PAIN AND DISABILITY IN LOW BACK INJURED INDIVIDUALS PARTICIPATING IN A PHYSICAL FITNESS PROGRAM

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PAIN AND DISABILITY IN LOW BACK INJURED INDIVIDUALS PARTICIPATING IN A PHYSICAL FITNESS PROGRAM

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ABSTRACT

Pain and Disability in Low Back Injured Individuals Participating in a Physical Fitness Program

The purpose of this study was to investigate changes in (a) components of physical fitness, and (b) self-reports of pain, disability and three psychological variables (mood, self-esteem, and state/trait anxiety) in 43 subjects with either acute or chronic low back pain who completed at least 8 weeks in a group physical fitness program in a fitness facility. A within-subjects repeated measures design was employed with each subject serving as his/her own control. Results from MANOVA analyses indicated significant improvement over the 8-week period in both cardiorespiratory aerobic fitness and muscular strength. Concurrently, significant improvements were found in self-reports of pain intensity, pain-related disability, state anxiety and the vigor subscale of mood. Taken as a whole, the results suggest that participation in a structured physical fitness program may play a role in the management of idiopathic low back pain.

Key Words: acute low back pain; chronic low back pain; aerobic exercise; self-esteem; anxiety; mood; disability; Workers' Compensation.

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CHAPTER 1

INTRODUCTION AND PURPOSE OF THE STUDY

In her essay entitled "On Being Ill," Virginia Woolf wrote: "English, which can express the thoughts of Hamlet and the tragedy of Lear, has no words for the shiver and the headache... The merest schoolgirl, when she falls in love, has Shakespeare or Keats to speak her mind for her; but let a sufferer try to describe a pain in his head to a doctor and language at once runs dry" (1967, p. 194).

How true this is for those of us who have tried to explain our own pain to others or who have attempted to understand what pain is like for another person. Far from the stimulus-response approach to pain of a few decades ago, the present level of knowledge indicates the vast complexity of the pain experience. Pain is now known to be a highly personal, variable experience that is influenced, not only by neurophysiological mechanisms responding to sensory stimuli, but also by social and cultural learning, the meaning of the situation and other physical, psychological and cognitive factors. The puzzle becomes even more complex when pain becomes chronic. Indeed chronic pain syndrome -- non-malignant pain lasting more than 6 months from time of expected healing -- is now thought to be an entity in its own right regardless of etiology.

It has been estimated that over one third of the North American population has persistent or recurrent pain problems necessitating medical intervention (Meinhart & McCaffery, 1983). Low back pain provides an especially important area for research because of its high prevalence in the general population, the detrimental effects of pain and disability on the individual and his/her family's quality of life, and the high cost to society of long term physical and psychosocial impairment that can accompany this syndrome.

The purpose of this study is to investigate one intervention in the treatment of low back pain -- participation in a group physical fitness program in a fitness facility -- and to measure any changes that occur in self-reports of pain, disability, and psychological well-being in a sample of low back injured individuals. It is postulated that this intervention strategy would increase the level of participants' physical fitness, decrease self-reports of low back pain and pain-related disability, and would enhance psychological well-being.

The Scope of the Problem

Low back pain (LBP), the so-called "nemesis of medicine and the albatross of industry", is a major health concern in the industrialized world (Nachemson, 1985). Epidemiological studies from Scandinavia, Britain, the Netherlands and the

United States report that LBP is of epidemic proportions, significantly affecting between 50% to 90% of all individuals in the adult population at some time in their lives (Andersson, Pope & Frymoyer, 1984; Frymoyer, 1988; Kelsey & White, 1980; White & Gordon, 1982). Not only is this true for western industrialized society, but recent medical anthropological and clinical studies have also indicated a high incidence of spinal pain in the general population of less developed nations such as Nepal and Oman (Anderson, 1984; Anderson, 1987; Waddell, 1987).

It is known that men and women are about equally affected by back pain with the peak onset between 20 and 30 years, and the highest prevalence between 40 and 60 years (Flor & Turk, 1984). In the age group over 55 years however, more women report low back symptoms than do men, a finding that may be related to the development of osteoporosis in the menopausal years (Bombardier, Baldwin & Crull, 1985; Frymoyer, 1988). It is not understood why low back pain and disability peak in middle age.

In most cases, LBP is a self-limiting condition with 70% of affected individuals recovering within 1 month and 90% within 2 months (Berquist-Ullman & Larsson, 1977; Flor & Turk, 1984; White & Gordon, 1982). However, an estimated 90% of this group suffer relapse and with each recurrence the LBP becomes more severe and long lasting (Hirsh et al., 1969; Horal, 1969; Valkenburg & Haanen, 1982). As a result, individuals with back complaints are likely to experience a significant number of disability days per year and to be frequent users of health care services (Bombardier et al., 1985; Nagi, Riley & Newby, 1973). LBP has been found to be one of the top five presenting symptoms of hospitalized patients, second only to headaches in frequency as a chronic pain problem (Aronoff, McAlary, Witkower & Berdell, 1988). Too often, the search for a cure leads to health seeking behaviours that result in problems that are worse than the original back complaint, problems such as drug dependency (polypharmacy) and unnecessary and numerous surgeries (polysurgery) (Murphy & Cornish, 1984).

An estimated 5% of those with LBP go on to develop chronic LBP, a condition that has generally been resistant to traditional medical management (Frymoyer, 1988). This group represents up to 80% to 85% of the cost of low back pain to society, an estimated $14 billion in the United States in 1978 (Flor & Turk, 1984; Frymoyer, 1988; Nachemson, 1984; White & Gordon, 1982). From a nursing point of view, even more significant is the human cost of chronic pain -- the physical, emotional and social consequences that occur, not only to the individuals who are suffering, but also to entire families (Rowat, 1983).

In the United States, data from the National Center for Health Statistics indicate that impairments of the back and spine are the leading cause of activity limitation in persons with chronic conditions under age 45 years and the third most frequent cause of impairment in persons aged 45 to 60 years after heart disease and arthritis/rheumatism (Kelsey & White, 1980). Canadian survey data show similar trends. The Canada Health Survey (CHS) collected information from approximately 32,000 individuals in 12,200 households across Canada in 1978-79. Back, limb and joint disorders were second only to arthritis/rheumatism as the most prevalent acute or chronic health problem for all ages, and was the most prevalent health problem for the 15-year-old to the 64-year-old age group (Health and Welfare Canada & Statistics Canada, 1981).

Among the 25 questions relating to chronic health problems in the CHS, respondents in the survey were asked if anyone in the family presently had a "serious back or spine problem". The overall point prevalence for perceived current serious back problems for the adult population, aged 25 years and older, was 6.85% with about equal prevalence in men and women (Bombardier et al., 1985). In addition, back problems had an important impact on short term disability experience defined as bed-days, major activity-loss days or cut-down days (for all or most of the day). Back problems accounted for 6% of all annual disability days reported and 13.5% of the population with back problems had visited a health professional in the previous 2 weeks specifically for the problem (Bombardier et al.,1985).

Additional support for these findings was provided by the Canadian Health and Disability Survey 1983-1984. This cross-sectional survey of over 15,000 disabled Canadians, reported that the most prevalent disabling conditions of adults were chronic conditions of the musculoskeletal system. The back was affected most often in the age group 35 years to 54 years and the reported incidence was almost equal for men and women (Statistics Canada & Secretary of State, 1986).

Since LBP tends to affect individuals in their most productive working years, the effect on industry is staggering. Rowe (1969) found that LBP was second only to upper respiratory infections such as colds as the cause of sickness absence from work over the 10-year period 1956 to 1965 in a New York plant. This was true for employees with sedentary work as well as for those with physically demanding jobs. In a Swedish study, Helander (1973 as cited in Andersson et al., 1984) found that from 1961 to 1971, 12.5% of all annual sickness absence days were related to low back disorders. No other disease category was responsible for a greater number of days lost from work. In Britain, 25% of all working men were reported to be affected by low back disorders each year (Haber, 1971).

In both Canada and the United States, the total number of claims for job-related back injuries, the average time off work, and the amount awarded in compensation payments are all increasing (Bombardier et al., 1985; Waddell, 1987). In Canada from 1972 to 1981, an average of 20% of all lost time work injuries occurred to the back or spine (Statistics Canada & Labour Canada, 1984). In 1986, this had increased to an average of 27% (Statistics Canada, 1988). The situation in the province of Newfoundland and Labrador has been similar to the national picture with injuries to the back and spine accounting for 26% of loss time injuries in 1986, 27% in 1987 and 27.8% in 1988 (Workers' Compensation Commission of Newfoundland and Labrador, 1987, 1988, 1989).

Correspondingly, compensation costs for job-related back injuries have continued to rise. For example, an estimated $788 million was awarded in 1983 as compared to $690 million in 1982 for job-related back injury claims in Canada (Bombardier et al., 1985). In addition, 1981-1983 Ontario statistics indicate that the duration of time off work for back injuries is, on average, 40% higher than that for all other injury claims combined (Bombardier et al., 1985).

The chronic and recurrent nature of back problems adds to the significance of the data. Only 50% of individuals who are absent from work for more than 6 months because of back pain will return to work; absence of more than 1 year reduces this to 25% and after 2 years of absence, the chances of a worker returning to productive employment are negligible (McGill, 1968; Nachemson, 1984). Thus, it is clear that the morbidity, disability, activity limitation and economic cost brought about by low back pain are considerable to both the affected individual, his/her family and to society as a whole (Kelsey & White, 1980).

Etiology of Low Back Pain

Low back pain is a nonspecific symptom and a subjective experience rather than a definite diagnostic category. Generally, the individual with LBP has constant or intermittent pain that has a particularly unpleasant quality often described as deep, aching and burning (Melzack & Wall, 1982). It is usually of musculo-skeletal origin and is located in the lumbar region of the spine, between the rib cage and the pelvis. Most commonly, the pain radiates from the lower back to one or both buttocks and upper thighs and is unassociated with any neurologic signs (such as focal muscular weakness, asymmetry of reflexes, sensory loss in a dermatome, or specific loss of intestinal, bladder or sexual function), signs which most often indicate disc herniation (Pope, Lehmann & Frymoyer, 1984; Spitzer, Leblanc & Dupuis, 1987). The pain, however, may radiate from below the gluteal fold to include the upper leg above the knee or may radiate to the entire limb; radiating pain to the leg may or may not be accompanied by neurologic signs.

For any given individual, the likelihood of identifying a specific cause for acute LBP is in the order of 5% to 20%

(Frymoyer, Pope, Costanza, Rosen, Goggin, & Wilder, 1980; Frymoyer, 1988). In a Quebec study of spinal disorders, Spitzer and his colleagues (1987) stated:

> The etiologic diagnosis of spinal disorders is difficult because the physical signs and symptoms often have little specificity. There is often a discrepancy between the level of pain and the loss of function, on the one hand, and the minimal physical signs on the other (p. S18, S20).

Occasionally, LBP is caused by metabolic disorders such as osteoporosis, inflammatory lesions, spinal trauma causing vertebral body fracture, congenital abnormalities such as spondylolysis and degenerative spinal diseases such as spinal stenosis or osteoarthritis (Frymoyer & Howe, 1984). It is noteworthy that degenerative changes of the disc and spine have a high base rate in the general population and often exist in individuals who are totally free of back pain symptoms (Dolce & Raczynski, 1985).

For the vast majority of individuals, the pathophysiology of their LBP is unknown and their condition is therefore categorized as idiopathic low back pain or low back syndrome. As Nachemson (1984), a respected researcher in the field for 30 years, stated: "The only thing we can say is that it is somewhere in the motion segment that pain is elicited. Something must rupture in the acute phase, but we don't really know what" (p.3). Although the exact offending structure remains obscure, research is focusing on the intervertebral disc, with its surrounding longitudinal ligaments and facet joints (Nachemson, 1985). (See Figure 1).

Melzack and Wall (1982) have hypothesized that in many cases of LBP, the major culprit is abnormal activity in nerve-root fibres due to minor changes in the surrounding vertebrae and tissues. These cumulative minor irritations might eventually produce symptoms that can be the beginning of a vicious cycle of spasm and pain. An alternate view, proposed by Sarno (1984), is that pain is caused by muscular tension that activates the autonomic nervous system causing vasoconstriction of the arterioles in skeletal muscle. Vasoconstriction could lead to relative ischemia in the muscle and thereby cause pain.

Predisposing Factors to LBP

The factors which make some people more susceptible to back pain than others are beginning to be identified (Troup, Martin & Lloyd, 1981). These risk factors include:

Physical factors: There is a positive relationship between low activity levels and LBP (Murphy & Cornish, 1984). Increased physical fitness and muscle strength appear to play a role in the prevention and recurrence of LBP episodes, and in the rehabilitation of those with chronic LBP (Biering-Sorenson, 1984; Cady, Bischoff,

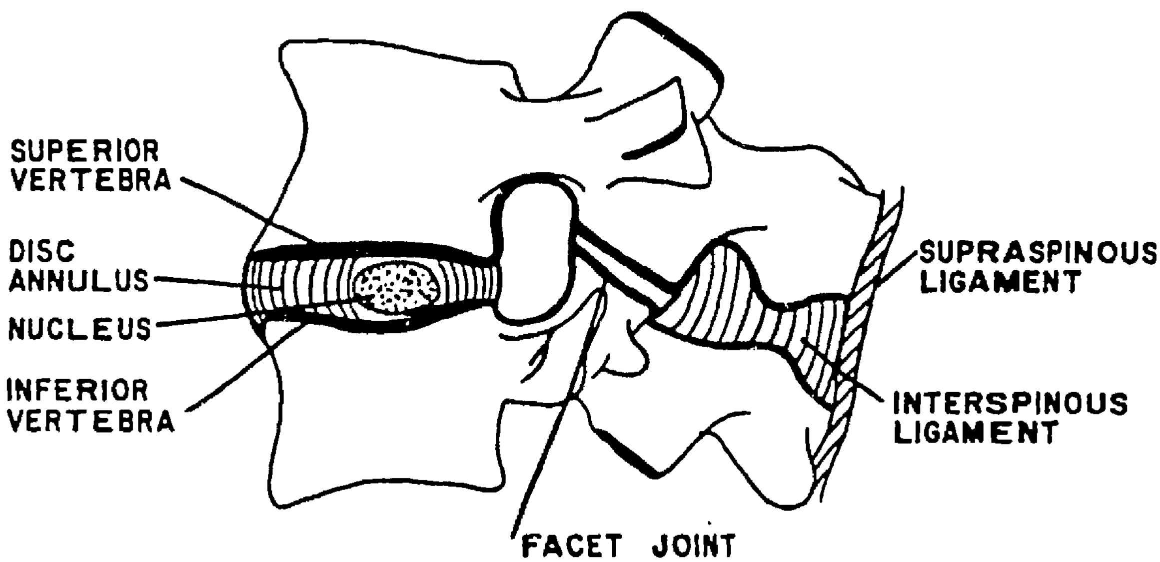


Figure 1 - The Basic Structured Unit of the Spine (Motion Segment)
Note. From "Structure and Function of the Lumbar Spine" by M. H. Pope, T. R. Lehmann, & J. W. Frymoyer (1984). In M. Pope, J. Frymoyer, & G. Andersson (Eds.), Occupational Low Back Pain, (p.6). Westport, CT: Praeger. Copyright 1984 by M. H. Pope. Reproduced by permission (see Appendix A).

O'Connell, Thomas & Allan, 1979; Kottke, Caspersen & Hill, 1984; Smidt, Amundsen & Dostal, 1980). In animal studies, moderate exercise has been found to increase the flow of nutrients into the intervertebral disc (Holms & Nachemson, 1983). Factors such as height, weight, body build and limb length have not been demonstrated to have a relationship to LBP (Andersson & Pope, 1984).

Occupational factors: Involvement in occupations that require repetitive lifting in the forward bent-and-twisted position (particularly when the lifting requirements exceed the worker's physical capacity), monotonous movements, uncomfortable and prolonged work positions (in either sedentary or active jobs), and exposure to vibrations have been related to an increased risk of LBP (Berquist-Ullman & Larsson, 1977; Frymoyer, 1988; Nachemson, 1984, 1985). Certain occupations have been identified as having high prevalence rates of back disorders; they include those working in transportation (especially those exposed to vehicular vibration), machining and metal shaping, and construction (Bombardier et al., 1985; Frymoyer, Pope, Clements, Wilder, MacPherson, & Ashikaga, 1983). Nursing has also been identified as a high risk occupation for the development of back problems (Buckle, 1987; Jensen, 1987; Mandel & Lohman, 1987; Rossignol, Suissa & Abenhaim, 1988). The static action necessary for patient lifts and transfers, and the frequent movement of equipment by nurses are thought to be factors in the high prevalence of LBP in nursing personnel (Harber, Shimozaki, Gradner, Billet, Vojtecky, & Kanim, 1987).

Psychological factors: Although a number of psychological factors have been related to LBP, especially chronic LBP, the cause and effect relationship remains unclear (Schmidt & Arntz, 1987; Spitzer et al., 1987). For example, alterations in mood and self-esteem, as well as high anxiety, increased life stress, depression, work dissatisfaction, hypochondriasis and somatization (focusing on bodily symptoms) have been associated with LBP (Andersson & Pope, 1984; Frymoyer, Rosen, Clements & Pope, 1985,; Frymoyer, 1988; Schmidt & Arntz, 1987). Pathopsychological conceptual models discuss chronic LBP in terms of chronic neurosis, the pain-prone personality, masked depression and learned helplessness. However, because most studies of the LBP population have been retrospective in design, it is not known whether these characteristics are predisposing factors to the onset of LBP, or whether they are a result of the pain experience (Fuerstein, Carter & Papciak, 1987). What is known is that emotional states modify the cognition of pain, and that during periods of depression and anxiety, symptoms may worsen (Pope, Lehmann & Frymoyer, 1984). It is also clear that psychological and social variables can serve to maintain disability (Fredrickson, Trief, VanBevern, Hansen, Yuan & Baum, 1988; Waddell, 1987). Thus it appears that the interplay of physiological and psychological factors are involved in the experience of chronic pain and in chronic pain behaviour.

<u>Other factors</u>: Smoking has been found to compromise the nutrition of the intervertebral discs in preliminary animal studies (Frymoyer et al., 1983) and has been identified as a risk factor for LBP in epidemiological studies (Frymoyer et al., 1983; Jensen, 1987). In addition, it has been postulated that coughing may lead to increased intradiscal pressure and thus to increased spine loadings resulting in LBP (Andersson & Pope, 1984).

Whatever the cause, the subjective experience of low back pain involves complex neurophysiological and psychological phenomena that may create distress in the individual. The acute pain experience, triggered by tissue damage of some kind, includes: activation of nociceptors -- specialized, peripheral nerve endings -- which are found in almost all structures of the back; afferent transmission through spinal cord pathways to the brain which may be accentuated or blocked by a number of mechanisms; cognitive integration and interpretation of these stimuli; and affective and behavioural changes (Fordyce, 1988; Pope et al., 1984). If the acute experience of LBP becomes chronic, then even more complex psychological and learning factors come into play resulting in major life disruption.

Treatment

Despite the magnitude of the problem, the advances in diagnostic procedures and the abundance of research and literature on the topic, little is really known about the specific causes of low back pain and hence effective treatment (Flor & Turk, 1984; Nachemson, 1984). Treatment in the acute phase tends to be symptomatic in nature, aimed at reducing the level of pain, promoting healing and maintaining function (Selby, 1982). Traditional conservative treatments espoused in the literature as being effective include a wide range of modalities, the most universal one being bedrest. Others include analgesics and muscle relaxants, physiotherapy, spinal manipulation, flexion and/or extension exercises, corsets and braces, traction, and educational programs that emphasize care of the back. However, evidence in the literature proving the effectiveness of these methods is conflicting, with most studies being descriptive and uncontrolled (Gilbert, Taylor, Hildebrand & Evans, 1985; Flor & Turk, 1984; Nachemson, 1985; Quinet & Hadler, 1979; Shotkin, Bolt & Norton, 1987; Spitzer et al., 1987).

Nachemson (1984, 1985), Gilbert and his colleagues (1985) and others have pointed out the difficulty in studying a condition that is usually self-limiting. It may be the case that most patients would improve in the acute phase regardless of treatment modality. However, because the recurrence rate is so high and the impact of chronicity so great, treatment approaches must look beyond the immediate acute episode, especially for those who are not improving with conservative measures. This has led to a search for other forms of treatment that might prevent the cycle of recurrence and chronicity.

One area receiving renewed attention in the literature is the role of activity, exercise and physical fitness in the LBP population (Frymoyer, 1988; Nachemson, 1984; Nutter, 1988; McQuade, Turner & Buchner, 1988; Simmons Raithel, 1989; Wynn Parry & Gingras, 1988). Although physical activity has always been recommended for individuals with LBP once the acute phase was over, very few studies have examined the specific effects of exercise and fitness on the LBP population.

Research Questions

The purpose of this study is to answer the following two research questions:

(1) Are there significant changes in measures of physical fitness in a population of low back injured individuals who participate in a group physical fitness program?

(2) Are there significant changes in measures of pain, disability, and three psychological factors -- self-esteem, state/trait anxiety and mood -- in a population of low back

injured individuals who participate in a group physical fitness program?

Definitions

Independent variable: participation in a group physical fitness program.

Dependent variables: changes in components of physical fitness, pain, disability, self-esteem, state/trait anxiety, and mood.

Physical activity: any bodily movement produced by skeletal muscles that results in energy expenditure and occurs during sleep, work and at leisure.

Exercise: a subset of physical activity that is planned, structured, repetitive and has a goal.

Physical fitness: a set of attributes that relate to an individual's ability to perform physical activity. Four health-related components of physical fitness as defined by Caspersen, Powell and Christenson (1985) are:

1. Aerobic (cardiorespiratory) fitness - the ability of the circulatory and respiratory systems to supply fuel during sustained physical activity and to eliminate fatigue products. In this study, this component was measured by heart rate during and after the aerobic component of the exercise program.

2. Muscular strength and endurance - the amount of external force that a muscle can exert, and the ability of

muscle groups to exert the external force for many repetitions or excessive exertions. In this study, muscle strength was measured by the percentage increase in weights lifted on strength-training machines, commonly called Nautilus equipment.

3. Flexibility - the range of motion available at a joint. This component was not measured in this study.

4. Body composition - the relative amounts of muscle, fat, bone and other vital body parts. This was measured by calculating body mass index (BMI), weight in kilograms divided by height in metres squared.

Pain - a highly complex subjective experience whose quality and intensity was measured by the McGill Melzack Pain Questionnaire and a Pain Questionnaire designed for this study.

Acute pain - pain of less than 6 months duration that bears a relatively straightforward relationship to peripheral stimuli, nociception, and tissue damage.

Chronic Pain - non-malignant pain of longer than 6 months duration that is increasingly associated with emotional and psychological distress.

Disability - limitations of a person's performance in activities of daily living compared with that of a fit person; this variable was measured by the Oswestry Low Back Pain Disability Questionnaire.

Self-Esteem - a perception of one's worth regardless of any shortcomings or deficiencies; this was measured by the Rosenberg Self-Esteem Scale.

Mood - a conscious subjective state of mind, or predominant emotion that was measured by the Memorial University Mood Scale.

State Anxiety - an unpleasant emotional state evoked by stressful situations that are perceived as dangerous and threatening and "characterized by subjective feelings of tension, apprehension, nervousness, and worry, and by activation, or arousal of the autonomic nervous system" (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983, p.1).

