A PILOT STUDY OF AN ONLINE GROUP EXERCISE PROGRAM FOR WOMEN LIVING WITH OBESITY AND EXPERIENCING INFERTILITY: FINDINGS FROM QUESTIONNAIRE DATA

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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 Medicine (Clinical Epidemiology)

Faculty of Medicine

Memorial University

October 2023

St. John's, Newfoundland and Labrador

Abstract

Introduction: Infertility impacts one in six Canadian couples. The experience of infertility can have lasting psychosocial consequences, manifesting in many ways, such as elevated levels of stress and anxiety to feelings of depression and hopelessness. Persons living with obesity and experiencing infertility are counselled on healthy behaviours to improve fertility-related outcomes. Patients also report decreased psychosocial well-being. **Purpose:** To explore the effect of a 12-week virtual exercise program on psychosocial measures of well-being. **Methods:** A pre-experimental feasibility study (Pre-Test, Post-Test with one group) with a patient-oriented research approach was conducted whereby participant discussion groups were utilized throughout the study. Questionnaires measuring: anxiety and depression (Hospital Anxiety and Depression Scale; HADS), quality of life (Short Form Health Survey Version 2; SF-12v2); social support (Multidimensional Scale of Perceived Social Support; MSPSS); global stress (Fertility Problem Inventory; FPI); and hopelessness (Beck Hopelessness Scale; BHS) were administered. **Results:** Eleven participants participated in the virtual exercise intervention (Age:34±3.7, BMI: 40.3±4.54); seven completed post-intervention questionnaires. Improvements in HADS (n=3 improved), BHS (n = 4 improved), SF-12v2;physical (n = 6 improved), and FPI (n = 5 improved) were observed. The average change declined for HADS; anxiety (n = 3), mental quality of life (n = 6), and MSPSS (n = 5). **Conclusion:** For most participants, fertility-related stress decreased but poor mental health increased following the exercise program. To further explore this relationship, a larger sample of participants is needed.

Keywords: Infertility, Obesity, Exercise, Mental Health, Women's Health, Comparative Study, Patient-Oriented Research

General Summary

One in six Canadian couples experience infertility. Obesity is one of many factors that affect fertility. Physicians recommend adherence to healthy behaviours for weight loss; however, there are many psychosocial consequences associated with counselling for weight loss. This is important to consider as a bidirectional relationship exists between one's psychosocial well-being and fertility-related outcomes. The research study in the current thesis examines the impact of a 12-week online exercise program on psychosocial outcomes. The findings of this study reflect the complexities of infertility; improvements were observed in symptoms of depression, hopelessness, physical quality of life, and fertility-related stress, while there were also increased symptoms of anxiety, decreased mental quality of life, and perceived social support. The present thesis work supports that the experience of infertility is closely connected to one's psychosocial well-being. Further, when prescribing an exercise intervention to persons experiencing infertility, consideration should also be given to psychosocial well-being.

Land Acknowledgement

We respectfully acknowledge the territory in which we gather as the ancestral homelands of the Beothuk, and the island of Newfoundland as the ancestral homelands of the Mi'kmaq and Beothuk. We would also like to recognize the Inuit of Nunatsiavut and NunatuKavut and the Innu of Nitassinan, and their ancestors, as the original people of Labrador. We strive for respectful relationships with all the peoples of this province as we search for collective healing and true reconciliation and honour this beautiful land together.

Acknowledgements

I would like to extend a warm thank you to all who contributed to the completion of this project. First, I must thank my wonderful committee: *my supervisor, Dr. Laurie Twells Faculty of Medicine, Dr. Katie Wadden of the School of Human Kinetics and Recreation, and Dr. Holly Etchegary and Dr. Deanna Murphy of the Faculty of Medicine at Memorial University of Newfoundland.* Without their continued dedication to the project and their encouragement, none of this would have been possible. Furthermore, I truly appreciate my committee for the opportunity to work on such a fantastic project. It has given me so many new and exciting opportunities and allowed me to work with a group of women at such a vulnerable time in their lives and provide members of the Newfoundland and Labrador Fertility Services with a little extra hope on their fertility journey. Thank you to the Healthcare Foundation, Mitacs and the Rita Love Foundation for stipend funding and providing the additional monetary support needed to undertake this interdisciplinary research.

Most importantly, I would like to send a sincere thank you to the strong women who participated in the study or represented the study population by being a patient-partner. Thank you for your time, your honesty, your bravery, and for sharing your most intimate struggles with my team and me. I would like to thank my family for their never-ending love and support. Especially my partner James, for being my biggest supporter, and my mother for the encouragement and showing me to always stand up for what I believe in.

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List of Abbreviations

AMA:	American Medical Association
ART:	Assisted Reproductive Technology
BHS:	Beck Hopelessness Scale
BMI:	Body Mass Index
CBT:	Cognitive Behavioral Therapy
CIHR:	Canadian Institutes of Health Research
CMA:	Canadian Medical Association
COMPI:	Copenhagen Multi-center Psychosocial Infertility
FIT-PLESE:	Improving Reproductive Fitness through Pre-treatment with Lifestyle Modification in Obese Women with Unexplained Infertility
FPI:	Fertility Problem Inventory
GSLTPAQ:	Godin-Shephard Leisure-Time Physical Activity Questionnaire
HADS:	Hospital Anxiety and Depression Scale
HRQoL	Health-Related Quality of Life
ICSI:	Intracytoplasmic Sperm Injection
IUI:	Intrauterine Insemination
IVF:	In-vitro Fertilization
LTPA:	Leisure Time Physical Activity
MBI:	Mind/Body Interventions
MOS:	Medical Outcome Study
MSPSS:	Multidimensional Scale of Perceived Social Support
NL:	Newfoundland and Labrador

OGTT:	Oral Glucose Tolerance Test
PARQ+:	Physical Activity Readiness Questionnaire for Everyone
PCOS:	Polycystic Ovary Syndrome
POR:	Patient-Oriented Research
PROM	Patient-Oriented Outcome Measure
QoL:	Quality of Life
WHO:	World Health Organization

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Chapter 1.0 Introduction and Overview

1.1 Overview of the Thesis

This thesis is presented in a traditional-style format. In chapter one, I present a high-level overview of the project, focusing on the background and rationale, assumptions for our research approach, problem statement, and research questions. Next, in chapter two, I review the current scientific literature on infertility and obesity, their relationship, the mitigation of infertility using physical activity, its associated psychosocial effects, and gaps in the literature. In chapter three, I describe the methodologies used throughout the research project, including information on patient engagement sessions, study planning, recruitment, data collection, and analysis. In chapter four, I present the results, including participant characteristics and the findings of the self-reported questionnaires, including individual participant data pre-and post-intervention. In chapter five, I discuss the results and interpretations of the study findings. Finally, in chapter six, I describe the strengths and limitations of the study and provide direction for future research.

1.2 Background and Rationale

Infertility is defined as the inability to conceive after a year of sexual intercourse without contraception (Crosignani et al., 2017). Infertility affects roughly one in six Canadian couples (Public Health Agency of Canada, 2019). This prevalence has risen significantly, doubling since the 1980s (Public Health Agency of Canada, 2019). The experience of infertility can have lasting psychosocial consequences, manifesting in many ways, such as elevated levels of stress and anxiety to feelings of depression and hopelessness (Bolvin & Lancastle, 2010; Gürtin et al., 2022; Pyrigidis et al., 2022; Skiadas et al., 2011;Ying et al., 2016). Further, the emotional burdens differ depending on the infertility stage and related treatment (Bolvin et al., 2010). For

those seeking fertility treatments, there are several physiological interventions, including Intrauterine Insemination (IUI), In-Vitro Fertilization (IVF), and Intracytoplasmic Sperm Injection (ICSI). Unfortunately, these treatments are highly invasive and physically and emotionally demanding (Thia et al., 2007). The psychosocial distress of an infertility diagnosis can increase in severity throughout treatment, and outlast the diagnosis, continuing through pregnancy and afterward (Clifton et al., 2010). One study found that the psychological burden associated with infertility can be comparable to those diagnosed with cancer (Skiadas et al., 2011). Thus, researchers in the field can not ignore the psychosocial distress associated with an infertility diagnosis.

Medically, infertility is managed with various treatments such as IUI, IVF, or ICSI; however, it is less common for those affected by infertility to seek emotional or psychological support (Clifton et al., 2020; Sexton et al., 2010; Winsor et al., 2020). In some Canadian provinces, the medical aspects of infertility treatments are partly compensated for through national healthcare coverage (Winsor et al., 2020). However, this coverage does not include counselling services or other psychological interventions for infertility-related stress (Winsor et al., 2020). Aside from financial barriers, several factors prevent those affected by infertility-related emotional distress from accessing psychological support, including stigma, fear of being dismissed from reproductive treatment, skepticism regarding efficacy, the uncertainty of whom to contact, travel-related challenges, and scheduling difficulties (Clifton et al., 2020). It is estimated that between 9% and 21% of people seeking infertility treatment access mental health support from a therapist or other healthcare professional (Clifton et al., 2020).

In the past decade, an increase in the number of individuals living with obesity seeking assisted reproductive treatment has challenged fertility services (Kupka et al., 2014). Without

using higher-risk pharmacological interventions, modifications to diet and physical activity behaviours can help to improve fertility outcomes (Kim et al., 2020). Thus, physicians counsel patients on a healthy diet and physical activity behaviours; however, they often lack the resources to support behavioural interventions. Further, the prescription of diet and physical activity to improve fertility outcomes is still being determined as studies' methodologies significantly vary (Maher et al., 2022). Lastly, there has been an excessive focus on weight loss as a primary goal of diet and physical activity interventions in fertility research (Hakimi et al., 2017). However, without proper weight-loss counselling, patients have reported adverse health outcomes such as medication nonadherence, mistrust of their healthcare provider and avoidance of medical care (Phelan et al., 2015).

Limited research examines the psychosocial changes in persons living with obesity and experiencing infertility who have been prescribed an exercise program (Dammen et al., 2019). To remedy the gaps in the literature, our research group explored the impact of a 12-week pilot virtual exercise program on psychosocial measures in persons seeking fertility-assisted services. The exercise program was progressive in intensity and duration while following the Canadian Physical Activity Guidelines, which recommend that individuals engage in 150 minutes per week of moderate to vigorous physical activity (Tremblay et al., 2011). Guidelines outlined by Health Canada also recommend that individuals engage in the same amount of physical activity for preconception care (Mottola et al., 2018).

Our research group engaged in patient-oriented research approaches to develop the research questions and methodology for this study. Our patient partners and stakeholders participated in an in-person exercise program in 2015. The discussion group sessions with our

patient partners and stakeholders helped shape the research question and methodology used in the present thesis, which is discussed in more detail in Chapter 2.

1.3 Assumptions for the Research Approach

Due to discrepancies in fertility services offered in this province compared to other provinces in Canada, preconception care has been in the public spotlight. It is under review by the current Newfoundland and Labrador (NL) government (White, 2020). Long wait times to see a fertility physician, the high cost of treatments and the lack of access to reproductive procedures in the province have resulted in negative experiences cited by patients (White, 2020). In addition to the more significant public issues, physicians who practice in the clinic report a lack of resources to help patients who are living with obesity to improve their reproductive health. Thus, our research team focused on evaluating the effects of an exercise program on the physiological and psychosocial outcomes of women living with obesity and experiencing infertility. A quantitative study would help improve statistical evidence to support information learned from a previous exercise program offered in 2015, patient-engagement sessions, and social media support groups. The assumptions made when starting this research project were: (i) there is a lack of patient support programs that focus on physical and psychosocial aspects of infertility, (ii) the majority of patients seeking fertility treatments (independent of the type of infertility) could benefit from increasing levels of physical activity, (iii) women carry higher levels of fertility-related stress than male-counterparts, (iv) there is a large proportion of patients living with obesity seeking fertility treatment in NL, and (v) a group-based exercise program would aid in lowering the psychosocial burden of infertility. The research questions were developed to help understand the population and the impact of a group exercise intervention on self-reported measures of psychosocial well-being of infertility patients who are also living with obesity.

1.4 Problem Statement

The body of literature investigating the effect of behavioural interventions (e.g., diet, exercise, psychological) on female infertility in a population of patients living with obesity has prioritized weight loss, conception, live-birth rates, and quality of life. There is a lack of literature examining the impact of a behavioural intervention, such as exercise participation, on psychosocial outcome measures within this population, despite evidence supporting the relationship between improved psychosocial measures and conception rates (Frederiksen et al., 2015; Hämmerli et al., 2009). The present thesis will explore the effect of a 12-week group virtual exercise program on psychosocial (e.g., anxiety and depression, hopelessness, social support, fertility-related stress) measures in persons living with obesity and experiencing infertility.

1.5 Research Questions

This research aims to describe (1) a sample of patients living with obesity who are seeking fertility treatment in NL and are interested in participating in an exercise program and (2) the impact of a virtual group exercise program on self-reported psychosocial measures. This pilot intervention study is one piece of a multi-part feasibility study focused on improving the quality of care and quality of life for women living with obesity and experiencing infertility. In this study, the following research questions were examined:

1. Using validated tools, what are the pre-intervention measures of anxiety, depression, quality of life, infertility-related stress, hopelessness, and perceived social support amongst the sample?
2. How do self-reported measures of anxiety, depression, hopelessness, infertility-related stress, and perceived social support change after a 12-week group exercise program?

Chapter 2.0 Review of the Literature

2.1 Introduction

Obesity is a globally increasing chronic disease defined by excess and dysfunctional adipose tissue accumulation that impairs health and well-being (Twells et al., 2014; Wharton et al., 2020). It is a multifactorial condition that arises from a complex interplay of genetic, environmental, and behavioural factors (World Health Organization (WHO), 2021). The presence of excess adipose tissue is strongly associated with decreased health-related quality of life, increased burden on the healthcare system and chronic medical conditions (Guh et al., 2009). Infertility is among the long list of chronic conditions associated with obesity (Silvestris et al., 2018; Talmor & Dunphy, 2015). Infertility is typically defined as the failure to conceive after twelve or more months of attempting natural fertilization (Habbema et al., 2004). Due to social stigmatization, living with obesity and experiencing infertility can have far-reaching consequences beyond physical health (Gautam et al., 2023; Puhl & Heuer, 2009). The compounding effect for those living with both conditions can be a worsening mental health status (Gautam et al., 2023). To advance clinical research in the population of individuals with obesity and experiencing infertility, it is necessary to investigate the potential changes in mental health and psychosocial outcomes that may arise during fertility treatment.

The existing research on obesity, infertility and the link between the two will be discussed in the following literature review. Other topics to be discussed include 1) local trends of obesity and infertility in NL and Canada, 2) psychosocial aspects of obesity and infertility, 3) possible interventions for those living with obesity and infertility, and 4) the psychosocial consequences of participating in exercise programs. A large body of literature found that behavioural and environmental factors, such as diet, lack of exercise, and psychological stress,

can adversely affect fertility (Hakimi et al., 2017; Kim et al., 2020; Mutsarts et al., 2016; Palomba et al., 2008; Sharma et al., 2013; Silvestris et al., 2018). For this reason, behavioural counselling, including diet, exercise, and psychological support, continues to be prescribed by physicians treating women living with obesity and experiencing infertility (Barker et al., 2018). To fully understand the impact of group exercise programs on psychosocial outcomes related to obesity and infertility, a review of the current literature is required.

2.2 Obesity

The prevalence of obesity is increasing globally and affects people of all physical, economic, political, and sociocultural backgrounds (Swinburn et al., 1999). In NL, in 2019, 40.3% of adults were living with obesity, an increase of 6.3% reported in 2005 (Statistics Canada, 2019). This province is not alone in observing an increase in obesity rates; across Canada, rates of obesity have tripled from 6.1% in 1984 to 18.3% in 2011 (Twells et al., 2014). In agreement with findings from the Atlantic provinces, this province has lower levels of self-reported leisure-time physical activity and reduced consumption of fruits and vegetables compared to other parts of Canada (Vanasse et al., 2006). A higher prevalence of obesity may be associated with increased rates of chronic diseases (e.g., cardiovascular disease, diabetes) amongst the NL population (Twells et al., 2010).

