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Structural Equation Model of Exercise in Women Utilizing the Theory of Unpleasant Symptoms and Social Cognitive Variables

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By

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of the requirements for the degree of
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Dedication

This document is dedicated to my daughters Farah Lee Flores and

Jennifer Ann Cobb, without whose encouragement and "YOU CAN DO IT,

MOM!" hollering from the bleachers I never would have survived all this work.

This work is in memory of Lieutenant Colonel Ronald Stem who exemplified valor

in the face of tumultuous times, and taught me tenacity.

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List of Acronyms

1. ANCOVA — Analysis of covariance
2. ANOVA — Analysis of variance
3. BMI — Body Mass Index
4. CAD — Coronary artery disease
5. CVD — Cardiovascular disease
6. HOMO-IR — Homeostasis insulin resistance
7. HS-CRP — High sensitivity C reactive protein
8. IL-6 — Interleukin-6
9. MANOVA — Multivariate analysis of variance
10. MANCOVA — Multivariate analysis of variance
11. MET — Metabolic equivalent
12. MPA — Moderate physical activity
13. MVPA — Moderately vigorous physical activity
14. PA — Physical activity
15. SEM — Structural equation modeling
16. VPA — Vigorous physical activity
17. VO_2 max — Maximal aerobic capacity

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ABSTRACT

A dramatic decline in physical activity levels occurs from adolescence to young adulthood. Those who were sedentary as adolescents tend to maintain a sedentary lifestyle. Women are particularly vulnerable to the effects of a sedentary lifestyle because of the risk for cardiovascular disease. The purpose of this research was to test a theoretical model of exercise in adolescent and young adult women using the theory of unpleasant symptoms with social cognitive variables and then to test a revised model that was determined a priori. The central hypotheses were that the relationships as depicted in the proposed theoretical models would be reproducible in data from adolescent and young adult women of ages 18 to 25.

CHAPTER ONE

Introduction

Promoting exercise among the United States (U.S.) population is a national priority. Several of the *Healthy People 2010* goals specifically target exercise to increase the proportion of adolescents and adults who engage in moderate physical activity (U.S. Department of Health and Human Services, 2002). Current recommendations for physical activity differ by age. Recommendations by the Centers for Disease and Control (2006) are that youth participate in physical activity for 60 minutes at moderate intensity on most days of the week, preferably daily. Recommendations for adults are that they participate in vigorous activity for 20 minutes on at least three days per week, or engage in moderate activity for 30 minutes on at least five days per week (CDC). Furthermore, the exercise does not have to be done all at once; it is beneficial even if the exercise time is divided into portions as small as 10 minutes (CDC).

Risk of Cardiovascular Disease

There are several reasons why exercise has been emphasized as a national priority. One of the key reasons is the risk of cardiovascular disease (CVD) or coronary artery disease (CAD) from the combined effects of physical inactivity / obesity. Women are particularly vulnerable to the effects of a sedentary lifestyle because of the risk for cardiovascular disease (Correa-de-

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Araujo et al., 2006). In the decade prior to year 2000, the number of deaths attributable to poor nutrition/physical inactivity increased substantially more than the other causes of death (CDC, 2005; Mokdad, Marks, Stroup, & Gerberding, 2004). Mokdad et al. calculated the number of deaths attributable to poor nutrition/physical inactivity from the percentage of persons who were overweight or obese; using this method, 400,000 (16.6%) of deaths in year 2000 were attributed to poor diet and physical inactivity, which was an increase from the 300,000 (14%) in year 1990. Mokdad et al. were able to use obesity as a proxy for poor physical inactivity because of the high correlation between the obesity and poor physical fitness. Recent evidence showed that the effect of body mass index (BMI) on predicting physical fitness was strong among healthy youth ($p <$ 0.0001) with a decrease of 0.069 minutes treadmill endurance for each unit increase in BMI (Chatrath, Shenoy, Serratto, & Thoele, 2002).

Youth's physical activity indices can predict BMI and adult waist circumferences as well. X. Yang et al. (2006) tested a model of physical activity and obesity longitudinally from 1980 through 2001 in four cohorts of youth (ages 9, 12, 15, and 18). After following these cohorts for 21 years, X. Yang et al. found a significant total effect that youthful physical activity had on adult waist circumference ($B = -$ .07, $t =$ 4.54, $p <$ .05). Furthermore, youthful BMI accounted for 13% of the variance in the adulthood waist circumference.

Interestingly, Wessel et al. (2004) found that among 906 women (mean age 58, SD 12 years) referred for clinically indicated coronary angiography, those who were found to have higher BMI were likely to have a history of hypertension,

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diabetes, dyslipidemia, and higher IL-6 levels and prevalence of metabolic syndrome (Wessel et al.). However, despite having these CAD risk factors associated with higher BMI, neither BMI nor anthropometric measures (waist circumference, waist/hip ratio, and waist/height ratio) were associated with the risk of mortality or major adverse events ($p > .10$). Instead, Wessel et al. found the risk of mortality was associated with poor physical fitness from physical inactivity, not higher BMI. To summarize, BMI and CAD risk factors are associated with each other, but it is the physical inactivity leading to poor physical fitness that is associated with mortality risk, and as noted by X. Yang et al. (2006), youthful physical activity can deter adulthood obesity significantly.

Similar associations of CAD risk factors and BMI were found by McGavock, Anderson, and Lewanczuk (2006). In a study among 135 otherwise healthy young adults (mean age for females 28 ± 5 years) categorized into three groups (sedentary, physically active, and endurance trained), BMI was significantly associated with systolic blood pressure ([BP], ($r = 0.36$, $p < .01$) but was unrelated to large or small artery compliance (McGavock et al.).

The strong association between BMI and CAD risk factors or poor physical fitness, which directly affects mortality risk, is considered evidence that obesity is a risk factor for the adolescents and the young adults under consideration. Whitlock, Williams, Gold, Smith, and Shipman (2005) found in an integrative review of evidence that single BMI measures successfully predicted risk factors in young adulthood in longitudinal studies, particularly for youth over age 13 ($r = > 0.6$). To date, BMI is considered the most reliable screening test for overweight

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in childhood for predicting obesity in adulthood. Adolescents who are overweight with BMI $> 95^{th}$ percentile have a 50% probability of adult obesity (Whitlock et al.). In summary, youthful physical activity predicts adulthood physical activity, which predicts adult waist circumference. Furthermore, physical inactivity at any age is associated with poor physical fitness, which is a prime indicator of cardiac fitness.

Impact on Chronic Diseases and Metabolic Syndrome

A second reason for the emphasis on engaging in physical activity is the effect that physical inactivity/low cardiorespiratory fitness has on chronic diseases and prodromal conditions such as metabolic syndrome. Physical inactivity has been shown to impact the risk of diabetes mellitus and certain cancers (Warburton, Nicol, & Bredin, 2006) as well as to exacerbate the risk of mortality from any cause whether or not a chronic disease is present (Wessel et al., 2004). One such condition is the metabolic syndrome which is a phenotype that links insulin resistance, hypertension, dyslipidemia, type II diabetes, and other metabolic abnormalities with an increased risk of atherosclerotic cardiovascular disease (R. Weiss et al., 2004). The metabolic syndrome is characteristic for nearly half of severely obese patients (R. Weiss et al.), and is a major risk factor for coronary artery disease(Council on Sports Medicine and Fitness & Council on School Health, 2006), particularly among women (LaMonte et al., 2005). However the metabolic syndrome is also linked to physical inactivity (McGavock et al., 2006) not just to BMI.

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McGavock et al. (2006) studied healthy young adults (ages 20-40) for physiologic differences among sedentary, physically active, and endurance trained participants. Using a glucose breath test as a noninvasive measure of insulin sensitivity, McGavock et al. determined that there was a trend toward reduced insulin sensitivity in the sedentary group; fasting insulin levels were nearly twice as high in sedentary participants compared to the endurance-trained participants, and there was a concomitant increase in homeostasis insulin resistance (HOMO IR) levels. These authors believed that sedentary lifestyles lead to cardiac dysfunction and vascular changes by causing a progressive decline in insulin sensitivity.

The relationship of obesity to the metabolic syndrome was reported by R. Weiss et al. (2004) who studied the metabolic syndrome in youth (N =439); youth were included in the exposed group if their BMI exceeded the 97th percentile for their age. The authors found that values for serum glucose, insulin, insulin resistance (HOMO IR), IL-6 and systolic BP all increased with increasing overweight ($p < 0.001$). The overall prevalence for the metabolic syndrome ranged from 38.7% to 49.7% for the moderately obese and the severely obese participants respectively, while there were no cases of metabolic syndrome among the nonobese participants (R. Weiss et al.). Each half-unit increase in BMI (measured in Z scores) significantly increased the risk of the metabolic syndrome (*OR* 2.20; 95% *CI* 1.35 – 3.59). At follow-up two years later, eight of the participants who had had impaired glucose tolerance at baseline had

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developed type II diabetes (R. Weiss et al.). The odds of developing type II diabetes are increased in adolescence if the youth are overweight.

Iannuzzi et al. (2006) also studied the metabolic syndrome among obese children ($N = 100$ obese youth, ages 6 to 14). Obese children with metabolic syndrome had significant differences relative to nonobese youth; obese youth had higher insulin levels ($p = 0.014$), higher HOMO IR levels ($p = 0.011$), and C-reactive protein concentrations ($p = 0.021$). Using ultrasound parameters for carotid thickness and stiffness, the obese children with metabolic syndrome also had significantly more carotid stiffness than nonobese children ($p = 0.023$).

LaMonte et al. (2005) prospectively studied adults ($N = 1,491$ women and 9,007 men, mean age 44 ± 9 years) for cardiorespiratory fitness relative to the incidence of metabolic syndrome. Among this group of adults, low cardiorespiratory fitness was significantly related to the development of the metabolic syndrome risk factors. A one metabolic equivalent (MET) increment in treadmill performance was associated with a 17% reduction in risk of metabolic syndrome for women (LaMonte et al.); in contrast, a significant inverse linear relationship was noted between cardiorespiratory fitness and the metabolic syndrome ($p = 0.02$ for women, $p < 0.0001$ for men).

Impact on Musculoskeletal Disorders

A third reason for advocating physical activity is that physical inactivity/ overweight in youth contributes to an increased risk for musculoskeletal disorders such as slipped capital femoral epiphysis, adolescent tibia vara, joint pain especially in the knees, and fractures (Taylor et al., 2006). Among a total of 355

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youth (mean age of the overweight = 12.6 ± 2.7) followed prospectively, the prevalence of musculoskeletal complaints was higher for the overweight group compared to the nonoverweight group (*OR* 4.41; 95% *CI*: 1.3-15.0, *p* = 0.0096). Taylor et al. noted that the customary increase in bone density seen in overweight children is not sufficient to overcome the forces that are generated when a child falls, for example, and that overweight youth fall with a much greater force than do nonoverweight youth.

One of the concerns about high levels of physical activity is a possible reduction in bone density. In a prospective cohort study among young women followed for 2 years for changes in bone density, neither body weight nor change in body weight explained the variability in bone density at time 2 (Elgan & Fridlund, 2006). Among those who were underweight (BMI < 19), high physical activity hindered bone density (*B* = 0.139, *SE* = 0.04, *p* = 0.004). However in contrast to underweight women, Elgan and Fridlund found that the bone density at time two among women with a BMI >24 was not affected by increased physical activity (*p* = 0.689). Thus physical activity should not be restricted among young women with BMI greater than 24 due to fears of change in bone density.

In prepubescent children, a notable osteogenic effect can be achieved with only a few hours of sports participation (Vicente-Rodriguez, 2006), physical activity stimulates bone hypertrophy and increases peak mass. In their position statement on osteoporosis and exercise, the American College of Sports Medicine (1995) noted that habitual inactivity causes rapid decrease in bone density, whereas the effect of habitual exercise is less rapid increase in bone

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density. As women age, it becomes more difficult to maintain the load-bearing stimulus needed for stimulating bone mass (American College of Sports Medicine). Stimulating bone density growth through regular physical activity is essential for women particularly as they mature (Borer, 2005).

Maintenance of Physical Activity

However maintaining regular physical activity for women is an issue. Dramatic declines in physical activity levels occur between adolescence and young adulthood (Gyurcsik, Bray, & Brittain, 2004). Women who are sedentary as adolescents tend to maintain a sedentary lifestyle (De Bourdeaudhuij, Lefevre et al., 2005; De Bourdeaudhuij, Philippaerts et al., 2005). Similar findings for young adults were noted by the CDC (2005). In the 18 to 44 age bracket, 32.9% had a sedentary lifestyle in 2003; overall, 37.6% of adults are inactive. According to a recent report by the National Heart Lung and Blood Institute (Krumholz et al., 2005), weight gain over 10 years (defined as an increased BMI of 5 kg/m^2) was the highest at ages 25 to 34. Therefore physical activity is even more important as adolescents prepare for young adulthood before the spurt in BMI occurs.

In summary, if weight gain can be avoided before those critical years, CVD risk factor levels can be reduced and can obviate the need for costly drug therapy later in life (Krumholz et al., 2005). Physical inactivity or sedentary lifestyles have substantial healthcare costs associated with them (Weiss, Froelicher, Myers, & Heidenreich, 2004). However, more importantly, physical activity can save lives and increase the quality of life (Jia & Lubetkin, 2005).

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Despite the growing body of evidence pertaining to the need for exercise, there are gaps in the literature related to impediments to exercise, particularly in the adolescent and young adult population. Impediments such as fatigue and pain were theorized to have an impact on physical activity outcomes even for this age population. In addition, there are gaps in the literature related to theoretical models of exercise in the adolescent and young adult population.

Theoretical Framework

Based upon a qualitative pilot study (Cobb, 2005), the exercise experience of women was often described as having been affected by the symptoms of pain and of fatigue, both of which are key symptoms in the theory of unpleasant symptoms. In the search for a model to test concerning exercise, the theory of unpleasant symptoms by Lenz, Suppe, Gift, Pugh, and Milligan (1995) and revised by Lenz, Pugh, Milligan, Gift, and Suppe (1997) emerged as a plausible theory that could explain the results of the qualitative study. Examples of the use of the theory found in the literature included a correlational study relating fatigue and exercise among older women who have experienced a myocardial infarct (Crane, 2005); studies relating fatigue and post-partum depression (Corwin, Brownstead, Barton, Heckard, & Morin, 2005), and studies relating fatigue to various pathologies such as chronic obstructive pulmonary disease (Reishtein, 2005), end stage renal disease (Liu, 2006; McCann & Boore, 2000), and cancer (Redeker, Lev, & Ruggiero, 2000). Other symptoms that have been studied using this middle-range theory include the symptom of nausea (O'Brien, Evans, & White-McDonald, 2002). However these studies mostly used the theory of

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unpleasant symptoms to explain activity outcomes among older persons with chronic illnesses. To this researcher's knowledge, the theory of unpleasant symptoms has never been testing using structural equation modeling. Thus the possibility of using the theory of unpleasant symptoms was explored further.