Trait Anxiety - refers to a relatively stable personality trait of anxiety proneness (Spielberger et al., 1983). State and trait anxiety were measured using the State-Trait Anxiety Inventory Form Y-1 and Y-2.

Low Back Injured Individuals - subjects who have sustained a back injury, who are not improving with traditional conservative treatment, and who have been referred to the Lifestyles Program (see below) either by their physician or physiotherapist. Subjects may or may not be recipients of Workers' Compensation benefits.

Lifestyles Program - a structured group physical fitness program located at the Aquarena fitness facility in St. John's, Newfoundland, Canada. The program, which is normally 3 months in length, serves as an adjunct to physiotherapy. The components of the Lifestyles Program consist of: (1) aerobic fitness classes conducted in the swimming pool (called waterfit classes), (2) the use of strength-training machines, manufactured by Nautilus Sports/Medical Industries to improve muscular strength and endurance, and (3) the use of sauna and whirlpool. In addition, subjects have access to the services of a nutritionist. The consultant physiotherapist tailors the program to each individual.

CHAPTER 2

LITERATURE REVIEW

The review of the literature will be divided into two sections. Part 1 will discuss the general health benefits of regular exercise and the possible role of endorphins. Part 2 will discuss specific research articles that deal with physical fitness and exercise and its role in LBP. A brief summary of the literature will follow. In addition, the theoretical framework guiding the study will be presented and the application of the conceptual framework to the study will be discussed.

Part 1 - Health Benefits of Regular Exercise

It is now accepted that physically active people of all ages tend to be healthier than their inactive counterparts (Haskell, Montoye & Orenstein, 1985). Although it may appear too obvious to state, it is widely recognized that inactivity has serious negative consequences on human health and well-being. In a survey of the literature, Bortz (1984) highlighted the structural and functional responses to disuse which include: a decrease in cardiovascular functioning; a rise in systolic blood pressure; a decrease in total body water content; a decrease in red blood cell mass; a decrease in sexual functioning; a fall in body temperature; a desynchronous circadian rhythm; alterations in metabolic and hormonal indices; possible immunological alterations; decreased activity in the sympathomedullary system; a decrease in catecholamine secretion and other neurosecretions; depressed mood and other sometimes severe psychological changes. In the musculoskeletal system, inactivity causes such changes as: a decrease in muscle mass and muscle fibre diameter; a change in slow-twitch fibres that are responsible for muscle endurance; joint and muscle stiffness; a decrease in calcium content and deterioration in bone matrix (Bortz, 1984). Hansson and Roos (1981) tested patients with LBP who had been off work for 6 months and found a much reduced bone mass in their vertebrae. Nachemson (1984, 1985) reported that inactivity promotes poor nutrition in intervertebral discs and that injured tissues of the type seen around the motion segment heal more quickly with continuous passive motion.

Idiopathic low back pain in the early stages is often aggravated by activity and relieved by rest. The individual who relies on pain as his guide to activity level is likely to stay inactive as long as the pain is present, especially if a planned program of activity is not a part of the treatment regimen. However, there is general agreement in the literature that prolonged inactivity in LBP is detrimental and must be discouraged (Mayer et al., 1986; Spitzer et al., 1987).

What then are the general health benefits to be derived from an activity program that promotes physical fitness? The health benefits ascribed to regular exercise and improved physical fitness cover a wide range of physical and psychological parameters. Because of the vast amount of literature on this subject, the conclusions of a number of major review articles will be highlighted.

In general, most benefits of exercise are produced by activity requiring the dynamic and rhythmic use of large muscle groups for 20 to 30 minutes. Activities fitting this description such as walking, jogging, swimming and cycling are most effective when done frequently (daily or every other day) and at a moderate intensity relative to the individual's capacity (Haskell et al., 1985). This aerobic exercise tends to increase the efficiency of the cardiorespiratory system, improve physical work capacity and optimize body weight (Serfass & Gerberich, 1984). Additional benefits are provided when such activity is supplemented by heavy resistive exercises that develop muscle strength and muscle tone and exercises that increase soft tissue and joint flexibility (Haskell et al., 1985).

It is now known that the greatest benefits are achieved when the least active individuals become moderately active; much less benefit is apparent when the already active individual becomes extremely active (Haskell et al., 1985). This is true for the physical as well as the psychological benefits (Wilfley & Kunce, 1986). This has implications for the participants in this study since the goal is to encourage moderate activity in individuals with LBP, a group who would otherwise probably be relatively inactive.

As well as the overall health benefits associated with activity, evidence has accumulated over the past 30 years that solidly supports the following disease-specific and mental health effects of regular physical exercise: (a) maintenance of overall musculoskeletal integrity, (b) overall reduced risk of coronary heart disease, (c) a decreased risk of hypertension, (d) a reduced risk of obesity, (e) a reduced risk of postmenopausal osteoporosis, and (f) an improved overall level of psychological well-being especially self-esteem (Goldwater & Collis, 1985; Haskell et al., 1985; Hughes, 1984; Phelps, 1987; Roth & Holmes, 1985; Siscovick, Laporte & Newman, 1985; Taylor, Sallis & Needle, 1985). There is also supportive evidence to suggest that increased fitness levels: (a) decrease the risk of Type II diabetes, (b) alleviate mild to moderate depression and elevate mood, (c) reduce state anxiety, stress and promote relaxation, (d) improve the serum lipid profile, and (e) enhance immune response (Haskell et al., 1985; Hughes, 1984; Phelps, 1987; Siscovick et al., 1985; Taylor et al., 1985).

The possible specific physical benefits of exercise for low back pain patients have been described by McQuade and his colleagues (1988). These include: increased strength of bone, tendons, ligaments and muscle; improved nutrition to joint cartilages including intervertebral discs; enhanced oxidation capacity of skeletal muscle; improved neuromotor control and coordination; increased mechanical efficiency; and general improvement in cardiovascular and respiratory function. In addition, the central and peripheral relaxation response and the feeling of well-being that has been demonstrated with aerobic activity would promote a decrease in the muscle tension associated with LBP (McQuade et al., 1988).

While a great deal is known about the physiology of exercise, it is still unclear what exactly occurs as a result of physical activity that produces the health benefit. For example, is the health benefit due to: biochemical changes in the body resulting from increased aerobic capacity; mechanical stress placed on muscle and bone; or psychological and social factors due to the exercising situation? Probably all of these factors play a role (Haskell et al., 1985).

Exercise and Endorphins

Another important area relevant to the population with pain is the possible effect of exercise on pain modulation.

Since the discovery of endogenous endorphins and their receptors in 1975, there has been a tremendous amount of experimental and clinical research into the role of these morphine-like substances on pain. Regrettably, this research has not yet generated all the answers to the pain puzzle that were expected a decade ago. Rather an even greater complexity of pain modulation is being uncovered. For example, it is now known that the endorphin-mediated analgesia system is probably only one of several central nervous system networks that play a role in pain modulation and that other neurotransmitters such as norepinephrine, dopamine and serotonin have an important function (Fields & Basbaum, 1984). In addition, many studies have shown that the activation of endogenous analgesia networks involves complex environmental, attentional and conditioning factors that make study results difficult to interpret (Fields & Basbaum, 1984).

Nonetheless, a great deal has been learned about endorphins. Some important properties of these substances are their ability to elicit analgesia, to modify the conscious appreciation of, and tolerance to, pain as well as to alleviate the concomitant fear/anxiety, and emotional distress that can accompany pain (Millan, 1986). In addition, these substances have potent effects on pituitary hormone secretions and have been linked to positive changes in mood states (Harber & Sutton, 1984; Millan, 1986; Steinberg & Sykes, 1985).

There are three general classes of endogenous opioid peptides: beta-endorphins, met-enkephalins and dynorphins. They are co-stored, along with other neurotransmitter substances and hormones, in many regions of the central nervous system: in the substantia gelatinosa of the dorsal horn of the spinal cord (the area that receives primary afferent nociceptive information); at the level of the midbrain, brain stem and thalamus (relay stations for nociceptive information); and at higher levels of the limbic system and cortex that are involved in the interpretation and affective dimensions of pain (Guyton, 1986; Melzack & Wall, 1982; Millan, 1986). These endogenous opioids have been found in the cerebral spinal fluid (CSF) and in the systemic circulation. The many classes of receptors that receive these peptides are located in multiple areas of the central nervous system as well as in peripheral nerve endings (Guyton, 1986; Millan, 1986).

In experiments with rats and humans, it has been demonstrated that the level of endorphins in the CSF is important in the suppression of pain (Nachemson, 1985). In the exercise situation, several studies have demonstrated an increase in beta-endorphin levels in the blood plasma in both trained athletes and normal non-athletes during strenuous aerobic exercise (Carr et al., 1981; Colt, Wardlaw

& Frantz, 1981; Fraioli, Moretti, Paolucci, Alicicco, Crescenzi & Fortunio, 1980). As well, exercise may increase met-enkephalin levels in the general circulation (Grossman & Sutton, 1985). However, it is not yet known to what extent exercise may increase endorphin levels in the CSF.

The role of endorphins in the peripheral circulation on pain is not at all clear. As Jackson and Brown (1983a) have observed, the production of endorphins and enkephalins in plasma and in CSF are under separate control; therefore, an increase in the blood plasma level of endorphins does not necessarily signal an increase in CSF endorphin level. In fact, the relationship between brain and plasma levels of endorphins is believed to be small (Millan, 1986). Thus, the clinical relevance of the endorphin-releasing effect of exercise is as yet unknown (Steinberg & Sykes, 1985). It may be that exercise affects other factors that modulate pain, factors such as anxiety, attention, cognition, learning, mastery, consciousness alteration, and biochemical changes in the brain such as amine release (Markoff, Ryan & Young, 1982; Morgan, 1985; Scott & Gijsbers, 1981).

Part 2 - Physical Fitness and LBP

The literature concerning aspects of physical fitness and its relationship to LBP will be reviewed in the following categories: prospective and retrospective studies highlighting preventive/protective effects; studies examining the role of exercise and physical fitness in the acute LBP population; and, studies examining the role of exercise and physical fitness in the chronic LBP population.

Studies Illustrating Preventive/Protective Effects

There is increasing evidence that individuals with a good state of general fitness and conditioning have a lower risk of LBP and also recover more rapidly after an acute episode. In a landmark study, Cady, Bischoff, O'Connell, Thomas and Allan (1979) measured the spinal flexibility, isometric lifting strength and cardiopulmonary function of 1,652 fire fighters, aged 22 years to 55 years, in Los Angeles from 1971 to 1974. The fitness measures were used to classify the participants into three groups: most fit, middle fit and least fit. The findings showed that the most physically fit employees had both fewer and less costly back injuries than the least physically fit group. The frequency of subsequent back injuries was 10 times higher for the least fit group.

A sub-study of several hundred firefighters who were eliminated from the main study because of various back injuries prior to their examination had the same results. Those who had fitness levels comparable to the best fit group at the time of examination had no further injuries, while one third of those who had fitness levels comparable to the least fit group experienced additional back injuries.

Cady and his associates concluded that physical fitness and conditioning are preventive of back injuries.

In a follow-up study by Cady, Thomas & Karwasky (1985), the benefits of a physical fitness program for fire fighters over a 14-year period were evaluated. A section of this study examined 320 healthy individuals aged 40 years to 49 years. Those with either greater flexibility, or strength, or work capacity were characterized by much lower back and total injury costs. It was concluded that these fitness traits provided a protective effect against recurrent low back injuries. Another study of a physical fitness program emphasizing flexibility and strengthening exercises also found reduced rates of back injuries in Toronto ambulance drivers (Imrie, 1983 as cited in Andersson & Pope, 1984).

Although not all investigations of strength and fitness have demonstrated a relationship to LBP (Snook & Jensen, 1984), positive evidence is accumulating. Rowe (1969) found a relationship between LBP and abdominal muscle weakness and LBP and trunk stiffness. Troup, Martin & Lloyd (1981) found reduced dynamic strength of trunk flexor muscles to be a consistent predictor for recurrence or persistence of back pain. Svensson and Andersson (1983) found LBP to be more common in men who were physically less active in their leisure time.

Biering-Sorensen (1984), who studied 928 men and women aged 30 years to 60 years in a Danish suburb, took measurements of the flexibility of back and hamstring muscles as well as tests for trunk muscle strength and endurance. One year later, the principal finding was that good isometric endurance of the back muscles prevented first-time experience of LBP in men. In addition, men with hypermobile backs (laxity of joints) were more liable to develop low back trouble. Recurrence or persistence of LBP was correlated primarily to the interval since the last episode of LBP: the more LBP, the shorter the intervals between episodes. Weak trunk muscles and reduced flexibility of the back and hamstring muscles were more pronounced among those who experienced recurrence or ongoing LBP.

It is not difficult to understand why a positive relationship exists between muscle strength, the flexibility of those muscles and LBP. The paraspinous muscles of the back provide the power necessary for movement, lifting and carrying. Along with the spinal ligaments, the muscles position and stabilize the back during awkward postures and increased loads. Various animal models have shown that without muscles, but with intact ligaments, the spine buckles under very small compressive forces. Thus, as Pope et al. (1984) have concluded, changes in muscular strength or changes of muscle balance may lead to an increased risk of LBP.

In contrast to the studies indicating the preventive effects of physical fitness and conditioning on the incidence of back pain is a study by Mandel and Lohman (1987). In a mail survey to 418 female nurses in one mid-western United States' hospital, an unexpected association was found between frequent aerobic dance exercise (at least 3 times per week) and an increased incidence of LBP lasting at least 48 hours within the past year. The fact that an association was not found between LBP and three other aerobic kinds of activity (jogging 3 times per week, the use of body building machines, and participation in sports) suggests that the specific exercises in the aerobic dance class or the exercise situation itself might have been the source of injury rather than aerobic exercise per se.

A number of studies have documented a long list of aerobic dance injuries, including injuries to the back and spine (Francis, Francis & Welshons-Smith, 1985; Garrick, 1985; Garrick, Gillien & Whiteside, 1986; Macintyre, Clement, Taunton, McKenzie & Filsinger, 1984; Richie, Kelso, & Bellucci, 1985). However, aerobic dance programs prior to 1986-87 tended to include high intensity activities such as jumping, skipping and hopping (Garrick & Requa, 1988) and also included a number of exercises now widely known to be unsafe for the back and spine, exercises that combined rotation of the trunk with extension and flexion movements (Allen, Marfell-Jones & Cove, 1983; G. Innes, personal communication, July 4, 1989). In addition, other extrinsic factors such as improper footwear and improper floors have been identified as possible causes of injury in aerobic dance exercisers (Garrick & Requa, 1988). It is worth noting that the data for the Mandel and Lohman study were collected in 1982-83, a number of years before the general change to low-impact aerobic programs.

Notwithstanding the study by Mandel and Lohman (1987), the overwhelming evidence of the literature on LBP supports the role of improved physical fitness and conditioning in the prevention of back injuries and a more rapid recovery after an acute episode.

Acute LBP and Physical Fitness

Few controlled clinical studies examining the exact role of exercise in the management of acute LBP exist, even though specific exercise protocols have been recommended by health care professionals for decades (Jackson & Brown, 1983a; Nutter, 1988). There is wide debate and conflicting data in the literature concerning the clinical indications for and the effectiveness of specific exercise regimes - for example, extension versus flexion versus hyperextension exercises (Davies, Gibson & Tester, 1979; Gilbert, Taylor, Hildebrand & Evans, 1985; Kendall & Jenkins, 1968; Kraus, Melleby & Gaston, 1977; Manniche, Bentzen, Hesselsoe, Christensen & Lundberg, 1988; Plum & Rehfeld, 1985). As well, no empirical support exists for the common practice of preprinted handouts which assume that every individual with low back pain requires the same 6 or 8 exercises (Garrett, 1987; Jackson & Brown, 1983b).

It is of special interest to this study that no research was found that evaluated the indications for and results of dry land versus water exercise for those with LBP. Jenkins (1974) and Zachrisson Forssell (1981) among others promote the use of body movement in water for clients with LBP and clearly, water exercise and rehabilitation is nothing new (Koszuta, 1986). The buoyancy and supportive nature of water make it an ideal environment for improving aerobic fitness for those with an injury (Koszuta, 1986). Anecdotal evidence suggests that water exercise is safer and may be more effective than working out on land for the well population as well as the injured population (Koszuta, 1989).

Although improved levels of physical fitness appear to offer significant benefits to individuals with LBP (Cady et al. 1979, 1985; Jackson & Brown, 1983a,b; Nachemson, 1984, 1985; Nutter, 1988), and although many physicians and therapists recommend aerobic and muscle-strengthening exercise to this population (Jackson & Brown, 1983b; Jenkirs, 1974; Lewinnek, 1983; Quinet & Hadler, 1979; Zachrisson Forssell, 1981), only two studies could be found where a physical fitness program was used as an adjunct to traditional therapy for individuals with LBP in the acute phase.

A study by Linton, Bradley, Jensen, Spangfort and Sundell (1989) investigated the effectiveness of a secondary prevention program that emphasized aerobic activity and lifestyle change for a population with non-chronic low back pain. A volunteer group of 66 female nursing personnel (LPNs and nursing aides), who had LBP and were currently working, were randomly assigned to either a treatment group (n=36), or to a waiting list control group (n=30). The 5-week program consisted of at least 4 hours of activity per day (walking, swimming, jogging, and cycling), ergonomic education in the form of "low back school," and behavioural therapy sessions that emphasized pain control and lifestyle management. It is important to note that subjects in the treatment program were given time off work to attend the program and were paid 90% of their regular salary by the Swedish National Health Insurance Authority.

The authors reported that the treatment group had significantly greater improvements than the control group for pain intensity, anxiety, sleep quality and fatigue ratings, observed pain behaviour, activities, mood, and helplessness directly after the program ended and that these differences were generally maintained at the 6-month follow-up. In addition, the treatment group broke a trend for increasing amounts of pain-related absenteeism, while the control group did not.

Hannah, Hannah, Mosher and Vardy (1988a, 1988b, 1988c) have done preliminary evaluations of the physical fitness and psychological benefits of a lifestyles modification program for a group of Workers' Compensation recipients, the majority of whom suffer from both acute and chronic low back pain. (This is the same program under investigation in the present study). In this set of studies, data from individuals with both acute and chronic pain were analyzed together. However, analysis did not reveal any differences as a function of sex, age, weeks off work or starting date in the program (Hannah et al., 1988a).

At the time of these preliminary studies, the Lifestyles Program, located in a fitness facility in St. John's, Newfoundland, included: a waterfit aerobic exercise program; the use of strength-training machines manufactured by Nautilus Sports/Medical Industries (commonly referred to as Nautilus equipment) to develop muscle strength and endurance; the use of sauna and whirlpool facilities; and diet and nutrition counselling. The primary goal of the program was to improve and maintain the physical fitness of injured workers so that they might return to work earlier than would otherwise be expected and avoid re-injury. The physical fitness benefits for 71 participants were analyzed over a 3-month period (Hannah et al., 1988b).

Three indices of physical fitness were measured and were found to show statistically reliable improvement over time: cardiorespiratory endurance as measured by cardiac recovery response after exercise, muscle strength as indexed by weights lifted, and body composition as measured by body weight.

In addition, the perceived psychological benefits of the program were assessed (Hannah et al., 1988a, 1988c). After 1 month in the program, 41 participants completed a 21-item, author-designed questionnaire which contained both multiple choice and open-ended questions. Participants rated the program positively and indicated that since entering the program they had experienced improved mood, an improved outlook on life, increased optimism about the future, and increased feelings of relaxation which affected at least two areas of their lives -- sleep and family/friend relationships. Because the study was retrospective and cross-sectional in design and a non-standardized tool was used, the authors expressed caution in interpretation of results. However, it appeared that participation in the Lifestyles Program produced a perceived improvement in psychological well-being in participants along with significant objective improvement in physical fitness as measured by three indices.

There are unique features of this program which warrant discussion. First, although the program is completely individualized with close monitoring by staff, all the program components are done in a group setting. Individuals do not remain isolated but make friends and acquaintances with others who have similar problems. As Hannah and his colleagues (1988a) pointed out, rehabilitation became a social rather than a strictly medical process. Secondly, once individuals who received Workers' Compensation benefits were referred to the program, their participation was compulsory, as were all other forms of active treatment. In contrast to conservative forms of therapy, injured workers were being encouraged to leave the house, to have a social life and to be physically active. In addition, their rehabilitation was being conducted in a fitness or health promotion setting rather than in a hospital or clinic, settings most often associated with sickness. All of these factors were designed to support and reinforce wellness.

There are three other unique studies of the acute LBP population that are relevant to the present discussion. As previously stated, activity level appears to be a factor in the development of chronicity. One prospective clinical study followed a group of patients in the acute stage of LBP in an attempt to identify the potentially chronic patient. Murphy and Cornish (1984) assessed 48 American male veterans in the acute stage of LBP on standardized measures of personality, physical signs and symptoms, illness behaviour including activity level, pain and locus of control. Six months later, these clients were followed up to establish whether or not the LBP had become chronic. The findings were that patients who developed chronic LBP had pain over a wider area of the body; had deeper, more central pain; were more highly anxious; and, had a lower activity level on initial screening. They concluded that a need exists for early intervention programs that teach clients a lifestyle that is incompatible with the development of chronic pain.

Another study that looked at a population with acute LBP was conducted by Fordyce, Brockway, Bergman and Spengler (1986). They compared traditional methods with behavioural methods in the early management of back injury; these two methods were based on different theoretical models of pain and healing. In this study, the use of traditional methods (analgesics, bedrest, other activity limits, and home exercises) ultimately rested on the patient's judgment and perception of his own pain: analgesics were taken as needed and prescriptions could be refilled, activity increased when the patient felt the pain had subsided, and exercises were done according to how much pain was being experienced. This approach was based on the assumption that if pain is present, then healing is not complete and activity should not be resumed.

The behavioural approach, on the other hand, assumes that the report of pain and pain behaviour is not necessarily based on the physiological process of healing.

The behavioural regime in this study was designed specifically to restore activity levels. Thus, analgesics, activity limits and exercises were physician-regulated, based on the expected healing time for the injury.

Subjects presenting to a hospital or clinic with LBP of less than 10 days duration were randomly assigned to one of the two treatment groups (Group A [traditional approach] _n_=50; Group B [behavioural approach] _n_=57). Patients were compared at 6 weeks and at 9-12 months on a set of "Sick/Well" scores based on vocational status, health care utilization, claimed impairment, pain drawings and measurement of activity level. No differences were found at 6 weeks but at 9-12 months, Group A were more "sick" as compared to Group B, those treated with the behavioural approach. Those in Group B had returned to pre-pain levels of functioning. An interesting and conflicting finding is that there were no differences in activity level between the two groups. Fordyce and his colleagues (1986) concluded that this may mean that the activity measures lacked reliability or that there may not always be a close relationship between how "sick" patients define or present themselves and their activity patterns.

Chronic LBP and Physical Fitness

More than 1,000 pain clinics have been established in the United States over the past 15 years in an attempt to treat the burgeoning chronic pain population (Mayer et al., 1986). Most of these clinics are multidisciplinary in nature using a wide variety of treatment modalities including physical therapy, cognitive, behavioural and psychological therapies, education and individual and family counselling (Aronoff, Evans & Enders, 1983). Although many of these programs promote increased activity levels, this is often measured in terms of up-time, ability to perform activities of daily living (ADL), or performance of increased quotas of particular exercises (Dolce, Crocker, Moletteire, & Doleys, 1986b; Doleys, Crocker, & Patton, 1982; Fordyce et al., 1981; Gottlieb et al., 1977; Mooney, Cairns, & Robertson, 1976).