There has been much debate in the literature about whether obesity is a disease or a condition that leads to disease. However, in 2013, obesity was officially defined as a chronic disease by the American Medical Association (AMA) (Meldrum et al., 2017). In Canada, the Canadian Medical Association (CMA) endorsed obesity as a chronic disease in 2015 (Canadian Medical Association, 2015). Canada has also published clinical practice guidelines for managing obesity in adults, which are currently being adopted in various countries across the globe

(Wharton et al., 2020). The management of obesity is a priority for healthcare professionals because there are various potential health consequences of obesity, including the development of diabetes mellitus, various cancers (colon, rectum, breast, uterus, esophagus, pancreas, kidney, and gallbladder), cardiovascular disease, hypertension, and osteoarthritis (Brewer et al., 2010; GBD 2015; Guh et al., 2009; Janssen, 2013; Meldrum et al., 2017). In developed countries, obesity has now overtaken smoking as the leading cause of premature death (Ho et al., 2021).

Body mass index (BMI) is a commonly used surrogate measure of body composition due to the simplistic, non-invasive, and inexpensive nature of data collection (Hall & Cole, 2006). To determine one's body weight classification, BMI is calculated by dividing a person's weight in kilograms by their height in metres squared. Based on the resultant BMI, individuals are categorized into ranges associated with health risk (Nutall, 2015). There are four categories of BMI ranges in the Canadian weight classification system; a classification of obesity is having a BMI greater than or equal to 30kg/m^2 (Douketis et al., 2005). While the measurement of BMI is efficient in clinical practice, patients have reported experiencing psychological distress during and after the calculation of BMI due to the increased weight stigma experienced by people living with obesity, especially women, within the healthcare system (Boswell & White, 2015; Puhl et al, 2021). Patients living with obesity often experience negative weight-related judgement, devaluation, and unfair treatment (Puhl et al, 2021).

2.2.1 Psychosocial Factors

The diagnosis of obesity predisposes individuals to various chronic diseases, including an increased risk of mental illness (Taylor et al., 2013). The bidirectional relationship between obesity and psychosocial aspects of life is well-understood (Barry et al., 2008; Taylor et al., 2013; Zhang, 2021). Several studies have shown high rates of psychiatric disorders (e.g.,

depressive and anxiety disorders) in individuals with obesity (Gariepy et al., 2010; Zhang, 2021). One study showed that people living with obesity were up to six times more likely to be diagnosed with a psychiatric disorder than those without obesity (Gariepy et al., 2010). Respectively, people living with psychiatric disorders, such as anxiety and depression, are up to two and a half times more likely to develop obesity (Strine et al., 2008). Gender differences have shown that women living with obesity report more symptoms of depression and anxiety, with higher levels of perceived stress and lower self-esteem than their male counterparts (Kanter & Caballero, 2012; Merwe, 2007).

Given this bidirectional relationship, the increased perception of stress may contribute to the increased rates of obesity observed in women (Merwe, 2017). Several studies have determined that women are more likely to recognize and acknowledge feeling stressed than men (Costa et al., 2021; Moore & Cunningham, 2011; Turner et al., 1995). Though sources of stress may vary, it is evident that women also handle perceived stress differently which may also lead to the development of obesity (Costa et al., 2021). It was found that when stressed, women were less likely to exhibit healthy dietary behaviors than men (Moore & Cunningham, 2011).

Further, the negative impacts of obesity extend beyond the internal experience. Unfortunately, people with obesity often face societal devaluation and mistreatment and are often subject to stigmatization and discrimination (Puhl & Heuer, 2009). Though the prevalence of obesity is similar in men and women, women are more likely to experience weight-based stigmatization (Sattler et al., 2018). It is evident that though obesity is a metabolic syndrome, it also negatively impacts the overall quality of life of the individuals who have obesity.

2.2.2 The Link Between Obesity and Infertility

The risk of infertility is three times higher in women living with obesity than those without obesity (Silvestris et al., 2018). In women, obesity promotes dysregulation of the hypothalamic-pituitary-ovarian axis, decreased oocyte quality, and decreased endometrial receptivity ultimately affecting fertility (Pasquali et al., 2008; van der Steeg et al., 2008). These disruptions can further lead to anovulation or cycle irregularity, increased rates of miscarriage, and poor neonatal and maternal pregnancy outcomes in women with obesity (Legro, 2017; Silvestris et al., 2018). Obesity also seems to also decrease the effectiveness of fertility treatments. In a recent meta-analysis conducted by Sermondade et al. (2019), obesity significantly reduced the probability of live births after receiving IVF, confirming results from previous studies (Metwally et al., 2008; Rittenberg et al., 2011; Sermondade et al., 2019). Therefore, to help improve fertility in patients with BMIs greater than 30 m/kg^2, patients are recommended by their physicians as part of a management plan to adhere to a healthy lifestyle consisting of a well-balanced diet and physical activity (Barker et al., 2018).

2.3 Infertility

There is no universal definition of infertility, making comparisons across studies difficult (WHO, 2020). In Canada, infertility is defined as the inability to conceive after one year (reduced to six months for women over 35) of intercourse without the use of contraception (Government of Canada, 2019). More and more individuals are affected each year as the prevalence of infertility continues to rise in Canada (Provencher et al., 2018). In addition to higher rates of obesity, NL also has the lowest fertility rates compared to other provinces (Provencher et al., 2018). However, limited available data on the topic makes estimating the prevalence of infertility in NL challenging. Infertility is a complex and multifaceted disease with

various causes and factors leading to unsuccessful pregnancy. For women, the female gonads are responsible for the production of gametes, oocytes, and sex hormones that support pregnancy and are regulated by endocrine and paracrine factors (McGee & Hsueh, 2000). Therefore, dysfunction or altered regulation of these mechanisms can directly or indirectly lead to infertility. Some common causes of female infertility include 1) deregulated ovarian function, 2) tubal infections, and endometriosis (Silvestris et al., 2018). However, only 70% to 85% of infertility cases have an identifiable cause leaving the remaining 15% to 30% of fertility cases diagnosed as "unexplained infertility" (Gelbaya et al., 2014; Carson et al., 2021). Infertility treatments include pharmaceuticals, surgical interventions and assisted conception, including IUI and IVF.

Without a definitive cause, infertility can be challenging to study. Researchers have struggled to provide consistent findings due to varying outcome measures across studies. The most desirable outcome measure for infertile women is a successful pregnancy, resulting in a healthy baby (Morin-Papuenen et al., 2012). Low numbers in interventional cohorts have forced researchers to focus on alternative outcome measures like altered hormones, ovulation and menstrual regularity, and rates of conception. Furthermore, improvements in ovulation and menstrual regularity are considered reasonable indications of improvements in overall fertility in interventional studies (Edison et al., 2016). Finally, conception rates may also be used to measure fertility in interventional studies. However, conceptions do not always lead to successful pregnancies, as many women experiencing infertility struggle with high rates of miscarriage (Kiel et al., 2018; Morin-Papunen et al., 2012; Palomba et al., 2008).

2.3.1 Psychosocial Factors

Infertility can be affected by various factors beyond pathophysiology. Anxiety, depression, stress, and emotional state can significantly influence reproductive health (Silvestris

et al., 2018). Some evidence suggests that increased stress could result in decreased natural conception rates and poorer fertility treatment outcomes (Aimagambetova et al., 2020; Palomba et al., 2018; Rooney & Domar, 2018). The relationship between fertility and these psychosocial factors is bidirectional, meaning these factors often increase and further impact fertility after diagnosis. In a series of studies, it was found that women experiencing infertility are more likely to experience higher levels of anxiety (King, 2003), depression (Cousineau & Domar, 2007), and psychological distress (Greil et al., 2010) compared to women not experiencing infertility. Regardless of the cause, when a couple is diagnosed with infertility, women carry the brunt of the psychological burden compared to their male counterparts (Abbey et al., 1992; Massarotti et al., 2019). Women affected by infertility report similar levels of anxiety and depression compared to women with cancer, myocardial infarction, and HIV-positive status (Domar et al., 2000). Psychosocial measures are further exacerbated while undergoing fertility treatment. One study revealed that the stress of infertility treatment was ranked second to that involving the death of a family member or divorce by couples undergoing IVF (Gabnai-Nagy et al., 2020). Women's psychological well-being plays a crucial role in fertility and fertility treatment outcomes.

As a result of decreased mental health experienced by women experiencing infertility, the effects of multiple psychological interventions have been studied, including psychotherapy, cognitive behavioural therapy (CBT), mind/body interventions (MBI), stress management, group support, and other interventions. CBT has been determined to be the most effective intervention in reducing anxiety, depression, and perceived stress (Frederiksen et al., 2015). Women receiving any form of psychological intervention are twice as likely to become pregnant compared to those receiving standardized care (Frederiksen et al., 2015).

2.4 Infertility Mitigation via Weight Loss Interventions

It is widely acknowledged that the management of obesity should prioritize overall health and well-being rather than solely focusing on weight loss (Wharton et al., 2020). However, despite clinical practice guidelines recognizing the complexity of obesity management, existing literature has focused primarily on weight loss outcome measures (Wharton et al., 2020). Weight loss interventions can play a crucial role in improving fertility for individuals struggling with excess weight or obesity (Kim et al., 2020). Various weight-loss interventions have been studied to determine the effects of weight loss on fertility, such as bariatric surgery, pharmacological therapies, and behavioural interventions (e.g., diet and exercise) (Kim et al., 2020; Milone et al., 2016; Mutsaerts et al., 2016; Taghavi et al., 2021; Elton et al., 2019). Findings from these studies have varying results.

Bariatric surgery could be a beneficial alternative for individuals with BMIs greater than 40 kg/m2 who struggle to maintain weight loss. Several literature reviews have found that bariatric surgery significantly improves fertility hormone levels, sexual function, and pregnancy rates, but research has failed to demonstrate a direct impact on live birth rates (Qurashi et al., 2022; Milone et al., 2016; Moxthe et al., 2020). Interestingly, a recent systematic review (Alibhai et al., 2022) examined the effects of bariatric surgery before assisted reproductive technology (ART) and found increased live birth rates with bariatric surgery. Further research is necessary to redirect the emphasis of obesity management towards enhancing patient-centered health outcomes beyond just weight loss (Wharton et al., 2020).

There are several pharmacotherapies used by healthcare professionals for obesity management and are used in conjunction with health behaviour changes (Wharton et al., 2020). On the other hand, anti-obesity drugs, such as Orlistat, are an effective way to achieve weight

loss without surgery (Li et al., 2013). However, there is minimal research on the use of anti-obesity drugs during preconception, and the risk of toxicity or congenital malformations outweighs the benefit of achieving pregnancy (Legro, 2017; Wang et al., 2021). Sibutramine, for example, may have teratogenic effects and is not recommended for women trying to conceive (Källén, 2014). The invasive nature of surgical interventions and risks associated with pharmacological therapy have led researchers to focus on preconception behavioural interventions for weight loss.

Behavioural interventions often include dietary or exercise interventions alone, combined diet and exercise, or combined diet, exercise, and psychological (e.g., behavioural modification therapy) interventions (Kim et al., 2020; Legro, 2017). Literature is abundant on various combinations of behavioural interventions with promising improvements to fertility outcomes (Kim et al., 2020; Palomba et al., 2008; Milone et al., 2016; Mutsaerts et al., 2016). A recent systematic review and meta-analysis found that diet and exercise-based interventions meaningfully increased pregnancy rates while potentially improving live birth rates (Kim et al., 2020). However, the study underlined the need for more studies that use live birth rates as a primary outcome to determine the true effects of behavioural interventions on fertility.

Many interventional studies mentioned above focus on successful weight loss as an outcome variable. There are two issues with focusing on weight loss: 1) desired weight loss from participants is rarely achieved in the literature, and 2) the highly restricted diets observed in the literature do not make weight loss sustainable (Legro, 2017; Mutsaerts et al., 2013). Additionally, previous studies that examined the efficacy of nonpharmacological weight loss interventions have not successfully shown improvements to live birth rates (Best et al., 2017). On the other hand, researchers that explored the effects of behavioural interventions irrespective

of weight loss have shown promising results whereby exercise-based interventions could lead to the resumption of ovulation in women living with obesity and anovulatory infertility (Hakimi et al., 2017). More intensive interventions lead to increased successful weight loss compared to non-intensive interventions but with little benefit to the live birth rate (Hoek et al., 2022).

In the FIT-PLESE study (Legro et al., 2022), intensive and standard interventions were randomly administered to 379 women living with obesity and unexplained infertility. The study found that the intensive intervention led to increased weight loss among participants, but there was no significant difference in the incidence of healthy live births between intervention types. While there is evidence of reductions in weight on metabolic improvements, there is no consistent positive impact on fertility. There is a clear need for additional treatment options and well-designed interventions that address the heterogenous causes of obesity and include fertility outcomes and perinatal morbidity as outcome measures (Vitek & Hoeger, 2022).

2.4.1 Psychosocial Impact of Behavioural Interventions

Many healthcare providers hold strong negative attitudes and stereotypes about people living with obesity (Phelan et al., 2015). Weight bias and stigma can lead to low self-esteem, depression, and reduced quality of life (Phelan et al., 2015). Research is starting to place less emphasis on weight loss and focus on other evidence-based ways to improve fertility parameters. There is considerable evidence supporting the relationship between psychosocial factors and the development of obesity and infertility. When anxiety, depression, and perceived stress increase, the risk of developing obesity and experiencing infertility increases (Frederiksen et al., 2015; Gariepy et al., 2010; Strine et al., 2008). However, the relationship between behavioural interventions and their impact on psychosocial factors is under-researched (Kim et al., 2020). One recent study explored the effects of behavioural interventions (diet, exercise, and

motivational counselling) on perceived stress, mood symptoms, quality of life, and sleep quality in women living with obesity and experiencing infertility. However, it yielded null results (Dammen et al., 2019). However, several limitations described by the researchers could have contributed to these results. Meanwhile, a previous study by the same researchers examined the effects of the same behavioural interventions on cardiometabolic health and physical quality of life, showing a significant increase in both outcome measures (Dammen et al., 2018). In a recent systematic review, exercise interventions were found to improve measures of anxiety, depression, and quality of life in women with Polycystic Ovary Syndrome (PCOS) (Patten et al., 2021).

In summary, the implications of behavioural interventions on mental health are unknown for patients experiencing infertility; however, we know that fertility increases when we improve psychosocial interventions. In a meta-analysis by Frederiksen et al. (2015), psychological interventions were analyzed for their effects on pregnancy outcomes. The results determined that psychological interventions, such as CBT, could improve clinical pregnancy rates and reported measures of depression. Regardless of achieved weight loss, the promising results of exercise-based behavioural interventions on fertility parameters promote their use as the first defence for physicians at fertility clinics (Kim et al., 2020). However, more literature is needed to understand the actual effects of behavioural interventions on mitigating the psychosocial aspects of obesity and infertility in women.

2.5 Patient-Oriented Research

Patient-oriented research (POR) involves partnering with patients who have lived experiences of health and illness. Understanding patient experiences within the healthcare system can help inform the provision of care, health policies and health research (Etchegary et

al., 2022). POR has been around for over a century, dating back to 1911, but has only been recognized and utilized recently within Canadian research communities (Ahrens, 1995; Pluye & Kaur, 2019). There is no universal definition of patient-oriented research which has long hindered its implementation into health-related research (Pluye & Kaur, 2019). To better define POR, Dr. Dennis Baumgardner outlined two conditions that must be met to classify any research as POR (Baumgardner, 2019). The two conditions are as follows: 1) Patients (including family, caregivers, and the public) are involved as research partners with multidisciplinary research team members along a continuum in addressing patient priorities or planning/conducting research; and 2) Studies are aimed to (a) address outcomes deemed important by patients; and/or (b) have a direct impact on at least one of the following targets: patient health and experiences, health professionals' practice, or health care services and policies (Baumgardner, 2019). With these two conditions satisfied, POR is founded on understanding the needs of people with lived experiences of health and illness to ensure research addresses relevant priorities and outcomes (Canadian Institutes of Health Research (CIHR)).

2.5.1 POR in Female Reproductive Health

In women's health research, there is an increased recognition of the value of both experiential and scientific knowledge (Wahl et al., 2021). There is a need to explore the effectiveness of using POR to improve female reproductive health research. In a recent commentary by Nagpal et al. (2021), researchers discussed how the incorporation of aspects of patient-oriented research to examine female reproductive health and exercise-based interventions might improve inclusivity, equality, recruitment rates, and adherence to the intervention (Nagpal et al., 2021). The current foundation and framework of patient-oriented research is described in an impactful article titled "nothing about us, without us" (Paul, 2016). To apply these

frameworks to perinatal and exercise research, Nagpal et al. (2021) stated that pregnant individuals for whom the exercise intervention is intended should be involved in the research design and knowledge dissemination (Nagpal et al., 2021). However, patients can engage and inform all aspects of research. For example, in prenatal exercise-based studies, the patient-oriented approach may inform the selection of which health outcomes are important to evaluate and include family members and partners in the study design. Women should also be engaged to establish the methods and procedures and subsequently evaluate the program based on barriers identified and the preferences of the participants who will be engaged in the study (e.g., type of exercise, frequency of program, intensity level, group-based or individual interventions). A patient-oriented approach to exercise interventions can identify barriers and priority areas and improve overall patient uptake (Nagpal et al., 2021). Regardless of how the patients are engaged, without the active participation of patients, sexual and reproductive health research risks losing relevance and validity (García-Martín et al., 2020).