One key feature of the theory of unpleasant symptoms is that multiple symptoms affect performance outcomes. Originally the theory of unpleasant symptoms was conceived as a single concept of fatigue during postpartum. This single concept eventually merged with the single concept of fatigue during intrapartum to become the framework for the study of fatigue during childbearing. Meanwhile, the single concept of fatigue during intrapartum merged with the single concept of dyspnea in chronic obstructive pulmonary disease and asthma to become the multiple concepts of dyspnea/ fatigue. Thus three single concepts through collaboration with their various authors merged into two multiple concepts. These two multiple concepts then were merged into a middle-range theory of unpleasant symptoms (Lenz et al., 1995). Key considerations to the merging of the concepts were that both fatigue and dyspnea were defined by the same subjective symptoms, could be altered by anxiety or depression, and had similar physiological, psychological and situational factors as antecedents. The symptom experience of either fatigue or dyspnea could in turn influence functional performance (Lenz et al., 1995).

The updated theory of unpleasant symptoms (Lenz et al., 1997) asserted that while symptoms can occur in isolation, they often occur simultaneously. Multiple symptoms catalyze each other; these multiple symptoms are

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multidimensional, with duration, timing, intensity, and quality being dimensions of each symptom. In the updated theory of unpleasant symptoms by Lenz et al. (1997) the physiologic, psychological and situational factors are depicted as being related, and performance is depicted as having a reciprocal effect onto the same three factors (see Figure 1). Because the definitions of each of the factors described by Lenz et al. included multiple examples, the factors can be considered as domains, and will be referred to as domains in this document.

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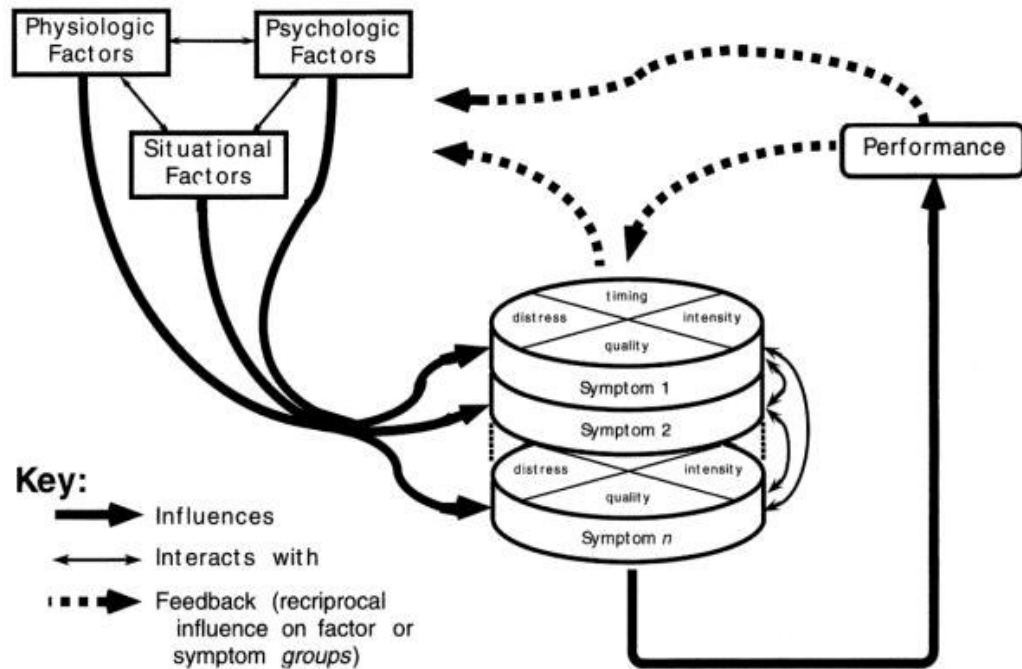
Figure 1. The Theory of Unpleasant Symptoms. Used by permission *(*Lenz, E. R.,

Pugh, L. C., Milligan, R. A., Gift, A., & Suppe, F. (1997). The middle-range theory

of unpleasant symptoms: An update. *ANS. Advances in Nursing Science, 19*(3),

14-27).

Lenz et al. (1997) depicted unpleasant symptoms as mediating the

relationship between the psychological, situational, and physiological factors and

performance outcome. However they stated that unpleasant symptoms

moderated the relationship (see *relationship among influential factors*, paragraph

two). In their model, each of the influencing factors related to each other as well

as interacted to influence the symptom experience. According to Lenz et al.

(1997), the psychological domain includes knowledge related to symptom, stress

and other affective reactions as well as social support. The physiological domain

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includes nutritional balance and both pathological and normal body systems. Of particular interest is that the situational domain includes social and physical environment influences such as social support, access to healthcare, family status, ambient temperature, humidity, and air quality (Lenz et al., 1997). It also includes lifestyle behaviours such as physical activity or nutrition. Finally, the outcome component of the theory is that of performance, which includes functional performance, functional health status, quality of life, and cognitive activity. Examples of functional performance given are physical activity, social activities and interaction, and work. Cognitive activity includes problem-solving as well as lower cognitive functioning (Lenz et al., 1997). The theoretical model for this in structural equation format is depicted in Figure 2.

Close examination of the conceptual definitions revealed some ambiguous boundaries, with social support listed in both psychological and situational factors; physical activity listed in both situational and performance factors, and nutrition listed in both physiological and situational factors. These ambiguities as well as theoretical concerns located in the literature review prompted the proposed model 2 (see Figure 3), in which unpleasant symptoms partially mediate the relationships between the other factors and physical activity. Other reasons for choosing a partially mediated model were that the literature review revealed different relationships amongst the variables for social support and the psychological domain, as described in more detail in chapter 2.

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The main purpose of this research was to test if the models for the theory of unpleasant symptoms would be reproduced in the data from college women of ages 18 to 25.
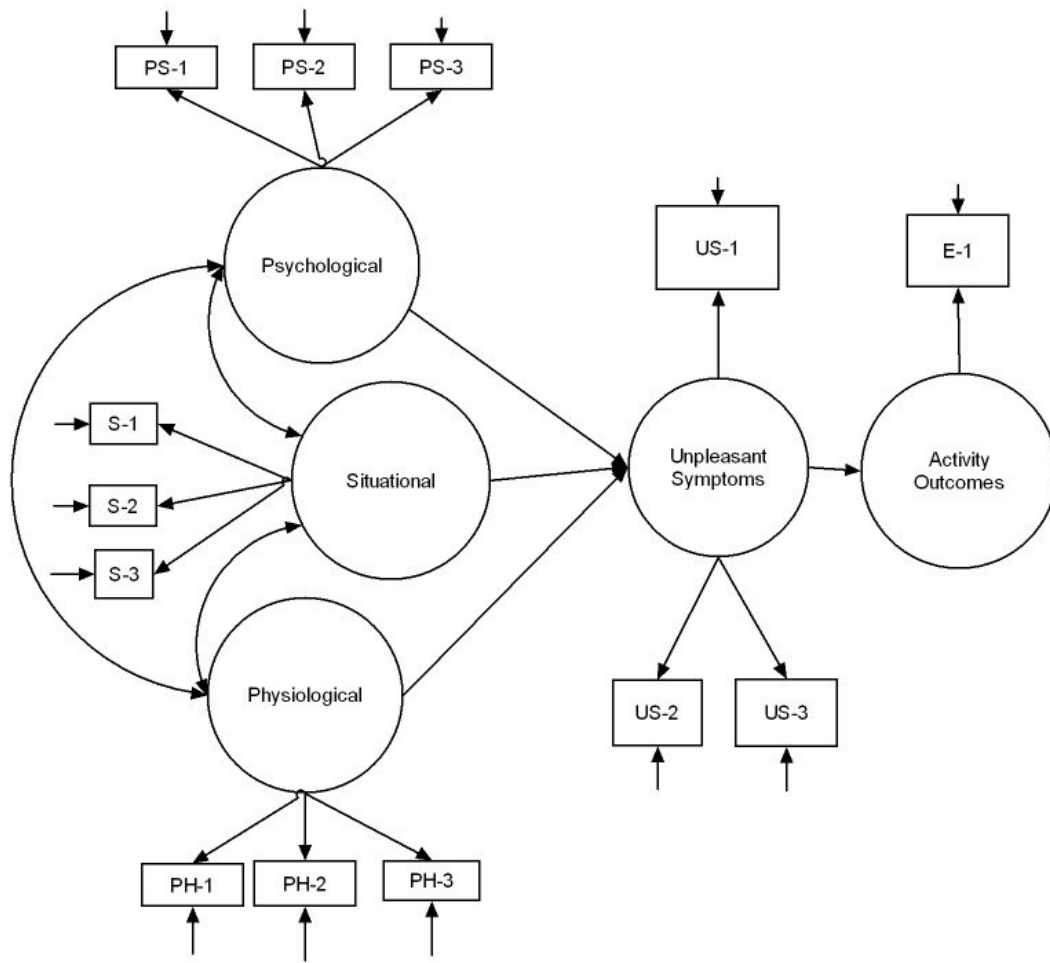
Figure 2. Model of Exercise Utilizing the Theory of Unpleasant Symptoms.

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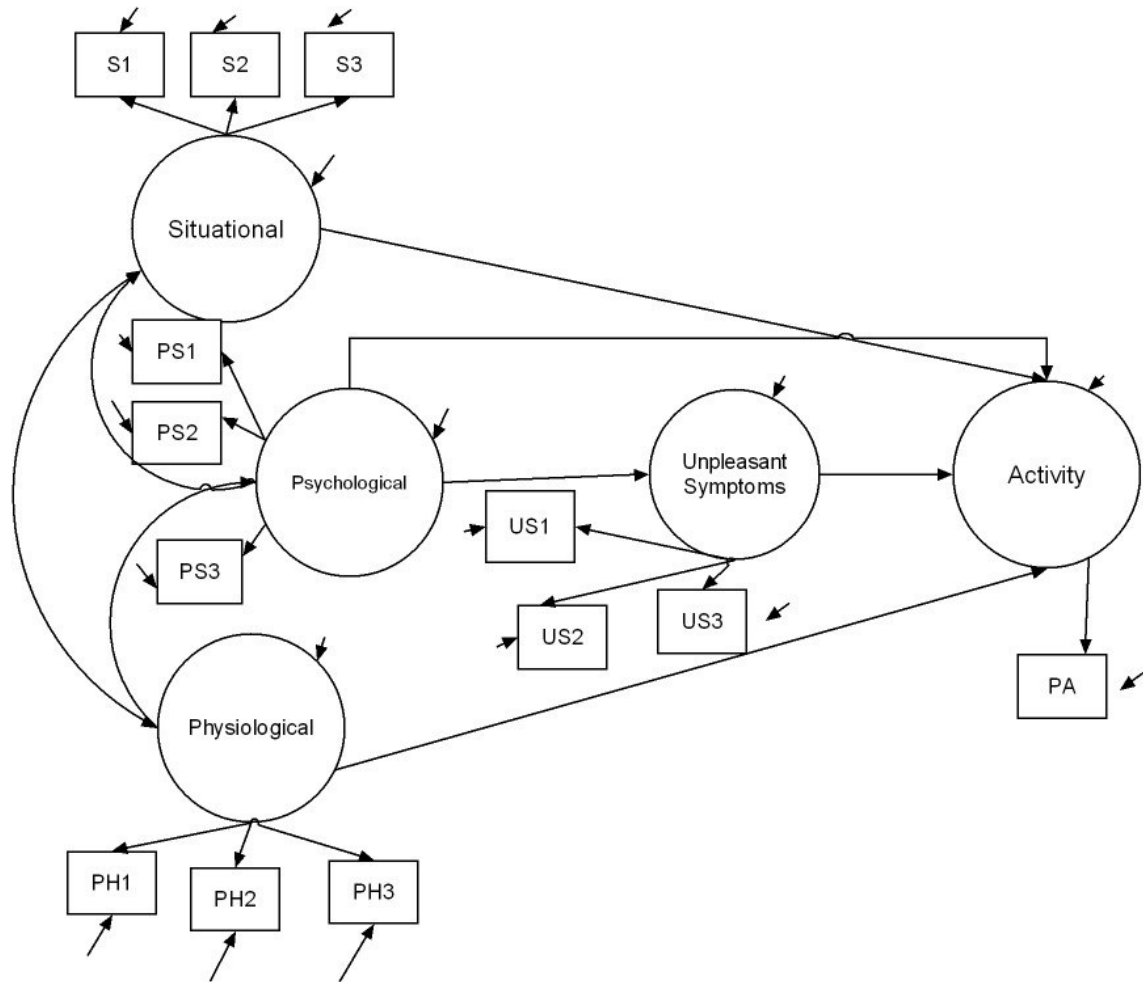
Figure 3. Model of Exercise Altering the Theory of Unpleasant Symptoms.

Primary Aims

1. Assess whether the relationships as depicted by the model for the theory of unpleasant symptoms would be reproducible in data from women of ages 18 to 25.

2. Assess whether the relationships as depicted by the altered model for the theory of unpleasant symptoms would be reproducible in data from women of ages 18 to 25 with a better fit than the first model.

Study Questions

1. Will model 1 be reproducible in data for women ages 18 to 25?

2. Will the altered model, model 2, be reproducible in the data with a better fit than model 1?

Significance

Physical inactivity or sedentary lifestyles provoke an economic burden that has burgeoned into an epidemic proportion among the last 20 years. Studying national data from hospital discharges of children and adolescents, Wang and Dietz (2002) found that there was a 197% increase for obesity-related diagnoses among those discharged. The frequency with which they found obesity listed as a secondary diagnosis showed that obesity may lead to other conditions, including asthma, adverse pregnancy outcomes, sleep apnea, and gallbladder disease. When obesity was listed as the principal diagnosis, the average length of stay was 13.5 days, more than twice the 6.8 days where obesity was the secondary diagnosis. This amounted to a cost of $127 million per year in 2001 dollars, which is more than a threefold increase.

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Physical inactivity or sedentary lifestyles have substantial healthcare costs associated with them for young and middle aged adults as well (J. P. Weiss et al., 2004). J. P. Weiss et al. performed a cost analysis of healthcare costs and exercise capacity among veterans (mean age 59). There was an inverse relationship between exercise capacity (measured in METs) and costs that was independent of age. With each one MET increase in exercise capacity, costs were incrementally lower by an average of 5.4% ($p < 0.001$). A higher peak MET was significantly associated with lower costs one year later (J. P. Weiss et al.). Therefore exercise, which increases exercise capacity, can reduce long-term healthcare costs.

