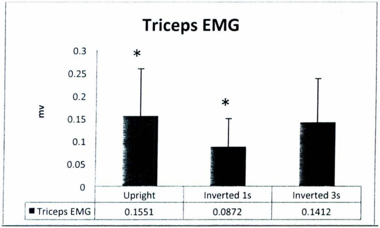


Fig.6. The average (n = 22) triceps EMG activity (mv) during the MVC of the biceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s rotations.

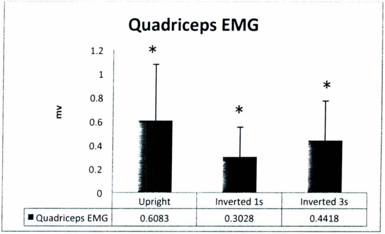


Fig.7. The average (n = 22) quadriceps EMG activity (mv) during the MVC of the quadriceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

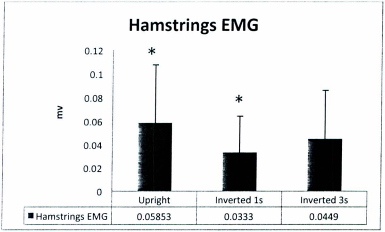


Fig.8. The average (n = 22) hamstrings EMG activity (mv) during the MVC of the quadriceps when biceps and quadriceps contracted together in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s rotations

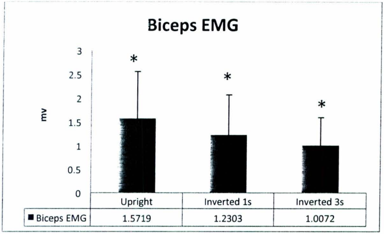


Fig.9. The average (n = 10) biceps EMG activity (mv) during the MVC of the biceps when biceps contracted individually in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

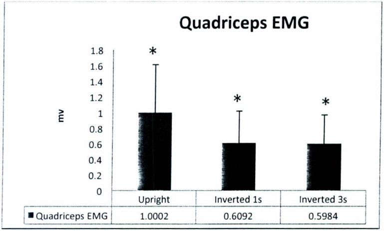


Fig.10. The average (n = 10) quadriceps EMG activity (mv) during the MVC of the quadriceps when quadriceps contracted individually in upright and inverted within 1s and 3s rotations. Columns represent average values of the EMG and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

3. Main effects for Time: Force

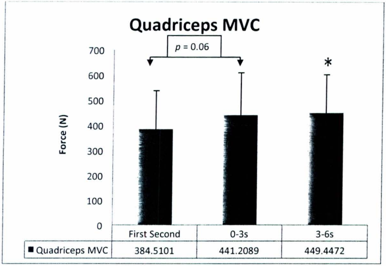


Fig.11. The average (n = 22) changes in quadriceps MVC force (N) in the first sec, 0-3s, and 3-6s time periods when biceps and quadriceps contracted together. Columns represent average values of the force and bars represent standard deviations (± SD). Asterisk (*) sign denotes significant differences between the first second and 3-6s periods. A tendency ($p = 0.06$) was observed from the first second to 0-3s.

4. Heart Rate and Blood Pressure

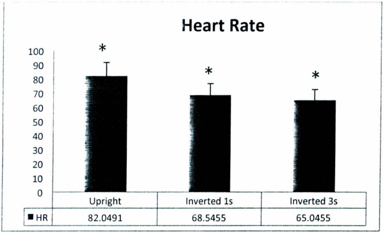


Fig.12. The average (n = 22) heart rate (beats/min) in the upright and inverted within 1s and 3s rotations. Columns represent average values of beats/min and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations.

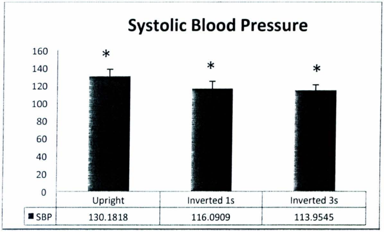
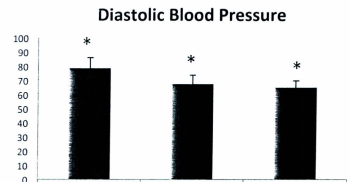


Fig.13. The average (n = 22) systolic blood pressure (mmHg) in the upright and inverted within 1s and 3s rotations. Columns represent average values of the pressure and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations



	Upright	Inverted 1s	Inverted 3s
■ DBP	78.6364	67.5455	65.1818

Fig.14. The average (n = 22) diastolic blood pressure (mmHg) in the upright and inverted within 1s and 3s rotations. Columns represent average values of the pressure and bars represent standard deviations (+ SD). Asterisk (*) sign denotes significant differences between upright and inverted within 1s and 3s rotations

5. Force Profiles

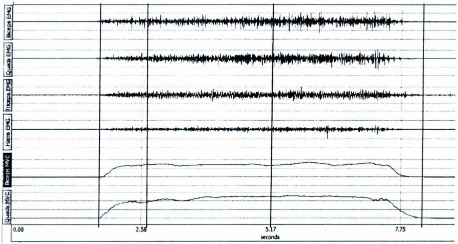


Fig. 15. Image represents the force profile when inverted within 1s rotation. The lines represent three different phases of analysis (0-1s, 0-3s, 3-6s).

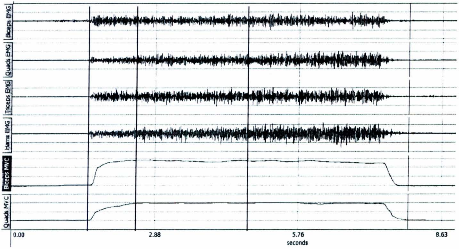


Fig. 16. Image represents the force profile when inverted within 3s rotation. The lines represent three different phases of analysis (0-1s, 0-3s, 3-6s).

APPENDICES

Variability in Rotation Times

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.12	3.07
Subject 2	1.23	3.21
Subject 3	1.09	3.14
Subject 4	1.11	3.11
Subject 5	1.17	3.17
Subject 6	1.21	3.01
Subject 7	1.08	3.26
Subject 8	1.19	3.04
Subject 9	1.14	3.12
Subject 10	1.02	3.13
Subject 11	1.17	3.00
Subject 12	1.00	3.22
Subject 13	1.24	3.03
Subject 14	1.16	3.19
Subject 15	1.19	3.14
Subject 16	1.23	3.17
Subject 17	1.12	3.26
Subject 18	1.27	3.08
Subject 19	1.05	3.20
Subject 20	1.14	3.16
Subject 21	1.11	3.21
Subject 22	1.02	3.02

Table 1. The variability in rotation times when subjects were inverted within 1s and 3s with concurrent biceps and quadriceps contraction.

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.15	3.01
Subject 2	1.09	3.20
Subject 3	1.21	3.16
Subject 4	1.17	3.11
Subject 5	1.23	3.11
Subject 6	1.07	3.09
Subject 7	1.19	3.19
Subject 8	1.02	3.05
Subject 9	1.11	3.16
Subject 10	1.06	3.18

Table 2. The variability in rotation times when subjects were inverted within 1s and 3s with individual biceps contraction.

	Time of inversion in 1s	Time of inversion in 3s
Subject 1	1.13	3.23
Subject 2	1.11	3.02
Subject 3	1.24	3.19
Subject 4	1.07	3.14
Subject 5	1.19	3.18
Subject 6	1.15	3.11
Subject 7	1.17	3.00
Subject 8	1.05	3.13
Subject 9	1.22	3.05
Subject 10	1.04	3.17

Table 3. The variability in rotation times when subjects were inverted within 1s and 3s with individual quadriceps contraction.

Figure: Photo of rotational chair in upright position.

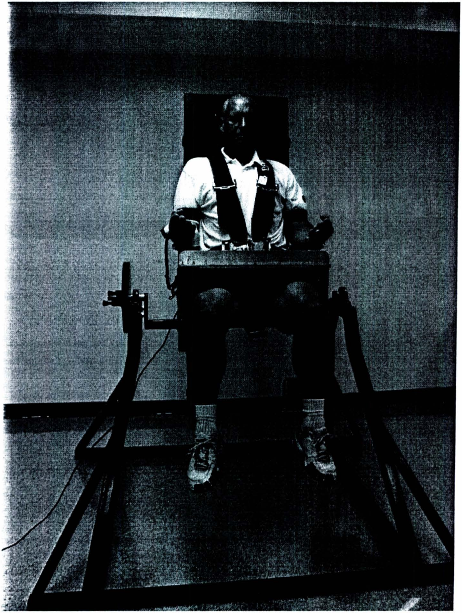


Figure: Photo of rotational chair in inverted position