2.6 Gaps in the Literature

This literature review highlighted the gaps in the current understanding of the relationship between obesity, infertility, and exercise interventions. First, there is limited research investigating the impact of exercise on psychosocial measures in women living with both obesity and infertility. Most exercise interventions focus on weight loss as a means of measuring success and often ignore the impact of the intervention on psychosocial measures. Understanding the psychological and emotional aspects of their experiences is essential for developing comprehensive and effective interventions. Second, the integration of patient-oriented research within the field of exercise interventions for women with obesity and infertility is notably lacking. Involving patients as active participants in research can provide valuable insights and

ensure that interventions are tailored to their unique needs and preferences. By addressing these gaps and considering the future directions outlined, researchers can advance the knowledge base in the field of obesity and infertility, leading to the development of evidence-based exercise interventions that not only improve physical health outcomes but also prioritize the psychosocial well-being of women living with obesity and infertility.

To our knowledge, the impact of a group exercise program, independent of weight loss, on the psychosocial measures in women living with obesity and experiencing infertility has not been studied. The current pilot study will measure the impact of a 12-week group exercise program offered virtually to women living with obesity and experiencing infertility to examine the impact on anxiety, depression, social support, global stress, and overall quality of life.

Chapter 3.0 Methodology

3.1 A Pre-Experimental Research Study Informed by Patient-Oriented Research

The present study is a pre-experimental study examining measures related to psychosocial well-being and quality of life before and after an exercise intervention in women living with obesity and experiencing infertility. Validated questionnaires were administered to a consenting sample of women living with obesity and experiencing infertility seeking fertility services. The study participants were part of a larger study examining cardiorespiratory fitness before and after the 12-week exercise intervention. To inform the current study, patients with lived experience of obesity and infertility attended patient engagement sessions. During these patient engagement sessions, the group discussed the impact living with the challenges of infertility had on their psychosocial well-being and quality of life. The difference between patient partners and research participants is illustrated in Figure 1. These discussions helped to inform the current study's research questions and the rationale for examining psychosocial measures before and after the exercise intervention (Figure 2).

The research team consisted of patient partners, faculty members experienced in exercise research and obesity, fertility clinic physicians, kinesiologists, exercise physiologists, and graduate students. During the early stages of study planning, patient-engagement sessions with our patient partners helped to inform the proposed research study (Etchegary et al., 2022) as well as the study's methods in terms of data collection of PROMs (Etchegary et al., 2022). This chapter includes the following sections with information on: patient engagement, research questions, recruitment, data collection of PROMs and data analysis.

3.1.1 Patient Engagement

The current study was informed by four patient partners who participated in an earlier exercise program conducted in 2015. In the previous exercise program, a fertility physician referred ten patients to an exercise program. In 2015, before the beginning of the program, an orientation session was held for participants, which emphasized socialization and peer support, and discussed general information on a healthy diet and physical activity practices. For the patients' convenience, the program was held at a private women-only fitness studio near the local fertility clinic. The program consisted of instructor-led 45-minute workouts that occurred twice weekly and involved various body-weighted exercises at differing intensities and durations. In 2018, our research group hosted two discussion group sessions with interested patients (n = 4) who completed the 2015 exercise program to learn about the patient's experience with this program and engage the patients as partners on our research team.

Figure 1

Engagement of Patient-Partners and Recruitment of Research Participants

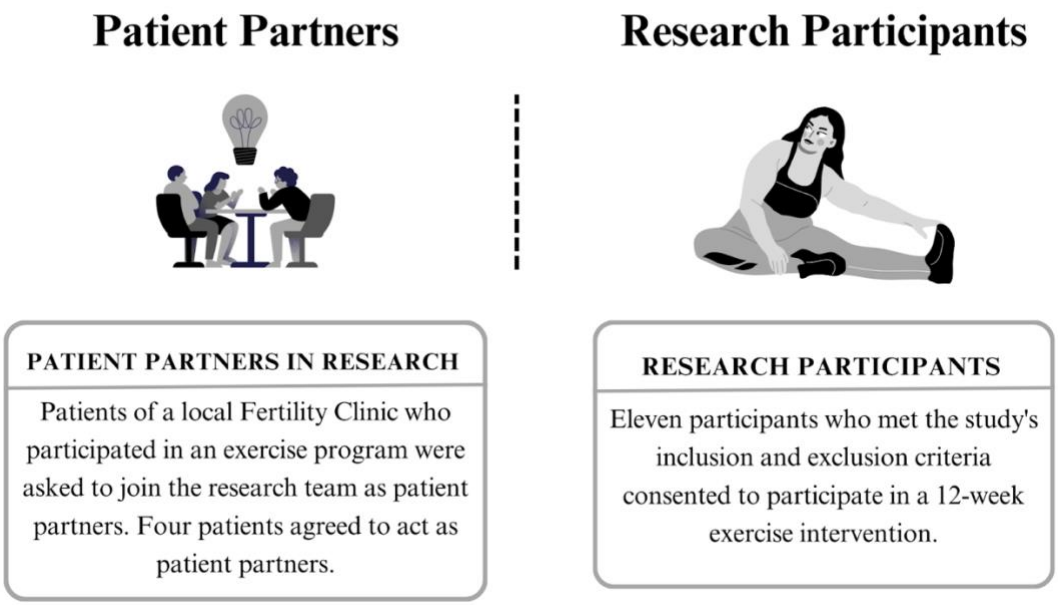
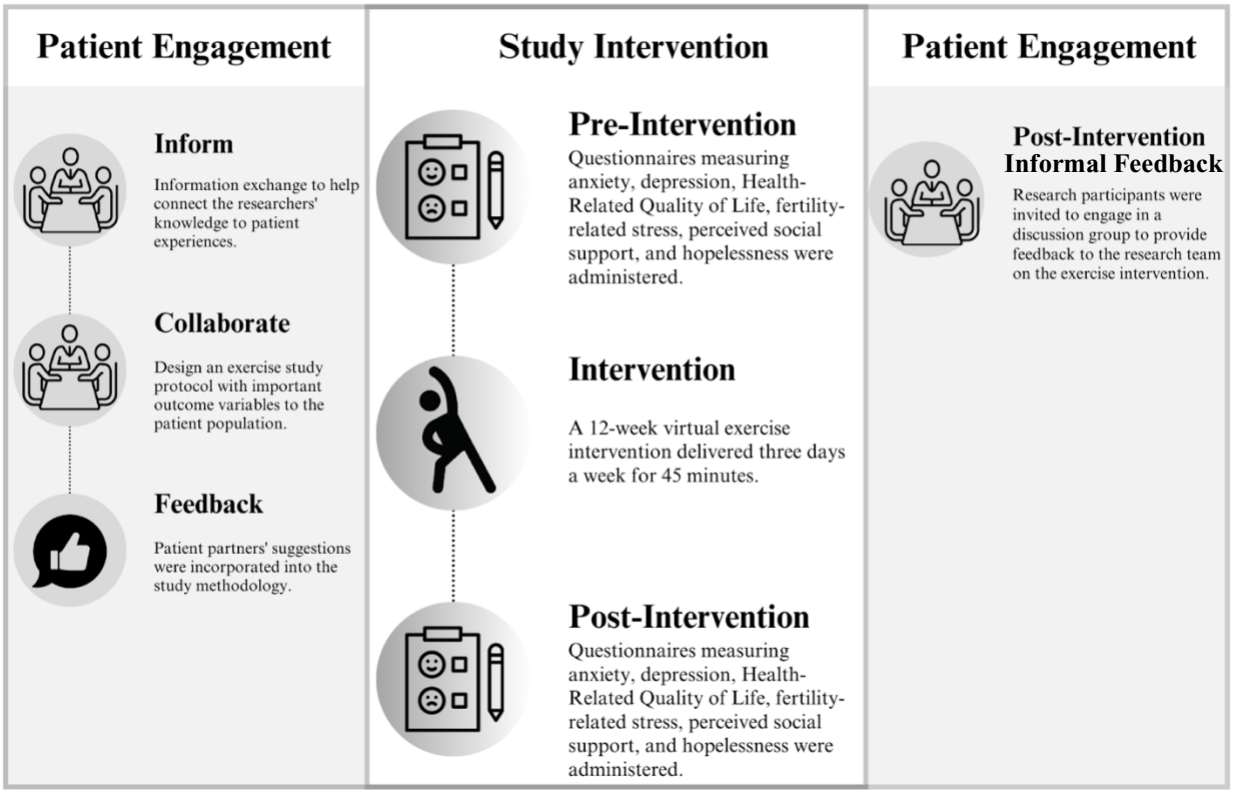


Figure 2

Patient Engagement and Study Intervention Research Design



The purpose of the first discussion group session was for researchers to consult the patient partners about the research topic and to engage in an exchange of information to connect the patient partners' experience with the researchers' knowledge. More specifically, in this session, researchers learned about the patient partners' experiences while participating in an exercise program. Next, to develop an exercise protocol, based on this discussion and evidence of exercise protocols for clinical populations in the literature, researchers and patient partners discussed the following questions: (1) What did you like the most about your experience with the exercise program?; (2) What can we do differently to improve patients' experience?; (3) What was the program's most challenging aspect?; (4) How did you physically feel while exercising, and did this change as you progressed?; (5) How would you describe the level of social support

you received?; (6) How can we make this study successful and meaningful for future patients?; (7) what are your concerns or comments regarding the currently proposed exercise protocol? Based on our patient partner's responses to these questions, we modified the study protocol to include questionnaires to measure psychosocial variables (See Table 1).

Table 1

Discussion Group Feedback on Study Design

High-level feedback from Patient Partner Discussion Groups	**Questionnaires added to reflect patient partners' experience**
Need for social support/importance of building a community	Multidimensional Scale of Perceived Social Support
Importance of shared experience with others	Beck Hopelessness Scale
Anxiety and stress surrounding need for weight loss and BMI cut-off for fertility treatment	Fertility Problem Inventory Hospital Anxiety and Depression Scale
Lack of understanding of impact of health status on fertility	Short Form-12

In the second discussion group session, the patient partners and researchers reviewed the developed methodology (e.g., recruitment, exercise logistics (timing, delivery, intensity)). Researchers documented the patient partners' feedback and revised the methods based on their recommendations. After the two discussion group sessions, the research team hosted a research day where the exercise protocol was presented to patients, stakeholders (potential funders) and physicians for additional feedback to inform the delivery of the exercise intervention. Please see Figure 2 for details on the patient engagement process.

3.1.1.1 Post-Intervention Patient Engagement

Due to the exploratory nature of this research and the patient-centred approach, after the study intervention, participants were invited to an in-person patient-engagement discussion group session to provide high-level feedback on their experience in the current research study.

The purpose of this session was for the study participants to act as patient partners to help the research team understand where improvements could be made to future studies and to learn more about the participants' experiences during the intervention. The high-level feedback for the post-intervention patient engagement session is summarized in the results section.

3.1.2 Patient-Informed Psychosocial Measurements

Following the patient engagement process, based on information collected during the patient partner discussion group sessions, the researchers compiled a collection of questionnaires to measure participant characteristics, amount of physical activity, anxiety, depression, quality of life, infertility-related stress, hopelessness, and perceived social support. The questionnaire package included six validated tools: (1) Leisure Time Physical Activity Questionnaire, (2) Hospital Anxiety and Depression Scale, (3) Short Form-12, (4) Beck Hopelessness Scale, (5) Fertility Problem Inventory, and (6) Multidimensional Scale of Perceived Social Support.

3.1.3 Patient-Informed Exercise Protocol

The motivation behind the exercise program was to develop a moderate-to-vigorous intensity (40–84% of aerobic capacity reserve (Warburton et al., 2007)) and a physically low-impact program for individuals with excess body weight and minimal exercise experience. Based on feedback from our patient partner discussion groups, the exercise program was intended to be delivered in a group setting, in person at a women-only fitness centre. However, due to the COVID-19 pandemic, all in-person research was halted, resulting in the online delivery of the exercise program through the utilization of Zoom Software. The exercise sessions were delivered live by a registered Kinesiologist three days a week, each lasting 45 minutes, spanning 12 weeks. Live participation was encouraged; however, sessions were recorded for participants unable to attend to complete at a later time. A private Facebook page for participants to engage with one

another was also created based on feedback from the patient partner discussion groups. On this Facebook page, members of the research team posted nutritional tips and recipes, motivational quotes, and, most importantly, links to the virtual exercise program. Specific information on the development and delivery of the administered exercise program are described in Appendix 4.

Based on the information obtained through discussion groups, the research team finalized two research questions:

1. Using validated tools, what are the pre-intervention measures of anxiety, depression, quality of life, infertility-related stress, hopelessness, and perceived social support amongst the sample?

2. How do self-reported measures of anxiety, depression, hopelessness, infertility-related stress, and perceived social support change after a 12-week group exercise program?

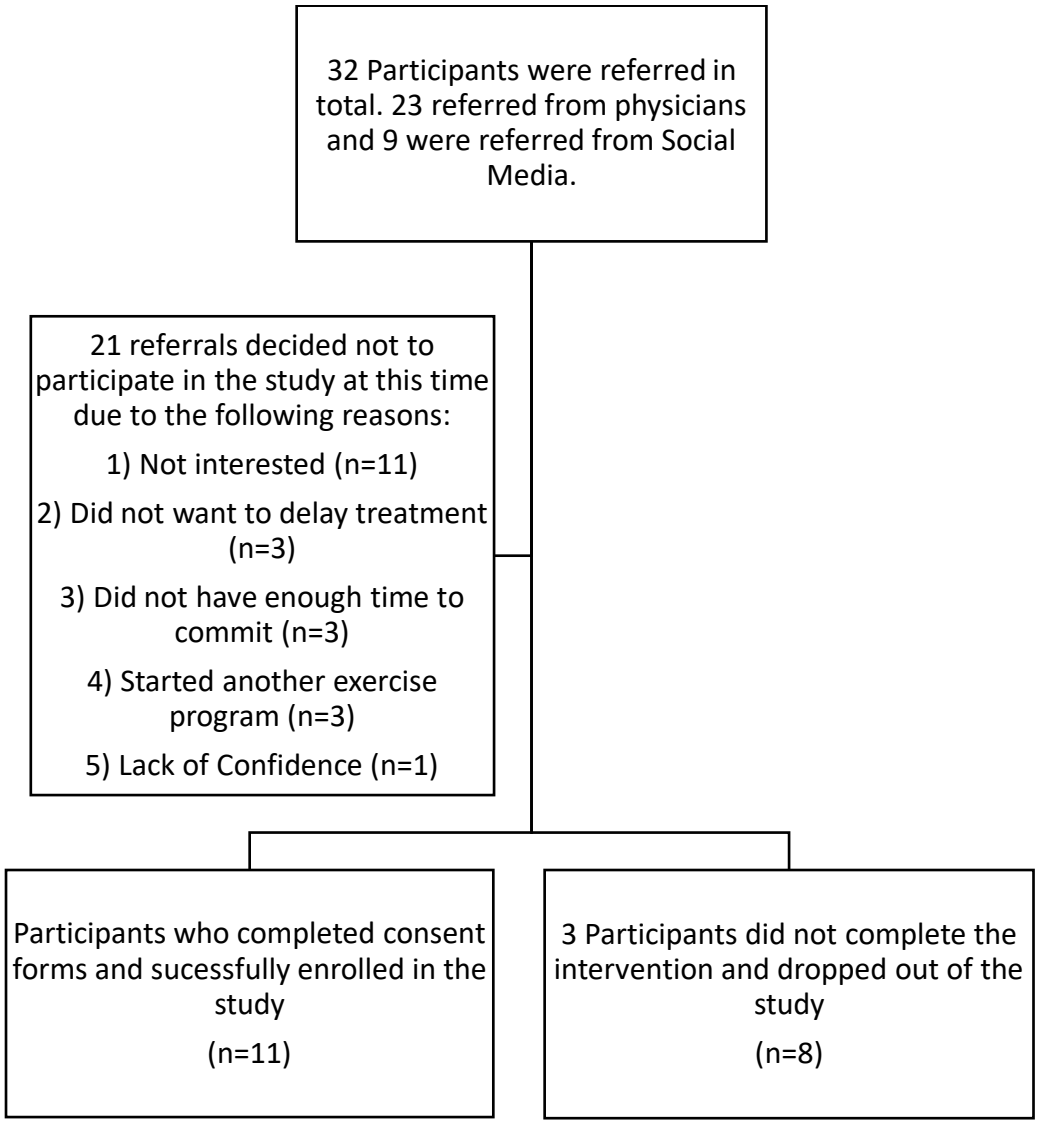
3.2 Recruitment of Study Sample

All recruitment efforts and dropout data are presented in Figure 3. The inclusion criteria for the present study were: 1) women referred to a fertility specialist physician with a BMI greater than 30 kg/m^2 and less than 40 kg/m^2, 2) who were not meeting the Canadian Physical Activity Guidelines for recommended physical activity, and 3) were willing to commit to a community-based group exercise program three days a week for 12-weeks. The exclusion criteria: 1) individuals less than 18 years or older than 37 years of age, 2) BMIs less than 30 kg/m^2, 3) metabolic disease including diabetes as excluded by fasting glucose level >126 mg/dl (SI: >6.99 mmol/l) or a 2-hour oral glucose tolerance test (OGTT) value >200 mg/dl (SI: >11.10 mmol/l) (The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 2003), 4) physical impairments limiting exercise training, 5) diagnosis of cardiovascular disease and 6)

diagnosis of infertility due to male factor, PCOS, endometriosis, fallopian tube obstruction, or diminished ovarian reserve, and 7) unwilling to delay fertility treatment for 16 weeks.