Similar findings exist among those with advancing age. Pronk, Goodman, O'Connor, and Martinson (1999) studied health care charges billed to a stratified random sample of 8000 individuals aged 40 years or older who had at least one of four chronic diagnoses: diabetes mellitus, heart disease, hypertension, or dyslipidemia. The health care charges were highly skewed, with 86% of the total charges accrued by a quintile of individuals (Pronk et al.). Healthcare costs for sedentary individuals (no physical activity done during a week) were 4.7% higher than for those who were physically active even just one day per week, even after controlling for the chronic diseases (Pronk et al.). Another interesting finding was that females had median charges that were 39% higher than for males

These three studies have shown that physical inactivity costs our nation millions of dollars. As noted earlier, sedentary rates increase with age, especially among women as they make the transition from adolescence to young

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adulthood. Physical inactivity is a modifiable behavior that has significant impact on our nation's women in particular. Learning ways to modify behaviors to promote physical activity is vital to our national health.

In summary, the context of the need for this research was introduced in this chapter. Key points were that physical activity decreases with age and that women are particularly susceptible to cardiac events. Because of the inverse relationship between cardiac events and cardiac fitness, exercise to increase the cardiac fitness is a valuable tool in prevention of cardiac events.

In chapter 2, the major concepts of the theoretical model are introduced and the preliminary pilot study leading to the interest in these variables is discussed. In the proposed model, there are thirteen key variables, each of which is discussed in depth in the following chapter. The literature review is presented sequentially by latent variables, with each manifest variable described. Table 1 provides the definitions of key terms used in the literature review.

Table 1

Definition of Terms

Term	Definition	Reference
Body Mass Index BMI	1. Weight in KG / Height M^2 2. Weight (kg) / height (cm) / height (cm) X 10 000 3. Weight (lb) / height (in) / height (in) X 703	(Council on Sports Medicine and Fitness & Council on School Health, 2006)
Metabolic Equivalents (MET)	1 MET = resting metabolic rate; rate of O2 consumption by normal adult at rest 2. 1 MET = 3.5 ml O2 /kg /min	(Bulwer, 2004)
Obesity	1. BMI z score of 2.0 or more 2. BMI ≥ 30	(R. Weiss et al., 2004; Wessel et al., 2004)
Moderately obese	1. BMI z score of 2.0 to 2.5	(R. Weiss et al., 2004)
Severely obese	1. BMI z score > 2.5	(R. Weiss et al., 2004)

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Table 1 (Continued)

Term	Definition	Reference
Overweight	1. BMI ≥ 95th percentile for sex and age according to 2000 CDC growth charts (term used by CDC for children and adolescents) 2. BMI 25 – 29 adults	(Miech et al., 2006; Wessel et al., 2004; Whitlock et al., 2005)
At risk for overweight	BMI in 85th to 95th percentile for age and gender; term used for children and adolescents	(Whitlock et al., 2005)
Exercise	1. Acute: Any bout of nonhabitual activity 2: Chronic: fitness training May be classified as: 1. Resistance (weight training) 2. aerobic (cardio respiratory training) 3. Flexibility (Stretching)	(Bulwer, 2004)

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Table 1 (Continued)

Term	Definition	Reference
Physical activity (PA)	Activity besides that which occurs in normal work day, which consumes energy	(Bulwer, 2004)
Physical inactivity	A dichotomous measure indicating respondents who reported both no moderate and no vigorous physical activity over a specified time period of 7 to 30 days	(Miech et al., 2006)
Sedentary lifestyle	Latin for "usually sitting" 1. <30 minutes/ day of aerobic exercise on < 3 days/week 2. demanding PA does not exceed 20-minute session, or if occur < 3 times / week	(Bulwer, 2004; McGavock et al., 2006)
Light PA	1. Physical activity that uses < 4 METs	(Bulwer, 2004)

Table 1 (Continued)

Term	Definition	Reference
Moderate PA	1. Physical activity using 5 METs, or 4 - ≤ 6 METs 2. Physical activity that burns 3.5 – 7 calories per minute (Kcal/min) 3. 30 – 45 min/day of moderate aerobic exercise 4. PA that burns near 150 Kcal / day or 1000 Kcal/wk	(Bulwer, 2004; Centers for Disease Control and Prevention, 2006; K. M. Harris, Gordon-Larsen, Chantala, & Udry, 2006; McGavock et al., 2006)
Moderately Vigorous PA (MVPA)	5-8 METS	(Nelson & Gordon-Larsen, 2006)

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Table 1 (Continued)

Term	Definition	Reference
Vigorous PA (VPA)	1. Physical activity using 8 metabolic equivalents (or ≥6 METs if skipping MVPA) 2. Physical activity that burns more than 7calories per minute (Kcal/min) 3. Endurance trained: > 45 min/day of moderate to intense aerobic exercise ≥ 5 days/week	(Bulwer, 2004; Centers for Disease Control and Prevention, 2006; K.M. Harris et al., 2006; McGavock et al., 2006)
VO_2max	1. Measure of maximal aerobic capacity as determined by a treadmill test 2. O^2max, mL*kg^{-1} * min^{-1}	(Kasa-Vubu, Ye, Borer, Rosenthal, & Meckmongkol, 2006; McGavock et al., 2006)

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CHAPTER TWO

Literature Review

In this chapter, the key psychological, situational, and physiological variables are discussed in depth as they relate to exercise among young women. Self-efficacy, outcome expectations for exercise and self-regulation (goals) are discussed as indicators for the psychological factor of the model. Loneliness, social support for exercise, and general social support are discussed as indicators for the situational factor of the model. Loneliness was selected as an indicator for the situational factor based upon Lenz et al. (1997) description of the situational factor as including the relationships with others as well as with the physical environment. Exercise capacity, physical health status, and anticipated fatigue in different activity situations are discussed as indicators for the physiological factor of the model. The unpleasant symptoms of chronic pain and chronic fatigue are discussed. And finally, the concept of exercise is discussed. Understanding the contribution of each of these variables to the overall model is one key to understanding the proposed model of exercise in women.

Theoretical Background

As mentioned in the previous chapter, the choice of using the theory of unpleasant symptoms as the theoretical basis for this research emerged as a consequence of seeking a theoretical model to help explain the findings from a

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qualitative study. The preliminary studies leading up to testing the theory of unpleasant symptoms via structural equation modeling are discussed next.

Preliminary Studies

Qualitative. In a pilot qualitative study (Cobb, 2005) college-aged adolescent women (*N* =4) from ethnic minority groups and of ages 18 to 25 were interviewed individually about their exercise experiences. Cultural differences were noted between Black women from the Caribbean Islands and Black women of African-American origin from the United States. However unpleasant symptomatology was a consistent reason across both cultures for stopping exercise, with fatigue and pain being the two most frequently mentioned symptoms. Although all the participants were university students who were knowledgeable about the benefits of exercise, exercise was not a priority with them. The question of how to promote physical activity among those who already knew the benefits intrigued this investigator and led to a desire to research the influence of unpleasant symptoms on exercise in more depth.

Quantitative. In a pilot study (Cobb, 2006) young collegiate females (*N* = 41, *M* age = 24.29, *SD* = 3.3, range 22 – 37) were queried about their exercise habits, unpleasant symptoms (defined as fear of pain, chronic fatigue, and loneliness), positive aspects (defined as benefits of exercise, perceived health status, and perceived exercise capacity), pros/cons of decisions about exercise, and the need for cognition when making choices. Data revealed a large range of activity with a mean of 3549 MET per minute per week, which indicated that the mean activity level was within the range categorized as high physical activity

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levels (IPAQ, 2005). Their average perceived exercise capacity was 10.29 metabolic equivalents, which indicated that their perceived exercise capacity was slightly higher than that of women from the same decade of life as measured by the scale's authors (Wisen, Farazdaghi, & Wohlfart, 2002). According to the authors, the predicted and the objectively tested metabolic equivalents were 11.4 and 11.2 respectively, and the self-rating of perceived exercise capacity was 9.2 (SD = 1.5). Interestingly the female students in the pilot study reported higher levels of loneliness than national norms (M = 50.6, SD = 7.6 pilot versus M = 34.5, SD = 18.2 national) as reported by Hays and DiMatteo (1987). In this study, 43.9% of the students were classified as lonely according to the cutoff point given by the authors. And finally, the mean summative fatigue score was 30.19 (SD = 5.12), which was slightly above the cutoff point of 28 designated as the point of fatigue by the authors (Chalder et al., 1993). Fifty-one percent of the students were classified as fatigued. And finally, the perceived rating of exercise capacity was the only variable to even approach significance as a predictor of metabolic minutes per week ($f_{(1, 59)}$ = 3.28, p = .069).

In summary, the qualitative and quantitative data both showed that collegiate females of ages 18 to 25 do have fatigue and pain, although the relationship of the unpleasant symptoms with exercise is not clear. Structural equation modeling with an appropriate sample size is warranted for testing these relationships.

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Factors in the Model of Exercise

The theory of unpleasant symptoms utilizes five concepts: a) psychological, b) situational, c) physiological factors, d) unpleasant symptoms as the mediating latent variable, and e) activity as the final variable. Indicators for these five latent variables were selected based upon the research for each variable.

Psychological Latent Variables

Self-efficacy, the primary construct from the social cognitive theory of behavioral change, was used for the psychological factor. Using literal dictionary definitions, self-efficacy is the awareness of one's ability to be effective and to control one's actions and outcomes (Merriam-Webster, 2007). In Kear's concept analysis of self-efficacy, three characteristics emerged: a) self-concept, b) control, and c) cognitive processes. Antecedent conditions were social experiences, efficacy expectations, and mastery experiences.

According to Bandura's social cognitive theory (Bandura, 1986, 1994; Bandura, Adams, & Beyer, 1977) perceived self-efficacy is defined as persons' beliefs about their capabilities to produce certain levels of performance that influence events that affect their lives. People with high confidence in their capabilities approach difficult tasks differently than those who doubt their capabilities. People with high confidence view the difficult tasks as challenges to be mastered, whereas people with low confidence shy away from difficult task.

There are four key sources of self-efficacy: Mastery experience, vicarious experience, social persuasion, and alteration of somatic and emotional states

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(Bandura, 1994). Mastery experiences boost persons' confidence in their capabilities to succeed and provide a sense of resilience. A vicarious experience is observation of someone else's modeling a behavior (Bandura et al., 1977). Repeated observations of successful performances boost persons' confidence in their own capabilities to succeed, particularly when the social models possess similar characteristics to the persons (Bandura, 1994). Social persuasion is done through verbal assurances that they possess the capabilities to master given activities. And finally, by altering persons' negative emotional proclivities and interpretations of their physical states, their stress is reduced and self-efficacy is boosted (Bandura, 1994).

The core determinants of self-efficacy are knowledge, perceived self-efficacy, outcome expectations, goals, perceived facilitators, and impediments to the changes one seeks (Bandura, 2004). Indicators for psychological factor of this study were chosen to reflect three of these dimensions of self-efficacy: a) self-efficacy for exercise, b) outcome expectations for exercise, and c) goal setting for exercise. Figure 4 depicts a model of exercise based upon those three dimensions of self-efficacy as described by Bandura (1997; 2004). In their studies, E.S. Anderson, Wojcik, Winett, and Williams (2006) and Rovniak, Anderson, Winett, and Stephens (2002) provided a more complex depiction of the SCT model of exercise that included social support as well as interrelations between self-efficacy, outcome expectations, and goal setting.

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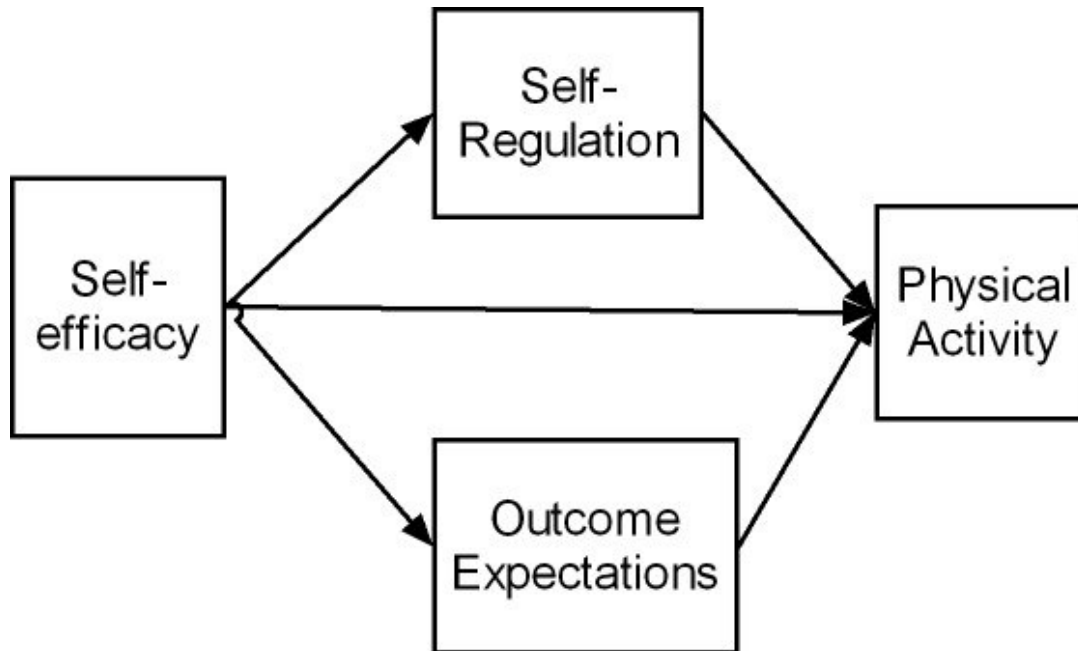
Figure 4. Social Cognitive Model of Physical Activity.

Social cognitive theory or self-efficacy have been used in several structural equations models to explain physical activity (E. S. Anderson et al., 2006; Dishman et al., 2005; McNeill, Wyrwich, Brownson, Clark, & Kreuter, 2006; Motl, Dishman, Saunders, Dowda, & Pate, 2007; Motl et al., 2002; Resnick, 2001; Resnick & Nigg, 2003; Rovniak et al., 2002). Table 2 summarizes the more recent structural equation models concerning self-efficacy and physical activity. A wide age range was selected purposefully because self-efficacy changes as one matures (Bandura, Caprara, Barbaranelli, Gerbino, & Pastorelli, 2003). Adolescents go through an especially taxing phase in which they have to deal with puberty changes, enlarged peer networks, and emotionally invested partnerships (Bandura et al., 2003). Common throughout most of these studies was that self-efficacy had large total effects on various modalities of exercise,

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and often mediated the relationships between social support and other situational variables. Important for this research is that Rovniak et al. (2002) found the largest total effect on physical activity ($B = .71$, $p < .001$) among adolescents and younger adults. Following Table 2 is a literature review of each of the key constructs utilized in the structural equation models.