A study by McQuade and colleagues (1988) examined the relationships between physical fitness and measures of pain, functional limitations and depression in persons with chronic LBP. Ninety-six subjects with chronic LBP, most of whom were working, were referred or were self-referred to the study following media publicity. Over a 1-week period, the subjects were evaluated with a battery of physical and psychologic disability measures and basic physical fitness tests for aerobic capacity, strength, and flexibility. The authors reported that there was a significant association between physical fitness and important elements of chronic LBP problems. Greater overall physical fitness was significantly correlated with less physical dysfunction and fewer depressive symptoms, but not with psychologic dysfunction as measured by the Sickness Impact Profile. Specifically, they found that (a) the stronger (particularly in back extensor muscle) the individual with LBP, the less that person appeared to be limited by LBP and (b) the higher the aerobic capacity, the more generally active was the individual. Of interest is that reports of pain quality and intensity as measured by the McGill Melzack Pain Questionnaire and by visual analogue scales were not affected by fitness for this study sample.

Only three studies of treatment programs that place primary emphasis on physical fitness and conditioning were found in the extensive literature that exists on the subject of chronic low back pain. Mayer and colleagues (1985, 1986) designed and evaluated a four-phase program for chronic back pain patients that integrated an active physical rehabilitation and reconditioning program with a multimodal pain management component. The underlying philosophy of the program was that the major physical deficits in these patients were the result of the deconditioning syndrome caused by prolonged disuse of spinal joints and muscles, by and large an iatrogenically-induced problem. Specific exercises, training, education and work simulation were done to improve spinal mobility, trunk muscle strength, endurance, cardiovascular fitness, and other physical parameters. Careful quantification of functional improvement was done and shared with the client and attending physician on an ongoing basis. Psychological intervention including behavioural, cognitive and counselling therapies focused on specific pain management strategies and other problems.

Sixty-six patients (mostly working class men and women, 90% of whom were receiving Workers' Compensation benefits) completed the 3-week, 58-hours-per-week program. Results of this study are remarkable. At the end of the program, participants had improved levels of physical fitness, a substantial improvement in self-reported pain and dysfunction, a decrease in self-reported depression, and significant changes in outcome criteria such as return-to-work. In a 5-month follow-up, 82% of patients had returned to work. A group of comparable patients who attended a traditional pain clinic was used as a comparison. Only 24% of these patients had returned to work in the same time period.

A study by Beekman & Axtell (1985) also noted significant increases in cardiovascular efficiency, increases in distance walking and other physical conditioning activities and a decrease in self-rated pain measures in 49 patients with chronic spinal pain who completed a 4-week, in-hospital rehabilitation program that emphasized physical fitness. These improvements remained significant at 1, 3, and 6 months after discharge. In another study of the same program, Beekman, Axtell, Noland and West (1985) investigated the change in self-concept in 50 patients with chronic spinal pain. Patients with chronic LBP have been shown to have disturbances of affect, particularly increased depression and chronic invalidism which are assumed to affect their self-concept. Since patients with other diagnoses have demonstrated an improved self-concept as a result of structured exercise programs and improved physical well-being, Beekman et al. (1985) anticipated a similar outcome for their patients. They reported a marked increase in self-esteem in these clients in response to a physical fitness rehabilitation program.

Unlike the multidisciplinary programs for chronic LBP, Manniche and colleagues (1988) studied a single intervention -- intensive muscle training. Physician-referred patients with chronic LBP (N=105) were randomly assigned to one of three groups:

1. Group C was put on a training cycle of intensive back strengthening exercises for 30 sessions over a 3-month period. The training regime consisted of just three dynamic back extensor exercises: trunk lifting, leg lifting and pull to neck. Patients attended three sessions per week for the first month and two sessions per week for the last 2 months.

2. Group B was put on an identical regime as Group C except that the exercises were one-fifth the intensity.

3. Group A was given applications of hot compresses and massage of back and gluteal muscles and did mild isometric exercises for eight sessions over 1 month.

The results consistently favoured intensive back muscle training, which had no adverse effects. Significant differences were found in measures of self-reported pain, disability and physical impairment from pretest, posttest and 6-month follow-up for the intensive back-muscle group. In their discussion, the authors expressed their surprise at the pronounced difference between treatment groups since other studies of this kind had shown equivocal or marginal changes. Manniche and his colleagues interpreted the success of their program in large measure to the duration of the training. They stated: "...in the first month of treatment many of our patients had increased discomfort from muscles (fatigue, tenderness) and continued back trouble; not until the second and third months did a gradual improvement become apparent" (Manniche et al., 1988, p. 1476).

Summary of the Literature

There are a number of general conclusions that can be drawn from the literature on low back pain and physical fitness:

1. There is strong evidence that improved physical fitness, both aerobic fitness and muscle strength, plays a

significant role in the prevention and recurrence of back injuries.

2. There is evidence to suggest that individuals with LBP (either acute or chronic) who participate in physical fitness programs derive both physical and psychological benefits.

3. Many studies of the chronic LBP population report decreased self-reports of pain and disability with increased activity levels.

4. Evidence supports the view that two major factors contribute to the development of chronicity: (a) the disuse syndrome that comes with inactivity, and (b) environmental conditioning factors that encourage the sick role.

Therefore, if deconditioning can be prevented and healthy behaviour reinforced, then physical fitness programs for individuals with LBP who are not improving with traditional therapies might be expected to: improve physical fitness, improve psychological well-being, reduce the self-report of pain and disability, lower the recurrence rate, and decrease the incidence of chronicity.

Conceptual Framework

This study is based on two separate but complementary perspectives on pain: the gate control theory of pain as proposed by Melzack and Wall (1965, 1982) and the behavioural learning theory by Fordyce (1976, 1986). This section will provide brief explanations of these theories followed by a discussion of how they are applicable to this study.

Historical Background of Pain Theory

From earliest recorded history until the 17th century, pain was characterized as an emotional or affective state rather than as a sensation (Craig, 1984). According to the affect theory, pain was regarded as an essential emotional component of the human spirit and was thought of as a quality of experience much like sadness or warmth. Aristotle, for example, attributed pain to violent forms of wave motions due to intensive sensations; but pain itself was an emotional experience that took place in the heart (Mersky, 1980).

With the 17th century came a change in the philosophical view of man. In opposition to the holistic view of man held by the ancient Greeks, Descartes' dualistic model described man as being composed of mind and body that were totally separate: neither derives from or in any way depends upon or is explicable by the other. From these ideas sprang the specificity theory, a pure sensory model of pain that was articulated by the neurophysiologist von Frey in 1894. It states that specific pain receptors in body tissue project impulses via pain fibres and pathways to the pain centre in the brain. In addition, this theory implies a direct, invariant relationship between a stimulus that produces pain and the sensation felt. In this model, then, pain is viewed as pure sensation, and sensation in Cartesian terms has to do with the body alone and not the mind.

The third traditional pain theory called the pattern theory was proposed by Goldschneider in the late 19th century. Although it too is a sensory model of pain, it contrasts with the specificity theory by maintaining that there are no specific mechanisms for pain. Instead, it is the transmission of nerve impulse patterns coded at the periphery that yields the sensation of pain (Melzack & Wall, 1965).

In evaluating these theories, it is clear that each makes an important contribution to the concept of pain (Kim, 1980). The affect theory suggests the vital importance of the emotional dimension; the specificity theory contributed to the understanding of the basic physiological mechanisms of acute pain; the pattern theory contributed further to the understanding of nerve signal physiology such as temporal and spatial summation and coding/patterning functions. However, it was not until Melzack and Wall (1965) described the gate control theory that all these elements were included in one framework.

Gate Control Theory of Pain

Currently, the most widely accepted theory of pain is the gate control theory postulated by Melzack and Wall in 1965 and expanded in 1968 by Melzack and Casey. They set out to develop a theory that took physiological, psychological and clinical evidence concerning pain into account. They particularly drew on the earlier neurophysiological work of Wall which indicated that impulses arriving at the spinal cord stimulated spinal cord fibres which transmitted onto the brain (Fordyce, 1976). Further work had provided evidence that the substantia gelatinosa in the spinal cord could both inhibit and facilitate transmission of sensory input from the periphery to central cells. The evidence of cultural influences on pain were being studied and recognized (Zborowski, 1952, 1969) and the evidence of the psychological influences on pain could no longer be ignored (Beecher, 1959). As Melzack stated in 1961:

> The psychological evidence strongly supports the view of pain as a perceptual experience whose quality and intensity is influenced by the unique past history of the individual, by the meaning he gives to the pain producing situation and by his state of mind at the moment. We believe that all these factors play a role in determining the actual patterns of nerve impulses ascending to the brain and travelling within the brain

> itself. In this way pain becomes a function of the whole individual including his present thoughts and fears as well as his hopes for the future. (p. 49)

The gate control theory proposes that a neural mechanism (located in the substantia gelatinosa (SG) of the dorsal horn of the spinal cord) acts as a gate which can be opened or closed thus facilitating or inhibiting the transmission of nerve impulses to the thalamus and cortex for processing and interpretation as painful. The degree to which the gate is opened or closed is determined by the relative activity in three areas: the large diameter (A-beta) nerve fibres, the small diameter (A-delta and C) nerve fibres, and by descending influences from central control processes in the brain (Melzack & Wall, 1982). Research suggests that the gate can be opened by the stimulation of the small (S) fibres, allowing for pain impulse travel to transmission or T-cells. When output of the T cells exceeds a critical level, the action system responsible for response to and perception of pain is activated in the brain.

Stimulation of large A-beta fibres is known to inhibit transmission of nerve impulses from afferent fibres to T cells (Melzack & Wall, 1982); this tends to close the gate and inhibit impulse transmission from the periphery to the brain. Large fibres carry signals for touch, temperature and movement. This theoretically explains why rubbing a painful area, and why heat, massage, electrical stimulation, acupuncture or physical exercise that activates large muscle groups might modulate pain (Meinhart & McCaffery, 1983).

Just as the gate can be opened or closed by impulses going from the periphery to the brain, so the gate can be controlled by descending nerve impulses from higher levels of the central nervous system (CNS). There is a rapidly growing body of evidence that psychological processes as well as several neuropharmacological systems (endogenous endorphins and other non-opioid analgesia systems) are involved in descending control (Guyton, 1986; Melzack, 1986). Thus, cognitive or higher CNS processes such as attention, anxiety, anticipation and past experience or learning can exert a powerful influence on pain processes by exerting control over the gating mechanism (Melzack & Wall, 1982).

Since its publication in 1965, the gate control theory of pain has been the major impetus behind the renewed interest in pain research in multiple disciplines, from basic science research to applied clinical research into new treatments for pain. As Meinhart and McCaffery (1983) stated: "In the years since the theory was proposed, virtually every article on pain at least mentions the contribution made by these men" (p. 79). However, Melzack and Wall (1982) are the first to admit that the entire field of pain is in a state of flux with scientific evidence expanding rapidly, especially in the fields of neurophysiology, chemistry, pharmacology and psychology. Although many of the details of the gate control theory have yet to be unravelled, almost all authors agree that the original concept of the gate control is valid (Noordenbos, 1984).

Behavioural Learning Theory

One of the most well developed and utilized theories relating to pain that has persisted beyond healing time is the learning or behavioural model. It is important to clarify that this model relates to pain that occurs as a result of an injury that is expected to heal and does not apply to malignant pain or to other disease-caused pain.

Like the gate control theory, the behavioural approach views pain as a complex set of events involving peripheral stimulation from any of several possible modalities, the neural and cognitive processing of those stimuli, almost certainly emotional expression and the expressed behaviour (Fordyce, 1986). The reason for focusing on behaviour (defined as verbal and non-verbal expressions of suffering, medication taking, health care seeking, and alterations in daily activities) is that behaviour is all that can be observed or measured as representative of the other's experience (Fordyce, Roberts & Sternbach, 1985).

The behavioural approach assumes that pain behaviours may occur for a variety of reasons. The principal reasons are nociception, the adverse effects of disuse and overguarding of involved body parts, and contingent reinforcement from the environment (Fordyce et al., 1985). Like all behaviour, pain behaviours are sensitive to learning or conditioning effects. Pain behaviours that started for one set of reasons (e.g., nociception) may persist for another set of reasons (e.g., contingent reinforcement from the environment). For example, in some situations, pain behaviours may elicit such responses as attention, sympathy, and encouragement to rest. These environmental consequences may serve as reinforcers, which in turn, strengthen the probability that pain behaviour will persist.

Whatever the reason pain behaviours occur, the further assumption is made that pain behaviours are modifiable. Treatment and rehabilitation approaches to pain strive to modify activity level and environmental contingencies in an attempt to alter the negative consequences of pain behaviour such as invalidism and excessive disability.

Although learning theory is limited in its scope and excludes the experience of suffering from the patient's perspective, it clearly has value in the clinical setting. The usefulness of the model for the treatment of chronic pain in particular has been documented in many studies, thus validating the utility of the theory in practice (Anderson, Cole, Gullickson, Hudgens & Roberts, 1977; Fordyce, Fowler, Lehmann, DeLateur, Sand & Trieschmann, 1973; Fordyce et al., 1985; Linton, 1982; Turk & Flor, 1984).

Application of Theories to the Study

As it relates to this study, the gate control theory provides a holistic model of pain, one that includes neurophysiological as well as powerful cognitive, psychological and social components. Pain is seen as a function of the whole person and is influenced by numerous variables and multiple interactions. Such an orientation is consistent with a nursing perspective of the person with pain (Donovan, 1989; Meinhart & McCaffery, 1983; Rowat, 1983).

The gate control theory guides this study by providing possible explanations as to how a physical fitness program might influence pain levels. For example, the exercise of large muscle groups might affect large A-beta fibres that act to close the pain gate; aerobic exercise may stimulate various neuropharmacological systems, such as the endorphin system, that might affect the pain gate; improved muscle strength might change the input of noxious stimuli at the level of injury by providing increased support to an unstable spine; the psychological influence of the group process may impact on cognitions, motivation and attention; the health setting of a fitness facility rather than an "illness" facility may change beliefs about self and influence pain; improved levels of fitness may influence psychological well-being, especially variables such as mood, anxiety and self-esteem. These are only some theoretical possibilities that the gate theory of pain in conjunction with the behavioural learning theory provides for this study.

As well, the intervention strategy of a physical fitness program in a fitness facility for both acute and chronic phases of a low back injury sets the stage for the curtailment of the deconditioning syndrome, and the application of positive reinforcers for healthy behaviour as postulated by Fordyce's learning theory.

CHAPTER 3

METHODOLOGY

A brief overview of the methodology used in this study will be presented first. This will be followed by a full description of the methodology, discussed under the following headings: study design, study sample, setting, ethical considerations, description of the Lifestyles Program, data collection procedure, research tools, and statistical methods used to analyze the data. The chapter concludes with a summary.

Overview

A within-subjects repeated measures design was utilized in this study of 50 subjects suffering from LBP who participated in a physical fitness program during a randomly-selected time period, from late May 1988 to mid-December 1988. Measures of the dependent variables -- physical fitness, pain, disability, and three psychological factors -- were collected over five data collection time periods. Complete data sets for the pain and disability variables were obtained for those subjects who completed 8 weeks in the physical fitness program (*n*=43) and for those subjects who went on to complete 12 weeks in the program (*n*=35). Separate multivariate analysis of variance (MANOVA) of the data collected at 8 weeks and at 12 weeks revealed similar results. In this study, the statistical results obtained at 8 weeks are reported. These data were thought to be more representative of the group as a whole since the study sample at 8 weeks still included the subjects who were doing exceptionally well (and who, therefore, returned to work) and the subjects who were doing poorly (and who were subsequently withdrawn from the program because of increased pain).

Study Design

A within-subjects repeated measures design was used in this study since the researcher was interested in changes in multiple variables (measures of physical fitness, pain, disability and three psychological variables) over time as subjects progressed through a structured group physical fitness program. In this study, each subject served as his or her own control.

Initially, the investigator had hoped to be able to design a quasi-experimental study with an untreated control group (i.e., subjects with LBP who were not improving with traditional conservative measures and who would ordinarily not have been referred to a physical fitness program). However, this was not possible for the following reasons. The only physiotherapy departments in the city of St. John's which did not refer to a structured physical fitness program such as the Lifestyles Program were the outpatient departments of two major hospitals. The chief physiotherapists at both these hospitals were contacted, and explanations about the purpose of the study and the need for a control group were discussed. Both departments were willing to cooperate; however, after investigation of their recent caseloads and a review of their current waiting lists (a list of 60 patients at one hospital and an even larger number at the second hospital), it was clear that numbers for a control group were unlikely to be found. Only 2 clients on the waiting list of both hospitals had a low back injury. Both physiotherapists had similar explanations for this. Since LBP often occurs in the working population, most of these clients are Workers' Compensation recipients. Because hospital outpatient physiotherapy departments have such long waiting lists, these clients tend to be sent to private physiotherapy clinics that have shorter waiting periods.

Other possibilities for a control group were considered such as polling general practitioners, orthopedic surgeons, and contacting physiotherapy departments in areas outside St. John's. However, these were rejected as being unworkable for this level of research. Similar problems in obtaining control groups for LBP studies have been reported in the literature (Aronoff et al., 1983).

Sample

The study sample consisted of all low back injured individuals, both men and women, who were referred to the Lifestyles Program at the Aquarena in St. John's, Newfoundland during a randomly-selected time period. The sample included those subjects who were sponsored by the Workers' Compensation Commission as well as those who were paying for the program privately. To be eligible for inclusion in the study, a low back problem had to be the primary but not the exclusive reason for referral. Those with accompanying pain problems in other areas -- for example, upper back, shoulders and neck -- were also included. In addition, subjects had to be able to understand English.

During the planning phase of the study, the average number of individuals referred to the Lifestyles Program was approximately 20-25 per month, approximately 75% of whom had low back injuries. Therefore, it was anticipated that 15-20 subjects would be eligible for admission to the study each month. It was also anticipated that data would be collected from 50 subjects. These estimates proved to be correct. Over a randomly-selected time period of 3 months, from late May to late August 1988, 52 subjects were eligible for inclusion in the study: 2 refused to participate and 50 subjects voluntarily consented to be in the study.

Although the Lifestyles Program was normally 3 months in length, subjects exited the program at various times. Of the 50 subjects, 4 dropped out of the program within the first 2 weeks due to the following reasons: 1 subject moved to another city, 1 subject broke his foot in an accident unrelated to the program, and 2 private-paying subjects decided that the program was "not for them." Two subjects exited the program at 4 weeks -- 1 subject went back to work and 1 subject was withdrawn from the program by the physiotherapist due to increased pain. In addition, 8 subjects exited after completing 8 weeks: 2 returned to work; 1 private-paying subject, who was already working, found the scheduling too difficult; another private-paying subject had financial difficulties; 1 subject went to hospital for a health problem unrelated to his back injury; another went to hospital for further investigation of his back injury; 1 subject developed a dermatological condition related to the chlorine in the pool; and 1 subject was withdrawn from the program because of increased back pain. In all, from the original 50 subjects in the study, 44 subjects completed 8 weeks and 36 subjects completed 12 weeks in the Lifestyles Program. Therefore, 44 subjects were eligible for inclusion in the statistical analyses at 8 weeks. However, 1 subject was dropped from the analyses because one data collection interview had been missed entirely resulting in incomplete data for all variables.

(The statistical analysis of repeated measures requires complete data sets. If one time measure is missing, the entire case is excluded from analysis).

Setting

Subjects were interviewed by the researcher at each data collection period in a private office close to the Lifestyles Program staff office in the Aquarena building. The following were exceptions to this general rule:

1. Two subjects were discharged from the program earlier than expected, and the researcher was invited and went to their homes to administer the final program questionnaires.

2. The researcher was away for a short time in July 1988, and the Nutrition Consultant for the program interviewed 4 subjects on the researcher's behalf, with the prior consent of the subjects. The researcher had instructed the Nutrition Consultant on the data collection procedure; written instructions were also left with her. The subjects were interviewed in the Lifestyles Program staff office.

Initially, the researcher had planned to interview subjects in the physiotherapy clinics where they were being treated prior to their starting the Lifestyles Program. It was thought that several baseline measures of pain, in particular, would be valuable to the study results.

However, two of the private physiotherapy units felt that because of a heavy client load, their space was at a premium; therefore, this was not possible.

Ethical Considerations

Although this study was considered to be of low physical and psychological risk to study participants, all research studies must protect the rights of subjects. This was done in a variety of ways: (a) by using an intermediary to gain initial permission to interview potential subjects, (b) by using informed consent, (c) by ensuring confidentiality, and (d) by proceeding through a formal ethical review process.

As part of the orientation from late May to late August 1988, new participants in the Lifestyles Program were given a letter briefly introducing the present study (see Appendix B). This letter was given to them by the individual who was conducting the orientation that day, either the Lifestyles Program Coordinator or the Nutrition Consultant. After reading the letter, those with a low back injury who were interested in knowing more about the study and who verbally agreed to be interviewed were directed to the office where the researcher was located.

At this point, a full verbal explanation of the study was given to all prospective subjects by the researcher. The consent form (see Appendix C) was explained in detail, and only when the researcher was confident that the subjects fully understood their role in the study were the subjects asked if they would like to participate. If they agreed, two consent forms were signed, one for the participant and one for the researcher's records.

In addition, during the orientation process, the Lifestyles Program Coordinator or the Nutrition Consultant had explained the nature of the fitness measurements that the Aquarena staff would be collecting. Only when informed consents for both the present study and the fitness measurements were signed was a subject admitted into the study.

Confidentiality was maintained throughout the study. Each subject was given a file number on entry into the study and the form identifying the client name with number was kept separately in a locked filing cabinet accessible only to the researcher. Only the subject number was recorded on questionnaires.

The proposal for the research study was presented to the Human Subjects Review Committee of the School of Nursing, Memorial University of Newfoundland and was approved. Although the agency where data collection took place did not have a formal ethical review process, the proposal was given to the director of rehabilitation programs and to the consultant physiotherapist of the Lifestyles Program, both of whom agreed to allow the study to proceed (see Appendices D & E). In addition, the medical director of the Workers' Compensation Commission of Newfoundland and Labrador was informed about the study; he had no objections to the study (L. Vardy, liaison to the WCC, personal communication, April, 1988). In addition, all physiotherapy departments in the city that referred clients to the Lifestyles Program were informed about the study (see Appendix F).

Description of the Lifestyles Program

A general overview of the Lifestyles Program has already been presented in the literature review describing the study by Hannah and colleagues (1988b). The following discussion will provide important details about how subjects would normally progress through the program during the period of this study.

In general, most subjects participated in two waterfit classes per week and three Nautilus sessions per week. Therefore, almost all subjects attended the Lifestyles Program from Monday to Friday for 1 hour each day. There were exceptions, however. Depending on the nature of the back injury, some subjects began with waterfit classes four times per week. As their endurance and general level of fitness improved, they were then placed on Nautilus machines as well, thereby increasing their overall participation in the program from four to five times per week.

The waterfit aerobics component, designed to improve cardiorespiratory endurance and flexibility, was conducted in the pool, in water waist-deep to shoulder-height. A minimum of two instructors were always in attendance. Subjects gradually increased their speed and level of exercise in a programmed fashion, week by week. By and large, the exercises consisted of variations of walking and jogging lengths in the pool with and without extra resistance for at least 20 minutes, as well as range of motion, flexibility and stretching exercises. (A floatboard held at arms length that was pushed and pulled through the water provided extra resistance.) The longer subjects were in the program, the more they were encouraged to work progressively harder and longer. As with any aerobics program, there was an 8-minute to 10-minute warm-up period prior to the aerobics component as well as a cool-down period before the end of the class.