Figure 3

Recruitment Efforts and Dropout Data



Based on the above inclusion/exclusion criteria, potential participants were identified by physicians at NL Fertility Services: 1) as new patients to the NL Fertility Services clinic for their initial assessment or 2) following a review of current patients' medical records by a physician in

their circle of care. However, due to low recruitment rates, inclusion and exclusion criteria were re-evaluated to include individuals with higher BMIs. Social media platforms (local Facebook Support Groups, such as "Faces of Fertility" and "Newfoundland and Labrador Infertility Support") were used as an additional means of recruitment using a recruitment poster (Appendix 2). As presented in Figure 3, a total of 32 women were referred to the research team to discuss the details of the study. A research team member called and emailed all potential participants to introduce the study. After initial referral, 21 women decided not to participate for one of the following reasons: 1) not interested at this time, 2) do not have enough time to commit during the week, 3) do not want to potentially delay fertility treatment to participate, 4) starting their weight-loss program, or 5) lack of confidence.

Participants who agreed to participate in the study were sent an email containing a consent form, a Physical Activity Readiness Questionnaire for Everyone (PARQ+), and the Godin-Shephard Leisure-Time Physical Activity Questionnaire to determine eligibility. As mentioned in Chapter Two, individuals living with obesity are at higher risk of developing other chronic conditions that could make participating in physical activity potentially dangerous. The research team utilized the PARQ+ to assess each participant's readiness to participate in physical activity. Upon revision of the PARQ+ responses, participants that indicated having specific comorbidities like asthma, or high blood pressure, were provided with a PARmed-X to obtain medical clearance from their healthcare provider. The Godin-Shephard Leisure-Time Physical Activity Questionnaire was used to determine whether participants were meeting the eligibility criteria for physical activity while also being used as a validated tool for data collection mentioned below. After one month of recruitment, eleven participants were successfully enrolled in the study. After the completion of consent forms and medical clearance forms, participants

were sent a welcome email with instructions on the next steps, including information on how to receive exercise equipment and an invitation to a virtual introductory meeting with the research team.

3.3 Measures of Data Collection

Participants were asked to complete the questionnaire package pre-intervention and after the 12-week intervention. Questionnaires were sent to participants' emails or printed and delivered to their home addresses. Due to the virtual nature of the program, all questionnaires were completed by the participant and contained self-reported data.

3.3.1 Anthropometric Measures

Anthropometric measures were collected via a data collection form created by the research team (Appendix 3) and shared with participants at both stages of the study. The information collected from the participants allowed researchers to collect height and weight for BMI calculations, year of birth, current medications, comorbidities, and date of last menstrual period. The collected variables from the participant characteristic survey allowed the research team to describe the study sample and ensure that inclusion criteria were met.

3.3.2 Godin-Shephard Leisure Time Physical Activity Questionnaire (GSLTPAQ)

The GSLTPAQ measures leisure time physical activity (LTPA) and has been validated for adults as an accurate classification of healthy adults into active and insufficiently active groups (Godin, 2011; Godin & Shepherd, 1985; Amireault & Godin, 2015). The GSLTPAQ has been translated into various languages and has been validated in a wide range of populations. All forms of physical activity people engage in on their own time are referred to as LTPA. Therefore, it can be distinguished from other types of physical activity done as a part of a job or during daily living. An LTPA score is calculated in two steps; the first step is to separate the

frequencies by strenuous, moderate, and mild, then multiply them by nine, five, and three, respectively. Next, the total weekly leisure activity score is calculated by adding the three numbers together. The formula used is below:

$$\text{Weekly Leisure Time Activity Score} = (9 * \text{strenuous}) + (5 * \text{moderate}) + (3 * \text{mild})$$

However, when determining if a person is sufficiently active, the 3*mild score is ignored, and the remaining values are added. A score of less than 14 equates to being insufficiently active, 14-23 represents a moderately active score, and 24 units and above is considered active enough to see substantial benefits (Amireault & Godin, 2015).

3.3.3 Hospital Anxiety and Depression Scale (HADS)

The HADS was created almost 40 years ago by two researchers, Zigmond and Snaith, to measure levels of anxiety and depression in patient populations (Zigmond & Snaith, 1983). The HADS has been validated for patients and the general public (Bjelland et al., 2002). The self-assessment questionnaire's simplicity and easy-to-use nature have made it a commonly used tool in research. The HADS questionnaire has *seven items* each for depression and anxiety. Scoring for each item ranges from zero to three, with three denoting the highest levels of anxiety or depression. A total subscale score equal to or above 8 points out of a possible 21 denotes considerable symptoms of anxiety or depression. Scores can range from 0-21.

3.3.4 Short Form Health Survey, version 2 (SF-12v2))

The SF-12v2 is a health-related quality-of-life questionnaire consisting of twelve questions that measure eight domains of health that assess physical and mental health. The SF-12 is a shortened and validated version of the SF36. The 36-question SF-36 was originally developed from the Medical Outcomes Study (MOS). The SF-36 has been validated in various populations. The SF-12v2, a shortened version of the SF-36 is a valid assessment of the same

domains with fewer questions to reduce the respondent burden amongst participants (Ware et al., 1996).

The eight domains measured in the SF12 include: 1) general health, 2) physical function, 3) role physical, 4) role emotional, 5) bodily pain, 6) mental health, 7) vitality and 8) social function. The ranges of responses on each domain is from 0-100 with higher scores signifying better health. Measures on the eight domains can be pooled into physical and mental health component summary scores. Summary scores can be compared to normative data with a mean of 50 and a standard deviation of 10 (Fleishman et al., 2010). A license from QualityMetric is required to administer and score the SF-12v2. Individual questionnaire responses were entered into the QualityMetric software in order to generate individual domain scores and physical and mental components scores.

3.3.5 Fertility Problem Inventory (FPI)

The FPI is used to measure self-perceived infertility-related stress and was developed by researchers in 1991 using significant infertility-related themes within the literature to help identify and measure patient concerns and perceived stressors associated with infertility (Abbey et al., 1991). The FPI has demonstrated validity in women experiencing infertility. There is limited literature determining the validity and reliability of the FPI within a population living with obesity and infertility (Abbey et al., 1991, Rodino et al., 2016). The 46-item questionnaire uses a Likert scale from 1 to 5 to measure the following five domains: 1) sexual concern, 2) social concern, 3) relationship concern, 4) need for parenthood, and 5) rejection of a childfree lifestyle. The questionnaire is separated into each domain for scoring, the first ten questions belong to the social concern domain, the following eight questions belong to the domain of sexual concern, questions 19 to 28 fall into the relationship concern domain, 29 to 36 belong to

rejection of childfree lifestyle, and finally questions 37 to 46 focus on the need for parenthood. Each question is scored on a Likert scale and summed for a total of each domain (Newton et al., 1999). Using the FPI domain scores, a measure of global stress can be calculated by summing the individual scores of the five domains. Global stress and domain scores were calculated before and after the exercise intervention. Higher global stress scores indicate higher infertility-related stress.

3.3.6 Beck Hopelessness Scale (BHS)

An essential psychological concept called "hopelessness" is defined as having low expectations for oneself and one's future and having a bad emotional state characterized by the inability to solve one's difficulties (Yip & Cheung, 2006). The BHS is a 20-item self-reported questionnaire developed by Beck et al. (1974) designed to quantify three significant aspects of hopelessness in outpatients: feelings about the future, loss of motivation, and expectations. The BHS has high predictive and internal validity, but some researchers recommend a shortened version (Steed, 2001). Scores ranging from 0 to 3 are considered within the normal range, 4 to 8 identify mild hopelessness, scores from 9 to 14 identify moderate hopelessness, and scores greater than 14 identify severe hopelessness. Scores range from 0 to 20.

3.3.7 Multidimensional Scale of Perceived Social Support (MSPSS)

The MSPSS was created by Zimet and Farley in 1988 and is a 12-item subjective measure of perceived social support from three sources: family, friends, and significant others (Zimet et al., 1988). The MSPSS has been validated for use in various populations (Dambi et al., 2018). The questionnaire uses a six-point Likert scale (0 = strongly disagree, 5 = strongly agree). A total score is calculated by summing the results for all items. The possible score ranges between 12 and 84 – the higher the score, the higher self-perceived social support. A score of 12-

35 denotes low perceived social support, 36-60 is medium, and 60-84 denotes high perceived social support. Scores were obtained from participants and compared before and after the completion of the intervention.

3.3.8 Post-Intervention Informal Feedback

After completing the exercise intervention, all participants were asked to share informal feedback on the exercise intervention, the study design, and psychosocial measures that were collected. Invites were sent to participants via email, and the feedback occurred in person at a women-only fitness centre. Two feedback sessions were held based on the availability of the participants. Both groups were audio recorded and transcribed in order to help with a summary of high-level feedback due to the exploratory nature of the study. The questions used to facilitate the feedback are listed in Table 2.

Table 2

Questions to Facilitate Post-Intervention Informal Feedback

Post-Intervention Informal Feedback Questions
1. How did you feel when the physician mentioned the study or found the poster online?
2. When the family physician referred you to the fertility clinic, did they provide you with any resources?
3. Did you utilize the local fertility support group online? Or using online resources to help you on your fertility journey?
4. From a patient perspective, what would you have wanted while you are waiting to see a doctor at the fertility clinic?
5. How did you feel when/if you did miss a workout?
6. Did you find the Facebook group to be beneficial?

3.4 Analysis

Due to the small sample size (n=11), statistical analysis is limited to descriptive statistics. Statistical analysis of pre-intervention and post-interventional data (e.g., age, weight) was performed using IBM SPSS Statistics (Version 28.0.1.0). For each questionnaire, individual responses before and after intervention are presented in table or figure format. A student license was obtained from QualityMetric to analyze the SF12v2 data. PRO CoRE scoring software was used to score SF-12v2 domains and to analyze means and standard deviations of the physical and mental component scores (PCS, MCS, respectively).

3.5 Ethical Considerations

Conducting a research study involving women living with obesity and infertility participating in a virtual exercise program raises several important ethical considerations. Firstly, informed consent becomes crucial, ensuring that participants fully understand the study's objectives, potential risks, and benefits, and that they voluntarily agree to participate. Given the sensitive nature of the study population, confidentiality and privacy safeguards must be in place to protect the participants' personal information. Additionally, it is vital to ensure that the virtual exercise program is designed with the participant's safety and well-being in mind, considering their specific health conditions and limitations. All participants were required to have medical clearance to participate in the study. The study should also prioritize inclusivity, ensuring all participants have equal access to the virtual program, irrespective of socioeconomic or technological barriers. Moreover, researchers must be mindful of potential emotional and psychological implications for the participants, offering appropriate support and counselling throughout the study. Finally, transparency in reporting and sharing the study's findings is essential to advance knowledge and benefit the broader community while respecting the participants' rights and privacy. This study received ethics approval from the provincial health research ethics authority (HREA # 2019.214); please see Appendix 1.

Chapter 4.0 Results

Eleven participants were enrolled in the exercise intervention study. Pre-intervention, nine participants completed all of the questionnaires with the exception of two participants who completed some questionnaires. Post-intervention, seven participants completed all post-intervention questionnaires. Four participants did not complete the 12-week exercise intervention and dropped out of the study not completing the post-intervention questionnaires. The results from questionnaire data are reported in the Tables and Figures below and include participant characteristics and scores from the questionnaires that include: the Godin-Shephard Leisure-Time Physical Activity Questionnaire (GSLTPAQ).

4.1 Participant Characteristics

The participants ranged from 28 to 42 years of age, with an average of 34 ± 3.7 at the time of enrollment. Self-reported anthropometric measures (e.g., height and weight) were collected using a survey pre-intervention and after the completion of the intervention. BMI (kg/m2) was calculated before and after the intervention. Pre-intervention participants' (n=11) average height and weight were 1.630 m ± 1.6 and 108.0 kg ± 19.5, respectively. Average BMI as pre-intervention was 40.3 kg/m2 ± 4.5 After completing the exercise program, participants (n=7) reported an average weight of 102.1 kg ± 23.3, an absolute difference of average weights of 5.9 kgs compared to the average pre-intervention. The average BMI was 38.9kg/m2 ± 5.8, a reduction from 40.3 kg/m2 pre-intervention. Measures of age, height, weight and BMI at pre-intervention and post-intervention are reported in Table 3.

Table 3

Self-Reported Demographic and Anthropometric Data as Pre-Intervention (n=11) and Post-Intervention (n=7)

		Participant ID (n =11)												
		001	005	006	008	009	013	017	019	024	027	031	Mean	SD
Baseline	Age (years)	33	32	30	36	37	28	34	33	42	36	35	34	3.737
	Weight (kg)	101.6	124.3	88.9	124.7	113.4	68.0	120.2	113.4	88.5	133.8	110.7	108.0	19.52
	Height (m)	1.575	1.676	1.651	1.702	1.651	1.448	1.676	1.626	1.549	1.702	1.676	1.630	0.074
	Calculated BMI	41.0	44.2	32.6	43.1	41.6	32.5	42.8	42.9	36.8	46.2	39.4	40.3	4.54
Post-Intervention	Weight (kg)	102.3	124.1	82.7	*	*	68.0	120.2	*	88.5	129.1	*	102.1	23.32
	Height (m)	1.575	1.676	1.651	*	*	1.448	1.676	*	1.549	1.702	*	1.630	0.091
	Calculated BMI	41.2	44.2	30.3	*	*	32.5	42.8	*	36.8	44.6	*	38.9	5.78

Note. Obesity is defined as having a BMI (kg/m^2) equal to or above 30, while severe or morbid obesity is defined as having a BMI (kg/m^2) greater than or equal to 40kg/m^2. BMI (kg/m^2)was calculated by the research team using self-reported measures of weight and height.

* *No Data*

4.2 Level of Physical Activity

Leisure time physical activity (LTPA) was measured using the GSLTPAQ. Scores range from 0 to 27, with higher scores demonstrating higher levels of leisure time activity. Scores <14 demonstrate insufficient levels of activity, scores between 14 - 23 demonstrate moderate levels of activity and scores >=24 demonstrate sufficient levels of activity. The Godin-Shephard Scores were calculated for each participant at pre-intervention and post-intervention and are presented in Table 4.

Pre-intervention, eight of eleven participants (72.7%) received scores below 14, which is indicative of being insufficiently active compared to five (71.4%) participants post-intervention. Two participants (18.2%) reported scores between 14-23, which is defined as being moderately active compared to one participant (14.3%) after the intervention. One participant pre-intervention (9.1%) and one participant after the intervention (14.3%) reported a Godin-Shephard Score above 23 pre-intervention, described as being sufficiently active.

Table 4

Leisure Time Physical Activity Questionnaire Data Collected Using the Godin-Shephard Leisure-Time Physical Activity Questionnaire at Pre-intervention (n=11) and Post-Intervention (n=7).