Table 2

Role of Self-efficacy in Structural Equation Models for Exercise

Author	Independent Variables	Outcome	Statistic for SE	Sample	Theory
(McNeill et al., 2006)	Social support; social pressure, SE [a]	Walking	Total Effect on walking B = 0.269, t = 6.74	Black vs. White adults age 18-65 N = 1090	SEM + SCT
(McNeill et al., 2006)	Social support; social pressure, SE [a]	MPA	Total Effect on Moderate Intensity activity B = 0.353	Black vs. White adults age 18-65 N = 1090	SEM + SCT
(McNeill et al., 2006)	Social support; social pressure, SE [a]	VPA	Total Effect on vigorous intensity exercise B = 0.443	Black vs. White adults age 18-65 N = 1090	SEM + SCT

Note. SE = Self-efficacy; PA = physical activity; SEM = Social ecological model;

SCT = Social cognitive theory; SET = Self-efficacy theory; HPM = Health

Promotion Model; TTM = Transtheoretical model MPA = Moderate physical

activity; VPA = vigorous physical activity

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Table 2 (Continued)

Author	Independent Variables	Outcome	Statistic for SE	Sample	Theory
(McNeill et al., 2006)	Physical Environment; Intrinsic Motivation; SE	Walking	B = 0.269,	Black vs. White adults age 18-65 $N = 1090$	SEM + SCT
(Rovniak et al., 2002)	Social Support → SE → self-regulation & outcome expectations→ PA	Physical activity	Total effect on PA $B = 0.71$ $p < .001$	Student Age 18-28 $N = 353$ (244 women)	SCT
(Resnick, 2001)	Chronic illness → Physical health → SE→ PA	Current Exercise	$R^2 = .24$ of SE explained by illness & health	Older adults $N = 201$	

Note. SE = Self-efficacy; PA = physical activity; SEM = Social ecological model; SCT = Social cognitive theory; SET = Self-efficacy theory; HPM = Health Promotion Model; TTM = Transtheoretical model MPA = Moderate physical activity; VPA = vigorous physical activity

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Table 2 (Continued)

Author	Independent Variables	Outcome	Statistic for SE	Sample	Theory
(E.S. Anderson et al., 2006)	Social Support → SE → Self-regulation & outcome expectations→ PA.	Physical activity	Total effect on PA B = 0.12 p <.05	Church Age 18-92 (M = 52.73, SD = 14.56) N = 999	SCT
(Motl et al., 202b)	SE → PA;	MPA	Direct effect on MPA B = 0.240 p <.0001	Teen Girls (M = 13.57, SD = 0.67) N = 1,797	SET
	SE → intentions → PA				
	SE → PA;	VPA	Direct effect on VPA B = 0.201 p <.0001		

Note. SE = Self-efficacy; PA = physical activity; SEM = Social ecological model;

SCT = Social cognitive theory; SET = Self-efficacy theory; HPM = Health

Promotion Model; TTM = Transtheoretical model MPA = Moderate physical

activity; VPA = vigorous physical activity

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Table 2 (Continued)

Author	Independent Variables	Outcome	Statistic for SE	Sample	Theory
(Shin et al., 2005)	Prior behavior → perceived SE→ PA	Commit to plan for exercise	Total effect on planned exercise B = 0.08 t = 8.40 p <.01	Adult with chronic disease (M = 53.57, SD = 13.9) N = 400	HPM
(Dishman et al., 2005)	SE → Self-management → PA	Physical activity	Direct effect 0.59	Teen females N = 309 6th + 8th graders	TTM + SCT
(Dishman et al., 2005)	SE → outcome expectations→ PA		Direct effect 0.46	(M age 11.5, SD .6)' + N = 296 M 13.5, SD .6	
(Dishman et al., 2005)	SE → perceived barriers→ PA		Direct effect -.45		

Note. SE = Self-efficacy; PA = physical activity; SEM = Social ecological model;

SCT = Social cognitive theory; SET = Self-efficacy theory; HPM = Health

Promotion Model; TTM = Transtheoretical model MPA = Moderate physical

activity; VPA = vigorous physical activity

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Table 2 (Continued)

Author	Independent Variables	Outcome	Statistic for SE	Sample	Theory
(Dishman et al., 2005)	SE → enjoyment→ PA		Direct effect 0.47		
(Dishman et al., 2005)	SE → PA		With PA $r = .38$, $p < .05$		
(Resnick & Nigg, 2003)	Health & Social Support → SE→ PA	Exercise	Direct effect .50	Older adults (M age 86.1, SD 5.9)	TTM + SCT
(Resnick & Nigg, 2003)	Health & Social Support → Stages of change → PA		SE to stage = 0.42 & stage to PA = .26		

Note. SE = Self-efficacy; PA = physical activity; SEM = Social ecological model;

SCT = Social cognitive theory; SET = Self-efficacy theory; HPM = Health

Promotion Model; TTM = Transtheoretical model MPA = Moderate physical

activity; VPA = vigorous physical activity

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PS-1: Self-efficacy for exercise. Self-efficacy expectation is the belief that one can successfully do the behavior required to produce outcomes (Resnick, 2005). A synonymous term is task self-efficacy, which is the belief in one's effectiveness in doing specific task (Zimmerman & Cleary, 2005). As noted in Table 2, task self-efficacy, or self-efficacy expectation, has been demonstrated by many authors to be the key construct in models for physical activity outcomes.

Moritz, Feltz, Fahrbach, and Mack (2000) conducted a meta-analysis of relations of self-efficacy measures to sport performance. The average correlation between self-efficacy and sport performance was significant ($r = .38$, $z = 25.80$, $p < .001$). Moritz et al. also found that familiarity with performance tasks was associated with larger correlations to self-efficacy ($r = .36$) compared to novel tasks ($r = .31$); this supported Bandura's (1994) position that mastery experiences lead to higher self-efficacy.

Using a prospective design, Rovniak et al. (2002) also tested the SCT model of social support leading to self-efficacy, outcome expectations, and self-regulation, which in turn lead to physical activity (depicted in Figure 3) among 283 undergraduate students. Self-efficacy had a strong total effect on physical activity ($B_{direct/total} = .71$, $p < .05$).

PS-2: Outcome expectations for exercise. Outcome expectancy is the expectation that a given course of action will produce certain outcomes as well as values for those outcomes (Bandura, 1994). These outcomes are perceived as either risks or benefits. Physical outcomes include gratifying and aversive effects of the behavior and the associated losses and benefits (Bandura, 2004).

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Social outcomes involve approval or disapproval that the behavior elicits among peers or family. Personal outcomes involve one's self-evaluated reactions to one's health behavior and health status (Bandura, 2004).

Using a prospective design, Rovniak et al. (2002) tested the SCT model of social support leading to self-efficacy, outcome expectations, and self-regulation, which lead to physical activity, among 283 undergraduate students. Rovniak et al. did not find significant total effects of outcome expectations on physical activity, and expectations did not predict levels of physical activity.

Similarly, E.S. Anderson et al. (2006) tested a revised SCT model among 999 adults recruited from area churches (age range 18 – 92, $M = 52.73$, $SD = 14.56$ years). Positive outcome expectations had a negative direct effect on physical activity, and a small but positive indirect effect on physical activity, producing a non-significant total effect (E.S. Anderson et al.).

However there have been multiple studies documenting the evidence for exercise benefits, which are synonymous with positive outcome expectations for exercise (Allison et al., 2005; C. Anderson, 2003; De Bourdeaudhuij & Sallis, 2002; Deforche, De Bourdeaudhuij, Tanghe, Hills, & De Bode, 2004; Enthoven, Skargren, Carstensen, & Oberg, 2006; Grubbs & Carter, 2002a; A. H. Harris, Cronkite, & Moos, 2006; Landers, 2006; McDevitt, Snyder, Miller, & Wilbur, 2006; Nelson & Gordon-Larsen, 2006). Perceived benefits of exercise noted by adolescents include increased stamina and muscle strength, and improved muscle tone (Grubbs & Carter, 2002). Psychological benefits include decreased stress or anger, increased self-confidence, greater self-discipline, and better

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feeling (Allison et al., 2005). Of key interest for this proposed model is that exercise has been shown to increase slow wave sleep and total sleep time, which are beneficial for replenishing the body's energy stores and offsetting fatigue (Landers, 2006).

A recent analysis of the National Longitudinal Study of Adolescent Health (Nelson & Gordon-Larsen, 2006) showed other benefits. Adolescents who exercised (N =11,957; M age 15.8, SD = 11.6 years) were less likely to have risky health behaviors such as having sex without birth control, smoking, drinking and driving drunk. Those who exercised ≥ 5 hours per week at moderately vigorous physical activity (MVPA) were less likely to have low self-esteem (ARR = .83, CI = .80 - .86), more likely to achieve grades of "A" in the hard sciences, and were more likely to sleep greater than or equal to eight hours per night (Nelson & Gordon-Larsen).

In another study of adolescents (Deforche et al., 2004), the sample (N = 90, mean age = 14.6, SD = .9 years) was categorized by weight status. MANOVA was used to analyze differences in attitudes towards exercise among the three weight groups. Perceived benefits that were statistically significant across the groups were pleasure (F = 8.1, $p < .001$), which was higher among nonobese adolescents; looking better (F = 3.2, $p < .05$), which was higher among obese adolescents; and losing weight (F = 8.6, $p < .001$), which was higher among obese adolescents. Benefits that were viewed the same across all three groups were social contacts, competition, feeling better, and improving health and physical conditions (Deforche et al., 2004).

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Anderson (2003) sampled collegiate women ($N =$397, mean age 23, $SD =$ 6.99) to determine motives for exercise as well as reasons for quitting. Mental motives cited by those who met CDC guidelines for exercise included centering (time to be alone, 32%), relieving tension and stress (75%), and improving mental performance (30%). Those who did not meet CDC guidelines for exercise cited the same benefits but had a reduced rate: centering (20%), relieving tension and stress (61%), and improving mental performance (23%). A similar pattern was noted throughout the entire list of cited benefits with the exception of exercising because it was a school requirement (cited by 5% of the 'no' exercise group).

De Bourdeaudhuij and Sallis (2002) investigated the contribution of perceived benefits in explaining variance in physical activity of moderate to vigorous intensity among three age groups, one of which was age group 16 -25 (mean age 21, $SD =$ 2.9). For females, perceived benefits showed R^2 of 3% in a regression analysis that ultimately explained 13% of the variance in physical activity for females. Competition benefits for males ($\beta = .14$) and health benefits for females ($\beta=.13$) were the most significant benefits (De Bourdeaudhuij & Sallis).

K.M. Harris et al. (2006) followed a cohort ($N =$424) of depressed adults across 10 years to examine factors that influence the naturalistic course of depression. At intake the mean age was 39.9 ($SD =$ 14.1). The effect of exercise on global depression was a 2.24-point drop in depression for each increment of

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physical activity (effect = -2.24, *SE* = .64, *p* < .001). This study showed that physical activity may help to reduce concurrent depression (K.M. Harris et al.).

Similar findings were found in a qualitative analysis of 34 participants (16 men, 18 women, age range 18 – 50) with serious mental illnesses including schizophrenia, mood disorders, and anxiety disorders (McDevitt et al., 2006). These participants were drawn from a larger sample (*N* = 2,216) housed in two midwestern rehabilitation centers. Key themes that emerged about exercise benefits were primarily mental health benefits ('happy feeling" and "can sleep at night"). In contrast with common mental illness symptoms (anergia and anhedonia), physical activity was seen as a way to "become more involved with life" (McDevitt et al., p. 53).

Regular exercise can also affect level of disability (Enthoven et al., 2006). Enthoven et al. queried patients with low back pain five years after their initial entry into an experimental design comparing chiropractics and physiotherapy for those with low back pain (Enthoven et al.). The main outcome variable was disability. Logistic regression was used. Among other predictors, those who had lower exercise levels at baseline had more disability both at baseline and at the five year follow-up (*OR* 3.35, 95% *CI* = 1.48 – 7.58, *p* < .01). One of the longer term benefits of exercise is a reduction in residual disability after having a back-pain event (Enthoven et al.).

In summary, the benefits of exercise range from mental benefits (feeling better, less fatigue, less depressed) to physical benefits (weight loss, less

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debilitation after injuries). Outcome expectations for exercise include benefits, and will be used as the indicator.

PS-3: Self-regulation. Self-efficacy beliefs also involve self-regulation. Self-regulation encompasses both goals and plans. The stronger the perceived self-efficacy, the higher the goals people use for themselves (Bandura, 2004). Those goals may either be proximal ones or distal ones. An example of proximal goals is intentions (Bandura).

Exercise self-regulation encompasses several skills, including planning, organizing, and managing one's exercise activities. It is important because motivation is not enough to sustain exercise behavior (Rovniak et al., 2002). As noted earlier, as women transition from adolescence through young adulthood, maintenance of physical activity becomes more and more difficult. Using a prospective design, Rovniak et al. tested a structural equation model of self-efficacy, outcome expectations and self-regulation leading to physical activity among 283 undergraduate students. Self-regulation had a strong total effect on physical activity ($B_{\text{direct/total}} = .48$, $p < .05$).

Situational Factors

S-1: Loneliness. Loneliness also has a significant impact on physical activity. Loneliness is defined as a continuum ranging from alienation to connectedness that is a pervasive, depressing, and debilitating condition (Killeen, 1998). In a study among 1,297 adolescents ($N = 630$ females, 654 males, mean age 15.3, $SD = 2.9$), Page and Tucker (1994) used loneliness as a dependent measure with exercise frequency as an independent variable. Exercise frequency

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was inversely associated with loneliness ($r = -.13$, $p < .001$). Furthermore, MANCOVA testing showed significant differences among the exercise frequency groups relative to loneliness (Wilks' Lambda $_{(12, 2560)}$ = 0.9657, $p < .0001$); those who exercised zero times per week had the highest least squares means for loneliness (mean least squares = 9.07), and those who exercised more frequently had lower loneliness scores (Page & Tucker). These authors offered a possible explanation for the findings that physical exertion resulted in reduced levels of loneliness: Regular exercise in groups may foster reduced loneliness, but biochemical mechanisms of the brain may also explain the findings, because regular physical activity increases levels of brain norepinephrine and serotonin which promote feelings of well being (Page & Tucker).

Storch et al. (2007) tested a cross sectional model of loneliness as a mediating variable between peer victimization and physical activity among overweight youth (N = 100, mean age 12.9 ± 2.8). Using Baron and Kenny's (1986) guidelines for mediation, loneliness met the criteria for being a mediator (Storch et al.). Loneliness exacerbated the difficulty that overweight youth had engaging in exercise.