The workout on Nautilus machines, which was designed to enhance the strength and endurance of specific muscle groups, consisted of a possible 14 exercises on 11 Nautilus machines (see Table 1). Not all subjects in this study used all machines; this depended on the nature of the injury and the stage of recovery. Individuals began by lifting light weights, gradually increasing the number of repetitions to 20. They then increased the weight, and again gradually increased the number of repetitions to 20 and so on.

Table 1

Nautilus Machines and Primary Muscle Groups Exercised[a]

Machine	Exercise	Primary muscle groups
1	Duo hip and back	Gluteus maximus, Erector spinae
2	Leg extension	Quadriceps
3	Side leg curl	Hamstrings
4	Duo squat	Gluteus maximus, Quadriceps, Hamstrings
5a	Abductor	Gluteus medius, Tensor fasciae latae
5b	Adductor	Adductors
6	Torso arm	Latissimus dorsi, Biceps
7	Super pullover	Latissimus dorsi, Teres major
8a	Double chest	Pectoralis major
8b	Chest press	Pectoralis major, Deltoid, Triceps
9	Lateral raise	Deltoid
10	Abdominal	Rectus abdominus, Illiopsoas
11a	Biceps	Biceps
11b	Triceps	Triceps

[a]Nautilus Manual, Lake Helen, Florida: Nautilus Sports/Medical Industries.

Participants were consistently monitored by Lifestyles Program staff throughout their Nautilus session for correct body alignment, correct use of equipment and appropriate increases in weights. Subjects were cautioned not to continue a particular exercise if pain increased significantly.

During the time frame of this study, subjects did not automatically obtain the services of the Nutrition Consultant. Previously, this had been an integral part of the Lifestyles Program (Hannah et al., 1988b); however, funding for this was withdrawn and subjects in this study were required to pay for this service themselves. Only 2 subjects chose to do so.

For the duration of their time in the Lifestyles Program, participation was compulsory for the WCC-sponsored subjects. They were obligated to come to all scheduled fitness classes and Nautilus appointments and to make up classes they missed. At times, this meant "doubling up" on classes, for example doing a waterfit class and a Nautilus workout on the same day. In contrast, the private-paying subjects were under no obligation to attend all classes; information from the Program Coordinator, however, indicated that the private-paying subjects, on the whole, missed very few classes. All subjects were seen by their physiotherapists at least biweekly while in the program. In addition, some subjects regularly saw their physicians.

Procedure

Data were collected from late May 1988 to mid-December 1988 while subjects were in the program. Measures of pain, disability, self-esteem, anxiety, and mood were collected by the researcher at the following time intervals: the initial day of orientation to the Lifestyles Program (Day 0), at 2 weeks, 4 weeks, 8 weeks and 12 weeks. In addition, the General Information Tool was administered at Day 0. (See Figure 2).

Subjects were interviewed by the researcher at each data collection period. It was thought to be important to interview subjects directly about their pain in particular since McGuire (1984, 1989), Rowat (1983) and others report that pain measures such as the McGill-Melzack Pain Questionnaire (MPQ) and visual analogue scales (VAS) used in this study, may need full explanation at each time of administration. It also gave subjects an opportunity to talk about their situation -- how they felt about the program and how they were coping with their pain. With the exception of the initial interview, the researcher telephoned clients at home a day or two ahead of each data collection period to arrange an appointment. Most clients were interviewed before their exercise class or Nautilus session; however, it was not possible to do so in every case.

DAY 0	2 WEEKS	4 WEEKS	8 WEEKS	12 WEEKS
Measures of:	Measures of:	Measures of:	Measures of:	Measures of:
Pain	Pain	Pain	Pain	Pain
Disability	Disability	Disability	Disability	Disability
Self-esteem	Self-esteem	Self-esteem	Self-esteem	Self-esteem
Anxiety	Anxiety	Anxiety	Anxiety	Anxiety
Mood	Mood	Mood	Mood	Mood
Physical fitness		Physical fitness	Physical fitness	Physical fitness
General information tool				

Figure 2: Time Line for Data Collection During Subjects' Participation in Lifestyles Program

The data for the measures of physical fitness were collected by the Lifestyles Program staff. Measures of: (a) heart rates before, during and after aerobic exercise; (b) weight in kilograms lifted on Nautilus machines; (c) flexibility; (d) body fat; and (e) balance were collected at regular intervals (Day 0, 4 weeks, 8 weeks and 12 weeks). Measures such as weight were taken weekly; height was taken at Day 0. Once all the data had been collected from all subjects, the researcher gained access to the subjects' measures of physical fitness as collected by the program staff for purposes of statistical analysis.

Research Tools

Seven research tools were used in this study. Five were tools previously reported in the literature and used in health-related research; two were designed by the researcher for the present study.

General Information Tool

The General Information Tool, a 16-item questionnaire, was developed by the researcher to gain information indicated in the literature as important to the LBP population (see Appendix G). Specifically, subjects were asked questions about: (a) demographic characteristics such as age, sex, marital status, household members, occupation, employment status, and financial status (Andersson & Pope, 1984; Bombardier et al., 1985; Payne & Norfleet, 1986); (b) the history of the low back injury, such as how the injury was sustained, if it was a first or recurrent injury, and length of time of injury (Frymoyer & Milhous, 1984; Spitzer et al., 1987); (c) other medical conditions (Frymoyer & Milhous, 1984); (d) current medication for LBP and previous back surgery (McQuade et al., 1988; Murphy & Cornish, 1984); and, (e) smoking, as a possible predisposing factor (Frymoyer et al., 1983).

The tool was administered and completed by the researcher by interviewing each subject individually. This was to ensure accuracy and to provide the opportunity to clarify subjects' answers to the questions.

McGill-Melzack Pain Questionnaire (MPQ)

The MPQ was used as the primary pain measure in this study (see Appendix H). Permission to use the tool was obtained from the tool developer, Dr. Ronald Melzack (see Appendix I). The tool was designed to assess the three components of pain - sensory, affective and evaluative - as postulated by the gate control theory and has five basic components (Melzack, 1975):

(1) Pain Rating Index (PRI): an index of overall pain intensity that consists of a list of 20 groups of words that describe pain quality. Each set contains up to six words,

from least severe to most severe. The subject is asked to select the word sets tha describe his/her pain and then to choose the most appropriate word within the set. The total PRI score is obtained by: (a) assigning each word in each set the number of its rank order within the set (i.e., the first word in the set is scored as 1, the second word is 2), and, (b) add up the number values from all the sets to obtain the total score. The word descriptors can be broken down into sensory, affective, evaluative and miscellaneous categories. In this study, only the total score was calculated (Turk, Rudy & Salovey, 1985).

(2) Present Pain Intensity (PPI): a number-word combination scale from 0 (no pain) to 5 (excruciating) that serves as an indicator of overall pain intensity.

(3) Number of Words Chosen (NWC): the total number of words chosen from the 20 groups of adjectives.

(4) Line Drawings of the Body: the subject pinpoints his/her pain on the body drawing, both front and back, and indicates if the pain is constant, periodic or brief.

(5) List of Symptoms: subjects indicate if, along with their pain, they also experience symptoms such as nausea and headache. They also indicate their general pattern of sleep, activity and food intake. For purposes of this study, only the PRI and the List of Symptoms were analyzed.

In an overview article of pain measurement, Chapman and colleagues (1985) reported that the MPQ is one of the most widely used pain measures in research studies and that considerable support for the basic structure, reliability, and validity of the MPQ has been demonstrated in the literature. Significant correlations have been reported among the subjects' ratings of the PRI, PPI and NWC ($p<.01$) (Melzack, 1975). It was also reported that the most valid index of change in pain levels is the PRI score, with the PPI being the least reliable (Melzack, 1975). In 1976, the tool was reported to differentiate between different clinical pain syndromes including arthritis, labour, cancer pain and low back pain 'elzack & Wall, 1982). The fact that it scales pain multi-dimensionally was thought to be a major advantage of the tool (Chapman et al., 1985).

In this study, the tool was administered by the researcher, closely following the guidelines outlined by Melzack (1975). As suggested, the following instructions for the PRI were read aloud to each subject:

> Some of the words I will read to you describe your present pain. Tell me which words best describe it. Leave out any word-group that is not suitable. Use only a single word in each appropriate group -- the one that applies best (Melzack, 1975, p. 297).

The researcher then clarified any misunderstandings. For example, some subjects thought that they must select a word from each set; others would choose two words from a set. As the researcher read the word descriptors aloud, subjects indicated the words that described their pain; the words were marked by the researcher to ensure accuracy. If subjects did not have pain at the moment of interview, they were asked to think of the last time they had experienced pain in the past 24 hours. In general, subjects reported that their "present" pain was very similar, if not identical, to the pain they had "most of the time."

One possible disadvantage of the MPQ reported by Chapman and colleagues (1985) is that the complex vocabulary may be difficult for some clients, and might be particularly problematic if comparisons are made across cultural or subcultural groups. To minimize this problem, subjects were provided with definitions of words they did not understand, as Melzack (1975) recommended. The researcher had a list of dictionary definitions compiled from Webster's Third New International Dictionary (Gove, 1976). When a subject indicated confusion about the meaning of a word, the definition was read to the subject. On the whole, the vocabulary of the MPQ was not found to be a problem for most subjects in the present study. As has been reported by Melzack (1975), these subjects would reject word after word until the word that described their pain came up. In addition, because all the subjects in the study were Newfoundlanders, the problem of cultural comparisons did not arise.

Pain Questionnaire

Because the MPQ is primarily a measure of present pain intensity (pain at the moment), a second pain questionnaire was developed that attempted to evaluate subjects' perception of the intensity, frequency, and duration of their pain over a 7-day period. This questionnaire was developed by the researcher in conjunction with the literature; content validity was assessed and deemed acceptable by Dr. Eliane Belanger, a post doctoral student working in pain research with Dr. R. Melzack at McGill University (personal communication, May 4 and 5, 1988).

The pain tool is a short seven-item questionnaire (see Appendix J). Items 1 (pain now), 5 (least pain in last week) and 6 (worst pain in last week) use a 100 mm visual analogue scale (VAS) with "No Pain" as the left anchor and "Worst Possible Pain" as the right anchor. These specific anchor words are the same as those used in the VAS of the short-form McGill Pain Questionnaire (Melzack, 1987). Subjects are asked to mark an X on the spot on the line that best describes how much pain they have experienced.

A VAS is a unidimensional measure that represents a continuum of pain intensity. The VAS is a commonly used clinical tool for the assessment of pain at different points in time. Although the psychometric properties of the scale are not fully established, it has been reported to have good reliability with repeated use by the same individuals

(McGuire, 1984, 1989; Reading, 1984), with validity having been assumed (McGuire, 1984, 1989).

Item 2 of the questionnaire is directed at subjects who do not have pain at the time of interview, and asks when they last had pain. Item 3 asks about the frequency of pain the subject has experienced in the past 7 days. Item 4 (Is pain constant, periodic or brief?) and item 7 (PPI) are taken directly from the MPQ, but stipulates the past week as the time period under question, rather than pain "right now".

The Pain Questionnaire was always administered before the MPQ to obtain information about how the pain had been in general over the week, before asking about pain at the moment. As McQuire (1984) notes, the VAS can be confusing for some subjects. Therefore, the VAS scales were carefully explained to all subjects at each data collection period.

The Oswestry Low Back Pain Disability Questionnaire

This is a self-administered questionnaire that assesses the degree of functional impairment an individual with low back pain is experiencing in various activities of daily living (see Appendix K). It was developed over a 4-year period at the Robert Jones and Agnes Hunt Orthopaedic Hospital in Shropshire, England and has been used in both the acute and chronic low back pain populations (Fairbank, Couper, Davies, & O'Brien, 1980; Mayer et al., 1985, 1986).

Permission to use the tool was obtained verbally (Dr. Stephen Eisenstein, Robert Cross and Agnes Hill Hospital, Oswestry, Shropshire, personnel communication, March 14, 1988). Written permission was also obtained (see Appendix L).

The questionnaire, which takes less than 5 minutes to complete, is divided into 10 sections relating to different activities of daily living -- personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, travelling, and pain intensity. These 10 activities were the ones found by the tool developers to be most relevant to the problems suffered by people with low back pain. Each section contains six statements that describe activities of increasing difficulty. These are scored on a scale from 0-5, with 5 representing the greatest difficulty. The scores for all sections are added together, doubled and then expressed as a percentage. In accordance with the authors recommendations, if a subject marked two statements, the highest scoring statement was recorded. If a section was not completed, the final score was adjusted to obtain a percentage.

The tool developers reported that the questionnaire is a valid indicator of disability if the score closely reflects the client's observed disability and symptoms (Fairbank et al., 1980). The correlation coefficient of test-retest reliability was 0.99 (p<.001), and additional analyses indicated good internal consistency (Fairbank et al., 1980). Interestingly, no other questionnaire was found in the literature that was specific to low back pain disability. The tool has been used in other studies of the LBP population (Mayer et al., 1986) and was thought to be very appropriate for use in this study.

Rosenberg Self-Esteem Scale

In this study, self-esteem was measured by the Rosenberg Self-Esteem Scale, a self-administered, 10-item, Likert-type scale (see Appendix M). The subject responds on a 4-point scale from "strongly agree" to "strongly disagree". The scale is thought to be a unidimensional measure of the self-acceptance aspect of self-esteem and all items revolve around liking and or approving of the self (Robinson & Shaver, 1973)

Reliability has been reported to be high for such a short scale with a test-retest correlation over two weeks of .85 (Robinson & Shaver, 1973). Convergent, discriminant, and predictive validity have been reported in the literature (Robinson & Shaver, 1973): the scale correlated from .56 to .83 with several similar measures and clinical assessment; correlations with measures of self-stability were .21 to .53; and, Rosenberg (1965) reported considerable data about the construct validity of the tool. The total score of the tool ranges from 40 (indicating low self-esteem) to 10 (indicating high self-esteem); therefore, the lower the score, the higher the self-esteem.

Although originally designed for use with high school students, the tool has been widely used with the adult population. It was selected for this study because of its brevity and ease of administration. In addition, the self-acceptance sub-scale of a longer self-esteem tool had been reported by Beekman and colleagues (1985) to change significantly for a population with spinal pain who were in a fitness program. Permission to use the tool was obtained by the Princeton University Press (see Appendix N).

<u>State/Trait Anxiety Inventory</u>

The State/Trait Anxiety Inventory (STAI) Form Y-1 and Y-2, developed by Charles D. Spielberger, was used in this study to measure both state and trait anxiety at each data collection period. Each scale is self-administered and consists of 20 statements to which subjects respond with one of four choices. (Examples of the state [Y-1] and trait [Y-2] portions along with the responses are presented in Appendix O). On the state inventory, subjects are asked to respond in terms of how they feel right now, and to the trait portion in terms of how they feel generally. This was explained to the subjects each time. In addition, the state portion was always administered first as recommended by Spielberger and colleagues (1983). This is because the state anxiety scale can be influenced by the emotional climate that may be created if the trait anxiety scale is given first. The possible range of scores on each scale is between 20 and 80; the lower the score, the lower the anxiety level. Permission to use the inventory in the study was obtained (see Appendix P).

The STAI has been used extensively in research and is considered to be among the best measures of the standardized anxiety measures (Dreger, 1978). Spielberger and colleagues (1983) reported that the test-retest reliability for the trait anxiety scale was reasonably high ranging from .73 to .86 for the college student population; the stability coefficients for the state anxiety scale were relatively low, ranging from .16 to .62. This was not unexpected since state anxiety should fluctuate under the influence of different situational factors (Spielberger et al., 1983). Both scales have a high degree of internal consistency with reported median alpha coefficients of .92 for state anxiety and .90 for trait anxiety (Speilberger et al., 1983). In addition, Spielberger and colleagues (1983) have provided extensive evidence of the concurrent, convergent, divergent and construct validity of the STAI scales.

Memorial University Mood Scale

The Memorial University Mood Scale (MUMS), a mood adjective check list, was utilized in this study as a measure of global mood (McNeil, 1986). (See Appendix Q). It is a brief, self-administered scale that asks subjects to answer "yes," "no," or "DK" (don't know) to 23 word items. A score of 0 is given to items answered "no"; 1 to "DK"; and 2 to "yes" items. The MUMS consists of two subscales: vigor and affect (both positive and negative). The global mood score is obtained by using the following equation: (positive affect score - negative affect score) + vigor. Scores can range from -14 (lowest mood) to +32 (highest mood). The scale has been reported to have high internal consistency ($\alpha > .80$), but had low temporal stability ($\underline{r} < .50$ over 3 days; $\underline{r} < .3$ over 2 years), a finding not unexpected with a measure of short-term mood (Hannah, Kozma, Stones, Mosher & Vardy, 1989). The tool was developed with 1600 subjects of all ages, and validated with 372 subjects.

This scale seemed particularly appropriate for use in this study for a variety of reasons as outlined by McNeil (1986): (a) it was reported to be the first mood scale for use with all adult age levels; (b) it is brief, and reported to be free of verbal ability response bias; and (c) it was reported that both subscales (vigor and affect) were affected by participation in exercise. Permission to use the tool was obtained from the tool developer (see Appendix R).

Data Analyses

All data were coded and analyzed using the Statistical Package for the Social Sciences (SPSS-X). The study sample of 50 subjects was divided into two groups: those who were included in the statistical analyses, and those who were excluded from analyses. Frequencies for characteristics of the study sample were tabulated and compared for the two groups. In addition, frequencies were computed for the ordinal level measures of pain. Sign tests were performed to test for significant differences between frequency scores at different time periods (Fitz-Gibbon & Morris, 1987).

To test for the homogeneity of (a) the complete study sample and (b) the subset of subjects included in the statistical analyses, Student *t*-tests were performed on pain and disability measures at Day 0. Statistical significance was set at the .05 level, and the more conservative separate variance *t*-statistic was used (Munro, Visintainer & Page, 1986). Because the analysis yielded a statistically significant *t*-statistic for age group, a repeated measures analysis of covariance was performed on all variables to test the effect of that factor.

A 5 (Interval) x 3 (Session) within-subjects repeated measures multivariate analysis of variance (MANOVA) was performed on the heart rate measures. Separate within-subjects repeated measures MANOVAs were performed on all other dependent variables: weights lifted, body mass index, four pain measures, the disability measure and the three psychological measures: self-esteem, state/trait anxiety and mood (including subscales). Both the Wilk's multivariate statistic and the averaged univariate *F*-statistic were set at the .05 level of significance (Hand & Taylor, 1987). Both statistics had to be significant in order for the analysis to be reported as significant (Dr. D. G. Bryant, personal communication, July, 1989). In this study, the averaged univariate statistics are reported (Norusis, 1985). When needed, Tukey's Honestly Significant Difference (HSD) was performed to test for significant differences between group means (Munro et al., 1986).

Since the results from the statistical analyses of the data collected at 8 weeks were very similar to the results obtained from the analyses of the 12-week data, a decision was made to report only one set of results. Because of the larger numbers in the 8-week sample compared to the 12-week sample (n=43 compared to n=35 in the analyses of the pain measures, and n=33 compared to n=19 in the analyses of heart rates), it was thought that the 8-week analyses would be a better overall representation of the complete group. In addition, it was noted that subjects lost to analyses after 8 weeks included those who returned to work because of significant improvement, as well as those who were withdrawn from the program because of increased pain. Thus, the 8-

week sample included a broader range of subjects than did the 12-week sample.

Summary

In this study, measures of physical fitness, pain, disability and three psychological variables -- self-esteem, state/trait anxiety and mood -- were collected from subjects with LBP who participated in the Lifestyles Program. In this repeated measures design, each subject served as his or her own control.

The sample selection and data collection procedures were explained. The Lifestyles Program was described and ethical considerations were discussed in detail. A discussion of the literature pertaining to the research tools was presented and the statistical methods used for data analyses were delineated and explained.

CHAPTER 4

RESULTS AND DISCUSSION

A brief overview of the results of the study will be presented. This will be followed by a full description of the study results, presented in three sections. Discussion related to the specific findings will be included with each section. First, the characteristics of the study population will be described. This will be followed by the findings and statistical analyses related to three physical fitness variables -- heart rate, weight lifted and body mass index. Next, the findings, statistical analyses, and discussion relating to pain, disability and three psychological variables -- self-esteem, anxiety and mood -- will be presented. The chapter will conclude with an overall summary of the results.

Overview

The study sample of 50 subjects with LBP who participated in the Lifestyles Program was divided into two groups: those included in the 8-week statistical analyses and those who were excluded from the analyses because of missing data. Frequencies tabulated for selected sample characteristics revealed no major differences between the subjects in the included group versus the excluded group. In general, both male and female subjects were in their mid-to-late thirties, were married with children and were receiving Workers' Compensation and/or disability benefits. About equal numbers of subjects had acute and chronic pain; similarly, the number of subjects experiencing their first episode of LBP was about equal to the number with a recurrent back injury. Student *t*-tests and an analysis of covariance found that the study subjects constituted a homogeneous group on measures of pain and disability at program entry. MANOVA analyses of the data collected at 8 weeks revealed that statistically reliable improvement was found among the following variables: aerobic fitness, muscle strength, two measures of pain intensity, disability, anxiety and the vigor subscale of mood.

Characteristics of the Sample

In all, 50 subjects voluntarily consented to participate in the study, 30 males (60%) and 20 females (40%). All subjects had been referred to the Lifestyles Program primarily, but not exclusively, for a low back injury. All subjects were English-speaking residents of Newfoundland and appeared to be able to read English sufficiently well to complete the self-administered questionnaires. Only 1 subject (who exited the program at 1 month and who was, therefore, excluded from the statistical analyses) appeared to have difficulty reading the questionnaires. In this one case, the researcher read each questionnaire to the subject.

Demographic and other selected characteristics of the study sample (N=50) are presented in Tables 2, 3 and 4, and data relating to the low back injury and other health-related information are presented in Table 5. Two groups of subjects are compared: (a) those subjects (n=43) who had completed at least 2 months in the Lifestyles Program and who had not missed a data collection interview and (b) the subjects who exited the program earlier than 2 months (n=6) or for whom one data collection interview had been missed entirely (n=1). Consequently, these 7 subjects were excluded from the analyses of all variables under study.

The characteristics of the individuals with LBP in this study were similar to LBP populations described elsewhere in the literature (Mayer et al., 1986) and were consistent with epidemiological data relating to LBP populations (Bombardier et al., 1985; Frymoyer, 1988). As well, no major differences in characteristics described in Tables 2, 3 and 4 were found between those subjects who were included in the analyses compared to those who were excluded. In general, all subjects who agreed to participate in the study (N=50) were in their mid-to-late thirties, were married with children, and were receiving Workers' Compensation and/or disability benefits. Almost all the subjects were not working due to their injury, but had full time jobs waiting

Table 2

Demographic Characteristics of Study Subjects (N=50)

Variable	Subjects included in analyses *n*=43		Subjects not included in analyses *n*=7	
Age				
Mean ± Standard Deviation	36.3 ± 9.28		37.9 ± 13.23	
Range of ages	21-57		22-54	
	n	*%*	*n*	*%*
Gender				
Male	26	60.5	4	57.1
Female	17	39.5	3	42.9
Marital Status				
Married/common law	33	76.8	5	71.4
Single	8	18.6	2	28.6
Divorced/separated	1	2.3	-	-
Widowed	1	2.3	-	-
Children at Home				
None	13	30.2	3	42.8
1-2	24	55.8	2	28.6
3-4	6	14.0	2	28.6

Table 3

Other Selected Characteristics of Study Subjects (N=50)

Variable	Subjects included in analyses n=43		Subjects not included in analyses n=7	
	n	%	n	%
Work Status				
Full time, working	3	7.0	1	14.3
Full time, unable to work	32	74.4	5	71.4
Part time, working	-	-	-	-
Part time, unable to work	3	9.3	-	-
Unemployed due to LBP	4	9.3	-	-
Other (homemaker)	1	2.3	1	14.3
Receiving Disability Benefits				
Yes	36	83.7	5	71.4
No	7	16.3	2	28.6
Program Status				
WCC-sponsored	31	72.1	5	71.4
Private-paying	12	27.9	2	28.6
Time Spent in Program				
12 weeks	35	81.4	1*	14.3
8 weeks	8	18.6	-	-
4 weeks	-	-	2	28.6
2 weeks or less	-	-	4	57.1

*Missing data for this subject precluded inclusion in statistical analyses.