		Participant ID										
	Training Sessions (per week)	001	005	006	008	009	013	017	019	024	027	031
Pre-intervention (n=11)	Strenuous Intensity	1	0	0	0	0	0	0	0	1	3	0
	Moderate Intensity	0	0	1	1	0	1	0	2	2	0	3
	Mild Intensity	1	1	1	7	3	2	2	2	2	0	3
	Godin-Shephard Score	9	0	5	5	0	5	0	10	19	27	15
Post-Intervention (n=7)	Strenuous Intensity	1	0	0	*	*	0	4	*	2	0	*
	Moderate Intensity	0	0	1	*	*	0	8	*	1	0	*
	Mild Intensity	2	2	2	*	*	0	2	*	1	0	*
	Godin-Shephard Score	9	0	5	*	*	0	76	*	23	0	*

Note. A LTPA score is calculated in two steps. The first step is to separate the frequencies by strenuous, moderate, and mild, then multiply the frequency by nine, five, and three, respectively. Second, the total weekly leisure activity score is calculated by adding the three numbers together. To determine if a person is sufficiently active, the 3*mild score is not included, and the remaining values are

added together to provide a total score. A score of less than 14 equates to being insufficiently active, 14-23 represents a moderately active score, and 24 units and above is considered active enough to see substantial benefits.

*No Data

4.3 Validated Measures of Anxiety, Depression, Quality of Life, Fertility-Related Stress, Hopelessness, and Perceived Social Support at Baseline

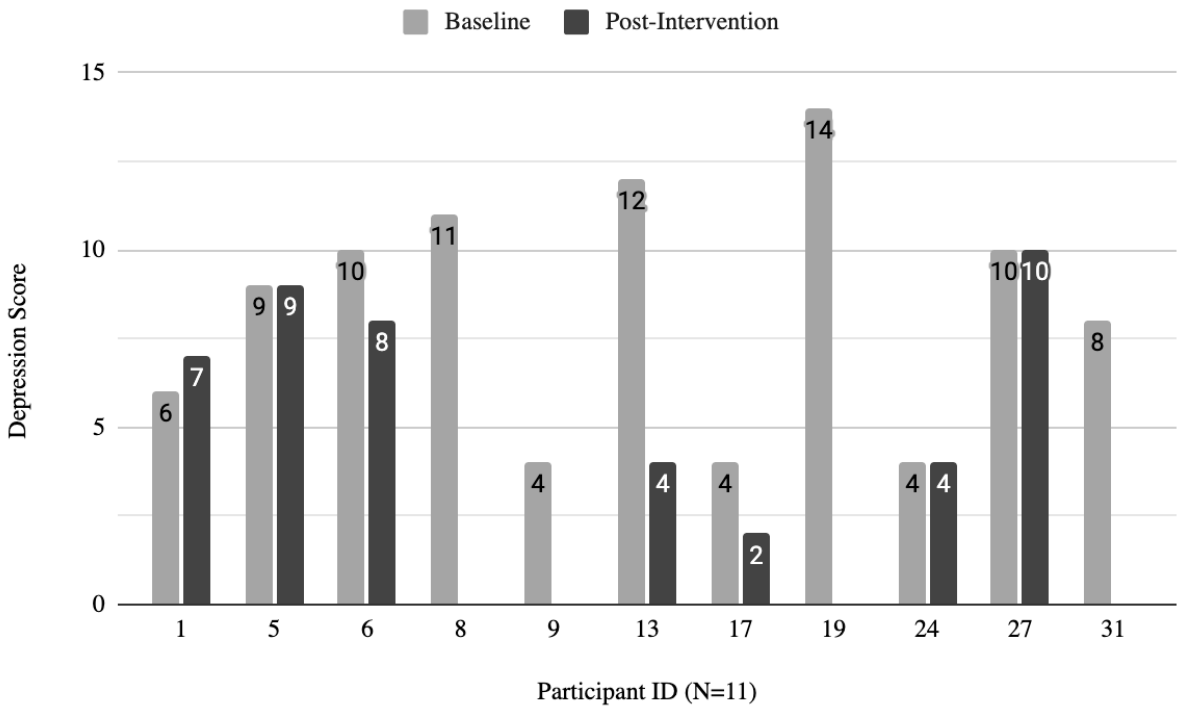
4.3.1 Anxiety and Depression

Individual scores for depression and anxiety were measured using the Hospital Anxiety and Depression Scale (HADS) and are displayed in Figures 3 and 4. Scores range from 0-21, with higher scores representing more severe levels of depression and anxiety. Total subscale scores for depression and anxiety equal to or above eight represent considerable symptoms of depression and anxiety. Pre-intervention, participant scores for depression and anxiety ranged from 4 to 14 and 1 to 8, respectively, with averages of 8.4 ± 3.5 for depression and 4.3 ± 2.2 for anxiety, respectively. Seven participants (63.6%) reported having considerable symptoms of depression, and one participant (9.1%) reported considerable symptoms of anxiety.

Post-intervention (n=7), scores for depression ranged from 2 to 10, with a mean score of 6.3 ± 3.0, a 2.1-point decrease from pre-intervention (8.4±3.5). Scores for anxiety ranged from 2 to 9, with an increase in average to 4.9 ± 2.5 from pre-intervention (4.3±2.2). After the intervention, three of seven participants (42.9%) reported considerable symptoms of depression, compared to 63.6% pre-intervention, while two participants (28.6%) reported considerable symptoms of anxiety compared to 9.1% as pre-intervention. Individual scores for depression and anxiety are illustrated in Figures 4 and 5.

Figure 4

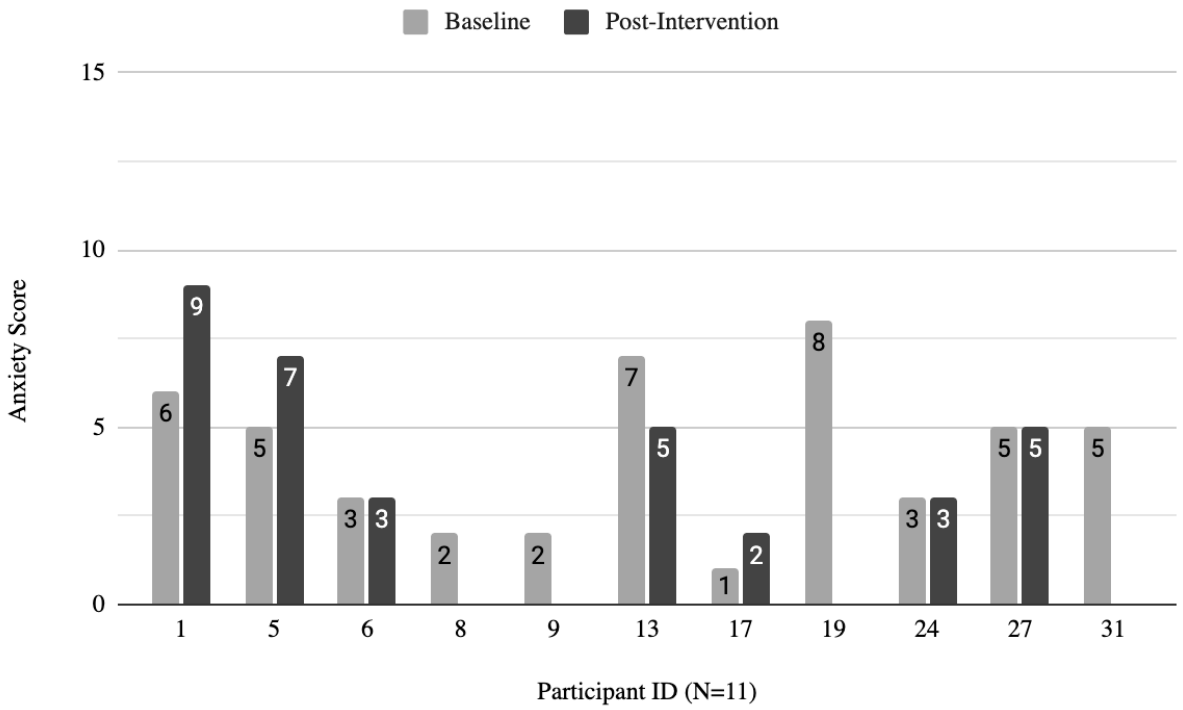
Participant Depression Scores at Pre-Intervention (n=11) and Post-Intervention (n=7) Collected Using the HADS



Note. Scores range from 0-21. Total subscale scores for depression and anxiety equal to or above eight represent considerable symptoms of depression.

Figure 5

Participant Anxiety Scores Pre-Intervention (n=11) and Post-Intervention (n=7) Collected Using the HADS Questionnaire



Note. Scores range from 0-21. Total subscale scores for depression and anxiety equal to or above eight represent considerable symptoms of depression.

4.3.2 Health-Related Quality of Life (HRQoL)

HRQoL was measured using the SF12v2. Based on survey questions on eight domains, physical and mental component scores can be calculated with scores ranging from 0-100 and 50 (±10), indicating normative scores for the general population. A physical component score of 50 or less has been recommended as a cut-off to determine a physical condition. While a mental score equal to or below 42 may be indicative of clinical depression (Fleishman et al., 2010).

Individual scores for physical and mental components are reported in Table 5. Pre-intervention, the average physical and mental component scores were 51.4 (± 4.3) and 43.03 (± 8.7), respectively. The sample average pre-intervention for mental and physical components scores was within normal ranges. Eight participants out of eleven reported a higher-than-average physical component score of 50.00 (±10.00), while six of eleven reported mental component scores lower than the average of 50.00 (±10.00).

After the intervention, the average physical and mental component scores were 55.7(± 6.1) and 32.8(± 8.5), respectively. An increase was observed in the physical component score from 51.4 (± 4.3) pre-intervention, while a decrease was observed in the mental component score from 43.0(± 8.7) pre-intervention. Four of the remaining seven participants reported physical component scores higher than those reported pre-intervention; one score remained consistent, and two scores decreased. Mental component scores decreased in four of seven participants; one decreased by over 20 points. Other mental component scores increased in two participants while one remained constant.

Table 5

Physical and Mental Component Scores Collected Using the SF-12v2

	Participant ID (n=11)												
	001	005	006	008	009	013	017	019	024	027	031	Mean	SD
	Baseline												
Physical	46.32	54.05	43.89	51.87	54.32	51.90	53.07	56.66	46.18	50.99	56.58	51.44	4.27
Mental	39.28	35.59	49.15	41.61	52.82	44.36	57.19	29.35	51.19	33.76	38.98	43.03	8.74
	Post-Intervention (n=7)												
Physical	61.83	57.78	54.85	*	*	61.83	57.78	*	51.58	44.69	*	55.76	6.09
Mental	24.93	32.09	28.51	*	*	24.93	32.09	*	49.06	37.65	*	32.75	8.48

Note. The physical and mental component scores are summary scores based on 8 domains, scores range between 0-100. The summary scores are based on national average whereby 50 represents an average score for each summary score. A physical component score 50 or less has been recommended as a cut-off to determine a physical condition. While a mental score equal to or below 42 may be indicative of "clinical depression".

**No Data*

4.3.3 Infertility-Related Stress

Two participants did not complete the questionnaire at baseline and dropped out of the program before completion, along with two additional participants. Individual scores for each domain and overall global stress are shown in Table 6. At baseline, participant scores for global stress ranged from 138 to 176, with an average score of 158.9 ± 12.8. Post-intervention global stress scores ranged from 138 to 164, and the average was reduced to 153.1 ±10.3. Compared to baseline measures, reported social concern was reduced in six out of seven participants (85.7%) with post-interventional data. Measures of sexual concern increased in three participants (42.9%) post-intervention and decreased in the remaining four (57.1%). Reported relationship concern remained the same or approximately the same in four of the seven participants and decreased by multiple points in the other three participants (42.9%). Scores representing the rejection of a child-free lifestyle increased amongst four participants (57.1%) and decreased in two (28.6%). Three of the participant scores (42.9%) reported that the need for parenthood domain remained within 1 point of their baseline scores, remaining stable. However, two scores (28.6%) for the need for parenthood domain decreased by multiple points after the exercise program, while one participant's score (14.3%) increased by multiple points. Finally, the global stress scores decreased in five of seven participants (71.4%) post-intervention. The averages for each domain were calculated for both time points; however, no significant changes were observed between the averages of each domain despite the changes observed on a participant level.

Table 6

Baseline and Post-Intervention Fertility Problem Inventory Data

		Participant ID (n=9)										
	Parameters	**001**	**005**	**006**	**008**	**013**	**017**	**024**	**027**	**031**	**Mean**	**SD**
Baseline	Social Concern	31	27	36	27	34	37	35	31	38	32.89	4.11
	Sexual Concern	21	31	25	27	39	31	24	36	26	28.89	5.86
	Relationship Concern	28	30	30	30	38	26	29	43	42	32.89	6.35
	Rejection of Child Free Lifestyle	32	21	31	25	29	26	45	33	39	31.22	7.33
	Need for Parenthood	35	38	38	29	30	39	28	29	31	33	4.47
	Global Stress Scores	147	147	160	138	170	159	161	172	176	158.89	12.81
Post-Intervention	Social Concern	25	37	33	*	32	28	30	26	*	30.14	4.22
	Sexual Concern	25	29	28	*	33	24	25	35	*	28.43	4.24
	Relationship Concern	29	30	30	*	30	26	27	36	*	29.71	3.20
	Rejection of Child Free Lifestyle	32	26	26	*	30	31	37	37	*	31.28	4.54
	Need for Parenthood	27	39	47	*	28	36	28	30	*	33.14	7.46
	Global Stress Scores	138	161	164	*	153	145	147	164	*	153.14	10.25

*No Data

4.3.4 Hopelessness

Hopelessness was measured using the Beck's Hopelessness Scale. Scores range from 0 to 20. Scores from 0-3 are considered in the normal range, those from 4-8 equate to mild hopelessness, and scores between 9-14 represent moderate hopelessness. Scores above 14 identify severe hopelessness. Individual scores for hopelessness are reported in Table 7. Ten of eleven participants completed the questionnaire pre-intervention, and seven completed the questionnaire post-intervention. Of the ten participants pre-intervention, only two participants (18.2%) reported mild hopelessness, with the remaining eight participants scoring (72.7%) in the normal range. Post-intervention, three of seven participant scores (42.9%) remained constant, while four participants (57.1%) reported decreases (a reduction) in hopelessness.

Table 7

Baseline and Post-Intervention Beck Hopelessness Scale Data

	Participant ID (n=11)										
Timepoint	001	005	006	008	009	013	017	019	024	027	031
Baseline	2	6	1	1	2	1	0	*	2	8	2
Post-Intervention	0	3	1	*	*	0	0	*	2	7	*

Note. Scores ranging from 0-3 are within a normal range, scores ranging from 4-8 equate to mild hopelessness, while scores between 9-14 represent moderate hopelessness, and finally scores above 14 identify severe hopelessness.

*No Data

4.3.5 Perceived Social Support

The multidimensional scale of perceived social support (MSPSS) includes 12 items scored on a Likert scale from 1-5. Scores range from 12-84, the higher the score, the higher the

perceived social support. Scores from 12-35 signify low levels, 36-60 medium levels and 60-84 high levels of social support. Pre-intervention, ten of eleven participants completed the questionnaires and post-intervention, seven of seven completed the questionnaire. All participants reported scores signifying high levels of perceived social support both before and after the intervention. Post-intervention, five of the seven participants reported decreases in their scores compared to pre-intervention, and two scores remained constant. Individual data for both timepoints are displayed in Table 8.

Table 8

Pre-Intervention and Post-Intervention Multidimensional Scale of Perceived Social Support Data

	Participant ID (n=11)										
	001	005	006	008	009	013	017	019	024	027	031
Baseline	84	84	68	84	79	80	84	*	82	66	65
Post-Intervention	82	84	62	*	*	71	82	*	81	66	*

Note. A score of 12-35 denotes low perceived social support, 36-60 is medium, and 60-84 denotes high perceived social support.

*No Data

4.3.6 Informal Feedback on Study Design

After the completion of the study, an informal feedback session was held for interested participants. Five of seven participants attended the post-intervention informal feedback session. The questions asked to stimulate and encourage discussion are listed in Table 2. Based on the discussion, participants highlighted a number of issues that could be used to inform future studies in this area. The following issues were raised: 1) physician/recruitment posters were not clear on obesity requirements for the study, 2) there is a lack of resources available to patients being

referred to the fertility clinic in NL, 3) online resources are oftentimes the only resources available and the virtual fertility support groups are often filled with misinformation, irrelevant or conflicting information, or triggering content, 4) it would be helpful to have a list of reliable resources to explore while on the waitlist to see a fertility doctor or a checklist of to-dos to prepare for initial appointments, 5) guilt was associated with missing workouts during the program, but this guilt decreased when they realized other participants were not attending, and 6) the link between obesity and fertility was not well understood amongst participants. As a result, no one expected to get pregnant because of the study.