Mahon, Yarcheski, and Yarcheski (1998) tested a cross sectional model of loneliness as a mediating variable between perceived social support and positive health practices, which included physical activity among young adults (N =70, men = 42, women = 28; mean age 24.93; SD = 2.50; range 22-34). Using Baron and Kenny's (1986) guidelines for mediation, loneliness met the criteria for being a mediator. Mahon et al. (1998) also found an inverse relationship

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between loneliness and positive health practices such as exercise (r = -.54, p <
.001).

This same research group (Mahon, Yarcheski, & Yarcheski, 2001) later
studied a younger age population (N =127, mean age 12.9, SD = .63; 55 girls, 72
boys) and found through regression of positive health practices on loneliness that
loneliness was significant (B = -.27, p=.01).

In a later study, Mahon, Yarcheski, and Yarcheski (2004) used a cross-
sectional, correlational design to test a model of loneliness as a mediating
variable in a younger age group as well (N = 134, mean age 12.9, SD = .58; 70
girls, 64 boys). In this younger age group, loneliness was a partial mediator
between social support and positive health practices. Mahon et al. (2004) also
found an inverse relationship between loneliness and positive health practices
such as exercise (r = -.50, p < .001). That finding indicated that although
loneliness was a dominant mediator in the relationship of social support and
positive health practices during young adulthood (Mahon et al., 1998), it was not
during adolescence (Mahon et al., 2004). However even as a partial mediator,
loneliness limited the extent to which the adolescents were motivated to carry out
positive health practices such as exercise (Mahon et al., 2004).

Yarcheski, Mahon, Yarcheski, and Cannella (2004) did a meta-analysis of
37 studies published since 1983 pertaining to predictors of exercise. Yarcheski et
al. found that loneliness had the largest effect size ($γ$ = -0.48) as a predictor of
positive health practices across all the studies. These studies were among
healthy adolescents and young adults.

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In summary, loneliness has been found to be a significant predictor of exercise, a mediating variable affecting exercise outcomes, as well as an outcome variable affected by exercise.

S-2: Social support. Bandura (1997) discussed the coaching influences on development and maintenance of self-efficacy as a key means of social support. "The task of developing resilient self-efficacy in athletes rests on the managerial efficacy of coaches (p. 397)". Effective coaching support includes carefully graded mastery experiences with gradually increasing pressure situations. At the same time, the effective coaches avoid placing players prematurely in situations that are set-ups for premature failure; precipitous removal of the athlete when he/she gets into trouble only undermines their sense of efficacy. Bandura (1997) also noted that perceived social pressure to become more physically active accounted for exercise involvement although at a lesser level than self-efficacy beliefs, expected benefits, and satisfaction with goals achieved.

Several authors examined the role of social support (Allen, Markovitz, Jacobs, & Knox, 2001; Barrera, Toobert, Angell, Glasgow, & Mackinnon, 2006; Callaghan, 2006; Cerin, Taylor, Leslie, & Owen, 2006; Marquez & McAuley, 2006; McNeill et al., 2006; Motl et al., 2007; Ward et al., 2006). Motl et al. (2007) examined the cross-sectional relationships of environmental factors, social support, and self-efficacy on exercise in 12th grade girls (N = 1,655; M age = 17.7 years, SD = .06). They targeted this particular grade level because they had found a sharp decrease in physical activity by the time girls reach 12th grade. Motl et al. (2007) specified three social functions to measure social support: a)

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guidance, b) nurturance, and c) reassurance of worth. Social support had a direct effect on physical activity (B = .28) as well as an indirect effect through self-efficacy. Targeting perceived social support among adolescent girls was a useful means of indirectly and directly increasing physical activity (Motl et al.).

McNeill et al. (2006) measured two aspects of social support in their structural equation model of exercise: a) emotional support and b) informational support. Both of these factors had indirect effects on walking outcomes that were mediated by motivation and self-efficacy. However, contrary to their hypothesis, the association between social support and self-efficacy was not significant.

Allen et al. (2001) specifically targeted hostile persons in their analysis of coronary artery risk development in young adults (CARDIA) study data. Allen et al. found gender and racial differences in the effects of social support on physical activity outcomes. Hostile Black women exercised significantly less than other subgroups, even in the presence of high social support. In contrast hostile White women with high social support exercised significantly more (p = .02) than those with low social support, as did men of both races. The age range was 18 to 30, N = 5,115 (n = 2,287 women). Allen et al. noted that there was accumulating evidence for the protective effect of social support on exercise, despite the racial differences in women.

Similar protective effects of social support on exercise as well as on other health care behaviors were found by Callaghan (2006). Of 254 participants (ages 14 – 19), the mean score on exercise was significantly different between those with high social support versus low social support (t = 4.10, p < .001).

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Cerin et al. (2006) used a technique to test for mediational analyses that was described by MacKinnon, Krull, and Lockwood (2000). In a small randomized controlled trial (N = 52 with 48 women, age 45 to 78), Cerin et al. found that social support was a mediator of walking both immediately after an intervention and at four weeks later (MacKinnon et al. test $ź$ = 1.144, p = .020).

Social support has also been found to mediate the effects of other interventions. Barrera et al. (2006) studied 279 women with type 2 diabetes by using an intervention that emphasized cohesion among the participants and the mobilization of social resources to change lifestyle behaviors. Barrera et al. found that social embeddedness mediated the effect of lifestyle intervention on physical activity.

Social support also has been shown to correlate well with physical activity in different ethnic groups. Marquez and McAuley (2006) found that among Latino adults (N = 153, M age = 29.4, females n = 86) social support from friends correlated significantly with the physical activity classification (r = .20, p < .05). However social support from the family was not a significant correlation.

In contrast, Ward et al. (2006) studied physical activity correlates in adolescent girls (N = 1162, M age 14.6, 45% African American) and found that physical activity status (active versus inactive) was significantly associated with family support. However among African American girls, it was true only for the active girls who were of normal weight status, versus any activity level for White girls (Ward et al.). Ward et al. stated that family support was relevant to all

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adolescent girls, irrespective of weight status, and that interventions should focus on social-cognitive variables unique to different races and activity levels.

However social support has not always been a consistent factor or predictor of physical activity. Von Ah, Ebert, Ngamvitro, Park, and Kang (2004) studied a convenience sample of 161 college students (*M* age 19.7 ± 4.09 years) to determine predictors of health behaviors including physical activity. They assessed social support by two methods: a) assessment of the number of available others, and b) assessment of satisfaction with perceived social support. Neither of these two indicators had a significant impact on health behaviors, which the authors attributed to measurement issues (Von Ah et al.).

In summary, social support was often included in structural equation models for physical activity. Some of these studies measured both the indirect effects of social support on exercise, through self-efficacy, as well as the direct effects of social support on exercise, while others measured only the indirect effects of social support on exercise through self-efficacy. Other studies found evidence that social support also functioned as a mediator in models between interventions and physical activity. And finally, social support has been demonstrated to correlate with physical activity in a wide range of age groups and ethnic groups. However, it has not always been a consistent determinant of health-related behaviors.

Physiological Latent Variables

Physiological factors are the antecedents that are often reflected in, and diagnosed by, the presence of unpleasant symptoms (Lenz et al., 1997). This concept includes normal bodily function and the individual's level of energy (Lenz et al. 1997). The indicators selected for this concept are perceived exercise capacity, anticipated fatigue from exercise, and perceived health status.

PH-1: Exercise capacity. Exercise capacity is a clinical measurement of maximal oxygen uptake. Wisen, Farazdaghi, and Wohlfart (2002) developed a scale that allows patients to select the most strenuous activity that they could sustain for 30 minutes, with corresponding metabolic equivalents (METs). By definition, one MET is the measurement of resting oxygen uptake (VO_2) with the patient in a sitting position; a higher level of activity uses up a higher amount of oxygen. Wisen et al. demonstrated that healthy women (age 21-79) were able to accurately predict their maximal MET level as confirmed by ramp testing. The MET level can be converted to VO_2 by the use of an age-adjusted formula (Wisen et al.). Being able to accurately predict VO_2 from patients' self-report of their perception of exercise capacity is valuable. This self-perception of exercise capacity is theorized by this PI to be a perception that positively impacts the client's decision to exercise.

Functional exercise capacity or physical fitness can be measured in other ways as well. Researchers from the National Heart, Lung, and Blood Institute Women's Ischemia Syndrome Evaluation enrolled women ($N = 936$) in a prospective multicenter cohort study (Wessel et al., 2004). They used the Duke

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(DASI) self-report measure of functional capacity where women reported their ability to perform various exercise activities; these were used to estimate METs. The exercise capacity scores significantly differentiated between the low fitness women (N =631, DASI < 25) and the high fitness women (N = 275, DASI > 25). The DASI functional capacity score was inversely related with serum levels of high sensitivity C-reactive protein ([hs - CRP], r = -.19, p < .001) and IL-6 (r = -.14, p < .001). The DASI functional capacity scores remained significant independent predictors of adverse events including mortality (Wessel et al., 2004).

Perception of functional capacity also affects other life events. Patients (N = 545) enrolled in a multicenter comparison of drug effects on functional capacity were asked to rate their perceived health perceptions on a visual analogue scale (VAS) of 10 cm with anchors of 0 on the left, corresponding to death and 10 on the right, corresponding to perfect health (Havranek et al., 2001). These researchers defined perceived health as being determined by a high level of physical functional capacity as well as a low level of emotional distress. Perceived functional capacity predicted cardiac events in patients with cardiac failure (RR with each VAS decile = .74, p = .001, 95% CI .61-.88), and predicted cardiac events more than did exercise treadmill time (Havranek et al.).

In summary, self-report measures of exercise capacity have been found to be reliable estimates of actual function as measured via treadmill testing, and as strong predictors of cardiac events.

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PH-2: Perceived health status. Perceived health status often is envisioned as being synonymous with quality of life (QOL). However in a meta-analysis, Smith, Avis, and Assmann (1999) examined 12 QOL studies to determine if QOL is a different construct from health status. The authors then used structural equation modeling to test a model of determinants of QOL that included biologic/physiologic status as the exogenous variable leading to symptom severity and through to quality of life. They determined that from the patient's perspective, QOL and health status are two different constructs (Smith et al.). The continuum for health states ranging from death to optimal functioning corresponds more closely to perceived health than it does for QOL. Quality of life focuses more on psychological functioning than physical health status (Smith et al.). Therefore, perceived health status is defined being part of the physical concept of perceived health.

Perceived health status is frequently measured when studying health disparities. Researchers from Tennessee (Ahmed et al., 2005) used the national Health Interview Survey data from 1999 to 2000 (N = 23,459 men) to examine health disparities using logistic regression. Those who perceived better health status had an increased likelihood of engaging in leisure time physical activity; however racial/ethnic disparities were noted even after accounting for socio-demographic characteristics.

Recently Chen, James, and Wang (2007) compared the health promotion practices across two cultures: Taiwanese (N =265) adolescents and American (N =285) adolescents from San Diego (age range 12 to 15). The researchers used

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the Adolescent Health Promotion (AHP) scale based upon Pender's model of health promotion and Orem's self-care deficit theory, which has 40 items with six dimensions including exercise behavior. In general, the American adolescents had better perceived health status and total AHP scores (x^2 = 10.6, p < .01) than the Taiwanese adolescents, indicating cultural disparities still exist.

Perceived health status has a medium effect on exercise outcomes; in their meta-analysis of predictors of positive health practices, Yarcheski et al. (2004) noted that predictors of positive health practices included perceived health status (γ = .37).

Using the physical component of the Medical Outcomes Study Short Form-36 ([SF-36], Ware & Sherbourne, 1992) Finnish researchers (Leino-Arjas, Solovieva, Riihimaki, Kirjonen, & Telama, 2004) followed a cohort of 902 industrial employees (mean age 34.6 at baseline) for 28 years to analyze trends in physical activity and perceived health status. Those who engaged in vigorous physical activity at baseline and at the 5 year follow-up had a decreased risk of poor physical functioning (age-adjusted OR = 0.34, 95% CI = .22 - .53). Those who reported vigorous physical activity at either of the time points (but not both) had a decreased risk of poor physical functioning as well, although not as much of a decreased risk (age-adjusted OR = .57, 95% CI = .33 - .98). Another interesting finding was that while total vigorous leisure physical activity did not vary between white-collar and blue-collar workers, blue collar workers with only moderate leisure physical activity fared well on the SF-36 scores, possibly

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indicating the protective effect of their on-the-job physical labor (Leino-Arjas et al., 2004).

Similar findings among much older adults (N = 316, mean age 69, SD 4.12) were found by Lee and Laffrey (2006). They tested a theoretical model that included three constructs as predictors of physical activity (individual characteristics, interpersonal influence, and environment). Individual characteristics included one's cognitive appraisal of perceived health status, which was queried by a single item "how would you rate your overall health at this time?" Scores ranged from one to four, with four meaning greater perceived health. They found that perceived health status influenced physical activity indirectly (γ = .032, p <.01) such that those with greater perceived health status had fewer barriers to physical activity (Lee & Laffrey).

PH-3: Anticipated fatigue from exercise. Anticipated fatigue as a result of exercise can be a barrier to exercise participation and often occurs in healthy individuals. Fatigue is not necessarily a symptom of disease (C. M. Yang & Wu, 2005). Among healthy college age students in Florida, (N = 147, ages 18 - 24), the statements "exercise tires me" and "I am fatigued by exercise" were rated as the first and third top barriers to exercise (Grubbs & Carter, 2002).

C. Anderson (2003) sampled collegiate women (N =397, mean age 23, SD = 6.99) to determine motives for exercise as well as reasons for quitting. Anderson found that fatigue ranked third as the primary reason for quitting; 17% of those who met CDC guidelines for exercise (N =174), and 26% of those who did not meet the CDC guidelines (N =217) cited fatigue as a reason for quitting.

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In summary, fatigue has been cited as the primary barrier to exercise as well as a reason for quitting. Fatigue can be exacerbated by exercise even without causing significant functional impairment (C. M. Yang & Wu, 2005). Anticipated fatigue is theorized to be a perception of physiological status that will impact the physical activity, mediated by existing fatigue as an unpleasant symptom.

Unpleasant Symptoms

US-1: Chronic fatigue. Ream and Richardson (1996) defined fatigue: "Fatigue is a subjective unpleasant symptom which incorporates total body feelings ranging from tiredness to exhaustion creating an unrelenting overall condition which interferes with individuals' ability to function to their normal capacity" (p. 527). Fatigue is a significant problem for adolescents, and can be attributed to medical or psychiatric disorders, syndromes of unknown etiology, and lifestyle choices such as exercise (Mears, Taylor, Jordan, Binns, & Pediatric Practice Research, 2004).