Table 4

Occupational Classification of Study Subjects (N=50)

Occupational Classification	Subjects included in analyses n=43		Subjects not included in analyses n=7	
	n	%	n	%
Clerical and related	4	9.3	-	-
Sales	5	11.6	-	-
Service				
Nursing aides	5	11.6	1	14.3
Other	4	9.3	-	-
Natural resources	5	11.6	-	-
Production and processing	5	11.6	2	28.5
Construction and trades	1	2.3	1	14.3
Transportation	6	14.0	1	14.3
Teaching	1	2.3	1	14.3
Scientific and technical				
Registered nurse	6	14.0	-	-
Other	-	-	-	-
Other (homemaker)	1	2.3	1	14.3

for them. All the individuals in the study were either born or raised in the province of Newfoundland and Labrador and were of British or French extraction.

In this study, occupations were coded by the researcher using the Standard Occupational Classification published by Statistics Canada (Health and Welfare Canada & Statistics Canada, 1981) as a guide. As Table 4 indicates, subjects in this study represented all occupational categories with highest representation in the production processing, transportation and scientific categories. Of special interest was the relatively large number of individuals involved in nursing. The 6 registered nurses in the scientific and technical group combined with the 5 nursing personnel in the service category (2 nursing assistants, 2 nursing aides and 1 orderly) accounted for 22% of the subjects in the study. Sixty-four percent of this group (n=7) worked in acute care hospitals, and the remaining 36% (n=4) worked in long term care or home care settings. The finding that almost one quarter of the study subjects were involved in nursing is consistent with epidemiological data that have reported high prevalence rates of LBP for nursing personnel in many developed countries (Buckle, 1987; Harber et al., 1987; Jensen, 1987; Mandel & Lohman, 1987).

Information on the Low Back Injury, Medication and Other Health Problems

Selected characteristics of the back injury for the entire group of subjects were also consistent with descriptions in the LBP literature (Bombardier et al., 1985; Frymoyer, 1988; Nachemsom, 1984). As Table 5 indicates, 25 subjects (23 included in the analyses and 2 in the excluded group) attributed their back injury to lifting. When asked to more fully describe the circumstances of their injury, subjects frequently reported a combination of lifting and twisting; this has been cited as the most common cause of back injury at the workplace (Frymoyer, 1988). Other causes of the back injury cited by subjects included "falls," "being struck," "just happened," and "other." The category "just happened" included situations such as bending over and twisting; bending and feeling something "snap;" turning and coughing; or, awkward positioning for a period of time while doing a job. One subject reported that pregnancy exacerbated a degenerative disc problem. Five of the 7 individuals reporting the category "other" had been in car accidents. Slightly less than half of all subjects ($\underline{n}$=24) reported that this was their first back injury, while the remainder had had at least one other episode of back pain.

Most of the pain literature differentiates acute pain and chronic pain using 6 months as the marker. Using this classification, 52% ($\underline{n}$=26) of the entire sample had acute

Table 5

<u>Characteristics of the Low Back Injury, Previous Surgery, Medication Use, Smoking, and Other Health Problems (N=50)</u>

Variable	Included in analyses n=43		Not included in analyses n=7	
	n	%	n	%
Cause of injury				
Lifting	23	53.5	2	28.6
Fall	5	11.6	-	-
Struck	3	7.0	-	-
Just happened	5	11.6	4	57.1
Other	7	16.3	1	14.3
First or recurrent injury				
First injury	22	51.2	2	28.6
Recurrent injury	21	48.8	5	71.4
LBP duration				
Pain <3 months	5	11.6	3	42.8
Pain 3-6 months	15	34.9	3	42.8
Pain >6 months	23	53.5	1	14.3
Previous surgery				
Yes	9	20.9	1	14.3
No	34	79.1	6	85.7
Regular medication use for LBP				
Analgesics	7	16.3	3	42.9
Muscle relaxants (MR)	3	7.0	1	14.3
Anti-inflammatories (AI)	1	2.3	-	-
Analgesics + MR	2	4.7	-	-
MR + AI	3	7.0	-	-
None	27	62.8	3	42.9
Smoking				
Yes	20	46.5	2	28.6
No	23	53.5	5	71.4
Other health problems				
Cardiovascular	6	14.0	-	-
Musculoskeletal	3	7.0	-	-
Neurological	4	9.3	-	-
Dermatological	1	2.3	-	-
Respiratory	1	2.3	-	-
Cancer (lymphoma)	1	2.3	-	-
None	27	62.8	7	100.0

pain (pain lasting less than 6 months) and 48% (n=24) reported chronic back pain (pain lasting more than 6 months). If, however, the differentiation between acute and chronic pain is defined as 3 months since time of injury as some authors recommend (Spitzer et al., 1987), then fully 84% of all subjects (n=42) had had pain longer than 3 months. For subjects in this study, the range of time since injury was as short as 6 weeks and as long as 3 years. The vast majority of subjects had had their low back problem from 4 to 12 months. Ten subjects (20%), 8 males and 2 females, all of whom had had pain for more than 6 months, reported that they had had back surgery in the past.

Since smoking has been queried as a risk factor related to LBP in epidemiological studies (Frymoyer et al., 1983), subjects in this study were asked if they presently smoked. Twenty-two of all subjects in the group (44%) were smokers and 28 (56%) were non-smokers. As Table 5 indicates, 16 subjects who were included in the analyses reported having other current health problems in addition to LBP; the most frequently cited health problem was cardiovascular disease.

During the initial interview, 20 subjects (40% of the entire group) were taking some form of medication for their back pain. Ten subjects (20%) reported that they took only analgesics for pain relief and 10 subjects reported taking muscle relaxants, anti-inflammatory agents or combinations of the three medication groups. Thirty subjects (60% of all subjects) reported that they did not take any kind of medication for their back pain; of these, 6 individuals with additional health problems were taking other kinds of medication such as anti-hypertensive agents, and anti-parkinsonian agents.

The 7 subjects excluded from analyses presented a slightly different picture of their low back problem and their general health as compared to the 43 subjects included in the analyses. In general, a larger percentage of the excluded subjects had acute, recurrent injuries and took medication for their back pain. A smaller percentage of them had incurred their injury as a result of lifting, and none of them had other current health problems. Because this group is small, representing 16% of the total sample of 50 subjects, it is unlikely that they would have significantly affected the overall study results, but this cannot be known for certain.

Results and Discussion of Physical Fitness Variables

For the purposes of this study, three indices of physical fitness were analyzed: (1) heart rate before, during and after waterfit aerobic exercise as a measure of cardiorespiratory fitness; (2) weight, in kilograms, lifted on the Nautilus machines as a measure of strength, and to a lesser extent, endurance; (3) body mass index, an indicator of body weight as it relates to height.

(1) Heart Rate

Forty-two of the 43 subjects in the study started the waterfit aerobic classes. Subjects' heart rates were taken by palpating the radial pulse and were measured in beats per minute (bpm). Pulse rates were monitored at subjects' first class and monthly thereafter. Five measures of heart rate were taken at each monitored session. At each of these monitored sessions, subjects were asked to sit by the edge of the pool for 2 to 3 minutes before the start of the waterfit class. Their "before exercise" heart rate was then measured. Subjects then participated in an 8-minute to 10-minute warm-up, followed by the 20-minute to 22-minute aerobic section. During the final third of the aerobic section, following a specific exercise, the "during" pulse rate was measured. At the end of the aerobic section, the subject was asked to stop and the "immediately after" pulse rate was taken followed by the "1-minute after" and "2-minute after" pulse rates.

The mean heart rates and standard deviations at these five intervals over three sessions (initial, 4 weeks and 8 weeks) for 33 participants who completed at least 8 weeks in the program and for whom complete data sets were available are shown in Table 6. (It must be noted that 11 subjects were lost to analysis because of incomplete data sets. This was beyond the control of the investigator, since the

Table 6

Mean Heart Rates Before, During, and After Waterfit Exercise Sessions (n=33)

	Mean heart rates in beats per minute (± Standard Deviation)		
Exercise interval	Initial session	4-week session	8-week session
Before exercise	87 (±13)	81 (±8)	78 (±8)
During exercise	97 (±15)	117 (±14)	125 (±14)
Immediately after	96 (±14)	115 (±15)	120 (±15)
1-minute after	82 (±12)	88 (±10)	89 (±11)
2-minutes after	79 (±11)	79 (±8)	78 (±8)

Lifestyles Program staff monitored and recorded the heart rates).

A 5 (Interval) x 3 (Session) within-subjects repeated measures MANOVA indicated a statistically significant Interval by Session interaction and significant main effects of Interval and Session at 8 weeks. The MANOVA data results are presented in Table 7.

As Figure 3 illustrates, the interaction effect was most probably due to the progressively higher levels of elevation of the heart rate "during exercise," and "immediately after" exercise compared to the "before" exercise heart rate within each session, and from the

Table 7

Results of 5 (Interval) x 3 (Session) Multivariate Analysis of Variance for Heart Rates Before, During, and After Waterfit Exercise Sessions (n=33)

Source	df	Mean Squares	F Ratio
Within cells	64	123.39	
Session	2	25693.95	208.23*
Within cells	128	61.58	
Interval	4	2602.95	42.27*
Within cells	256	130.37	
Interval by session	8	8576.48	65.78*

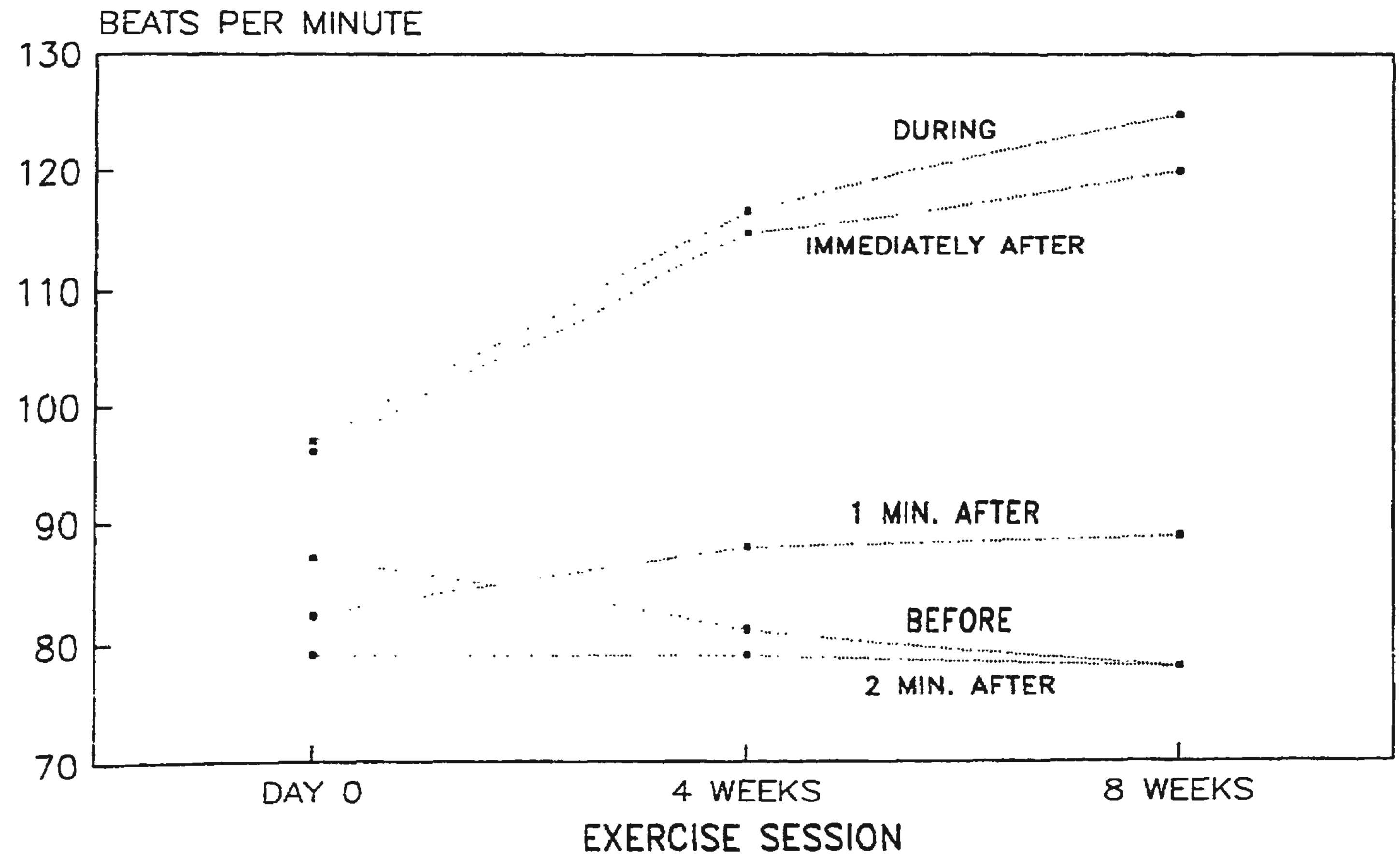
*$p<.001$

initial session compared to the 4-week and 8-week sessions. In other words, the longer subjects were in the program, the harder they worked during the aerobic section of the fitness class as indicated by the progressive elevation in heart rates during exercise. The main effect of Session indicates that there were significant changes in "during exercise" and "immediately after" exercise over the three monitored sessions; the main effect of Interval indicates that significant changes in heart rate occurred within a given fitness class, with significant changes in heart rate at the start of exercise, compared to during exercise, compared to 1-minute and 2-minutes after exercise.

For all sessions, the heart rate returned to

Figure 3

Mean Heart Rates Before, During and After Waterfit Aerobic Exercise (n=33)



approximately the "before exercise" heart rate with the exception of the initial session. In this case the "2-minute after" heart rate was 8 beats lower than the "before exercise" heart rate. It is postulated that the high "before exercise" heart rate at the initial session was in large measure due to fear and anxiety. These individuals were in an unfamiliar situation, and thus were very likely anxious and afraid that exercise might cause more pain (Dolce et al., 1986b). The central relaxation response that occurs with aerobic exercise might be one plausible explanation for the lower heart rate at the end of exercise at the initial session (McQuade et al., 1988).

Clearly, over the course of participation in the water-fit component of the Lifestyles Program, subjects were working harder during the aerobic section and were elevating their heart rates into the training sensitive zone by 8 weeks into the program. Generally, the training sensitive heart rate zone is calculated at 70% of maximal heart rate (220 bpm - age) (McArdle, Katch & Katch, 1986). For water exercise however, the literature and anecdotal experience suggest that the target heart rate should be adjusted lower than for dry-land exercise to take account of the cooling effect of the water as well as the lessened gravitational pull on the heart (G. Innes, personal communication, July 1989; Koszuta, 1989; McArdle et al., 1986). McArdle and his colleagues (1986) have suggested that an adjustment of 13 bpm be made to the heart rate. Therefore, for the 33 subjects in this analysis, with a mean age of 35.2 and a standard deviation of 8.9 years, the recommended training heart rate is [(.70) x (220 bpm - 13 bpm - 35.2 years)] = 120 bpm (McArdle et al., 1986). As Figure 2 illustrates, the mean exercise heart rate "during" exercise was just under the target heart rate at 4 weeks (117 bpm), and was over that rate by 8 weeks (125 bpm). The fact that subjects were able to increase their cardiac workload substantially during exercise over the three sessions and then return to their pre-exercise heart rates by "2-minutes after" exercise is another index of a cardiac training effect. Although subjects in this study did not achieve as dramatic a cardiac training effect as did the subjects in the Lifestyles Program in the Hannah et al. (1988b) study, the results from the present study confirm that for this group of 33 subjects with LBP, participation in the Lifestyles Program for 8 weeks produced a significant change in aerobic fitness.

<u>(2) Nautilus Weights</u>

In this study, 42 of the 43 subjects included in the analysis started a possible 14 exercises on 11 Nautilus machines at some point during their program. At each session, participants and/or Lifestyle Program staff recorded the amount of weight lifted and the number of repetitions done; Lifestyles Program staff reviewed these data on an ongoing basis. It was from these records that the data were taken for analysis. For purposes of this study, the sum of the number of kilograms lifted on each machine per Nautilus session (excluding repetitions which were not analyzed) was taken to be an index of muscle strength.

Data from all subjects (n=41) who had completed 15 Nautilus sessions (approximately 5 weeks) were included in the analysis. One subject was excluded because less than 15 sessions were completed. Because of the large amount of data, the sum of the weights lifted in kilograms from a possible 11 machines on the first, fifth, tenth, and fifteenth sessions were analyzed using a within-subjects repeated measures MANOVA. Table 8 presents the mean and

Table 8

Mean Sum of Weights Lifted on Nautilus Equipment and Percentage Increase (n=41)

Mean weight in kilograms (± Standard Deviation) Session				
1st	5th	10th	15th	% increase
97.5 (±26.0)	153.1 (±43.2)	198.9 (±61.1)	227.46 (±68.4)	133

standard deviation of the sum of weights lifted for each session, and the percentage improvement across the 15 sessions. Table 9 presents the within-subjects repeated

Table 9

<u>Results of Multivariate Analysis of Variance for Mean Sum of Weights Lifted on Nautilus Equipment Over 15 Sessions (n=41)</u>

Source	*df*	Mean Squares	*F* Ratio
Within cells	120	794.40	
Time	3	132256.04	166.49*

*$p < .001$

measures MANOVA results of the sum of weights lifted. The results indicated that there was a statistically reliable improvement in the amount of weight lifted over time. The overall percentage increase from session 1 to session 15 for all machines was 133%. Thus, muscular strength, as one index of physical fitness, can be said to have improved significantly for 41 subjects with LBP who were in the Lifestyles Program for at least 8 weeks. These results are consistent with data presented in the Hannah et al. (1988b) study which reported separate analyses for weight lifted on each Nautilus machine; the results are also in general agreement with findings from other studies describing treatment programs using weight-strengthening machines for LBP (Garrett, 1987; Manniche et al., 1988; Plum & Rehfeld, 1985).

(3) Body Mass Index

On the initial introduction to the program, all subjects had their height and weight measured and were subsequently weighed weekly by the Lifestyles Program staff. To be included in the analysis of Body Mass Index (BMI), subjects had to have been in the program for 8 weeks and have complete data sets. Only the body weights taken at the initial session, at 4 weeks and 8 weeks were included in the analysis.

As Table 10 shows, the mean BMI for subjects in this

Table 10

Mean Measures of Body Mass Index (BMI) (n=39)

Mean Body Mass Index (± Standard Deviation)		
Day 0	Week 4	Week 8
26.99 (±4.16)	26.87 (±4.05)	27.0 (±4.03)

analysis ($\underline{n}$=39) was about 27.0 for all intervals; a within-subjects repeated measures MANOVA showed that there was no significant change in the mean BMI over the 8 weeks in the Lifestyles Program ($p > .05$). (See Table 11).

Table 11

Results of Multivariate Analysis of Variance for Body Mass Index (BMI) (n=39)

Source	df	Mean Squares	F Ratio
Within cells	76	0.14	
Time	2	0.21	1.50

In contrast to the Hannah et al. (1988b) study that reported a statistically significant weight loss for 13 subjects who completed 12 weeks in the program, the subjects in this study did not automatically obtain the services of a nutritionist, as previously discussed. It is known that exercise in combination with mild dietary restriction is a good way to decrease body weight (McArdle et al., 1986). Therefore, it is perhaps not surprising that body mass index did not significantly change for these subjects and may indicate a need for ongoing nutritional counselling.

The literature strongly suggests that Body Mass Index is a more useful measure of weight status for the healthy Canadian adult aged 20 to 65 years than is weight alone (Health and Welfare Canada, 1988). The BMI, calculated as weight in kilograms divided by height in metres squared, takes body type and body fat into account and therefore is thought to be a valid measure of weight as it relates to health risk (Health and Welfare Canada, 1988).

It is of some concern that the group mean BMI for this group of subjects was in a zone considered, by the Canadian Expert Group on Weight Standards, to be in the acceptable but cautious range (Health and Welfare Canada, 1988). It is suggested that a BMI between 25 and 27 may lead to health problems in some people and that a BMI of over 27 indicates increased risk in developing health problems such as hypertension, hyperlipidemia and coronary heart disease (Health and Welfare Canada, 1988). Although epidemiological data have not identified increased weight per se as a risk factor for LBP, some subjects in this study have the potential to develop additional health problems related to their weight.

Results and Discussion of Pain, Disability and Psychological Factors

Since the primary focus of this research was to study how the group as a whole changed during participation in the Lifestyles Program, the 43 subjects completing 8 weeks were considered to be one group and were not divided into sub-groups for statistical analyses. Nonetheless, it was important to know (a) whether or not the subjects excluded from the analyses were significantly different in terms of pain and disability from those subjects included in the analyses and, (b) whether or not the 43 subjects in the analyses were equivalent at program entry on measures of pain and disability.

To test the equivalence of the included versus the excluded group of subjects, Student t-tests were performed using the Day 0 scores of three pain measures (least pain this week, worst pain this week, and PRI), and the Oswestry Low Back Pain Disability Questionnaire. These three pain measures were the ones thought most likely to yield differences in pain scores if differences in pain level actually existed. Table 12 presents the results of the analysis. Significant differences were not found on measures of worst pain this week, PRI or disability but, interestingly, there was a significant difference on the least pain score. The 7 subjects excluded from analyses (because of early departure from the program or missing data) reported significantly lower mean least pain this week scores (2.9) than did the subjects included in the analyses (13.0). This may indicate, that as a group, the subjects excluded from analyses were slightly better off in terms of pain than those subjects included in the analyses.