Chapter 5.0 Discussion

5.1 Introduction

The present thesis was a pre-experimental study using a patient-oriented research approach that examined psychosocial measures before and after an exercise program for women living with obesity and experiencing infertility. This methodological approach resulted in developing and testing a patient-centred intervention that focused on psychosocial outcomes associated with living in a larger body, having an infertility diagnosis and participating in an exercise program. This thesis was a substudy of a larger study investigating the feasibility of a virtual exercise study for women living with obesity and experiencing infertility. The primary objective of the larger study was the assessment of recruitment and consent rate, adherence, adverse events, and acceptability through heart rate levels. However, the impact of using a patient-oriented research approach helped inform the assessment of PROMs. Based on a literature review, the research team selected validated measures to explore psychosocial outcomes of the study population. While it was beyond the scope of this thesis, future research may include a more immersive qualitative research methodology in order to better understand study participants' experiences of participating in exercise programs.

For the current thesis, patient partners contributed in several ways and at different stages. The aim of the patient engagement sessions (also described as ‘informal feedback sessions’) was to collaborate with the patient partners to create research objectives and obtain feedback on the methodology. Initially, patient engagement sessions were held to build rapport between the researcher and patient partners and to inform the patient partners on the current issues in obesity and infertility and, more specifically, exercise programming as it relates to infertility. Because our patient partners had previous experience participating in a physician-referred exercise

program, during these sessions, they discussed their experiences with infertility and the importance of social support when participating in an exercise program. In patient-oriented research, this is considered engagement at the levels of inform and consult whereby the patient partners are informed on existing problems, opportunities, and solutions (Amirav et al., 2017), but are also consulted on their experiences. In the subsequent patient engagement sessions, the patient partners participated in level two engagement as the researchers consulted with the patient partners to develop research questions and receive feedback on methodological considerations for the pilot exercise study (Amirav et al., 2017).

Based on feedback from the patient partners, the purpose of the study was to evaluate the overall health and well-being of individuals living with obesity and experiencing infertility before and after a 12-week virtual exercise program. Based on discussions with patient partners, the research team chose to assess anxiety, depression, quality of life, fertility-related stress, hopelessness, and perceived social support. This pilot feasibility study did not have statistical power for hypothesis testing; the primary study aimed to assess adherence to the exercise program. In addition, significant attrition complicated the capacity to conduct inferential statistics and interpret the findings related to changes in psychosocial outcomes.

Nevertheless, based on descriptive statistics and individual dataset observations, the intervention may have improved psychosocial outcomes such as depression, physical components of quality of life, fertility-related stress, and hopelessness while negatively impacting anxiety, mental components of quality of life, and perceived social support. Due to the exploratory nature of this pilot study, following the study, study participants were invited to engage in discussion-group feedback sessions in a patient-partner capacity. Based on the patient engagement sessions post-intervention, the patient partners' feedback provided additional insight into the descriptive quantitative findings. For example, patient partners expressed guilt associated with missing

workouts during the program; this guilt decreased when patient partners realized other participants were not attending. The self-report negative increase in anxiety, mental components of quality of life and perceived social support may be connected to feelings of guilt associated with exercise program participation. Further qualitative research is needed to explore patients' experiences with feelings of guilt and other mental processes, such as anxiety, in the context of exercise participation.

To summarize, this thesis aimed to investigate two research questions informed by the gaps identified in the literature review (Chapter 2) and the combined POR and quantitative methodological approach (Chapter 3):

1. Using validated tools, what are the pre-intervention measures of anxiety, depression, quality of life, infertility-related stress, hopelessness, and perceived social support amongst the sample?
2. How do self-reported measures of anxiety, depression, hopelessness, infertility-related stress, and perceived social support change after a 12-week group exercise program?

The following sections will provide a summary and interpretation of the main findings from the pilot study presented in Chapter 4.

5.2 Anthropometric Measures

Self-reported measures such as age, weight, and height were collected to characterize the study population and evaluate any changes resulting from the intervention. Although changes in anthropometric measurements were not a primary research objective, summarizing the results can provide valuable insights and comparisons with other studies in the field.

Pre-intervention, the average age and BMI of the study cohort were 34 years and 40.3 kg/m2, respectively. The BMIs of our participants are much higher than those of similar studies

(Mutsaerts et al., 2016; Palomba et al., 2008). The higher BMI in our sample may be due to our study's inclusion criteria, which required individuals with a BMI greater than 30, in contrast to other studies that included a wider range of BMI starting at a minimum cut-off of 25 (Best et al., 2017; Biviá-Riog et al., 2020; Palomba et al., 2008). We specifically targeted individuals with a BMI greater than 30 kg/m^2, because the metabolic profile of individuals who are classified as overweight (BMI of 25 to 29 kg/m^2) differs from that of someone who is classified as obese (BMI over 30kg/m^2) (Janssen, 2013). As the primary study was a pilot feasibility study, researchers were interested in adherence to a moderate-to-high-intensity exercise program in an obese population. Additionally, the higher average BMI may be attributed to higher rates of Class III obesity in Newfoundland and Labrador compared to other populations (Twells et al., 2014).

When examining the effects of our exercise-based intervention on weight loss, we found that 29% of participants reduced their reported weight by multiple kilograms. In contrast, 57% of participants reported little to no weight loss. The average weight loss achieved during our study was 1.5kg which is lower than reported in similar studies (Vitek et al., 2022). Other studies reported an average weight loss of 4.4 kg (Mutsaerts et al., 2018), 5.5 kg (Espinos et al., 2017), and 3.8 (Moran et al., 2011). However, other studies included an additional diet component of their behavioural intervention (e.g., restrictive diets, behavioural-change counselling). A recent systematic review of systematic reviews and meta-analysis revealed that most non-surgical weight loss interventions reported weight losses of less than 2 kg (Twells et al., 2021). In the present study, there was no emphasis on weight loss for two reasons: (1) the inconsistencies reported in the literature on the impact of exercise for weight loss to improve fertility-related outcomes, and (2) the primary focus of the pilot study was investigating the feasibility of the exercise program (e.g., adherence) (Best et al., 2017; Hoek et al., 2022; Legro et al., 2022; Vitek et al., 2022).

5.2.1 Physical Activity

Physical activity, exercise and reproductive health is an area that has received a significant amount of attention in the past number of years. For example, exercise has been shown to positively impact fertility outcomes by improving ovulation rate and restoration of menstrual cycles (Maher, 2022; Palomba et al., 2008).

In the present research, pre-intervention, only one participant scored sufficiently active on the Godin-Shephard Leisure-Time Physical Activity Questionnaire. These results were expected as participants were recruited based on eligibility criteria for not meeting the Canadian Physical Activity Guidelines (participating in less than 150 minutes of moderate-to-vigorous physical activity per week) (Tremblay et al., 2011). Studies have shown that having a higher BMI is directly related to reduced leisure time-physical activity levels (Bradbury et al., 2017; Godin et al., 2008). Based on similar studies with longitudinal follow-up, it was anticipated that self-reported leisure time physical activity would increase amongst participants following our intervention (Elten et al., 2019; Moran et al., 2011). In this study, participants continued to adhere to a healthier lifestyle and reported lower BMIs five and a half years after the completion of the intervention (Elten et al., 2019). In comparison, post-intervention data from our study showed similar levels of physical activity before and after the completion of the intervention, suggesting that the intervention did not motivate participants to increase leisure-time physical activity once the study ended.

Feedback from the post-intervention session revealed that participants did not understand the link between physical activity and fertility, which provided insight into why some participants did not adhere to the exercise program, may have dropped out of the study, or decided to stop exercising altogether after the completion of the study. These findings support the findings of a study conducted by Kucuk et al. (2009), where women reduced their physical activity during

assisted reproductive technology (ART) because they thought it would decrease their chance of conceiving. Patient misconceptions surrounding physical activity and exercise prescription and participation have been documented in multiple studies (Symons Downs & Hausenblas, 2003; Kucuk et al., 2009). Based on the findings from the present study, which is supported by previous work in the area, to improve physical activity levels in this population, mitigating misconceptions and providing education and training to patients living with infertility and obesity is critical.

5.3 Psychosocial Measures

5.3.1 Anxiety and Depression

Anxiety and depression are commonly reported among women living with obesity and experiencing infertility (Massarotti et al., 2019; Palomba et al., 2018; Rodino et al., 2016). In our study sample of eleven participants, as demonstrated by scores on the HADS questionnaire, most participants reported considerable symptoms of depression pre-intervention (63.6%). In contrast, only one participant reported substantial anxiety symptoms and stopped participating in the exercise program before the 12 weeks. These findings may indicate that persons with higher levels of anxiety may be challenged with adherence to exercise. Previous behavioural intervention studies reported higher levels of anxiety and depression among women with an infertility diagnosis pre-intervention (Kim et al., 2019; Massarroti et al., 2019; Palomba et al., 2018; Patten et al., 2021). For example, Palomba et al. (2018) showed that exercise demonstrated significant improvements in depression and anxiety symptoms in women living with obesity and experiencing infertility. The experience of social physique anxiety has been shown to reduce levels of physical activity (Gammage et al., 2014). The existing literature and the findings of this thesis suggest that it would be valuable to investigate potential disparities in exercise engagement among individuals with higher levels of anxiety compared to depression.

Based on the literature, we anticipated that self-reported symptoms of depression and anxiety would decrease after the completion of the intervention (Galletly et al., 1996; Kim et al., 2019; Massarotti et al., 2019). In our study sample, we observed that in comparison to pre-intervention, three of seven participants had decreased depressive symptoms, while one participant had increased symptoms, and three participants reported no change post-intervention. Meanwhile, for symptoms of anxiety, three of the participants reported an increase in symptoms, one reported a decrease, and three reported no change. In general, the findings suggest that the intervention and engagement in the study had a beneficial effect on depressive symptoms but an unfavourable effect on anxiety symptoms. Nevertheless, it is essential to note that individual differences were observed. In a meta analysis conducted by Dammen et al., (2018), results showed that behavioural interventions (diet, exercise, and motivational counselling) in women of reproductive age living with overweight or obesity consistently reduced symptoms of depression and anxiety. However, the authors did not focus on women also living with infertility. The improvement in depressive symptoms is aligned with the results found in other studies and could be attributed to experienced weight-loss by participants or improvements in self-esteem as a result of the exercise program (Dammen et al., 2018; Patten et al., 2021). The increase in symptoms of anxiety reported by our sample has not been explained by other studies.

There is limited research on the barriers to participation experienced by women living with obesity and experiencing infertility (Mutsaerts et al., 2013). However, a study by Sharifi et al. (2013) identified several barriers to participating in lifestyle programs reported by women living with obesity. These barriers included stress, depression, lack of time, and lack of motivation (Sharifi et al., 2013), barriers echoed by patient partners in our patient engagement sessions. Interestingly, a study reviewing variables for predicting dropouts in research involving women living with obesity and experiencing infertility could not find significant predictive

measures (Mutsaerts et al., 2013). The authors concluded that pre-intervention data does not accurately predict a participant's risk of drop-out and that drop-out may be related to the rate of weight loss at the beginning of the intervention (Mutsaerts et al., 2013).

For the present thesis, it is important to acknowledge the potential impact of the COVID-19 pandemic on outcomes related to mental health. According to the WHO, the pandemic resulted in a 25% increase in anxiety and depression globally (WHO, 2022). Levels of depression and anxiety were further increased for patients seeking fertility services during the COVID-19 pandemic (Gordon & Balsom, 2020; Gürtin et al., 2021). Fertility patients were affected by clinic closures without any anticipated date of re-opening, leading to delayed or cancelled appointments and procedures (Gürtin et al., 2021). A recent study examined the effects of fertility treatment suspensions and revealed that the suspensions had a considerable negative impact on women's mental health and quality of life (Gordon & Balsom, 2020).

5.3.2 Quality of Life (QoL)

Quality of life (QoL) measures are designed to allow patients' perspectives on the impact of health and healthcare interventions on their lives (Addington-Hall & Kalra, 2001). This measure aligns with patient-oriented research, which prioritizes patient input and values. The SF-12 is the most widely used tool to measure health-related quality of life (Huo et al., 2018). Based on patient engagement sessions, it became clear that incorporating a patient-reported outcome measure (PROM) would provide valuable insights into the impact of our intervention on patients' perspectives of their physical and mental health, social functioning and overall well-being (Huo et al., 2018).

Comparing the SF-12 findings to normative data, despite seven of eleven participants having BMIs greater than 40 kg/m^2, 72.3% of participants reported a higher-than-average QoL for

the physical component during the initial assessment (pre-intervention). Conversely, 54.5% of participants reported mental component QoL scores indicative of clinical depression. The high physical component scores were unexpected as obesity has been shown to decrease both physical and mental components of quality of life (Taylor et al., 2013). A higher perceived physical quality of life has been observed in the Newfoundland and Labrador population (Statistics Canada, 2019).

After completing the study, 86% of participants reported an increase in the physical component QoL scores from pre-intervention; however, 14% reported a decrease in this component scores. For the mental component QoL scores, the opposite was true, 86% of participants reported a decrease following the intervention, with one participant showing a reduction of over 20 points. In research that focused on men and women living with obesity, exercise interventions have shown to improve health-related outcomes and physical QoL, but it is unclear whether these positive effects can extend to mental quality of life (Baillot et al., 2018). There is limited research on the effects of exercise interventions on QoL in women living with obesity and experiencing infertility, and in the literature focusing on men and women living with obesity the results are inconsistent (Carraça et al., 2021). In general, the observation of an increased physical component QoL score and a decrease in the mental component QoL score support findings that are supported by previous literature investigating QoL following an exercise intervention (Baillot et al., 2018). Notably, Dammen et al. (2019) conducted a randomized control trial on women living with obesity and experiencing infertility. Authors showed that the behavioural intervention had limited effects on mental and physical QoL at follow-up but attributed the null findings to the lack of specific factors like combining group sessions with individual coaching sessions (Wadden et al., 2011). Dammen et al. (2019) found an improvement in physical QoL shortly after the completion of the intervention, which later returned to pre-

intervention after 5 years. The increase we observed in physical QoL could be attributed to the timing of the follow-up after the intervention.

Based on feedback from our post-intervention patient engagement sessions, the reduction in the mental component scores could have resulted from multiple reasons that may have been unrelated to the intervention. For example, as this study was delivered during the COVID-19 pandemic, patient partners discussed the emotional stress of cancelled fertility appointments and long treatment wait times. Cancelled services lead to longer wait times for fertility consultations and reduce patients' mental health and quality of life (Gordon & Balsom, 2020). Based on the findings from the present study, and the potential impact of the COVID-19 pandemic, it would be beneficial to complete this study on participants who are not challenged by delays in healthcare and the unpredictability of treatment times on health-related QoL.

5.3.3 Infertility-Related Stress

Infertility can catastrophically impact levels of perceived stress. Women experiencing infertility reported similar levels of perceived stress than women diagnosed with cancer (Skiadas et al., 2011). There is a bidirectional relationship between stress and fertility, where heightened stress levels can negatively impact biological mechanisms related to fertility and experiencing infertility can increase the amount of stress experienced (Palomba et al., 2018). The Fertility Problem Inventory (FPI) measures infertility-related stress by summing five domains; the domains consist of 1) sexual concern, 2) social concern, 3) relationship concern, 4) need for parenthood, and 5) rejection of a childfree lifestyle (Newton et al., 1999). The summative score is a global stress score that indicates the overall infertility-related stress experienced in an individual’s life (Newton et al., 1999). Patient partners discussed the stress of infertility diagnosis

during our patient engagement; thus, researchers selected the FPI to measure infertility-related stress before and after the exercise program.