To study characteristics of fatigue among adolescents, Mears et al. (2004) collected data for a one-year period on adolescents visiting a primary care clinic. They determined the prevalence of chronic fatigue syndrome like illness (4.4%) and of prolonged fatigue of greater than one month (8%). Symptom predictors of prolonged fatigue included the adolescents' reporting that exercise worsened their fatigue; among the fatigued group, exercise worsened fatigue in 38.2%, and among the not fatigued group, exercise worsened fatigue 10.5% in (Mears et al.).

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Using data that were obtained from a sub-sample of the United States National Longitudinal Study of Adolescent Health, Rhee, Miles, Halpern, and Holditch-Davis (2005) interviewed 20,745 adolescents about 10 symptoms, and asked them to rate the frequency of having experienced the symptoms during the past 12 months. Over 20% ($N = 3,962$) reported having experienced fatigue and fatigue was the third most prevalent symptoms. Fatigue also was associated with other symptoms. The definition of fatigue used in this study was '"tiredness with no reason". Striking gender differences were noted: 15.96% ($N = 1,495$) of boys and 25.38% ($N = 2,467$) of girls reported fatigue ($OR = 1.79$, 95%, $CI = 1.62$-1.98; Rhee et al., 2005). Another interesting finding was that the probability of recurrent fatigue increased in a linear fashion with each increase in year of age. However in the same study reported elsewhere (Rhee, 2005) no significant differences occurred between racial groups when reporting prevalence of fatigue.

Other authors studied the prevalence rates of fatigue among healthy adolescents ($N = 3,467$; 1,718 boys and 1,749 girls, mean age 14.7, SD 1.4) from the Netherlands (ter Wolbeek, van Doornen, Kavelaars, & Heijnen, 2006). These researchers found the prevalence rates for fatigue among the girls was 20.5% and among the boys was 6.5% ($p < .001$). Of those who reported fatigue, fatigue lasting for ≥ 1 month was reported by 80.0% of the girls and 61.5% of the boys ($x^2 = 17.80$; $p < .001$). In contrast to the study by Mears et al. (2004), ter Wolbeek et al. (2006) found that exercise was not a significant predictor of fatigue. Instead, ter Wolbeek et al. found that a decreased participation in sports

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was related to fatigue in both girls (t = 6.80, SD = 4.17, p<.001) and boys (t = 7.76, SD = 4.48, p < .001).

As shown, fatigue is a common unpleasant symptom among healthy adolescents. The impact of fatigue on exercise outcomes has been studied as well (C. Anderson, 2003; Grubbs & Carter, 2002; Y. H. Kim, 2006). In a 10-year longitudinal study of a large biracial cohort of girls, Y.H. Kim et al. reported that fatigue ("I'm too tired") was the second most frequently cited barrier to exercise. These results were obtained in a multicenter prospective study of obesity development in 2,379 girls who were followed annually from ages 9 or 10 to ages 18 or 19 (Y.H. Kim et al.). There were no significant differences in the amounts of sleep obtained; the fatigued girls averaged 8.3 hours per night of sleep, and the nonfatigued girls averaged 8.6 hours per night (p = .77 - .85).

US-2: Chronic pain. Pain is a limiting factor to exercise as well. Melzack (2001) defined pain as a multidimensional experience produced by multiple influences which include genetic and sensory influences, and modulated by psychological stress and other cognitive events. Melzack posited that a neuromatrix translates cognitive, sensory, and affective inputs into outputs such as pain perception and stress signals. Thus cognitive, sensory, and affective beliefs all contribute to the perception of pain.

Fear of movement or reinjury among patients with muscular skeletal injuries can lead to longstanding pain or disability (Cook, Brawer, & Vowles, 2006). After a painful experience has occurred, some people catastrophize the experience, which perpetuates fear, avoidance, and disuse (Lethem, Slade,

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Troup, & Bentley, 1983; Slade, Troup, Lethem, & Bentley, 1983). However the prevalence of pain among healthy adolescents was not fully documented until recently.

Using data that were obtained from a sub-sample of the National Longitudinal Study of Adolescent Health, (Rhee et al., 2005) interviewed 20,745 adolescents about 10 symptoms and asked them to rate the frequency of having experienced the symptoms during the past 12 months. Over 28% (N = 5,301) reported having experienced headaches; over 27% (N =5,038) reported having experienced musculoskeletal pain; and over 17% (N =3,331) reported having experienced stomachaches. All of these were commonly associated with fatigue as well as with other symptoms. Striking gender differences were noted for all three symptoms: 20.73% (N =1,801) of boys and 37.43% (N = 2,236) of girls reported headaches (OR = 2.29, 95%, CI = 2.06-2.54; Rhee et al.). Similar findings were noted for musculoskeletal pain. The probability of recurrent musculoskeletal pain increased in a curvilinear/quadratic fashion; the pain peaked at ages 16 to 17 and decreased to age 22.

The impact of pain on exercise outcomes has been documented by several researchers (Allison, Dwyer, & Makin, 1999; C. Anderson, 2003; Bigal, Liberman, & Lipton, 2006; Gyurcsik et al., 2004; Parks, Housemann, & Brownson, 2003; Poulton, Trevena, Reeder, & Richard, 2002). Bigal et al. (2006) studied the influence of baseline weight status on the prevalence, severity, and disability of migraines. The sample consisted of 30,215 participants of ages 18 to 89 (M = 38.7), of whom 45% were overweight, obese, or morbidly obese (Bigal et

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al.). Among those who were morbidly obese, physical activities exacerbated the pain more than for the normal weighted (OR = 1.7, CI = 1.2 - 2.2).

Parks et al. (2003) queried 1,818 adults to study barriers to exercise across different settings (urban, suburban, or rural) and two incomes (lower or higher). Those who were urban, lower income reported being afraid of injury as a barrier to exercise significantly more than the others (x^2 = 17.80, p < .005).

These findings by Parks et al. (2003) have been corroborated by other researchers using younger adolescents. Allison et al. (1999) used a two-stage cluster sample of 1,041 high school students (9th and 11th graders) to study perceived barriers to exercise across three settings: a) physical education classes, b) sports at school, and c) non-school sponsored recreational sports. Discomfort and injury both emerged as perceived barriers and both items loaded onto the same factor in a principal components analysis of the perceived barrier items (Allison et al., 1999).

Gyurcsik et al. (2004) examined barriers to vigorous physical activity among 132 students (M age = 17.84, SD = .46 years) in their freshman year at a university in Alberta. Eighteen of the students identified injury as a barrier to exercise in the intrapersonal barriers domain.

Anderson (2003) sampled collegiate women (N =397, M age 23, SD = 6.99) to determine motives for exercise as well as reasons for quitting. Of those who met CDC guidelines for exercising, 9% cited a medical/injury/physical condition or symptom as a reason to quit exercising, whereas among those who

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did not meet CDC guidelines for exercising, 13% cited a medical/injury/physical condition or symptom as a reason to quit exercising.

Poulton et al. (2002) followed a birth cohort of participants to age 26 ($N =$ 980, 499 males) and assessed them regularly for physical activity in New Zealand. Some study members began declining the sub-maximal exercise bike test because they feared discomfort. Therefore the researchers added questions about "How much discomfort do you anticipate" and then "How much discomfort did you actually experience" during the bike test. The researchers then separated the participants into under-predictor, accurate predictor, and over- predictor groups. A 3 (group level) X 2 (gender) ANOVA was done for each physical health measure (Poulton et al.). Those in the over prediction group had worse physical health, had higher BMI, and lower VO_2 max scores (Poulton et al.). Thus fear of discomfort can have devastating effects even in the mid-twenties age group. In summary, pain often deters persons from exercising due to fear of injury, discomfort, or more pain.

Research as shown that healthy adolescents and young adults can experience negative symptoms such as fatigue or pain and yet a gap in the literature still exists for the knowledge about negative symptomatology related specifically to exercise among healthy students. Three factors have been posited to affect one's predisposition to, or manifestation of, unpleasant symptoms: a) psychological, b) situational, and c) physiological. The reactions to the unpleasant symptoms are theorized to mediate the relationship between the antecedent factors and physical activity as the outcome.

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Activity

   E-1: Exercise. Exercise is defined as an activity for developing the mind or the body (U.S. Department of Health and Human Services, 2002). For the purposes of this model, exercise is working the muscles to develop cardiovascular fitness by increasing the body's maximum capacity to consume oxygen (Noakes, 2000). Exercise is also working the muscles to obtain mental health benefits. Although there is a definite semantic difference between exercise and physical activity, both are used interchangeably in this dissertation.

   Exercise can be whole body or can be of isolated muscles. Experienced cyclists similar in age (*M* age 28.5), height and weight, years of cycling experience (5 ± 3) and forced vital capacity (*M* = 5144 ± 888) were randomized to respiratory muscle endurance training or control/placebo groups (Holm, Sattler, & Fregosi, 2004). After training, the experimental group showed a significant increase in pulmonary ventilation rate after training, and no improvement was seen in the control/placebo group. The training group also had a significant increase in VO_2 ($p < .027$).

   In summary, chapter 3 summarized the literature review including the theoretical background to the study, the preliminary studies leading up to the choice of the theoretical model, and the key factors that are used in the model of exercise. Physical indicators include anticipated capacity to exercise, health status, and anticipated exercise fatigue. Psychological indicators include exercise self-efficacy, anticipated exercise outcomes, and self-regulation. The unpleasant symptoms include chronic fatigue and pain. The unpleasant symptoms of fatigue

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and pain are evident in the lives of health adolescents and young adults. However little is known about how all these variables intertwine, and whether or not the psychological, situation, or physical factors are mediated by the unpleasant symptoms. In the following chapter, the design and methods are discussed in depth, including a description of each of the key indicators used for the variables of interest.

CHAPTER THREE

Design and Methods

Overview of Research Design

A non-experimental, cross sectional design was used with data collected

from a sample of 463 adolescent and young adult women attending the

University of South Florida (USF). An Internet survey approach using Dillman's

(2007) tailored design recruitment method was used to collect study design

variables. Threats to validity were minimized by using established reliable and

valid instruments to assess the study variables and by using a computer random

generator (SPSS) to select those to invite from among all the eligible participants.

Sample Description and Selection

Sampling frame. The sampling frame used in this study consisted of a

listing of female USF students between ages 18 and 25 obtained from the office

of the registrar (University of South Florida, 2006a). This age range was chosen

as a target because it is the time of transition into the age bracket where most

weight gain occurs (National Heart Lung and Blood Institute working group,

2006).

Sample size. Calculations were undertaken to determine the required

number of responses for analysis to test the proposed theoretical model using

structural equation modeling (SEM). The proposed structural model consisted of

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32 parameter estimates and 59 degrees of freedom. Using the power calculations proposed by MacCallum, Browne, and Saguwara (1996), a minimum sample size of 187 was needed to achieve a power of .80 with 60 degrees of freedom. Since Marsh, Balla, and McDonald (1988) suggested that parameter estimates are unstable in samples of less than 200, the guidelines of Bentler and Chou (1987), which were a ratio of 5:1 or 10:1 responses to estimated parameters, were applied. The optimal sample size using these ratios was 160 to 320. Therefore 320 were selected initially as the sample for this study. However, the sample size was double checked by another method.

MacCallum, Widaman, Zhang, and Hong (1999) conducted a Monte Carlo study using 100 data sets to generate a matrix of ratio of variables to factors and communality level by sample sizes. Highest communality levels were obtained with 20:3 ratios of variables to factors which remained constant at 100% across all levels of the sample sizes. At 10:3 ratios of variables to factors, the communalities of the studies did not reach 95% ('good') until the sample sizes exceeded 200. At higher ratios, wide and high communalities were obtained with smaller sample sizes of 60 to 100. For this analysis, there was a ratio of 13:5, which is approximately comparable to a ratio of 8:3. According to the matrix given by MacCallum et al. (1999), at 10:3 ratios a sample size of at least 400 was needed to reach good communality (defined as being in the .92 to .98 range). Because this study did not reach the necessary ratio of 10:3, a sample size of greater than 400 was thought to be needed, and 500 were sought.

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The registrar's list of age-eligible female students contained seventeen thousand names; therefore, the population at USF was more than adequate to meet the sampling size (See Table 3). It was anticipated that the racial/ethnic distribution of responses would closely correspond to the distribution of USF students, as indicated by the data in Table 3 from USF (University of South Florida, 2006b).

Table 3

Diversity Profile of all USF Students

	Undergraduate		Graduate		Total	
	# enrolled	% enrolled	# enrolled	% enrolled	# enrolled	% enrolled
Total	19,931	100.0%	5,473	100.0%	27,263	100.0%
Race/Ethnicity						
African Am	2,877	14.4%	405	7.4%	3,460	12.7%
Hispanic	2,295	11.5%	466	8.5%	2,890	10.6%
Asian	1,256	6.3%	232	4.2%	1,612	5.9%
Am Indian	75	0.4%	22	0.4%	103	0.4%
Alien	477	2.4%	526	9.6%	1,047	3.8%
White	12,479	62.6%	3,755	68.6%	17,550	64.4%
Not reported	41	0.2%	25	0.5%	89	0.3%
Gender						
Male	7,836	39.3%	1,905	34.8%	10,318	37.8%
Female	12,054	60.5%	3,543	64.7%	16,856	61.8%
Not reported	41	0.2%	25	0.5%	89	0.3%

Participants

Participants were female students recruited via email at the University of South Florida during the spring 2007 semester. Inclusion criteria for the study were the following: a) female and b) between the ages of 18 and 25. All the

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invited students' email addresses were placed into a lottery for two separate cash prizes of $100 each. No student was paid or given extra credit for participating.

Procedures

Following institutional review board (IRB) review and approval, the survey instruments were entered into an Internet-based software program called Ultimate Survey® (Prezza Technologies, 2007). This program is designed to send out invitations to a list of email addresses and to provide the recipient of the email with a link to the online survey. The sample was randomly selected from the electronic file of all 17,000 eligible female students of ages 18 to 25 using SPSS' random selection syntax. Email addresses from this selection process were transferred to Ultimate Survey®, which was capable of tracking responses and deleting respondents' email addresses from the invitation list whenever subsequent reminders were sent. A demographic question confirmed the age and asked the participant not to continue if they were out of the stated age range of 18 to 25.

Data Collection

The elements of Dillman's (2007) total design method, revised for email/ Internet surveys, guided the data collection process. Potential participants could receive a maximum of four email contacts; the second contact was four days after the first, and the third and fourth contacts would follow in 5-day increments. Data collection spanned two weeks in spring 2007 (See Figure 5). However due to upcoming scheduling constraints (midterm exams) for many students, the fourth contact was eliminated.