In order to test the homogeneity of the 43 subjects at program entry, Student t-tests were performed using the Day 0 scores of the same three pain measures and the

Table 12

Analysis of Mean Scores for Three Pain Measures and Oswestry LBP Disability Measure at Day 0 (N=50)

Variable	*n*	Mean (± *SD*)	*df*	*t*
Least pain this week				
Included subjects	43	13.0 (±16)		
Excluded subjects	7	2.9 (±6)	24	3.03**
Worst pain this week				
Included subjects	43	68.5 (±25)		
Excluded subjects	7	50.0 (±31)	7	1.49
PRI (MPQ)				
Included subjects	43	21.6 (±9)		
Excluded subjects	7	21.1 (±9)	8	0.13
Disability				
Included subjects	43	35.2 (±13)		
Excluded subjects	7	25.4 (±13)	8	1.81

**$p<.01$, two-tailed, separate variance estimate.

disability measure and the following factors: age group (20-39 versus 40-59), sex, WCC-sponsored/private-paying, acute/chronic pain and first/recurrent injury. As shown in Tables 13-17, no significant differences in mean scores of the pain and disability measures were found between the groups with respect to sex, WCC-sponsorship, chronicity, or

Table 13

Analysis of Mean Scores by Gender for Three Pain Measures and Oswestry LBP Disability Measure at Day 0 (n=43)

Variable	*n*	Mean (± *SD*)	*df*	*t*
Least pain this week				
Male subjects	26	11.9 (±16)		
Female subjects	17	14.8 (±18)	31	-0.56
Worst pain this week				
Male subjects	26	65.0 (±29)		
Female subjects	17	73.9 (±19)	41	-1.24
PRI (MPQ)				
Male subjects	26	20.3 (±9)		
Female subjects	17	23.6 (±8)	36	-1.21
Disability				
Male subjects	26	34.8 (±14)		
Female subjects	17	35.9 (±12)	37	-0.28

Table 14

Analysis of Mean Scores by WCC-Sponsored/Private-Paying Status for Three Pain Measures and Oswestry LBP Disability Measure at Day 0 (n=43)

Variable	*n*	Mean (± *SD*)	*df*	*t*
Least pain this week				
WCC-sponsored	31	10.2 (±14)		
Private-paying	12	20.5 (±20)	15	-1.65
Worst pain this week				
WCC-sponsored	31	67.7 (±27)		
Private-paying	12	70.5 (±21)	25	-0.35
PRI (MPQ)				
WCC-sponsored	31	20.2 (±9)		
Private-paying	12	25.2 (±8)	20	-1.69
Disability				
WCC-sponsored	31	34.9 (±13)		
Private-paying	12	36.1 (±14)	18	-0.26

Table 15

Analysis of Mean Scores by Acute/Chronic Pain for Three Pain Measures and Oswestry LBP Disability Measure at Day 0 (n=43)

Variable	*n*	Mean (± *SD*)	*df*	*t*
Least pain this week				
Acute pain	20	11.7 (±16)		
Chronic pain	23	14.2 (±17)	40	-0.50
Worst pain this week				
Acute pain	20	75.1 (±20)		
Chronic pain	23	62.8 (±28)	39	1.67
PRI (MPQ)				
Acute pain	20	22.3 (±10)		
Chronic pain	23	21.0 (±8)	36	0.43
Disability				
Acute pain	20	32.1 (±13)		
Chronic pain	23	37.9 (±13)	39	-1.46

Table 16

Analysis of Mean Scores by First/Recurrent Injury for Three Pain Measures and Oswestry LBP Disability Measure at Day 0 (n=43)

Variable	*n*	Mean (± *SD*)	*df*	*t*
Least pain this week				
First injury	22	13.4 (±18)		
Recurrent injury	21	12.6 (±15)	40	0.17
Worst pain this week				
First injury	22	71.2 (±24)		
Recurrent injury	21	65.7 (±26)	40	0.72
PRI (MPQ)				
First injury	22	21.1 (±8)		
Recurrent injury	21	22.1 (±10)	37	-0.38
Disability				
First injury	22	32.7 (±13)		
Recurrent injury	21	37.9 (±14)	40	-1.29

Table 17

Analysis of Mean Scores by Age Group for Three Pain Measures and Oswestry LBP Disability Measure at Day 0 (n=43)

Variable	*n*	Mean (± *SD*)	*df*	*t*
Least pain this week				
20-39 years	28	13.4 (±18)		
40-59 years	15	12.3 (±14)	35	0.22
Worst pain this week				
20-39 years	28	77.1 (±23)		
40-59 years	15	52.5 (±22)	29	3.42**
PRI (MPQ)				
20-39 years	28	23.4 (±9)		
40-59 years	15	18.3 (±8)	31	1.90
Disability				
20-39 years	28	36.7 (±13)		
40-59 years	15	32.4 (±13)	30	1.04

**$p<.01$, two-tailed, separate variance estimate.

first/recurrent injury ($p>.05$). A significant difference, however, was found in worst pain this week and age group ($t[29]=3.42$, $p<.01$). Twenty-eight subjects in the 20-year to 39-year age group reported significantly higher mean levels of worst pain (77.1) than did the 15 subjects in the 40-year to 59-year age group (52.5). The other pain measures and the disability score were not statistically significant for age group. Only one study in the LBP literature was found that indicated a statistically significant difference in pain report based on age. Mechanic and Angel (1987) found that older persons complained less of pain in comparison to other age groups at comparable levels of pathology in a survey of 2,431 persons suffering from LBP. However, these findings were significant only for individuals over 66 years of age. The oldest subject in the present study was 57 years old.

While recognizing that the significant difference found between worst pain this week and age group may simply have been due to chance, it was decided to test for the possible effect of age group on other dependent variables over the 8 weeks of participation in the program. Separate within-subjects repeated measures analysis of covariance were done on all pain measures, the disability measure, and all psychological measures since it was not known what effect initial higher or lower worst pain scores might have on overall outcome on any variable. Results showed that age group was not a significant factor in the 8-week analyses for any of the pain measures (including worst pain), nor for the disability or psychological variables under study. Results of the analyses are in Appendix S.

Based on these statistical results, it was thought appropriate to consider the 43 subjects included in the analyses as a homogeneous group.

a. Results of Measures Relating to Pain and Disability

The pain variables analyzed for the 43 subjects who completed 8 weeks in the Lifestyles Program included items 3 to 7 of the Pain Questionnaire (see Appendix J), the PRI from the MPQ and the list of symptoms from the MPQ (see Appendix H). On examination, items 1 and 2 of the Pain Questionnaire were not found to add any additional information about subjects' pain experiences and were consequently excluded from the present analysis.

Item 3 of the Pain Questionnaire asked subjects how frequently they had experienced pain within the past 7 days. Subjects tended to report their answers in terms of numbers of days they had had pain, rather than by specific episodes. As seen in Figure 4, 33 subjects (76.7%) at the initial interview reported pain every day; this decreased to 26 subjects (60.5%) by 2 weeks and stayed constant. At Day 0, only 1 subject reported having had no pain in the previous week compared to 6 subjects reporting no pain at week 8. A sign test comparing pain frequency scores at Day 0 and Week 8 showed no significant differences ($p > .05$).

Item 5 asked subjects about the duration of their pain: had the pain been constant (never free of pain), periodic (comes and goes) or brief (less than 15 minutes) over the past 7 days? As Figure 5 illustrates, from Day 0 to 8 weeks, there was a small but steady decline in the number of subjects who reported periodic pain, and a rise in the

Figure 4

Frequency of Pain in Last 7 Days
($\underline{n}$=43)

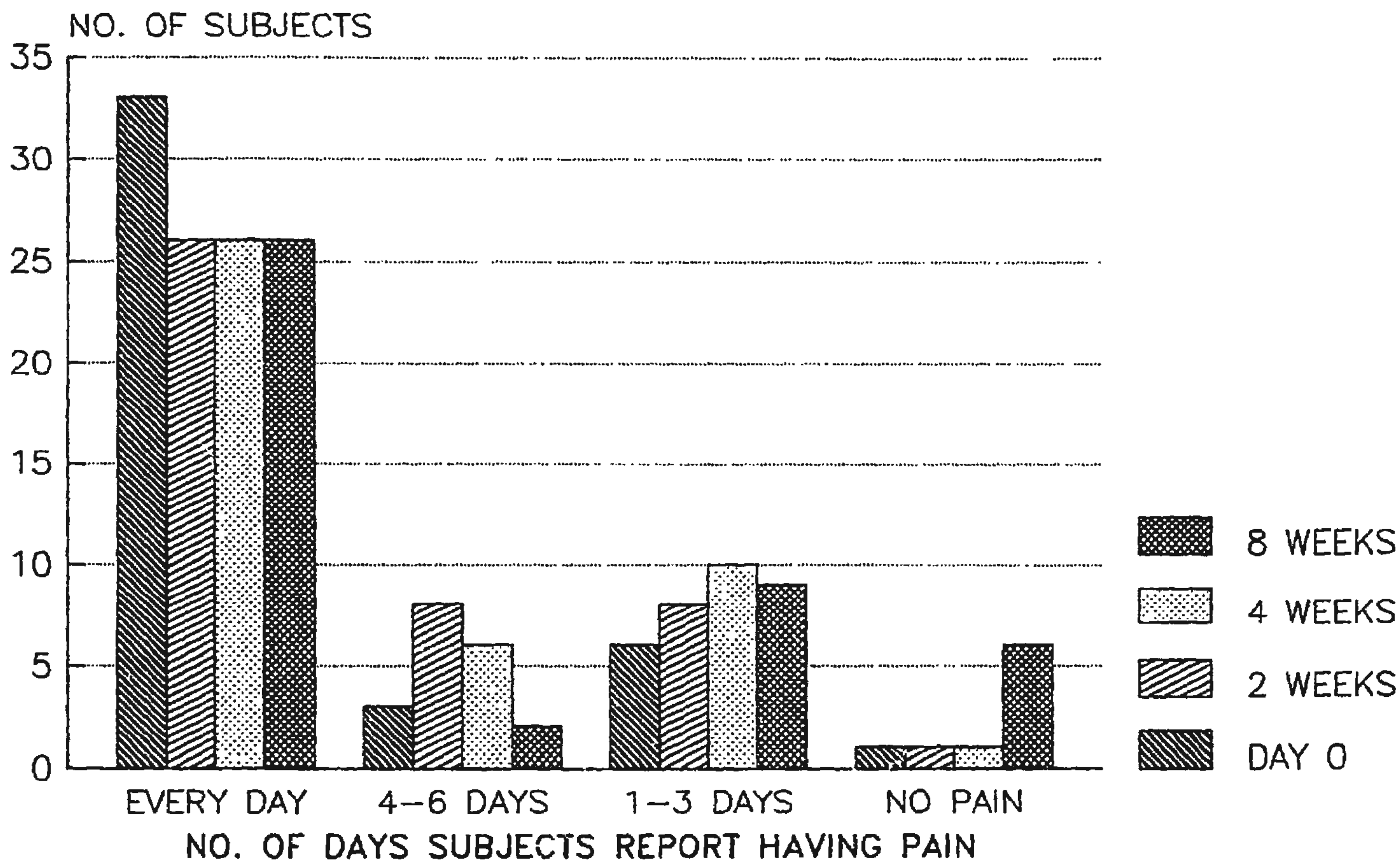
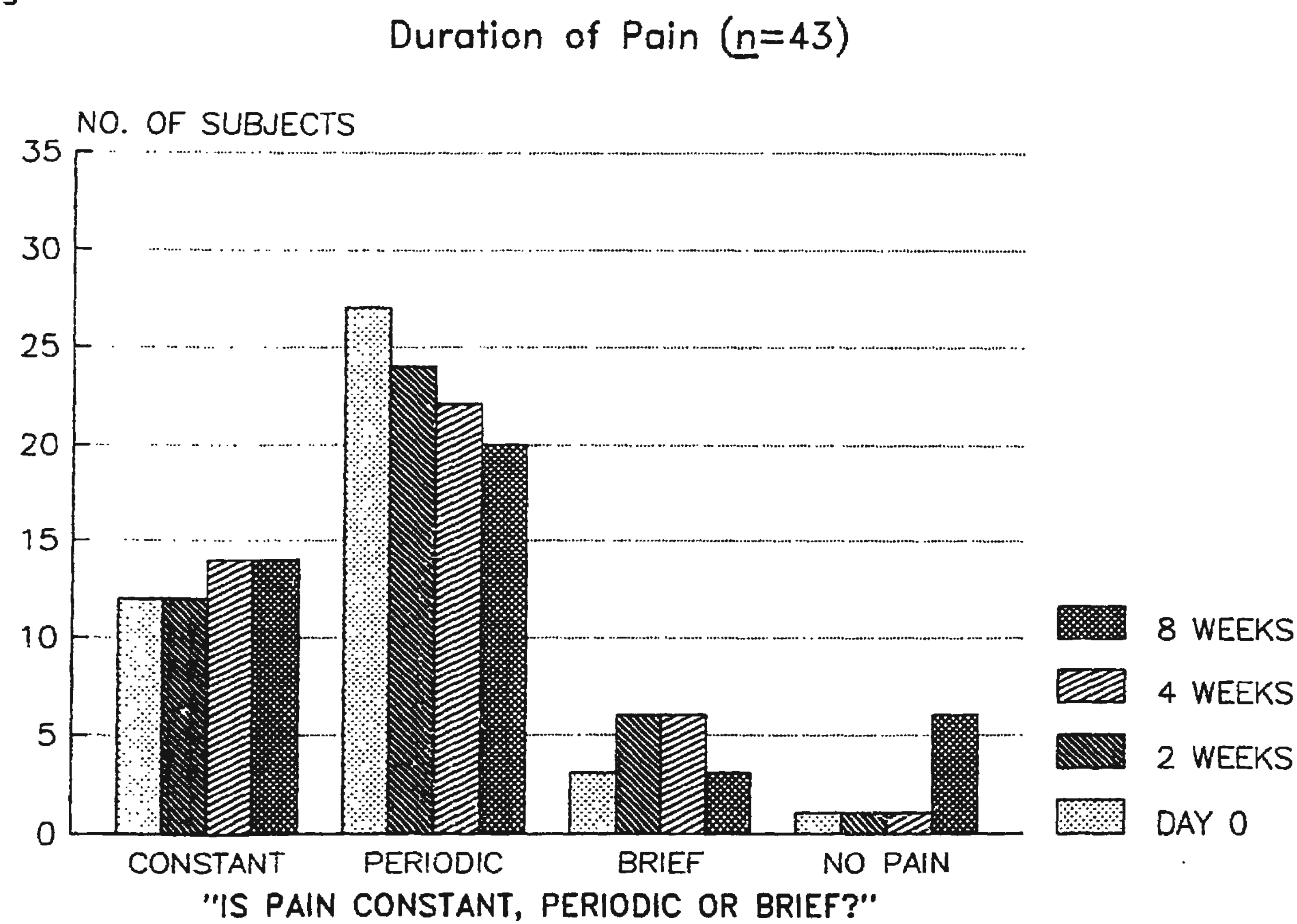


Figure 5


Duration of Pain (n=43)
NO. OF SUBJECTS
35
30
25
20
15
10
5
0
CONSTANT
PERIODIC
BRIEF
NO PAIN
"IS PAIN CONSTANT, PERIODIC OR BRIEF?"
8 WEEKS
4 WEEKS
2 WEEKS
DAY 0

number of subjects reporting no pain. There was also a slight rise in the number of subjects reporting constant pain: at Day 0, 12 subjects (27.9%) reported constant pain and at 8 weeks, 14 subjects (32.5%) reported constant pain. A sign test indicated no significant differences between Day 0 and Week 8 scores ($p>.05$).

As part of the MPQ, subjects were asked about symptoms that are often associated with pain. Figure 6 depicts the number of subjects ($n=43$) reporting these associated symptoms over the previous week at Day 0 and at 8 weeks. All symptoms improved or stayed constant over the 8 weeks in the program. Sign tests conducted on the associated symptoms indicated a statistically significant decrease in the incidence of headache (19 subjects reporting headache at Day 0 compared to 9 subjects at 8 weeks, $p<.02$), and a statistically significant decrease in sleep disturbance (28 subjects complaining of sleep disturbance at Day 0 compared to 9 subjects at 8 weeks, $p<.01$).

Scores for items 6-8 of the Pain Questionnaire -- least pain this week, worst pain this week, and the rating index for pain this week -- and the total PRI score from the MPQ were analyzed using separate within-subjects repeated measures multivariate analysis of variance (MANOVAs). Table 18 shows the means and standard deviations of the pain scores at Day 0, 2 weeks, 4 weeks and 8 weeks; Table 19 shows the appropriate computed MANOVA results from the

Figure 6

Symptoms Associated with Pain ($\underline{n}$=43)

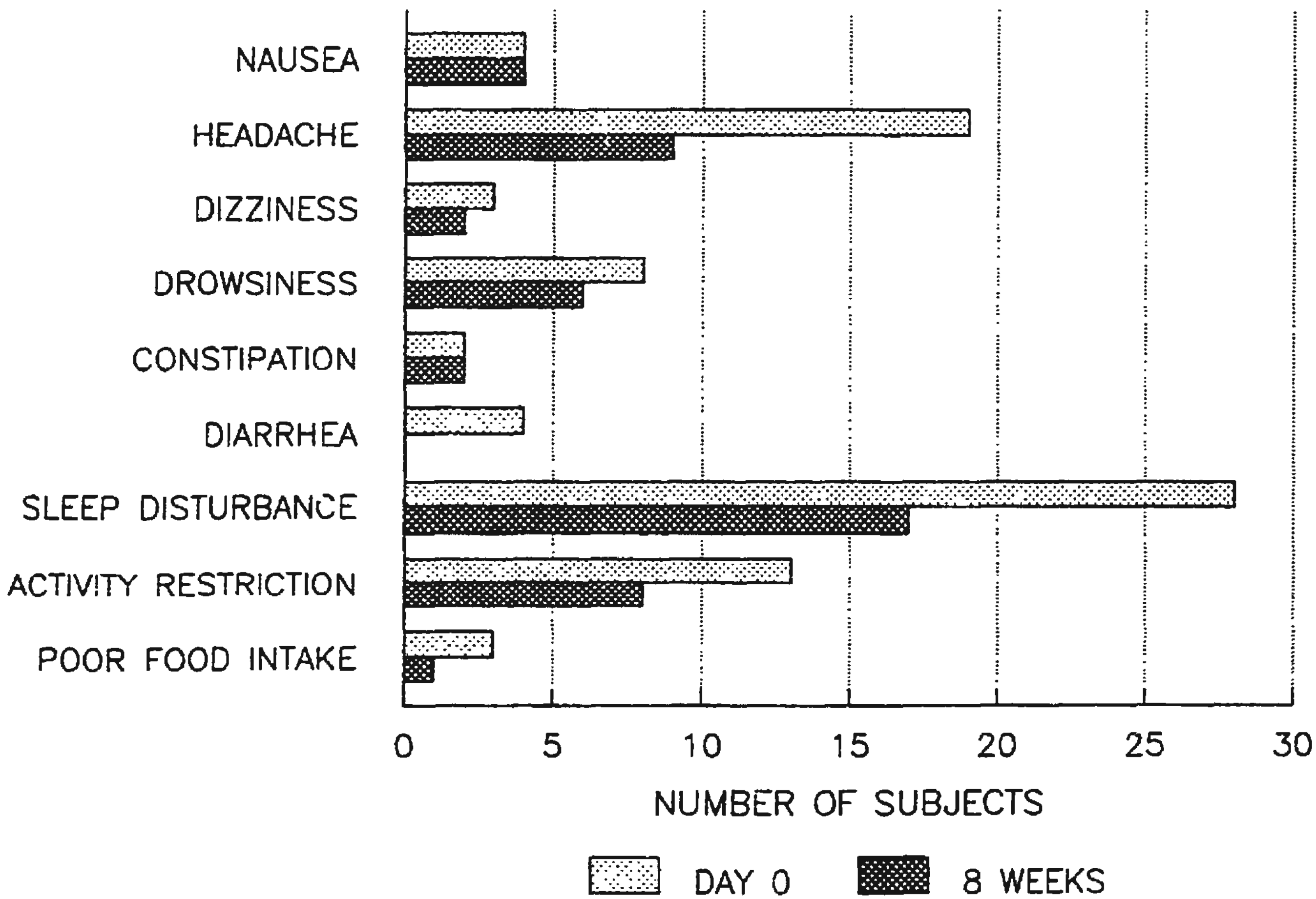


Table 18

Mean Scores for Four Pain Measures (n=43)

Variable	Mean score (± Standard Deviation)			
	Day 0	Week 2	Week 4	Week 8
Least pain this week	13.1 (±16.3)	13.0 (±15.6)	11.6 (±15.8)	8.3 (±12.1)
Worst pain this week	68.5 (±25.2)	64.2 (±24.9)	60.0 (±26.4)	51.8 (±32.6)
Pain rating this week	2.3 (±0.8)	2.1 (±0.8)	2.1 (±0.7)	1.9 (±1.1)
Pain rating index (PRI from MPQ)	21.6 (±8.9)	17.5 (±7.4)	15.8 (±7.4)	14.8 (±10.1)

Table 19

Results of Separate Multivariate Analysis of Variance for Four Pain Measures (n=43)

Variable	Source	*df*	Mean Squares	*F* Ratio
Least pain this week	Within cells	126	107.59	
	Time	3	210.09	1.95
Worst pain this week	Within cells	126	389.24	
	Time	3	2193.70	5.64**
Pain rating this week	Within cells	126	0.52	
	Time	3	1.04	2.01
Pain rating index (PRI from MPQ)	Within cells	126	45.75	
	Time	3	385.47	8.42*

*$p<.001$. **$p<.01$.

analyses. The analyses indicated a statistically significant reduction in worst pain scores with a mean score at Day 0 of 68.5 compared to 51.8 at 8 weeks. The largest change in the mean worst pain score took place between the 4th and 8th weeks. In addition, the total PRI of the MPQ showed a statistically significant reduction over the 8 weeks with a change in mean score from 21.6 at Day 0 to 14.8 at 8 weeks. Although the largest change in the mean PRI score was between Day 0 and 2 weeks, the mean scores continued to decrease over time.

Mean scores for least pain this week, gradually decreased over the 8-week period, as well, but these results were not found to be statistically significant. Because a large number of subjects reported that their least pain was "0" even at the initial interview, this was not a surprising result. The mean scores for the rating index for pain this week (a scale from 0 to 5, no pain to excruciating) also decreased over time, but not significantly. For this pain measure, most subjects reported their pain as being discomforting, with a value of 2.

A within-subjects repeated measures MANOVA was conducted on the Oswestry LBP Disability scores for subjects who completed 8 weeks in the program (n=41). Two subjects were lost to analysis because questionnaires were incompletely filled out. Table 20 shows the mean scores and standard deviations obtained at Day 0, Week 2, Week 4

Table 20

Mean Scores for Oswestry Low Back Pain Disability Questionnaire (n=41)

Mean score (± Standard Deviation)			
Day 0	Week 2	Week 4	Week 8
35.4 (±13.1)	32.3 (±13.1)	31.1 (±13.6)	29.6 (±14.6)

and Week 8. Table 21 shows the MANOVA results of the analysis.

The analysis indicated a statistically significant improvement in disability scores over time. At Day 0, subjects reported a mean disability score of 35.4 compared to 29.6 at 8 weeks, indicating an overall improvement in the ability of subjects to perform activities of daily living.

Table 21

Results of Multivariate Analysis of Variance for Oswestry Low Back Pain Disability Questionnaire (n=41)

Source	*df*	Mean Squares	*F* Ratio
Within cells	120	40.28	
Time	3	247.95	6.16**

$^{**}p<.01$

The specific areas of improvement were not analyzed for purposes of this study.

b. Discussion of Pain and Disability Results

The significant changes observed in mean worst pain scores and in mean PRI scores suggest that as subjects progressed through the program, the intensity of their pain decreased. The pattern of pain, however, appears not to have changed significantly for the group. In other words, the group as a whole had pain just as often and for the same duration at Week 8 as at Day 0. For some individuals, however, the pattern did change -- 6 individuals reported having had a pain free week at the 8 week interview, compared with 1 individual at all previous interviews. In summary, the results suggest that participation in a physical fitness program for 8 weeks did not aggravate low back pain, but may have played an important role in decreasing perceived pain intensity for the 43 subjects in this study.