Unfortunately, no normative data for the FPI tool is available, limiting the ability to compare and interpret the present thesis findings. Nevertheless, the change score showed 71% of participants reported lower global stress scores after completing the exercise program. There is a large demand for more studies that examine the effects of exercise on perceived stress (Dammen et al., 2018). This finding agrees with findings from a randomized control trial conducted by Kirca & Pasinlioglu (2019), whereby researchers found that physical activity in the form of yoga performed twice a week showed significant improvement in stress levels of women experiencing infertility. Of interest to the global stress score finding, the domains of 'Social Concern' and "Relationship Concern" saw reductions in the overall average post-intervention scores compared to pre-intervention. 86% of participants reported a decrease in social concerns while 43% of participants reported a reduction in relationship concerns. Interestingly, in the study conducted by Kirca & Pasinlioglu (2019), relationship/marital concern reduced significantly while social concern saw slight reductions according to the Copenhagen Multi-center Psychosocial Infertility (COMPI) Fertility Problem Stress Scale. However, the reduction in relationship concern is not what we had hypothesized. Previous research has shown that a weight-loss attempt by one partner in a relationship increases negative interactions, threatens the other partner's security, or changes the nature of the relationship (Romo & Dailey, 2013). Dailey et al. (2018) observed that weight loss attempts by one or both partners cause imbalance or dissatisfaction in the relationship as measured by using thematic analysis of participant interviews. Researchers found that if individuals had the necessary support from their partners and can rely on their partners to make them healthy food, for example, they have more time to devote to other responsibilities, ultimately leading to improved relationship satisfaction and successful weight loss (Dailey et al.,

2018). In the present thesis, reduced relationship concerns for several participants may indicate increased partner support for the intervention.

5.3.4 Hopelessness

Based on feedback during the patient engagement sessions, patient partners expressed a feeling of hopelessness during their infertility journey. This feedback led the researchers to measure hopelessness using BHS (Steed, 2001). Hopelessness is an important psychological construct, defined as negative expectations regarding oneself and one's future life and a negative emotional state characterized by the lack of finding a solution for one's problems (Kaya & Oskay, 2020; Yip & Cheung, 2006). The BHS has been commonly used in previous studies involving individuals with psychiatric disorders but has also been used in measuring hopelessness in fertility patients (Balsamo et al., 2020). In the present thesis, pre-intervention, compared to normative data, 80% of participants reported normal levels of hopelessness (0-3). Interestingly, only 20% of participants reported mild hopelessness. This finding may indicate differences in the characteristics of our patient partners and the study participants as a primary factor contributing to feelings of hopelessness is the length of time infertility is experienced (Iordachescu et al., 2020). Our patient partners were invited to engage with our research team based on their lived experience participating in an exercise program from 2015, with some of the partners continuing to seek fertility services during the patient engagement sessions in 2018. The study participants were more recently seeking fertility services or on the waitlist to see a fertility physician. From previous literature, it has been shown that the longer a patient experiences infertility, the more significant the feelings of hopelessness experienced (Kaya & Oskay, 2019).

With regard to wait times and resources, women living with obesity and experiencing infertility are at a disadvantage as a 5 to 10% weight reduction is prescribed prior to the initiation

of fertility treatment (Kim et al., 2020; Kort et al., 2014). Patients are provided with limited resources and weight loss strategies, and for this, among others, are often unsuccessful in achieving their weight loss target (Pandey et al., 2010). Based on our discussions with patient partners, we anticipated that participation in an exercise program decreased levels of hopelessness. Offering additional support to participants to initiate behavioural change (e.g., increased physical activity levels) and provide a sense of control over their fertility journey is also supported by an abundance of literature (Iordachescu et al., 2020; Kim et al., 2020; Kort et al., 2014; Pandey et al., 2010)

Post-interventional data supported this notion. While participants reported normal levels of hopelessness pre-intervention, 57% of the participants reported decreases in self-reported hopelessness, with only 14% of participants experiencing mild hopelessness. One participant reduced their hopelessness score from mild hopelessness to a normal range. During our patient engagement session following the completion of the study, patient partners vocalized the need for additional resources during the pre-treatment phase of infertility when patients are waiting to see a fertility physician. The present thesis findings support the need for additional resources for individuals seeking fertility services.

5.3.5 Perceived Social Support

Perceived social support broadly refers to the perception that one has a reliable social network to turn to and is cared for in times of need and contributes to the quality of life and emotional well-being (Taylor, 2013). Social support in the form of emotional understanding and physical and mental care from family members can help patients actively accept treatment and enhance their confidence to overcome infertility (Ni et al., 2021). Specific to relationships, social support acts as a protective factor which moderates the relationship between emotional disorders

and marital adjustment (such as an infertility diagnosis) (Iordachescu et al., 2020). Discussions from the patient engagement sessions had a significant focus on the importance of social support, specifically surrounding the social support that was provided by other participants in the exercise program (2015 program). This supports the findings from previous literature, which found that women prefer to exercise in contexts where safety and practical knowledge of the exercise is supervised by a professional (Lovell et al., 2016).

In the present thesis, results from pre- and post-interventional showed all participants reported high levels of social support. Unfortunately, participants reported reductions in perceived social support after the intervention's completion, though no changes resulted in a categorical shift (e.g., from high to medium social support). The slight reduction in social support may have been caused by a potential strain on participants' relationships, which is commonly observed for couples during behavioural interventions (Romo & Dailey, 2013). However, findings from the FPI, which saw a positive increase in the relationship domain, would suggest otherwise. The lack of social support may reflect the virtual aspect of the exercise program.

5.4 Conclusions

An infertility diagnosis can be a life-altering experience for individuals and couples, often resulting in complex and intense emotions. Individuals diagnosed with infertility who also live with obesity are typically advised to lose between 5 to 10% of their body weight as a means of improving their fertility-related outcomes (Kim et al., 2020; Kort et al., 2014). However, for many patients, learning that their body weight is a significant factor affecting their fertility can be a devastating revelation (Cardozo et al., 2012). The motivation for the current thesis was informed by using a patient-oriented approach to help identify the research questions. Using patient-oriented research, partner partners helped to inform the research objectives and

methodology to investigate changes in psychosocial measures following an exercise program for women living with obesity and experiencing infertility. For persons living with obesity and experiencing infertility, there are gaps that exist in our knowledge of the contribution and impact of psychosocial factors associated with participating in an exercise program (Maher et al., 2022; Massarotti et al., 2019; Palomba et al., 2018). Findings from the present thesis provide insight into changes in psychosocial measures, specifically, that participating in an exercise program may reduce depression and perceived stress for a proportion of the study participants. The relationship between obesity, infertility, and psychosocial factors is intricate, and further research is required to understand effective exercise-based interventions may have on psychosocial aspects associated with living with obesity and experiencing infertility.

Chapter 6.0 Strengths, Limitations, and Future Research Recommendations

6.1 Strengths

The present research had several strengths, including the use of a patient-centred approach to focus on an under-researched and under-served population (Dammen et al., 2019). Specifically, using patient-oriented research methodology, our research team was motivated to explore the psychosocial implications of prescribing an exercise program for women living with obesity and experiencing infertility. The work in this thesis has provided valuable insights for future preconception care research for our research team and, hopefully, others in the field. By adopting a patient-centred approach, our pilot study highlighted the significance of measuring outcomes that are often overlooked in health research, particularly among stigmatized populations who are rarely given a voice (Etchegary et al., 2022). The POR provided an opportunity for the patient voice of those with lived experiences to share their perspective and help inform study methods and outcomes. It also helped to establish a deeper insight and gave a level of authenticity to the intervention and helps identify future POR type research questions.

To further highlight this strength, our research team conducted in-person patient engagement sessions prior to the study. During these sessions, our patient partners and research team members engaged in extensive discussions regarding the research study objectives and methodology. The patient partners shared their experiences of being diagnosed with infertility, having their BMI measured at the clinic, being referred to an exercise program by their physician, and participating in the program alongside other women with similar infertility experiences. We carefully considered their feedback and discussions, and selected validated questionnaire tools to measure psychosocial constructs that were prioritized by the patient partners.

This study was conducted during the COVID-19 pandemic that halted in-person research work. Based on the COVID-19 restrictions, the study was conducted in a virtual environment. Based on our patient engagement sessions following the completion of the study, the virtual environment can be viewed as a strength as it removes barriers to participation for our population. For example, participants participate in the exercise program in the safety of their own homes and without the potential judgement of others. In our population, women living with obesity, one barrier to exercise is the discrimination experienced by individuals with obesity at the gym (Argüelles et al., 2021). When attempting in-person exercise at a fitness facility, people living with obesity commonly experience negative comments about body weight and body size, internalization of negative stereotypes on weight, ability, or appearance and explicit or symbolic rejection related to weight-centric exercise (Argüelles et al., 2021). Further, for people with symptoms of anxiety and depression, exercising in person via fitness classes or fitness facilities can trigger social physique anxiety which has shown to reduce levels of physical activity (Gammage et al., 2014). Thus, the strength of the virtual exercise environment is that it reduces the amount of stigma experienced by individuals living with obesity and decreases the social physique anxiety that is often experienced in in-person exercise.

6.2 Limitations

A major limitation of the present thesis was the generalizability of the findings. Firstly, our participants were located in the province of NL, where the population has lower than national average levels of leisure-time physical activity, higher than national average rates of obesity, and higher rates of mental health issues (Statistics Canada, 2019). As a result, the low physical activity levels, high BMIs, and potential adherence issues to the exercise program may be unique to this province. Moreover, the sample size chosen for the pilot study was not powered for

statistical testing, as the primary goal was to investigate feasibility. Consequently, we were limited to descriptive statistics.

6.2.1 Virtual Program and Self-Reported Measures

As mentioned previously, the COVID-19 pandemic had a significant impact on how the exercise program was administered. The virtual nature of the exercise program made it difficult to determine whether participants were adhering to the exercise program. Though some research suggests that virtual interventions are as effective as in-person, there is not enough evidence to fully understand how results would have been different if the program was administered in-person. Another negative impact that the virtual administration of the intervention had on the current study was the dependence on self-reported data. Despite the use of validated tools, self-reported data can sometimes be unreliable and only used when other methods of data collection are not possible.

6.2.2 Low Recruitment and High Dropout Rates

A limitation of the present thesis study was the low recruitment and high dropout rates. Recruiting participants was difficult during the early stages of the study. This resulted in the implementation of different strategies for outreach. Initially, we planned to recruit participants through physicians at the Fertility Clinic in NL. However, potential participants wanted to avoid delaying treatment since many of the patients at the fertility clinic wait over a year for referrals. The use of social media helped supplement recruitment from physicians. Researchers have experienced similar struggles in the same study population; however, the other interventions involved longer durations (6-12 months) and strict dietary components (Mutsaerts et al., 2016; Sim et al., 2014).

Our dropout rate was also higher than expected at 36.3%, much higher than similar studies, which also experienced high dropout rates at 20.4% and 10.6% (Mutsaerts et al., 2016; Sim et al., 2014). There were factors related to dropout that were evaluated in the present thesis study. For example, in the LIFEstyle Study, participants who dropped out reported lower levels of self-esteem pre-intervention than those who completed the program (Mutsaerts et al., 2016). Interestingly, one individual who referred to the study stated "lack of confidence" as their reason for not wanting to participate (see Figure 3). Given that our study population, persons with obesity, experience lower levels of self-esteem, known to negatively impact exercise participation (Kim et al., 2020; Mutsaets et al., 2016), a limitation of the present thesis study was the lack of psychological support in our intervention. For example, studies that did not experience high dropout rates included an important component missing from the current pilot study – motivational interviews (Best et al., 2017). More research should focus on mitigating the barriers to participating in research amongst the study population.

6.2.3 Respondent Burden

The virtual administration of the intervention caused additional challenges with data collection. Only 81.8% of participants completed all questionnaires pre-intervention. The questionnaires were sent via email or printed and dropped at the participant's home. Participants often returned incomplete questionnaires or ones that were not completed correctly despite having a member of the research team review each questionnaire over the phone. The research team followed up a maximum of three times with participants who did not complete questionnaires via phone and email. The participants who needed help completing the questionnaires dropped out of the study before the completion of the intervention, which could indicate an unknown barrier to participation. Completing six questionnaires and participating in the intervention may have been interpreted as labour-intensive in addition to the emotional strain

of infertility-related questionnaires, increasing the respondent burden.

6.2.4 The Use of Patient-Informed Outcome Measures

This thesis detailed a pilot study intervention developed through POR and tested using quantitative methodology through the collection of self-reported psychosocial questionnaires. By utilizing POR, patient-oriented outcomes were assessed. The research team faced some significant limitations in taking a POR approach. For example, the time required to conduct the pilot intervention study on a clinical population was substantially lengthened using both POR and quantitative methodologies. While we believe it was worthwhile, this combined approach was a substantial time commitment for the patient partners and researchers.

The next limitation of our POR approach was the level of patient engagement of the methodology. We engaged in three in-depth discussion group sessions, working closely with our patient partners to identify important research objectives. However, while we reviewed the research study design with our patient partners and discussed psychosocial constructs that influenced living with obesity, having an infertility diagnosis and participating in an exercise program with persons with shared experiences, we did not confirm with the patient partners that the selected validated questionnaires were representative of their feedback. Rather, the research team used the patient partner's feedback to investigate and select what they viewed as appropriate measurement methods.

6.3 Future Research Recommendations

The present thesis study aimed to explore changes in psychosocial outcomes following participation in an exercise program for women living with obesity and experiencing infertility. The findings from this study demonstrated the complex intersection of the experience of living with obesity and having an infertility diagnosis while participating in an exercise program. To

further expand on our psychosocial findings, future research should employ a POR approach to guide a mixed methods research study that incorporates qualitative and quantitative research. Using mixed methods research would provide additional insight and deeper understanding into understanding psychosocial constructs of change. A study population representative of the population seeking fertility services would also provide additional insight and perspective on similar studies. Our research team is currently characterizing the waitlist of participants seeking fertility service for future research involving this population.

Another important suggestion for future research is the replication of the present thesis research methodology, however, with a larger sample size that accounts for a high dropout rate. When powering the sample size for a high attrition rate, researchers can determine if the differences we observed are statistically significant or not. Additionally, it would be beneficial for future studies to focus on finding ways to reduce dropouts and improve adherence to exercise interventions. By addressing barriers to participation, researchers can contribute to promoting overall well-being and improving the quality of life for these individuals.

In clinical practice, physicians spend a significant amount of time recommending behavioural modifications (e.g., diet and exercise); however, clinics have limited resources to support patients in making these necessary changes to improve fertility-related outcomes. In addition to recommending adherence to physical activity participation and a healthy diet, the findings from this thesis support that psychological support for fertility patients, especially those with higher BMIs, should be advised. Future studies in this area should continue to incorporate patient-centred approaches to inform study design and desired outcome measures. Additionally, future research should focus on improving generalizability, reproducibility within the literature. Lastly, we recommend that a larger randomized control study, designed from information and lessons learned from this pilot study, should be conducted. In conclusion, there are many

questions to address in this field, and based on the current study's POR approach, we are touching the surface of the investigation into the unmet needs of women living with obesity and experiencing infertility.

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Appendix 1: Ethics Approval

Research Ethics Office
Suite 200, Eastern Trust Building
95 Bonaventure Avenue
St. John's, NL
A1B 2X5

December 17, 2019

35 Major's Path,
Suite 103 St. John's, NL A1A 4Z9

Dear Dr Murphy:

Researcher Portal File # 20200919
Reference # 2019.214

RE: Moving beyond BMI: Cardiovascular fitness as a marker of reproductive health

Your application was reviewed by the Health Research Ethics Board (HREB) at the meeting held on November 7, 2019 and your response was reviewed by the Co-Chair under the direction of the HREB and the following decision was rendered:

X	Approval
	Approval subject to changes
	Rejection

Ethics approval is granted for one year effective December 16, 2019. This ethics approval will be reported to the board at the next scheduled HREB meeting.

This is to confirm that the HREB reviewed and approved or acknowledged the following documents (as indicated):

- ☐ Application, approved
- ☐ Research proposal, approved
- ☐ Informed Consent Form, approved
- ☐ Telephone Recruitment script, approved
- ☐ Telephone script – physician,approved
- ☐ Recruitment Poster, approved
- ☐ Participants Characteristics, approved
- ☐ Recruitment Presentation for Physicians, approved
- ☐ Recruitment Info for Physicians, approved

Appendix 2: Recruitment Poster

NL Fertility Services
35 Major's Path
St. John's, NL. A1A 4Z9
t: (709) 752-3687
e: w94kpw@mun.ca

Research Ethics Office
Health Research Ethics Authority
Suite 200, 95 Bonaventure Avenue
St. John's, NL. A1B 2X5
t: 709-777-6974 f: 709-777-8776
e: info@hrea.ca

BEYOND WEIGHT LOSS: THE PHYSIOLOGICAL & PSYCHOLOGICAL EFFECTS OF A COMMUNITY-BASED EXERCISE PROGRAM ON FERTILITY

Are you living with infertility and obesity and want to be a part of a study that examines the benefits of cardiovascular health on fertility?