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```
    First              Second             Third            Fourth
   contact            contact            contact          contact


Pre-notification    Invitational       Reminder         Reminder
    Email              Email             Email            Email

   [____]             [___]             [__]             [__]

                   Cover Letter
                  Incentive Notice    Survey URL       Survey URL
                    Survey URL


      Start  ───────▶   4 days  ───────▶   9 days  ───▶  14 days
```
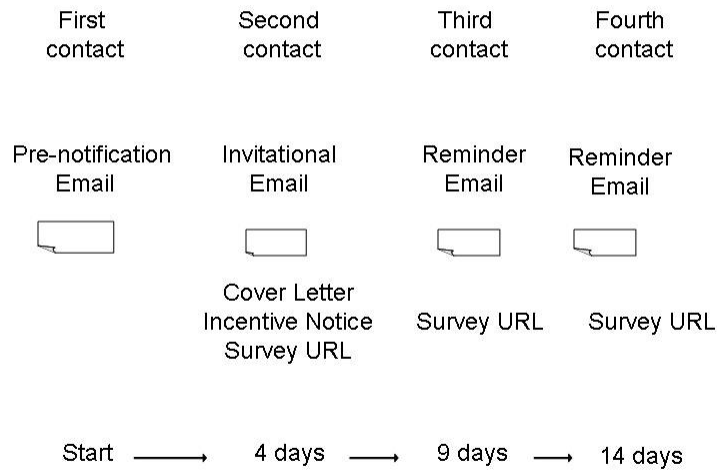
Figure 5. *Data Collection Process.*

Participants were able to complete the online questionnaire on a computer in any location that afforded them access to the Internet. However an occasional student reported problems opening the link from their home computer, which was resolved by amending their firewall. The email addresses were all campus emails; however many students had their campus emails forwarded to an offsite email system, which resulted in a number of undeliverable emails.

Questionnaire items were not randomized due to constraints of the Ultimate Survey® system. The order of the questionnaires was as follows: The demographic profile, the International Physical Activity Questionnaire (IPAQ), Exercise Self Efficacy Scale, the Rating of Perceived Capacity scale, the Social Support for Exercise Scale, the Situational Fatigue Scale, the West Haven-Yale Multidimensional Scale, the Exercise Goals Scale, the Outcome Expectations for

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Exercise Scale, the Multidimensional Scale of Perceived Social Support, the UCLA-8 Loneliness Scale, the SF-12, and the Chalder Chronic Fatigue Scale. To assess the extent to which the participants were attending thoughtfully rather than responding randomly, four items were created and interspersed randomly throughout the questionnaire. This strategy provided validity to some of the questions (for example, the question 'Are you a lonely person?" was inserted as a validity check for the UCLA-8 Loneliness Scale). It also allowed for easier identification of respondents who were not attentive so that they could be excluded from analyses.

After all data were collected, data were exported from the Ultimate Survey ® to SPSS® version 11.4 (2002) on a dedicated computer. Data transfers were completed in one bulk export.

Measures

Measures for the Physiological Latent Variable

PS-1: Self-efficacy for exercise. Self-efficacy for exercise was operationally defined as the confidence that one has to exercise when other things get in the way. The empirical indicator for this was the Exercise Self-Efficacy Scale created by Shin, Jang, and Pender (2001) for adults with chronic diseases. It was chosen because it included both pain and fatigue situations according to specifications given by Bandura for rating exercise self-efficacy. It is an instrument with three factors (situational/interpersonal, competing demands, and internal feelings) with a standardized Cronbach's coefficient of .94. These three factors explained 96.4% of the variance. The participants rated their

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confidence to exercise regularly three times per week under a given situation using a percentage scale from 1% (can not do it) to 100% (certainly can do it). Exercise self-efficacy was an indicator for the latent variable PSYCHOLOGICAL with the label PS1 used in the figures. The scale is provided in Appendix A.

PS-2: Outcome expectations for exercise. An outcome expectation for exercise was operationally defined as the belief that one can do the behavior required to produce the outcomes of physical activity. The empirical indicator for this variable was the Outcome Expectations for Exercise Scale-2 (Resnick, 2005). It is a 13-item scale that has two subscales: Positive outcome expectations and negative expectations that are scored separately, with the negative expectations being reverse scored. Confirmatory factor analysis showed a fair fit to the data (x^2 = 167.3, *df* = 64, *p* < .05; RMSEA = .08). Alpha coefficients of the two subscales were .93 and .80 respectively. The Outcome Expectations Scale – 2 explained 66% of the variance in outcome expectations. The Outcome Expectations Scale – 2 is a revision from the first Outcome Expectations Scale, which included only the positive expectations. The negative expectations were added specifically to capture the outcomes of fatigue or pain expected to result from exercise. The Outcome Expectations Scale was an indicator for the latent variable PSYCH and was labeled as PS2 in the figures. The scale is provided in Appendix B.

PS-3: Self-regulation for exercise. Exercise goals were operationally defined as the setting of goals in advance, self-monitoring, and problem solving, which are part of self-regulation (Rovniak et al., 2002) The empirical indicator for

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this was the Exercise Goals Scale (Rovniak et al., 2002). The scale exhibited

good internal consistency ($α$ = .89) and test-retest reliability ($t_{test-retest}$ = .87). The

Exercise Goals Scale was an indicator for the latent variable PSYCH and was

labeled as PS3 in the figures. The scale is provided in Appendix C.

Measures for the Situational Factor

    S-1: Loneliness. Loneliness was operationally defined as the feeling of

being alone even in the midst of others. The empirical indicator for this variable

was the UCLA-8 Loneliness Scale which is a revision from the original UCLA-20

and the UCLA-4 (Hays & DiMatteo, 1987; Russell, Peplau, & Ferguson, 1978).

When tested among college students (*M* = age 21, range 17-48, *SD* = 4.5), it had

an overall coefficient $α$ of 0.8996 and the standardized item $α$ of 0.90

(Hartshorne, 1993). Mahon, Yarcheski, T, and Yarcheski, A. (1995) validated the

use of the scale among adolescents ages 12 to 21. Statements in the

questionnaire are evaluated on a 4-point Likert scale from strongly disagree (1)

to strongly agree (4). Positively worded items are reverse scored to negatives, so

that for each item a high score (4) indicates the loneliest (Hartshorne). According

to the recommendation of Hartshorne, one item that was problematic (item 17: "I

am unhappy being so withdrawn") was revised to read "I am unhappy and

withdrawn". Raw scores were transformed into a 0-100 scale (Mahon et al.).

    Normative measurements revealed that in the United States, the mean

score for the UCLA-8 Loneliness Scale after transformation to a 0 – 100 scale

was 35.4 (*SD* 19.2, range 0 – 100) reported by Hays and DiMatteo (1987).

However in the pilot study for this research (Cobb, 2006), after transformation the

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mean was 50.6 (*SD* 7.69, range 40 to 71). The UCLA-8 Loneliness Scale was an indicator for the latent variable SITUATIONAL and was labeled S1 in the figures. The scale is provided in Appendix D.

S-2: Social support for exercise. Social support for exercise was operationally defined as the support received for participating in regular physical activity from the people closest to you. The empirical indicator for this was the Social Support for Exercise Scale (Reis & Sallis, 2005; Sallis, Grossman, Pinski, Patterson, & Nader, 1987). There are two subscales, each with the same questions but referencing different sources of social support. Each subscale has 13 items. Scores were computed by summing the responses for each scale. The Cronbach's α coefficients ranged from 0.81 to 0.87 for the friend scale (Reis & Sallis). Courneya, Plotnikoff, Holz and Birkett (2001) used the same questionnaire but changed it to a single item "How much support do you receive for participating in regular physical activity from the people closest to you?" rather than asking the same series of questions with references first to friends and then to family. A combination of the two approaches was used, with all 13 items from one subscale asked in reference to 'the people closest to you'. The Social Support for Exercise Scale was an indicator for the latent variable SITUATIONAL and was labeled as S2 in the figures. The scale is provided in Appendix E.

S-3: General social support. General social support was operationally defined as an exchange of resources between at least two individuals intended to enhance the well being of the recipient. The empirical indicator of this was the Multidimensional Scale of Perceived Social Support (Zimet, Dahlem, Zimet, &

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Farley, 1988). This instrument specifically addressed the subjective assessment of social support adequacy from three specific sources: family, friends, and significant other/ special person (Zimet et al,). Each of these groups was measured by four items, with a total of 12 items on the total scale. For the Significant Other Subscale, Cronbach's coefficient α was 0.91, with that of the total scale being 0.88. This research used just the four items from the Significant Other Subscale. This Multidimensional Scale of Perceived Social Support was an indicator for the latent variable SITUATIONAL and was labeled as S3 in the figures. The scale is provided in Appendix F.

Measures for Physiological Factor

PH-1: Perceived exercise capacity. Perceived exercise capacity was operationally defined as the most strenuous activity and the corresponding metabolic equivalents (METs) that one could sustain for 30 minutes. The empirical indicator for this was the one-item Rating of Perceived Capacity (RPC) scale (Wisen et al., 2002). The scale is a progressive scale from 1 to 20 METs with corresponding activity descriptions. The scale can be used to mathematically calculate predicted physical capacity for exercise. The RPC scale was validated against the ramp cycle test, and reference values for METs are available for each decade of life (Wisen et al.). In the pilot study for this research (Cobb, 2006) the mean was 10.29 (*SD* = 3.69; range 5 – 20). The Rating of Perceived Capacity scale was an indicator for the latent variable PSYCHOLOGICAL and was labeled as PH1 in the figures. The scale is provided in Appendix G.

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PH-2: Perceived health status. Perceived health status was operationally defined as one's perception of overall health. The empirical indicator for this variable was the SF-12 (Ware, Kosinski, & Keller, 1996). Test-retest reliability of the SF-12 summary measure was 0.890 in the United States. Coefficients ranged from 0.760 to 0.774 in the initial analysis. The shorter version of the scale was able to reproduce more than 90% of the variance in the SF-36 measure in the general US population (Ware et al., 1996). The SF-12 has been validated for different populations, including young adult homeless persons (*M* age 37.40). Cronbach's α for this group ranged from 0.82 for physical health to 0.79 for mental health (Larson, 2002). The SF-12 was an indicator for the latent variable PHYSIOLOGICAL and was labeled as PH2 in the figures. The scale is provided in Appendix H.

PH-3: Anticipated fatigue. Anticipated fatigue was operationally defined as the fatigue that is anticipated from doing various future activities. The empirical indicator for this was the Situational Fatigue Scale (C. M. Yang & Wu, 2005), which was specifically designed to measure both mental and physical fatigue while taking the situational demands of various activities into consideration. It has two subscales. Four items comprise the Physical Fatigue Subscale, with a Cronbach's α of 0.88. Nine items comprise the Mental Fatigue Subscale, with a Cronbach's α of 0.89. Overall, the Cronbach's α was 0.90. The Situational Fatigue Scale was an indicator for the latent variable PHYSIOLOGICAL and was labeled as PH3 in the figures. The scale is provided in Appendix I.

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Measures for Unpleasant Symptoms Factor

US-1: Chronic fatigue. Chronic fatigue was operationally defined as the lessening of either mental or physical energy that has been ongoing for at least a week. The empirical indicator for this variable was Chalder Fatigue Scale (Chalder et al., 1993). This is an 11- item scale with two primary factors: physical and mental fatigue. Cronbach's α reliability of the Chalder Fatigue Scale was 0.845 for the physical fatigue items, 0.821 for the mental fatigue items, and 0.8903 overall. Subsequent testing by Morriss, Wearden, and Mullis (1998) revealed that scoring may be done on a dichotomous basis and still retain the overall reliability. When used in this pilot study (Cobb, 2006) the standardized α was .8629 and the mean was 30.19 (*SD* = 5.12; range 20 – 46). The Chalder Fatigue Scale was an indicator for the latent variable UNPLEASANT SYMPTOMS and was labeled as US1 in the figures. The scale was provided in Appendix J.

US-2 and US-3: *Chronic pain.* Chronic pain was operationally defined as an ache, discomfort, soreness, or throbbing that that was ongoing for at least a week. The empirical indicator for this variable was the West Haven-Yale Multidimensional Pain Inventory by Kerns, Turk, and Rudy (1985). The first part of the scale is comprised of 20 items, each rated on a Likert-type scale but with varying response patterns depending upon the nature of the question. It is a subjective assessment of pain descriptions and how it affects the participant's life. From those 20 questions are five subscales, two of which were used for this study (the Pain Severity Subscale, with factor loadings ranging from .68 to .80,

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and the Negative Mood Subscale, with factor loadings ranging from 0.59 to 0.87).
These two subscales were used as indicators for the latent variable
UNPLEASANT SYMPTOMS and were labeled US2 and US3 respectively. The
scale is provided in Appendix K.

Measure for Activities

    E-1: Exercise. Physical activity was measured using the short form of the
International Physical Activity Questionnaire ([IPAQ], Craig et al., 2003; IPAQ,
2005). Exercise was operationally defined as the use of physical activity to
expend energy, which was measured by intensity, frequency, and duration of the
exercise. The empirical indicator for this variable was the International Physical
Activity Questionnaire short form which assessed walking, moderate-intensity
activities and vigorous-intensity activities. The IPAQ provided separate scores for
each of the levels of activity. The total minutes per week in physical activity was
computed by summing the frequency in minutes by duration in days. Data were
converted into metabolic equivalents per minute per week (METs min $^{-1}$ / week)
by weighting each type of activity by its energy requirements defined in METs.
The weights were as follows: a) 8 for vigorous intensity activity, b) 4 for
moderate-intensity activity, and c) 3.3 for walking. Test – retest Spearman's
reliability coefficients for the IPAQ short form when tested in the United States
ranged from .81 to .88 (Craig et al.). The pooled ρ for the short form was .76 by
1,974 persons across 12 countries (Craig et al.). When used in the pilot study for
this research (Cobb, 2006) the mean was 4036.27 (SD = 4297, range 198 –
23,460). In the pilot study, participants reported difficulty with estimating the