Treatment programs for LBP that emphasize physical fitness and conditioning have reported results similar to those reported here. A decrease in pain intensity and an improvement in performing activities of daily living have been cited as outcomes of treatment programs for acute LBP populations (Linton et al., 1989), as well as for chronic LBP populations (Beekman & Axtell, 1985; Dolce, Crocker &

Doleys, 1986a; Fordyce et al., 1981; Kleinke & Spangler, 1988; Manniche et al., 1988; Mayer et al., 1985, 1986). The results of the analyses of the pain and disability measures of this study lend further support to the general proposition that increasing activity plays a role in improving the pain picture for most subjects with LBP, as well as improving the functional capacity of the individual.

Results and Discussion of Psychological Variables

Separate within-subjects repeated measures MANOVAs were conducted on each of the psychological variables measured: self-esteem, state/trait anxiety, and mood (including subscales). Results of each variable will be discussed individually.

Self-Esteem

Self-esteem, the variable most often cited in the literature as improving with increasing levels of physical fitness, did not show a statistically significant change over time in this study ($p>.05$). (See Table 22). In fact, as indicated in Table 23, the mean self-esteem scores became slightly more negative, going from 17.3 to 18.4 at 8 weeks (the higher the score, the lower the self-esteem). Part of the explanation for this may be that this group of subjects were not particularly low in self-esteem (as measured by the Rosenberg Self-Esteem Scale) to begin with. The mean score of 17.3 at Day 0 is much closer to the score of "10"

Table 22

Results of Multivariate Analysis of Variance for Mean Scores of Rosenberg Self-Esteem Scale (n=43)

Source	df	Mean Squares	F Ratio
Within cells	126	7.02	
Time	3	9.37	1.33

Table 23

Mean Scores of Rosenberg Self-Esteem Scale (n=43)

Mean score (± Standard Deviation)			
Day 0	Week 2	Week 4	Week 8
17.3 (±4.3)	18.0 (±4.8)	17.6 (±4.8)	18.3 (±5.0)

indicating the highest self-esteem, than it is to the lowest self-esteem score of "40," thus making significant improvement less likely.

In a study of self-esteem in 50 subjects with spinal pain who were in a physical fitness rehabilitation program, Beekman and colleagues (1985) reported significant improvements on the self-acceptance aspect of self-esteem, the component measured by the Rosenberg Self-Esteem Scale. However, a much longer and more comprehensive tool -- the

Tennessee Self-Concept Scale -- was used in the Beekman et al. (1985) study. Overall, it may have been a more sensitive instrument than the scale used in the present study.

State/Trait Anxiety

State and trait anxiety mean scores, standard deviations and number of subjects in the analyses at Day 0, 2 weeks, 4 weeks and 8 weeks are presented in Table 24,

Table 24

Mean Scores for State and Trait Anxiety

		Mean score (± Standard Deviation)			
Variable	n	Day 0	Week 2	Week 4	Week 8
State anxiety	42	39.5 (±9.9)	37.5 (±10.0)	35.8 (±10.9)	36.7 (±10.6)
Trait anxiety	39	38.5 (±10.5)	35.8 (±9.9)	35.4 (±9.8)	36.3 (±9.8)

while Table 25 presents the appropriate separate MANOVA results. Subjects were lost to analyses on both anxiety scores because of incomplete filling out of the tool. In most cases, subjects forgot to turn over the two-sided questionnaire to complete the trait anxiety scale.

Table 25

Results of Separate Multivariate Analysis of Variance for State and Trait Anxiety Scores

Variable	n	Source	df	Mean Squares	F Ratio
State anxiety	42	Within cells	123	27.60	
		Time	3	103.45	3.75***
Trait anxiety	39	Within cells	114	12.84	
		Time	3	76.97	5.99**

**$p<.01$. ***$p<.05$.

The results of the state anxiety MANOVA revealed a statistically significant decrease in state anxiety overall. Mean scores decreased from 39.5 at Day 0 to 36.7 at Week 8 for 42 subjects. However, the lowest mean state anxiety score was at 4 weeks, with a rise of 0.9 at Week 8. Not surprisingly, mean state anxiety scores for this group of subjects were elevated compared to mean state anxiety score norms of 35.7 (± 10.4) for working men and 35.2 (± 10.6) for working females as reported by the tool developer (Spielberger et al., 1983). This was not an unexpected finding considering the physical, emotional and financial stress that many of these individuals were experiencing as a result of their injury.

The results of the trait anxiety MANOVA follow the same trend as the state anxiety results. A statistically significant decrease in trait anxiety was found with a mean score of 38.5 at Day 0 down to 36.3 at 8 weeks, with the lowest mean score occurring at Week 4 (35.4). Again, the mean trait anxiety scores of study subjects ($\underline{n}$=39) were elevated in comparison to mean norm scores of 34.89 (± 9.19) for working men and 34.79 (± 9.22) for working women (Spielberger et al., 1983).

It is interesting to speculate on why there was a slight rise in both anxiety scales at Week 8. It may be that subjects were getting closer to program completion and felt anxious about what the future would hold. Many subjects, although stating that they felt better both in terms of pain and overall well-being, were still surprised at how long recovery seemed to be taking. Many of them had expected to be better (i.e. pain free) by this point in time. In addition, it was my observation in listening to subjects during the process of data collection that the course of recovery was not always a smooth one -- some days were good, other days not so good. With the passage of time, some subjects expressed concern about the nature of their injury -- "perhaps there is something more wrong than just a back problem." Although these are just general observations, these expressed concerns may have influenced anxiety.

Studies on the LBP population have reported higher state anxiety scores for individuals with LBP problems. Fuerstein and colleagues (1987) in a study of 33 chronic LBP patients with 33 matched controls found that the LBP group had higher mean state anxiety scores (43.6) than did the matched controls who had mean scores similar to the mean norm scores of 35. Similarly, Garron and Leavitt (1983) reported a mean state anxiety score of 44.0 for both acute and chronic LBP patients (N=143). Thus, the subjects in the present study, although having some elevation of state anxiety, were not as highly anxious as two other LBP populations reported in the literature.

The statistically significant decrease in state anxiety found in this study is consistent with the physical fitness literature as well, where vigorous exercise has been demonstrated to show a reduction in state anxiety especially in individuals who have clinical elevations in state anxiety (Taylor et al., 1985).

Whereas the change in state anxiety is well supported in the literature and was not unexpected for subjects in this study, the statistically significant decrease in trait anxiety (thought to be a relatively stable personality characteristic) is less established in the literature and is somewhat open to question (Long, 1984; Phelps, 1987). A reasonable explanation may lie in an observation made by Spielberger et al. (1983), the developers of the tool. They found that state-trait anxiety correlations tend to be higher when the scales are given in the same testing session, one immediately following the other as was the case in this study procedure. The fact that a statistically significant decrease in trait anxiety was found between the Day 0 and 2 week mean scores (using Tukey's Honestly Significant Difference statistic, $p<.05$) indicate that these scores may not be true representations of trait anxiety but may more likely be artifacts of the testing procedure.

Mood

As Table 26 shows, the mean scores on the measure of overall mood changed in a positive direction over time, with the highest mean mood scores at 2 and 4 weeks; the mean scores of the positive and negative subscales showed similar trends, (i.e., positive mood increased and negative mood decreased overall compared to Day 0). However, these changes were not statistically significant as shown in Table 27. The vigor subscale of the MUMS, however, did yield a significant result with a mean score of 7.2 at Day 0, rising to 9.9 at 2 weeks and decreasing to 9.0 and 8.9 at 4 and 8 weeks respectively. The highest score at 2 weeks may be a reflection of the dramatic change in activity level for most of these subjects during that 2-week period, i.e. from being fairly sedentary prior to participation in the program to being physically active every day.

The statistically significant improvement in the vigor subscale is consistent with both the physical fitness

Table 26

Mean Scores for Memorial University Mood Scale Including Subscales (n=43)

	Mean score (± Standard Deviation)			
Variable	Day 0	Week 2	Week 4	Week 8
Overall mood	14.5 (±10.2)	18.3 (±11.6)	18.1 (±11.8)	16.7 (±12.6)
Positive affect	9.5 (±3.9)	10.1 (±4.5)	10.5 (±4.3)	9.8 (±4.6)
Negative affect	2.2 (±2.7)	1.8 (±2.7)	1.4 (±2.6)	1.9 (±3.2)
Vigor	7.2 (±5.4)	9.9 (±6.1)	9.0 (±6.5)	8.9 (±6.8)

literature and the LBP literature. Research on physical fitness has suggested that improvements in fitness may play a role in the elevation of mood, especially in individuals who are at low levels of physical fitness initially, and who are also experiencing higher levels of stress (Serfass & Gerberich, 1984). It seems reasonable to suppose that the vigor subscale of mood would be especially prone to improvement with increasing activity. Supporting this supposition is a study by Wilfley and Kunce (1986). They reported that the vigor component of the Profile of Mood States (POMS) was found to improve significantly when

Table 27

Results of Separate Multivariate Analysis of Variance for Memorial University Mood Scale Including Subscales (n=43)

Variable	Source	df	Mean Squares	F Ratio
Overall mood	Within cells	126	51.99	
	Time	3	128.86	2.48
Positive affect	Within cells	126	7.64	
	Time	3	7.63	1.00
Negative affect	Within cells	126	3.55	
	Time	3	4.42	1.25
Vigor	Within cells	126	16.80	
	Time	3	54.72	3.26***

***$p < .05$.

administered to 83 normal adults before and after their participation in an 8 week exercise program. Studies of the LBP population have found a positive relationship between LBP, depressed mood and low levels of vigor (Fuerstein et al, 1987; Kleinke & Spangler, 1988; Mechanic & Angel, 1987). Therefore it is perhaps not surprising that vigor was the component that improved significantly for the LBP subjects in this study. In addition, a study of 14 injured workers in the Lifestyles Program (the same program in this study) who completed 12 weeks, found a statistically significant improvement in overall mood, positive mood, and vigor, with no significant change found in negative mood (Hannah et al., 1989). Therefore, the study results suggest that the vigor component of mood, in particular, may be positively affected by participation in a physical fitness program.

Summary of the Results

The results of the study indicate that, as a group, subjects with both acute and chronic low back pain were able to significantly improve two components of their physical fitness. Statistically reliable improvement was found in cardiorespiratory aerobic fitness and muscular strength after 8 weeks in a structured group physical fitness program. There was no significant change in Body Mass Index, which remained relatively high.

In conjunction with this improvement in physical fitness, there were statistically significant changes in pain intensity, disability scores and two of the three psychological variables measured. The analyses of the pain measures suggests that although frequency and duration of pain did not change significantly, there was a statistically reliable decrease in pain intensity over the 8 weeks in the Lifestyles Program. A statistically significant change in disability scores also occurred, suggesting an improvement in the ability of subjects to perform activities of daily living. Additionally, there were also significant improvements in state and trait anxiety scores; however the validity of the trait anxiety data is open to question. Finally, the study results indicate a statistically significant improvement in the vigor subscale of mood. Measures of self-esteem did not change significantly for the study subjects, whose initial scores reflected a relatively high level of self-esteem. Overall, the results of this study are consistent with studies described elsewhere in the literature, both for LBP populations in rehabilitation programs, and for well populations who participate in physical fitness programs.

Clearly, these analyses only describe the changes that took place in the study subjects during the 8 weeks of their participation in the Lifestyles Program. The analyses do not make any suggestions about cause and effect relationships.

CHAPTER 5

IMPLICATIONS AND LIMITATIONS

In this chapter, the implications of the study results as they relate to nursing practice, nursing education and nursing research will be discussed and the limitations of the study will be outlined.

Implications of the Study

Although the study implications are potentially far-reaching, particularly as they relate to the potential role of nursing in community-based rehabilitation programs, the following discussion will confine itself to implications that are directly related to the study results. This cautious approach is taken because of the complex nature of the variables under study.

Results from this study have implications for nurses who practice in hospitals, in the community, in primary care settings, and in occupational health settings. As well, the study results have implications for nurses, themselves, as an occupational group.

a. Nursing Practice

Because of the high prevalence of LBP in the general population, the majority of nurses will at some point have contact with individuals who experience LBP. In their roles as patient educators, nurses are in a particularly important position (because of their access to clients in all settings) to provide counselling about: the deleterious physical and psychological consequences of inactivity and deconditioning; the overall positive effects of keeping active once the acute phase of an low back injury is over; and about what constitutes a "safe" physical fitness program for individuals with idiopathic low back pain. It is important for clients to realize that all fitness programs are not alike and nurses have a central role to play in helping clients with LBP become "wise consumers" of fitness programs.

The results of this study showed that 33 subjects with LBP could safely improve their levels of aerobic fitness when exercises were done gradually and in a way that produced little stress on joints and muscles, such as in a water environment. Forty-one subjects were able to improve muscle strength, by gradually increasing weights lifted on well-designed muscle-strengthening machines, with the consultation of a physiotherapist. As one client put it after he had been in the program for 1 month:

> Just imagine how I would be if I wasn't doing this program. How bad would I be just sitting around doing nothing. I think I would have injured myself many times if I'd been doing exercise on my own. This

program is controlled, with a gradual increase in exercise.

Clients with low back pain should be made aware of the safety features they should look for in a fitness program and the need for appropriate professional consultation before embarking on such a fitness program.

In addition to the teaching role, community health nurses, especially those who work in smaller communities, might benefit from the results of this study since many of them are instrumental in designing and/or teaching fitness programs in the communities where they work.

Nurses who work in industry have traditionally had wide responsibilities related to the prevention of low back injuries in employees. The results of this study might provide them with useful information about safe fitness programs, particularly if there are fitness programs in place on the job. Occupational health nurses are in an ideal position to assess activity levels of employees who are returning to the workplace after a low back injury, and in counselling them about the importance of "safe" fitness.

b. Nursing Education

To fulfil the potential of their roles as client educators, nurses themselves need to be made aware of the benefits of activity for the LBP population. Not only physicians but nurses as well, particularly those who work in primary care settings, see clients with uncomplicated idiopathic LBP and advise them about appropriate levels of activity. All nurses need to be more aware of the problems that occur due to the deconditioning effects of inactivity, and the role that improved aerobic fitness and muscle strength may play in the treatment, and perhaps prevention, of LBP.

Inservice educators might benefit from knowing about the results of this study and in disseminating the results to nursing staff since LBP is a very prevalent problem in the nursing population itself.

Education programs in Schools of Nursing need to include information about the role of activity and fitness in LBP not only so that students will provide the best care for their clients but also for their own personal knowledge and benefit.

c. <u>Nursing Research</u>

The implications of this study for nursing research are many. First, this study needs to be replicated with larger numbers of subjects and with the use of a control group, if at all possible, in order to verify the study findings of decreased pain intensity, decreased disability, and the improvements in anxiety and in the vigor subscale of mood in LBP clients. In addition, a long term follow-up study would be important to assess the effects the program has on preventing recurrent back injuries.

The results of the analysis of Body Mass Index (BMI) indicate that many of the subjects in this study were approaching an unhealthy weight. A research study, conducted in conjunction with the nutritionist at the Lifestyles Program, that randomly assigned program participants to one of two groups: a group that received nutrition counselling and a group that did not receive counselling might be a way of evaluating the effectiveness of a nutrition counselling component as an integral part of the Lifestyles Program.

The fact that nursing personnel constituted the largest occupational group in the study sample has direct implications for nursing research. While numerous studies document the back injury problem in nursing staff, few nurse researchers have studied the area. Jensen (1987) has urged nurse researchers to become involved stating:

> Whatever the reasons, this injury problem needs research, and nurses with research skills should be able to contribute more than other researchers due to greater familiarity with nursing tasks and procedures, appreciation for constraints on the way tasks are performed, understanding of patient needs, and access to appropriate study populations (Jensen, 1987, p. 29).

The results of this study support the need for research in the area of LBP among nurses.

Although not arising directly from the study results, a number of descriptive studies would be important to consider as being appropriate for nursing investigation. Many of the ideas for the following study suggestions came from listening to subjects talk about their concerns and the wide range of problems related to their back injury. One of the first questions that needs to be answered is: What is the normal course of recovery and rehabilitation from a low back injury? In relation to this: What do clients want and need to know about their back injury and its affect on daily life?

From listening to clients during interviews, it became apparent that many of them did not understand the nature of their injury and did not anticipate the set backs that are often involved in the course of rehabilitation. Many of the subjects would describe similar sorts of situations: After a month in the program, they were starting to feel better and found their stamina for activity had increased somewhat. As a result they attempted to do activities that they hadn't done since before their injury. For example, some would vacuum the entire house, decide to tackle that household painting job that needed doing, go shopping for an afternoon or, as one woman did, just sit for 45 minutes in the car over a bumpy road going to the cottage. They were surprised at the intensity of the pain that followed these kinds of activities and were confused about what this meant. Many similar comments from subjects were made throughout the entire data collection phase. There may be a need to incorporate a "back education" module, as many multi-disciplinary treatment programs employ, to achieve improved results. However, before this was done, a study assessing learning needs would have to be completed.

There are other descriptive studies that would be of interest. The whole issue of how a problem like LBP affects the family, family roles and family relationships are important issues that came up repeatedly when clients would talk about how things were going. It might also be important to look at the special problems of new mothers who have a back injury. In this study, three women had infants whom they were unable to care for completely because they could not hold their babies due to their back pain. One young mother was especially concerned because she couldn't feed her baby herself. Interestingly, two of these mothers had babies with health problems that made their care that much more difficult. For many subjects in this study, low back pain significantly affected family life. This remains an important area for nursing research.

Limitations of the Study

There are a number of limitations to this study. They will be discussed under two general categories: limitations of the design and limitations of the research tools.

a. Design

One of the major weaknesses of the study design is the lack of a control group that consisted of low back injured subjects comparable to subjects in this study. Although the strength of a repeated measures design is that the impact of treatment can be examined across time by using subjects as their own control, the possible effect of maturation cannot be controlled. In other words, changes seen in measures of pain, disability and the three psychological variables could have been due to the passage of time. Although it seems unlikely given the chronicity of the low back problem for the majority of subjects, changes observed within individuals may have been more related to the healing process of the back injury than to participation in the physical fitness program.

To control for the possible effect of maturation, studies of similar populations have recommended the use of a waiting-list control group; however, this seems improbable for this study sample given the fact that the majority of subjects are being sponsored by the Workers' Compensation

Commission, an organization whose primary goal is to return injured workers to the workplace as quickly as possible.

Although integral to the nature of repeated measures designs, another possible limitation is the repeated use of tools. Because subjects in this study were assessed repeatedly, there may have been difficulties regarding sensitization to the instruments resulting in boredom and careless filling out of the self-administered questionnaires in particular. This may have been less problematic with the pain measures since these were conducted in an interview format; however, familiarization and boredom may have been present with these as well.

Another possible limitation is the so-called "experimenter effect." Since subjects were interviewed about their pain, the subjects' responses may have been affected by the presence of the researcher. Although this was controlled for as much as possible, (at least at a conscious level), by strictly adhering to guidelines as proposed by Melzack (1975) in asking questions from the pain tools, at an unconscious level expectations about subjects' improvements may have been communicated unwittingly.

A further limitation of the study was the lack of complete data sets and, therefore, of unequal numbers of subjects in some analyses. This was particularly pronounced for the measures of heart rate. On reflection, it may have been helpful if a formal information session had been held for all Lifestyles Program staff who were involved with the measurement of physical fitness variables. The session might have helped to clarify the purpose of the study and to emphasize the importance of obtaining complete sets of data for statistical analyses. Having said this, it must be emphasized that it was only because of the high degree of cooperation provided by all staff involved in the program at every level that any of the data collection for the study was possible.

The final design limitation is related to the small sample size which limits generalizability of the results to the subjects in this study.

b. Research Tools

In addition to the limitations related to the study design, there were also limitations, or possible limitations, related to the specific measurement instruments used in the study.

The Oswestry Low Back Disability Questionnaire was, on the whole, a useful instrument that subjects found appropriate and easy to complete. However, a number of subjects had difficulty with section 7 of the questionnaire, an item relating to sleep (see Appendix K). In the list of 6 statements in that section, there is no provision made for the individual who has trouble sleeping but does not resort to taking medication. Several subjects did not complete this section because they were in this "poor sleep - no medication" category, and did not fit into the items as listed under the sleep section. Therefore for future use, a revision of section 7 of the questionnaire is suggested along with piloting that section with a group of LBP subjects who are in the community rather than in hospital.

Another limitation concerned the problem of validity of the trait anxiety scores. Although each subject was reminded at each data collection session that the first questionnaire (Y-1) pertained to how they felt "right now" and the reverse side of the questionnaire (Y-2) related to how they felt "generally," it is perhaps possible and even highly probable (given the study results) that subjects tended to answer all statements based on their subjective feelings at the moment. The problem lies not with the tool, but with the administration procedure used in this study (the trait scale directly following the administration of the state scale).

Since there is good evidence in the literature that state anxiety changes with improving levels of physical fitness, future studies on this population might want to concentrate on measuring longer term changes, and use only the trait scale as Long (1984) suggests. Another option might be to administer both tools within a battery of tests as in this study, but to space them out with other questionnaires in between.

Another possible limitation is related to the Pain Questionnaire developed by the researcher for use in this study (see Appendix J). Two questions, item 4 and item 7, were taken directly from the MPQ, but attempted to measure pain "over the past 7 days" as opposed to pain "right now." Although content validity was established with an expert in the field, the reliability of these questions as they relate to the measurement of pain "over the past 7 days" has not been firmly established.

Had a pilot study been undertaken prior to the formalized data collection phase, it is possible that some of these problems with the tools might have been identified and corrected.

Summary

In conclusion, even with the limitations imposed by the study design and the research tools, the results of the study have specific implications for nursing practice and education, and have wide-ranging implications for future nursing research studies in the area of low back pain.

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APPENDIX A

The University of Vermont
THE UNIVERSITY OF VERMONT
COLLEGE OF MEDICINE
DEPARTMENT OF ORTHOPAEDICS & REHABILITATION
GIVEN BUILDING BURLINGTON VT 05405

DIVISION OF ORTHOPAEDICS
SECTION OF BIOMECHANICAL RESEARCH
(802) 656 2250

September 13, 1989

Ms. Sandra M. LeFort
School of Nursing
Memorial University of Newfoundland
Prince Philip Drive
St. John's, NFLD,
Canada A1B 3V6
FAX #: 709-737-6400

Dear Ms. LeFort:

Permission is hereby given to reprint Figure 1.2 on page 6 of Occupational Low Back Pain, edited by M.H. Pope et al. This permission is given for reprint in your thesis and for reprinting by the National Library of Canada. Credit should be given to the authors.

Best of luck with your thesis defense!

Sincerely yours

Malcolm H. Pope
McClure Professor of
Musculoskeletal Research
Director of Orthopaedic Research

MHP:kg

APPENDIX B

Hello!

I am a registered nurse, presently completing a master's degree in nursing at Memorial University of Newfoundland. As part of my program, I am doing a research project with people who have a low back problem and who are going to be in the Lifestyles Program at the Aquarena -- people like yourself.

If you think you might like to be part of this project, please let Carey or Robin know. I would be pleased to meet with you now or at your earliest convenience and explain what the study involves. Basically it would mean filling out some questionnaires every month while you're in the fitness program -- questionnaires about how "you and your back" are doing. This should take only 20-30 minutes of your time once per month.

You are under no obligation to be in the study. However, your participation would be greatly appreciated.

Thanks,

Sandra LeFort, R.N.