Researchers at Memorial University are conducting a study investigating the physiological and psychological effects of a virtual 12-week fitness program on women living with obesity and infertility. It would involve participating in three weekly virtual live sessions with a Kinesiologist and completing a series of lifestyle and wellness questionnaires.

Eligibility criteria:

- The inclusion criteria for the present study: Women referred to a fertility specialist physician with a BMI greater than 30 kg/m (current patient or on the waitlist), who are not participating in a current exercise program and are willing to commit to a home-based virtual group exercise program three days a week for 12 weeks.

Each exercise session is performed virtual and live, however recordings will be provided to accommodate those who cannot attend the live session.

Please call Dr. Katie Wadden at (709) 693-4704 for more information.

If you have questions regarding your rights as a research participant please contact the Health Research Ethics Authority at (709) 777-6974 or info@hrea.ca.

RECRUITMENT FOR STUDY: JUNE 2021

Appendix 3: Participant Characteristic Questionnaire

Date: _____

Subject Info

Participant Number: _____

Date of last menstrual period: _____

Medication List: _____

Height (ft/in): _____

Weight (lbs): _____

Year of Birth: _____

Data Collection Start Time and Date: _____

Data Collection End Time and Date: _____

Appendix 4: Description of the Exercise Program

We assessed cardiorespiratory fitness using the Modified Canadian Aerobic Fitness Test (mCAFT) before and after the exercise program. Due to COVID-19, patients performed the testing virtually. Therefore, we requested participants to have a support person present during the duration of the test. For the nine participants that lived within the metropolitan area, custom-made, two-step stairs that complied with the mCAFT testing criteria, were delivered to participants' homes.

Participants used the Polar fitness tracker wrist and chest-strap heart rate monitors to record heart rate as often as possible (during the day) and mandatory recording during exercise sessions. Blood pressure was recorded with a blood pressure monitor provided to them during their pre/post-intervention MCAFT testing by the research team. Measures were recorded during the pre-intervention and post-intervention sessions.

During an orientation session to meet the exercise instructors, discuss study involvement (e.g., attendance, withdrawal from the study, vacation, injuries), the use of technology (e.g., heart rate devices and smartphones), and ask questions. During the orientation, researchers and Kinesiologists focused on introducing the types of exercises participants would complete during the classes and the proper form and technique to perform the exercises safely. Participants were instructed to perform works in a clear space, ideally with a yoga mat or towel. They were instructed to have another individual home while completing the exercise program. A biochemist and nutritionist discussed healthy eating behaviours based on the Canadian Food Guide**.**

Two kinesiologists co-lead the virtual sixty-minute workouts. Exercise sessions were held on the video hosting platform "Zoom" on Tuesday and Thursday mornings at 06:00 and Friday evenings at 18:00. If participants could not attend the sessions live, they could make up the

session as all sessions were recorded and posted to a private Facebook group. Live attendance was encouraged for the Tuesday & Thursday sessions; however, live attendance for the Friday session was optional. Participants were informed they could complete the exercise session during the weekend at a more convenient time. Each session included progressive intervals with work/rest ratios, with a combination of cardiovascular, mobility, strength, balance and functional exercises. Movements were whole body, designed for sedentary individuals living in larger bodies. Each session included a full warm-up and cool-down period. Participants were instructed to wear their heart rate devices, which included a chest strap, watch and phone with the recording app in recording mode.

Example exercises include the following:

- (1) Step Jacks (2) Jumping Jacks (3) Cracker Jacks
- (1) Standing Mountain Climbers (fast or slow) (2) Plank Mountain Climbers
- Glute Bridge
- Side Plank
- Single Leg Balance
- 3-Point Toe Touch
- Single Leg Water Bottle Pass

Appendix 5: Godin-Shephard Leisure-Time Physical Activity Questionnaire

IMPORTANT: This next set of questions focus on leisure-time physical activity. Leisure time means activity done during your free time and does not include your work/job or household chores. Physical activity means any activity that results in a substantial increase in energy expenditure (resulting in a noticeable increase in heart rate and breathing rate). Examples of physical activities include brisk walking, jogging, cycling, swimming, and dancing. Please note that from here on out we will use **PA** as a short form for physical activity.

For this next question, we would like you to recall your average weekly participation in leisure time PA **during the past month**.

When answering these questions please remember:

- Only count PA sessions that lasted 10 minutes or longer in duration.
- Only count PA that was done during free time (i.e., not occupation or housework).
- Note that the main difference between the first three categories is the intensity of the endurance (aerobic) PA and the fourth category is for strength (resistance) exercise.
- Please write the average frequency on the first line and the average duration on the second.
- If you did not do any PA in one of the categories, please write in "0".

Considering a typical week (7 days) over the PAST MONTH how many days on average did you do the following kinds of PA and what was the average duration?

	Times Per Week	Average Duration
a. **VIGOROUS INTENSITY EXERCISE** (HEART BEATS RAPIDLY, SWEATING (e.g., running, aerobics classes, cross country skiing, vigorous swimming, vigorous bicycling).	_____	_____
b. **MODERATE INTENSITY EXERCISE** (NOT EXHAUSTING, LIGHT PERSPIRATION) (e.g., fast walking, tennis, easy bicycling, easy swimming, popular and folk dancing).	_____	_____
c. **LIGHT INTENSITY EXERCISE** (MINIMAL EFFORT, NO PERSPIRATION) (e.g., easy walking, yoga, bowling, lawn bowling, shuffleboard).	_____	_____
d. **RESISTANCE/STRENGTH EXERCISE** (e.g., lifting weights, push ups, sit ups therabands).	_____	_____

Appendix 6: Hospital Anxiety and Depression Scale

Hospital Anxiety and Depression Scale (HADS)

Tick the box beside the reply that is closest to how you have been feeling in the past week.
Don't take too long over you replies: your immediate is best.

D	A		D	A	
		I feel tense or 'wound up':			**I feel as if I am slowed down:**
	3	Most of the time	3		Nearly all the time
	2	A lot of the time	2		Very often
	1	From time to time, occasionally	1		Sometimes
	0	Not at all	0		Not at all
		I still enjoy the things I used to enjoy:			**I get a sort of frightened feeling like 'butterflies' in the stomach:**
0		Definitely as much		0	Not at all
1		Not quite so much		1	Occasionally
2		Only a little		2	Quite Often
3		Hardly at all		3	Very Often
		I get a sort of frightened feeling as if something awful is about to happen:			**I have lost interest in my appearance:**
	3	Very definitely and quite badly	3		Definitely
	2	Yes, but not too badly	2		I don't take as much care as I should
	1	A little, but it doesn't worry me	1		I may not take quite as much care
	0	Not at all	0		I take just as much care as ever
		I can laugh and see the funny side of things:			**I feel restless as I have to be on the move:**
0		As much as I always could		3	Very much indeed
1		Not quite so much now		2	Quite a lot
2		Definitely not so much now		1	Not very much
3		Not at all		0	Not at all
		Worrying thoughts go through my mind:			**I look forward with enjoyment to things:**
	3	A great deal of the time	0		As much as I ever did
	2	A lot of the time	1		Rather less than I used to
	1	From time to time, but not too often	2		Definitely less than I used to
	0	Only occasionally	3		Hardly at all
		I feel cheerful:			**I get sudden feelings of panic:**
3		Not at all		3	Very often indeed
2		Not often		2	Quite often
1		Sometimes		1	Not very often
0		Most of the time		0	Not at all
		I can sit at ease and feel relaxed:			**I can enjoy a good book or radio or TV program:**
	0	Definitely	0		Often
	1	Usually	1		Sometimes
	2	Not Often	2		Not often
	3	Not at all	3		Very seldom

Please check you have answered all the questions

Scoring:
Total score: Depression (D) _____ Anxiety (A) _____
0-7 = Normal
8-10 = Borderline abnormal (borderline case)
11-21 = Abnormal (case)

Appendix 7: SF-12v2

SF-12 Health Survey

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. **Answer each question by choosing just one answer**. If you are unsure how to answer a question, please give the best answer you can.

1. **In general, would you say your health is**:

☐1 Excellent ☐2 Very good ☐3 Good ☐4 Fair ☐5 Poor

The following questions are about activities you might do during a typical day. Does <u>your health now limit you</u> in these activities? If so, how much?

	YES, limited a lot	**YES, limited a little**	**NO, not limited at all**
2. **Moderate activities** such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.	☐1	☐2	☐3
3. Climbing **several** flights of stairs.	☐1	☐2	☐3

During the <u>past 4 weeks</u>, have you had any of the following problems with your work or other regular daily activities <u>as a result of your physical health</u>?

	YES	**NO**
4. **Accomplished less** than you would like.	☐1	☐2
5. Were limited in the **kind** of work or other activities.	☐1	☐2

During the <u>past 4 weeks</u>, have you had any of the following problems with your work or other regular daily activities <u>as a result of any emotional problems</u> (such as feeling depressed or anxious)?

	YES	**NO**
6. **Accomplished less** than you would like.	☐1	☐2
7. Did work or activities **less carefully than usual**.	☐1	☐2

8. **During the <u>past 4 weeks</u>, how much <u>did pain interfere</u> with your normal work (including work outside the home and housework)?**

☐1 Not at all ☐2 A little bit ☐3 Moderately ☐4 Quite a bit ☐5 Extremely

These questions are about how you have been feeling during the <u>past 4 weeks</u>.
For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the <u>past 4 weeks</u>…

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
9. Have you felt calm & peaceful?	☐1	☐2	☐3	☐4	☐5	☐6
10. Did you have a lot of energy?	☐1	☐2	☐3	☐4	☐5	☐6
11. Have you felt down-hearted and blue?	☐1	☐2	☐3	☐4	☐5	☐6

12. **During the <u>past 4 weeks</u>, how much of the time has your <u>physical health or emotional problems</u> interfered with your social activities (like visiting friends, relatives, etc.)?**

☐1 All of the time ☐2 Most of the time ☐3 Some of the time ☐4 A little of the time ☐5 None of the time

Patient name: Date: PCS: MCS:

_____

Visit type (circle one)

Preop 6 week 3 month 6 month 12 month 24 month Other:_____

Appendix 8: Fertility Problem Inventory

THE FERTILITY PROBLEM INVENTORY (FPI) The Fertility Problem Inventory is designed to measure your distress, beliefs, and attitudes related to infertility. Please answer as accurately as possible. Simply mark your choice for each item with an "X".	**Strongly Disagree** **1**	**Disagree** **2**	**somewhat Disagree** **3**	**somewhat Agree** **4**	**Agree** **5**	**Strongly agree** **6**
1 It doesn‟t bother me when I‟m asked questions about children.						
2 Family members don‟t seem to treat us any differently.						
3 The holidays are especially difficult for me.						
4 Family get-togethers are especially difficult for me.						
5 I can‟t help comparing myself with friends who have children.						
6 I still have lots in common with friends who have children.						
7 I find it hard to spend time with friends who have young children.						
8 When I see families with children I feel left out.						
9 I feel like friends or family are leaving us behind.						
10 It doesn‟t bother me when others talk about their children.						
11 I find I‟ve lost enjoyment of sex because of the fertility problem.						
12 I feel just as attractive to my partner as before.						
13 I don‟t feel any different from other members of my sex.						
14 I feel like I‟ve failed at sex.						
15 During sex, all I can think about is wanting a child (or another child).						

16 Having sex is difficult because I don‟t want another disappointment.						
17 If we miss a critical day to have sex, I can feel quite angry.						
18 Sometimes I feel so much pressure, that having sex becomes difficult.						
19 I can‟t show my partner how I feel because it will make him/her feel upset.						
20 My partner doesn‟t understand the way the fertility problem affects me.						
21 My partner and I work well together handling questions about our infertility.						
22 It bothers me that my partner reacts differently to the problem.						
23 My partner is quite disappointed with me.						
24 My partner and I could talk more openly with each other about our fertility problem.						
25 I couldn‟t imagine us ever separating because of this.						
26 When we try to talk about our fertility problem, it seems to lead to an argument.						
27 Because of infertility, I worry that my partner and I are drifting apart.						
28 When we talk about our fertility problem, my partner seems comforted by my comments.						
29 Couples without a child are just as happy as those with children.						
30 I could see a number of advantages if we didn‟t have a child (or another child).						
31 I could visualize a happy life together, without a child (or another child).						
32 At times, I seriously wonder if I want a child (or another child).						
33 Not having a child (or another child) would allow me time to do other satisfying things.						
34 Having a child (or another child) is not necessary for my happiness.						
35 We could have a long, happy relationship without a child (or another child).						

36 There is a certain freedom without children that appeals to me.						
37 Pregnancy and childbirth are the two most important events in a couple‟s relationship.						
38 For me, being a parent is a more important goal than having a satisfying career.						
39 My marriage needs a child (or another child).						
40 It‟s hard to feel like a true adult until you have a child.						
41 A future without a child (or another child) would frighten me.						
42 I feel empty because of our fertility problem.						
43 Having a child (or another child) is not the major focus of my life.						
44 I have often felt that I was born to be a parent.						
45 As long as I can remember, I‟ve wanted to be a parent.						
46 I will do just about anything to have a child (or another child).						

Appendix 9: Beck Hopelessness Scale

A-6

Beck Hopelessness Scale

Instructions:

This questionnaire consists of 20 statements. Please read the statements carefully one by one. If the statement describes your attitude for the past week including today, darken the circle with a 'T' indicating TRUE in the column next to the statement. If the statement does not describe your attitude, darken the circle with an 'F' indicating FALSE in the column next to this statement. Please be sure to read each statement carefully.

I look forward to the future with hope and enthusiasm	(T)	(F)
I might as well give up because there is nothing I can do about making things better for myself	(T)	(F)
When things are going badly, I am helped by knowing that they cannot stay that way forever	(T)	(F)
I can't imagine what my life would be in 10 years	(T)	(F)
I have enough time to accomplish the things I want to do	(T)	(F)
In the future, I expect to succeed in what concerns me most	(T)	(F)
My future seems dark to me	(T)	(F)
I happen to be particularly lucky, and I expect to get more of the good things in life than the average person	(T)	(F)
I just can't get the breaks, and there's no reason I will in the future	(T)	(F)
My past experiences have prepared me well for the future	(T)	(F)
All I can see ahead of me is unpleasantness, rather than pleasantness	(T)	(F)
I don't expect to get what I really want	(T)	(F)
When I look ahead in the future, I expect to be happier than I am now	(T)	(F)
Things just don't work out the way I want them to	(T)	(F)
I have great faith in the future	(T)	(F)
I never get what I want, so its foolish to want anything	(T)	(F)
Its very unlikely that I will get any real satisfaction in the future	(T)	(F)
The future seems vague and uncertain to me	(T)	(F)
I can look forward to more good times than bad times	(T)	(F)
There's no use in really trying to get anything I want, because I probably won't get it	(T)	(F)

XX

Appendix 10: Multidimensional Scale of Perceived Social Support

Multidimensional Scale of Perceived Social Support (Zimet, Dahlem, Zimet & Farley, 1988)

Instructions: We are interested in how you feel about the following statements. Read each statement carefully. Indicate how you feel about each statement.

Circle the "1" if you **Very Strongly Disagree**
Circle the "2" if you **Strongly Disagree**
Circle the "3" if you **Mildly Disagree**
Circle the "4" if you are **Neutral**
Circle the "5" if you **Mildly Agree**
Circle the "6" if you **Strongly Agree**
Circle the "7" if you **Very Strongly Agree**

1.	There is a special person who is around when I am in need.	1	2	3	4	5	6	7	SO
2.	There is a special person with whom I can share my joys and sorrows.	1	2	3	4	5	6	7	SO
3.	My family really tries to help me.	1	2	3	4	5	6	7	Fam
4.	I get the emotional help and support I need from my family.	1	2	3	4	5	6	7	Fam
5.	I have a special person who is a real source of comfort to me.	1	2	3	4	5	6	7	SO
6.	My friends really try to help me.	1	2	3	4	5	6	7	Fri
7.	I can count on my friends when things go wrong.	1	2	3	4	5	6	7	Fri
8.	I can talk about my problems with my family.	1	2	3	4	5	6	7	Fam
9.	I have friends with whom I can share my joys and sorrows.	1	2	3	4	5	6	7	Fri
10.	There is a special person in my life who cares about my feelings.	1	2	3	4	5	6	7	SO
11.	My family is willing to help me make decisions.	1	2	3	4	5	6	7	Fam
12.	I can talk about my problems with my friends.	1	2	3	4	5	6	7	Fri

The items tended to divide into factor groups relating to the source of the social support, namely family (Fam), friends (Fri) or significant other (SO).