APPENDIX C

CONSENT TO PARTICIPATE IN NURSING RESEARCH

Subject's name: ____________________________________

Date: ___________

I hereby authorize Sandra LeFort, R.N., graduate student in the School of Nursing, Memorial University of Newfoundland, to perform the following study:

1. I understand this is a study of individuals who have a low back injury and who will be taking part in the Lifestyles Program at the Aquarena in St. John's, Newfoundland.

I understand that I will be asked to fill out questionnaires on pain, disability and psychological factors on several occasions while I am a participant in the Lifestyles Program.

I understand that one month after completing the Lifestyles Program, I will again be asked to fill out these questionnaires.

I further understand that participation in this study will in no way influence the care or treatment that I receive.

2. I understand that the researcher will need to access my physical fitness files at the Lifestyles Program and I give permission for the researcher to do so.

3. I understand that participation in this study entails no risk or discomfort to me. While encouraged to answer all questions on the questionnaires, I understand that I am under no constraints to do so.

4. I understand that information about specific individuals in this study will be strictly confidential and will not be available to employers, government or other official agencies. Questionnaires will be available only to the researcher.

5. I understand that I may terminate my participation in the study at any time.

6. I understand that the researcher will answer any questions that I have about the study.

7. I understand that at the end of the study, the researcher will send me a summary of the findings if I so wish.

I freely and voluntarily consent to my participation in this project.

Subject (Sign and Date)

Witness (Sign and Date)

Researcher (Sign and Date)

APPENDIX D

To: Daniel Mosher, Manager, Fitness and Rehabilitation Programs, Canada Games Park Commission

From: Sandra M. LeFort, R.N.

Subjects: 1. Request for access to low back injured individuals who are enrolled in the Lifestyles Program

2. Request for access to Lifestyles Program progress forms of study participants

I am a graduate student in the School of Nursing at Memorial University of Newfoundland. As part of my program, I am conducting a research project on low back injured individuals. My study will look at changes in measures of physical fitness, pain, disability and three psychological variables in this population.

I would like to request your permission to administer questionnaires to approximately fifty low back injured individuals at Day 0, 2 weeks, 4 weeks, 8 weeks and 12 weeks of the Lifestyles Program. These questionnaires are designed to measure pain levels, disability, anxiety, mood and self-esteem and will take each participant approximately twenty to thirty minutes to complete.

I am also requesting access to each participant's Lifestyles Program progress form at Day 0, 4 weeks, 8 weeks and 12 weeks in order to assess physical fitness levels.

It is understood that informed consents will be obtained from each participant and that no individual will be coerced into taking part in the study. There is no physical or psychological risk to the participants, and their anonymity will be protected at all times.

Thank you for your cooperation.

Sandra M. LeFort

Date

APPENDIX E

To: Lorraine Vardy, Consultant Physiotherapist
Aquarena Lifestyles Program

From: Sandra M. LeFort, R.N.

Subjects: 1. Request for access to low back injured individuals who are enrolled in the Lifestyles Program

2. Request for access to Lifestyles Program progress forms of study participants

I am a graduate student in the School of Nursing at Memorial University of Newfoundland. As part of my program, I am conducting a research project on low back injured individuals. My study will look at changes in measures of physical fitness, pain, disability and three psychological variables in this population.

I would like to request your permission to administer questionnaires to approximately fifty low back injured individuals at Day 0, 2 weeks, 4 weeks, 8 weeks and 12 weeks of the Lifestyles Program. These questionnaires are designed to measure pain levels, disability, anxiety, mood and self-esteem and will take each participant approximately twenty to thirty minutes to complete.

I am also requesting access to each participant's Lifestyles Program progress form at Day 0, 4 weeks, 8 weeks and 12 weeks in order to assess physical fitness levels.

It is understood that informed consents will be obtained from each participant and that no individual will be coerced into taking part in the study. There is no physical or psychological risk to the participants, and their anonymity will be protected at all times.

Thank you for your cooperation.

Sandra M. LeFort

Date

APPENDIX F

March 16, 1988

Dear Physiotherapists,

I am a graduate student in the School of Nursing at Memorial University of Newfoundland. As part of my Master's degree program, I will be conducting a research project on pain and disability in low back injured individuals. The focus of this study is to explore how participation in a group physical fitness program in a fitness facility might influence pain, disability, three psychological factors, and measures of physical fitness in a group of low back injured individuals.

Because substantial numbers of back injured people participate in the Lifestyles Program at the Aquarena, I will be studying approximately 50 program participants who have low back injuries. The study will involve administration of questionnaires that measure pain, disability, mood, anxiety and self esteem to be completed by study participants each month while they are in the program. The questionnaries will take approximately 20-30 minutes to complete.

The three private physiotherapy clinics who refer patients to the Lifestyles Program, of which you are one, have been informed about the project. Permission has already been received from the Aquarena Lifestyles Program.

It is anticipated that the study will start sometime in late April. I can be reached at 737-7333 if vou have any questions.

Sincerely,

Sandra LeFort, R.N., B.N.

APPENDIX G

I.D.Number:____

General Information

Directions: For each of the following questions, please check ( ) or write in the answers which best describe yourself. This information is confidential and will not be personally identified with you.

1. What is your age? ______ Years

2. What is your sex? ______Male ________Female

3. What is your marital status?

______ Single ______ Divorced/Separated

______ Married/Common Law ______ Widowed

4. Who are the others in your household? Select as many answers as apply to you.

_____ Spouse/Partner(if unmarried)

_____ Child/Children: Ages of children:____________

_____ Adult relative(s) or friend(s)

_____ Live alone

_____ Other: Please specify ____________________

5. (a) Will you be living at home while you are in the Lifestyles program?

_____ Yes _____No

(b) If not, will you be staying at:

_____ Hotel/Boarding Home

_____ Home of family/friends

_____ Other

6. Were you born in:

_____ Newfoundland/Labrador

_____ Other Canadian province

_____ Outside Canada. Please specify:_____________

7. What is your current employment status? Check only one answer.

___ Employed full-time and working

___ Employed part-time and working

___ Employed full-time but unable to work due to back injury

___ Employed part-time but unable to work due to back injury

___ Unemployed due to back injury

___ Unemployed due to other reasons

___ Other. Please specify: _________________

8. What do you do for a living?

9. If you are presently unable to work, are you receiving disability income?

___ Yes ___ No

10. How did you get injured?

_____ Lifting

_____ Fall

_____ Struck by or against an object

_____ Just happened. Please explain:

_____ Other. Please specify.

11. Is this: _______ your first back injury

_______ a recurrent back injury

12. How long have you had your present injury?

13. Do you have any other medical conditions besides your back problem? Please specify.

14. (a) Do you currently take medication for your back problem?

_____ Yes _____ No

(b) If yes, do you take:

Analgesics ______________________

Muscle Relaxants ________________

Anti-inflammatories _____________

15. Are you a smoker?

_____ Yes _____ No

16. Have you ever had surgery for your back problem?

_____ Yes _____ No

APPENDIX H

McGILL - MELZACK PAIN QUESTIONNAIRE

Patient's Name__________ Date__________ Time______ ______am/pm

Analgesic(s)__________ Dosage__________ Time Given__________am/pm

__________ Dosage__________ Time Given__________am/pm

Analgesic Time Difference (hours): +4 +1 +2 +3

PRI: S_____ (1-10) A_____ (11-15) E_____ (16) M(S)_____ (17-19) M(AE)_____ (20) M(T)_____ (17-20) PRI(T)_____ (1-20)

1 FLICKERING ☐ QUIVERING ☐ PULSING ☐ THROBBING ☐ BEATING ☐ POUNDING ☐

2 JUMPING ☐ FLASHING ☐ SHOOTING ☐

3 PRICKING ☐ BORING ☐ DRILLING ☐ STABBING ☐ LANCINATING ☐

4 SHARP ☐ CUTTING ☐ LACERATING ☐

5 PINCHING ☐ PRESSING ☐ GNAWING ☐ CRAMPING ☐ CRUSHING ☐

6 TUGGING ☐ PULLING ☐ WRENCHING ☐

7 HOT ☐ BURNING ☐ SCALDING ☐ SEARING ☐

8 TINGLING ☐ ITCHY ☐ SMARTING ☐ STINGING ☐

9 DULL ☐ SORE ☐ HURTING ☐ ACHING ☐ HEAVY ☐

10 TENDER ☐ TAUT ☐ RASPING ☐ SPLITTING ☐

11 TIRING ☐ EXHAUSTING ☐

12 SICKENING ☐ SUFFOCATING ☐

13 FEARFUL ☐ FRIGHTFUL ☐ TERRIFYING ☐

14 PUNISHING ☐ GRUELLING ☐ CRUEL ☐ VICIOUS ☐ KILLING ☐

15 WRETCHED ☐ BLINDING ☐

16 ANNOYING ☐ TROUBLESOME ☐ MISERABLE ☐ INTENSE ☐ UNBEARABLE ☐

17 SPREADING ☐ RADIATING ☐ PENETRATING ☐ PIERCING ☐

18 TIGHT ☐ NUMB ☐ DRAWING ☐ SQUEEZING ☐ TEARING ☐

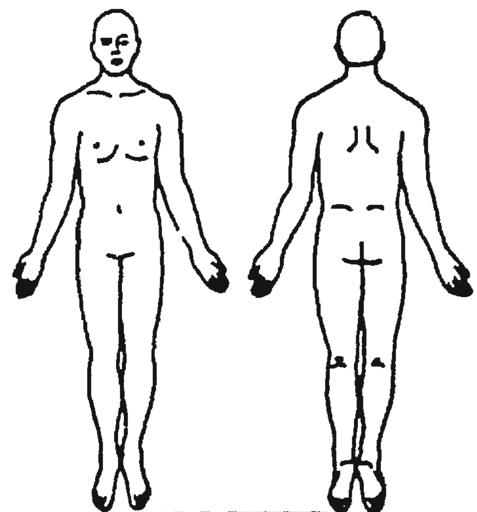
19 COOL COLD ☐ FREEZING ☐

20 NAGGING ☐ NAUSEATING ☐ AGONIZING ☐ DREADFUL ☐ TORTURING ☐

PPI

0 NO PAIN ☐
1 MILD ☐
2 DISCOMFORTING ☐
3 DISTRESSING ☐
4 HORRIBLE ☐
5 EXCRUCIATING ☐

PPI______ COMMENTS:



CONSTANT ☐ PERIODIC ☐ BRIEF ☐

ACCOMPANYING SYMPTOMS: NAUSEA ☐ HEADACHE ☐ DIZZINESS ☐ DROWSINESS ☐ CONSTIPATION ☐ DIARRHEA ☐

COMMENTS:

SLEEP: GOOD ☐ FITFUL ☐ CAN'T SLEEP ☐

COMMENTS:

FOOD INTAKE: GOOD ☐ SOME ☐ LITTLE ☐ NONE ☐

COMMENTS:

ACTIVITY: GOOD ☐ SOME ☐ LITTLE ☐ NONE ☐

COMMENTS:

McGill Pain Questionnaire. Used with permission of Ronald Melzack. For additional information or authorization to use this instrument, please write Ronald Melzack, M.D., Pain Clinic, McGill University, Montreal, Canada.

APPENDIX I

McGill
University

Department of Psychology
Stewart Biological Sciences Building

March 14, 1988

MS. SANDRA LEFORT
111 STRAWBERRY MARSH ROAD
ST. JOHN'S, NEWFOUNDAND
A1B 2V7

Dear Ms. LeFort:

It is a pleasure to give you permission to use the McGill Pain Questionnaire. I am also enclosing a copy of the Major Properties and Scoring Methods, as well as the MPQ. Make as many copies of the Questionnaire as you need.

You will also find enclosed, a notice that is now going out to users of the MPQ. As you will see, it involves an "honour system" of payment to the International Association for the Study of Pain.

Sincerely,

Ronald Melzack
Professor

Postal address 1205 Docteur Penfield Avenue, Montreal, PQ, Canada H3A 1B1

APPENDIX J

PAIN QUESTIONNAIRE

1. Are you having pain right now? Yes _____ No _____

Please mark an X at the spot that best describes your pain right now.

NO PAIN |————————————————————| WORST POSSIBLE PAIN

2. If you are pain free now, when did you last have pain?

3. About how often have you had pain this week?

4. In general, was your pain this week:

_____Constant (never free of pain)	_____Periodic (comes and goes)	_____Brief (less than 15 min.)

5. Please mark an X at the spot that describes the least pain you had this week.

NO PAIN |————————————————————| WORST POSSIBLE PAIN

6. Please mark an X at the spo that describes the worst pain you had this week.

NO PAIN |————————————————————| WORST POSSIBLE PAIN

7. Overall how would you rate your pain this week?

0	1	2	3	4	5
no pain	mild	discomforting	distressing	horrible	excruciating

APPENDIX K

Number:______________

Date:________________

The Oswestry Low Back Pain Disability Questionnaire

Instructions: This questionnaire has been designed to give the researcher information about how your back pain has affected your ability to manage in everyday life. Please answer every section, and mark in each section only the one box which applies to you. I realize that you may consider that two of the statements in any one section relate to you, but please just mark the box which most closely describes your problem.

Section 1 - Pain Intensity
☐ I can tolerate the pain I have without having to use pain killers.
☐ The pain is bad but I manage without taking pain killers.
☐ Pain killers give complete relief from pain.
☐ Pain killers give moderate relief from pain.
☐ Pain killers give very little relief from pain.
☐ Pain killers have no effect on the pain and I do not use them.

Section 2 - Personal Care (Washing, Dressing, etc)
☐ I can look after myself normally without causing extra pain.
☐ I can look after myself normally but it causes extra pain.
☐ It is painful to look after myself and I am slow and careful.
☐ I need some help but manage most of my personal care.
☐ I need help every day in most aspects of self care.
☐ I do not get dressed, wash with difficulty and stay in bed.

Section 3 - Lifting
☐ I can lift heavy weights without extra pain.
☐ I can lift heavy weights but it gives extra pain.
☐ Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, eg. on a table.
☐ Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned.
☐ I can lift only very light weights.
☐ I cannot lift or carry anything at all.

Section 4 - Walking
☐ Pain does not prevent me walking any distance.
☐ Pain prevents me walking more than 1 mile.
☐ Pain prevents me walking more than 1/2 mile.
☐ Pain prevents me walking more than 1/4 mile.
☐ I can only walk using a stick or crutches.
☐ I am in bed most of the time and have to crawl to the toilet.

Section 5 - Sitting
☐ I can sit in any chair as long as I like.
☐ I can only sit in my favourite chair as long as I like.
☐ Pain prevents me sitting more than 1 hour.
☐ Pain prevents me from sitting more than 1/2 hour.
☐ Pain prevents me from sitting more than 10 minutes.
☐ Pain prevents me from sitting at all.

Section 6 - Standing
- ☐ I can stand as long as I want without extra pain.
- ☐ I can stand as long as I want but it gives me extra pain.
- ☐ Pain prevents me from standing for more than 1 hour.
- ☐ Pain prevents me from standing for more than 30 minutes.
- ☐ Pain prevents me from standing for more than 10 minutes.
- ☐ Pain prevents me from standing at all.

Section 7 - Sleeping
- ☐ Pain does not prevent me from sleeping well.
- ☐ I can sleep well only by using tablets.
- ☐ Even when I take tablets I have less than six hours sleep.
- ☐ Even when I take tablets I have less than four hours sleep.
- ☐ Even when I take tablets I have less than two hours sleep.
- ☐ Pain prevents me from sleeping at all.

Section 8 - Sex Life
- ☐ My sex life is normal and causes no extra pain.
- ☐ My sex life is normal but causes some extra pain.
- ☐ My sex life is nearly normal but is very painful.
- ☐ My sex life is severely restricted by pain.
- ☐ My sex life is nearly absent because of pain.
- ☐ Pain prevents any sex life at all.

Section 9 - Social Life
- ☐ My social life is normal and gives me no extra pain.
- ☐ My social life is normal but increases the degree of pain.
- ☐ Pain has no significant effect on my social life apart from limiting my more energetic interests, eg. dancing etc.
- ☐ Pain has restricted my social life and I do not go out as often.
- ☐ Pain has restricted my social life to my home.
- ☐ I have no social life because of pain.

Section 10 - Travelling
- ☐ I can travel anywhere without extra pain.
- ☐ I can travel anywhere but it gives me extra pain.
- ☐ Pain is bad but I manage journeys over two hours.
- ☐ Pain restricts me to journeys of less than one hour.
- ☐ Pain restricts me to short necessary journeys under 30 minutes.
- ☐ Pain prevents me from travelling except to the doctor, physiotherapist or hospital.

APPENDIX L

Physiotherapy

The Journal of the Chartered Society of Physiotherapy

14 BEDFORD ROW LONDON WC1R 4ED Tel 01-242 1941 Fax 01-831 4509

Editor Jill Whitehouse

Ms S LeFort RN BN
111 Strawberry Marsh Road
St John's
Newfoundland
Canada A1B 2V7

3 August, 1989

Dear Ms LeFort,

Thank you for your letter of July 13 asking to reproduce a questionnaire from our issue of August 1980. You are welcome to use this for the stated purpose.

With best wishes for your degree programme.

Yours sincerely,

Jill Whitehouse (Mrs)
Editor

APPENDIX M

Number:__________

Date:__________

Rosenberg Scale

<u>Instructions</u>: For each of the items below, indicate on the scale underneath whether you strongly agree, agree, disagree, or stongly disagree by circling the appropriate number.

1. I feel that I'm a person of worth, at least on an equal basis with others.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

2. I feel that I have a number of good qualities.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

3. All in all, I am inclined to feel that I am a failure.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

4. I am able to do things as well as most other people.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

5. I feel I do not have much to be proud of.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

6. I take a positive attitude toward myself.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

7. On the whole, I am satisfied with myself.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

8. I wish I could have more respect for myself.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

9. I certainly feel useless at times.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

10. At times I think I am no good at all.

1	2	3	4
Strongly Agree	Agree	Disagree	Strongly Disgree

APPENDIX N

JUL 25 1989

To answer your letter more promptly . . . we are taking the liberty of replying by notations on your letter. We feel certain that you will permit us this informality which allows a faster reply.

Princeton University Press

Permissions Editor
Princeton University Press
41 William Street
Princeton, New Jersey
08540

Dear Permissions Editor,

I am requesting permission to use the Self Esteem Scale (Rosenberg, 1965) in a research study entitled: Pain and Disability in Low Back Injured Individuals Participating in a Physical Fitness Program. This study is in partial fulfill of the requirements for a Master of Nursing degree at Memorial University of Newfoundland. Self esteem has been reported to improve in the well population who engage in physical fitness programs. In conjunction with other measures, I am exploring whether this is also the case for individuals who have a low back problem and who engage in fitness activities.

I obtained a copy of the scale from: Robinson, J.P. and Shaver, P.R. (Eds.). (1973). Measures of Social Psychological Attitudes, Ann Arbor, Mich: Institute for Social Research, The University of Michigan.

In addition, I would like to reprint the scale in the Appendix of my thesis if this is acceptable to you. Of course, credit to Princeton University Press would be duly noted.

Thank you for your prompt attention in this matter.

Sincerely,

Sandra LeFort

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~~[illegible]~~

~~[illegible]~~

APPENDIX O

SAMPLE ITEMS FROM THE STATE-TRAIT ANXIETY INVENTORY

Y-1 (State portion)

1. NOT AT ALL
2. SOMEWHAT
3. MODERATELY SO
4. VERY MUCH SO

I feel calm

I feel secure

I am tense

Y-2 (Trait portion)

1. ALMOST NEVER
2. SOMETIMES
3. OFTEN
4. ALMOST ALWAYS

I feel pleasant

I feel nervous and restless

I feel satisfied with myself

APPENDIX P

CONSULTING PSYCHOLOGISTS PRESS, INC.

577 College Avenue (P.O. Box 60070), Palo Alto, CA 94306 (415) 857-1444

Sandra LeFort
111 Stawberry Marsh Rd
St. John's Newfoundland
CANADA A1B 2V7

In response to your request of June 26, 1989 (Date) permission is hereby granted you to

include sample items from the State-Trait Anxiety Inventory Form Y-1 & Y-2 for use in your thesis. Permission is also granted for the sample items to be included when your thesis is microfilmed. Permission is granted for this project only.

subject to the following restrictions:

(a) Any material used must contain the following credit lines:

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Please remit without further notice and mail to my attention. Be sure to identify material for which payment is made.

CONSULTING PSYCHOLOGISTS PRESS, INC.

By Tina Steele Date July 10, 1989

Tina Steele Permissions Department

Agreed to by

APPENDIX Q

M U M S

Number:__________

Date:___________

Instructions: On the next set of questions, please report how you are feeling right now. If you are experiencing the feeling right now, respond "yes" by circling Y, if you are not, say "no" by circling N, and if you are unsure, say "don't know" by circling DK.

Right now, at this moment, are you feeling:

1.	ACTIVE?	Yes	No	DK
2.	BLUE?	Yes	No	DK
3.	ACTIVATED?	Yes	No	DK
4.	CONTENTED?	Yes	No	DK
5.	DOWNHEARTED?	Yes	No	DK
6.	ENERGETIC?	Yes	No	DK
7.	ENTHUSIASTIC?	Yes	No	DK
8.	HAPPY?	Yes	No	DK
9.	LIVELY?	Yes	No	DK
10.	LONELY?	Yes	No	DK
11.	PEPPY?	Yes	No	DK
12.	PLEASANT?	Yes	No	DK
13.	PLEASED?	Yes	No	DK
14.	STRONG?	Yes	No	DK
15.	REFRESHED?	Yes	No	DK
16.	VIGOROUS?	Yes	No	DK
17.	WORRIED?	Yes	No	DK
18.	ANGRY?	Yes	No	DK
19.	CHEERFUL?	Yes	No	DK
20.	SAD?	Yes	No	DK
21.	SATISFIED?	Yes	No	DK
22.	GROUCHY?	Yes	No	DK
23.	PEACEFUL?	Yes	No	DK

APPENDIX R

CONCORDIA
UNIVERSITY

DEPARTMENT OF PSYCHOLOGY

July 15, 1989

Sandra M. Lefort
111 Strawberry Marsh Road
St. John's Newfoundland
A1B 2Z7

Dear Ms. Lefort,

I hereby grant you permission to use the Memorial University Mood Scale (the MUMS) in your research entitled: Pain and Disability in Low Back-Injured Individuals Participating in a Physical Fitness Program.

Please feel free to reprint my scale in the appendix of your thesis.

All the best with your research.

Sincerely,

Kevin McNeil, Ph.D.
Assistant Professor

SIR GEORGE WILLIAMS CAMPUS
1455 DE MAISONNEUVE BLVD. WEST
MONTREAL, QUEBEC H3G 1M8

Appendix S

Results of Separate Analysis of Covariance for Pain, Disability and Psychological Variables at 8 Weeks with Age Group as Covariate

Variable	n	Source	df	Mean Squares	F
Least pain	43	Within cells	123	109.70	
		Age group by time	3	21.00	.19
Worst pain	43	Within cells	123	374.84	
		Age group by time	3	979.74	2.61
Pain rating this week	43	Within cells	123	.53	
		Age group by time	3	.19	.36
PRI (MPQ)	43	Within cells	123	45.29	
		Age group by time	3	64.87	1.43
Disability	41	Within cells	117	40.98	
		Age group by time	3	12.99	.32
Self esteem	43	Within cells	123	7.14	
		Age group by time	3	2.08	.29
State anxiety	42	Within cells	120	28.16	
		Age group by time	3	5.26	.19
Trait anxiety	39	Within cells	111	12.86	
		Age group by time	3	12.33	.96
Mood	43	Within cells	123	52.43	
		Age group by time	3	34.06	.65