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hours/minutes in each activity level, and therefore there were several who selected 'Don't know" as a response. To enhance the response rate of those questions, the 'Don't Know' response option was deleted for this research. Scoring instructions for the IPAQ (IPAQ, 2005) were to discard participants who reported more than 3 hours per day of vigorous activity or of moderate activity; therefore, the response options for the 'hours per day' question was limited to a drop-down menu of four options (0 – 3 hours). Likewise, instructions for the IPAQ were to discard those who reported more than 16 hours per day cumulative in all activities. Accordingly, the menu of options was limited to 12 hours maximum for the walking, and to 16 hours maximum for sitting. The IPAQ responses were all provided in drop-down menus to eliminate the 'fill-in-the-blank' question format. These changes were anticipated to increase the overall response rate for the IPAQ, and to minimize outliers.

Physical activity was represented by a latent variable EXERCISE with EX1 as the label for its sole indicator, the IPAQ. Because it was a single indicator, the measurement error for EX1 was fixed at .25, which was derived from the test-retest reliability of .75 reported by Craig et al (2003). The IPAQ questionnaire is provided in Appendix L.

Reliability and Validity of the Research Design

The purpose of this study was to determine the validity of two theoretical models of exercise utilizing the theory of unpleasant symptoms and social cognitive variables. The cross-sectional approach to data collection was most

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appropriate at this early stage in the development of the model to isolate the relationships among the variables.

Structural equation modeling (SEM) was the appropriate choice of analytic techniques available to test the theoretical models that were proposed a priori. Structural equation modeling, using the maximum likelihood estimation procedure, is a full information technique in that all model parameters are estimated simultaneously and a change in one parameter during the iteration process could result in a change in other parameters in the model (Diamantopoulos & Siguaw, 2005). Additionally, SEM models measurement error as part of the parameter estimation process and is therefore more germane to testing the model than the use of path analysis, which carries an assumption of measurement of variables without error.

The reliability of the research design was ensured through the consistent application of procedures for data collection, correction, and analyses. The integrity of the research was also enhanced by specifying more that one theoretical model apriori and by making model modifications only if theory-driven not data driven, thereby helping reduce error from over analyzing the data.

Assumptions

The proposed study was based on the assumption that an adequate sample would be obtained. The use of Dillman's (2007) revised total design method that included a total of four contacts with potential respondents was projected to yield a response rate of 34%. This response rate was based on

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studies by Leece et al. (2006) that addressed certain design features of the letters that were sent in Internet surveys.

Model Identification

Prior to beginning analysis, the number of parameters to be estimated in the model was calculated and compared to the number of data points. To be testable, the model needed to have fewer parameters than data points. Using Bentler and Chou's formula (1987), there were 91 data points in the variance/covariance matrix, which met the criterion of having more data points than parameters to be measured. The following formula was used to calculate the number of data points:

$$p^* = p\,(p + 1)\,/\,2,$$

where p was the number of variables and p* was the number of data points. The calculations for this research were as follows:

$$p^* = 13(13 + 1)\,/\,2 = 91 \text{ data points}$$

This satisfied the requirement to exceed the 32 parameters for the model

An alternative formula for checking identification is the following formula

$$t \leq s\,/\,2,$$

where t is the number of parameters to be estimated, s is the number of variances/covariances amongst the observed variables calculated as

$$(p + q)(p + q + \text{f1}),$$

where p is the number of y-variables and q is the number of x variables (Diamantopoulos & Siguaw, 2005).

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In this case, the model was over-identified (having more data points than parameters). Had the opposite been true, the model could not have been tested reliably. Generally under-identified models produce unreliable statistics (Bentler & Chou, 1987) because the *p* -values for the model might have been too low as a result of under-identification.

<center>Data Analysis</center>

Structural equation modeling is a causal model in which the paths in a graphic model are expressed as a series of algebraic equations (Boyd, Frey, & Aaronson, 1988). Theoretical variables, which are not observable but are presumed to exist, are known as latent variables. Measurable and observable variables known as manifest variables are used as indicators for the theoretical constructs. Karl Joreskog created a software program for the analysis of linear structural relations and named it LISREL by its acronym (Boyd et al.). This was the software program chosen for this analysis.

The analytic strategy followed the steps outlined by Diamantopoulos and Siguaw (2005) for structural equation modeling. The term LISREL is an acronym for linear structural relationships, and is the name of the computer software used for covariance structure analysis. Covariance structure analysis is a multivariate statistical technique which combines confirmatory factor analysis and modeling to analyze hypothesized relationships among latent variables and manifest indicators. The typical full covariance structure model contains two parts: a) the measurement model and b) the structural model. The analysis seeks to confirm that the hypothesized relationships across latent variables and their manifest

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indicators are consistent with empirical data. This is done by comparing the covariance matrix implied by the structural equation (hypothesized) model to the actual covariance matrix derived from the empirical data.

The goal of SEM is to explain the patterns of covariance observed among the study variables (Kelloway, 1998). In essence, the model explains if two or more variables are related. Path diagrams depict the models; a simple path represents the direct relationship between two variables and a compound path represents the product of two or more paths. In turn, the sum of the simple and compound paths linking two latent variables produces the correlation that links the two variables. Decomposition of the correlations produces the beta weights (standardized regression coefficients). These structural relations are represented by structural equations, which in turn are combined to produce the implied correlation matrix (Kelloway, 1998). Therefore examination of the bivariate correlations is a necessary preliminary step.

The manifest indicators are reflective, meaning that they are simply the observed characteristics of an underlying construct (Diamantopoulos & Siguaw, 2005). It is the underlying construct's relationships that define the value of each X. Recalling from the methods chapter that

$$X_1 = \beta_1\, \eta_1 + \varepsilon_1,$$

if correlations amongst the manifest reflective indicators for any given latent variable are not related, then that reflects a misspecified or poorly conceptualized underlying concept.

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Preliminary analyses included identification of values outside the range of permissible responses and listwise deletion of outliers, assessment of univariate and multivariate normality, and examination of bivariate relationships among the indicators. Next the measurement model was assessed as described in the methods section, including validity and reliability of the model. Once an acceptable fitting measurement model was obtained, the full structural models as well as associated mediating variables were tested as described in the methods section. Model modifications were attempted but not retained, and model cross-validation was not feasible for this single-sample set of data.
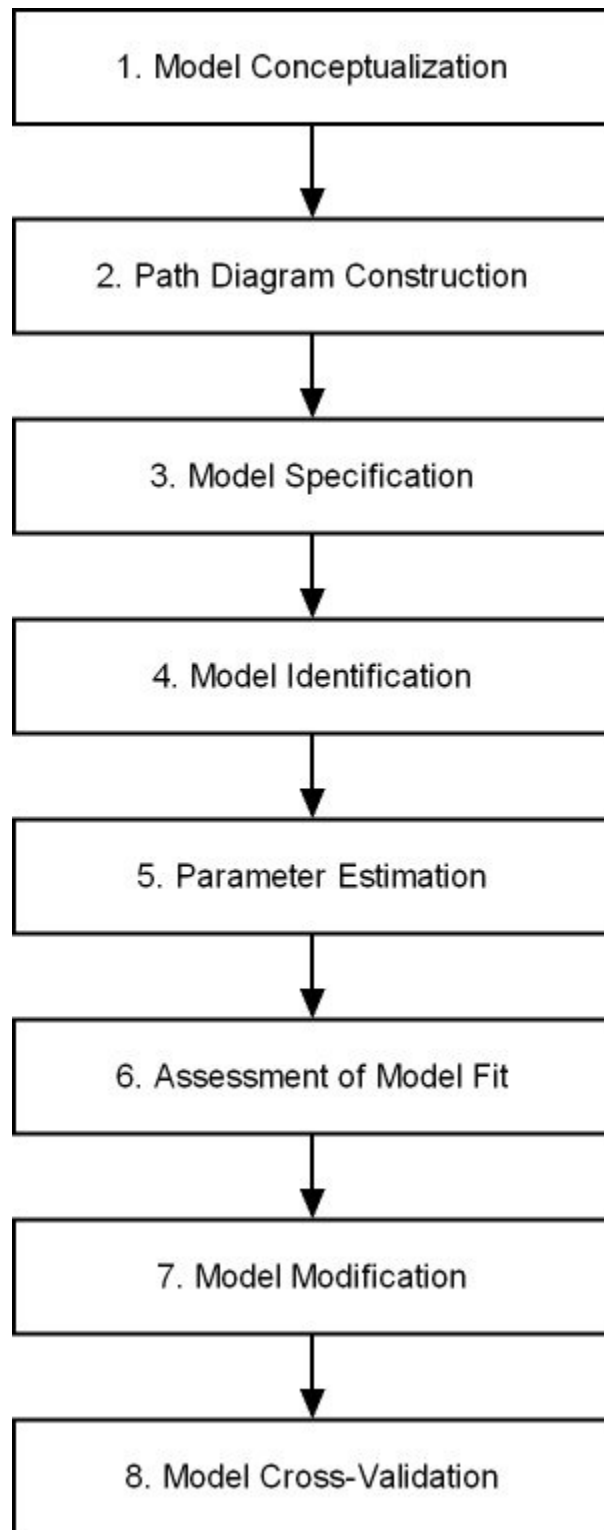
Figure 6. *LISREL Steps* (adapted from Diamantopoulos & Siguaw, 2005, p.7).

Parameter Estimation

 As noted earlier, structural equation modeling (SEM) is a method of doing
a covariance structure analysis. The implied covariance matrix is one which
implies certain predictions for the variances and covariances of the variables in
the model. Written in matrix notation, the model-based covariance matrix is as
follows:

$$\Sigma\theta = \begin{pmatrix} b^2 VAR(X) + & VAR\ (e) \\ bVAR(x) & VAR(x) \end{pmatrix}$$

where θ is a vector containing the model parameters. The covariance matrix is
expressed as a function of the model parameters. If the model is correct and if
the parameters are known, the population covariance matrix Σ would be exactly
reproduced by the data. The observed sample variances and covariances
contained in matrix **S** are compared to the model-based covariance matrix; the
difference between the two matrices is known as the residual matrix. The aim of
SEM is to minimize this difference (Diamantopoulos & Siguaw, 2005).

 The model equations are written as a set of matrices that correspond to
different components of the model. These matrices are denoted in Greek
notation. These matrices and their corresponding model components are
described in Table 4. LISREL matrix notation involves designating numbers as
functions: the value of 1 in the equation tells LISREL to estimate the parameter
for that matrix element; the value of 0 in the equation tells LISREL to 'fix' or
'constrain' that matrix element to zero (Diamantopoulos & Siguaw, 2005).

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Table 4

Summary of LISREL Matrices and Greek Notation

Matrix Title	LISREL Notation	Matrix Symbol (Element Symbol)	Model Components
Lambda X	LX	Λ_x (λ_x)	Paths from latent X variables to their indicators
Lambda Y	LY	Λ_y (λ_y)	Paths from latent Y variables to their indicators
Theta Delta	TD	Θ_δ (θ_δ)	Variance-covariance matrix between error scores for X variables
Theta Epsilon	TE	Θ_ε (θ_ε)	Variance-covariance matrix between error scores for Y variables
Phi	PH	Φ (φ)	Variance-covariance matrix for the latent X variables
Gamma	GA	Γ (γ)	Causal paths from latent X to latent Y variables
Beta	BE	B (β)	Causal paths from latent X to latent Y variables

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Table 4 (continued)

Matrix Title	LISREL Notation	Matrix Symbol (Element Symbol)	Model Components
Psi	PS	Ψ (ψ)	Variance-covariance matrix of residual terms for latent Y constructs

Data Preparation and Screening

After all data were exported from the Ultimate Survey ® to SPSS ® (SPSS, 2002), error-checking procedures were undertaken. First, the frequency distributions of all collected variables were examined to identify values outside the permissible range of response options. Individual records with outliers were identified, errors corrected, and the entire record examined for data entry accuracy. The process of checking the frequency distribution of all study variables continued iteratively until no values outside the permissible range of response options were identified.

The second error-checking procedure involved selection of a random sample of 10 of the records in the database. Data in each entry were checked against the source document in Ultimate Survey ® to verify successful data export directly into SPSS.

Missing Data

The design of the Internet survey gave participants a visual indicator of their progress in the survey. Missing data was minimized by visually presenting only one question matrix at a time. Conditions were set to restrict any

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unnecessary questions from appearing to the participant by using skip patterns. For example, if they responded that they did VPA on zero days of the week, they did not receive the subsequent two questions dealing with hours per day and minutes per day spent in VPA. However, there were no forced responses, so missing data were anticipated. A number of strategies were undertaken to assess and/or intervene with missing data. First, SPSS ® was used to count the number of missing responses for individual items included in the survey batch. Since the analysis plan included variables expressed as a total subscale score of a measure and variables expressed as a single indicator of the respective latent variable, different strategies were necessary to deal with missing data, based on how the individual items were used in the planned analysis.

For variables that were expressed as a total subscale score, the pattern and quantity of missing data was assessed for each individual item comprising the respective subscales as well as the aggregate responses for all items included in all subscale calculations. If less than 10% of the responses were missing from an item comprising a specific subscale, and the pattern of missing data was determined to be missing at random, missing data were supplanted by the mean of that item. If greater than 10% of the data were missing for a single item included in the calculation of a subscale score, the item was excluded from the calculations used to determine the subscale score.

There is an application program for manipulating data, transforming data, computing covariance matrices, and performing exploratory analyses called PRELIS (precursor to LISREL). Using a graphical interface, users can define

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variable properties, insert variables, or delete cases (DuToit, DuToit, Mels, & Cheng, 2005). Data from SPSS or from Excel can be imported into PRELIS and then the data can be cleaned. This mechanism was used as a safety check for cleaning done in SPSS; the output matrices were the same using either program. Ultimate Survey ® had the option of exporting data as a comma delimited file with an SPSS® code book of variables and value labels. This option was chosen. After all data screening and missing data procedures were completed, the mean subscales scores were calculated to come up with the indicators for the latent variables to be tested in the theoretical models outlined in Figures 2 and 3. Next PRELIS (Joreskog & Sorbom, 2005) was used to construct the covariance matrix used to test the theoretical model as depicted in Figures 2 and 3.

Preliminary Analyses

　　Multivariate normality. In this analysis, the multivariate normality of the data was assessed as specified by Diamantopoulos and Siguaw (2005). Assessment of univariate and multivariate normality was done through PRELIS, which is a program used for preprocessing the raw data. One of the assumptions of parameter estimation using the maximum likelihood (ML) estimation method is that departures from multivariate normality are not too severe. While ML estimation is robust to minor violations, severe ones render the ML estimation questionable. Multivariate normality assumption is also needed for interpretation of standard errors and chi-square statistics (Diamantopoulos & Siguaw). The tests for univariate normality for continuous variables were assessed. The univariate tests examined each variable individually and calculated a z-score

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coefficient of skewness and kurtosis; significant *p* values indicated departures that were significantly different from zero. The multivariate measures of skewness and kurtosis were also measured. Skewness has to do with the symmetry of the distribution, whereas kurtosis has to do with the peakedness of the distribution. Skewness is 0 and kurtosis is 3 with a normal distribution (Olsson, Foss, Troye, & Howell, 2000).

According to Curran, West, and Finch (1996), ML estimation is robust even at higher levels of skewness and kurtosis, given large sample sizes. Curran et al. found that ML was more likely to detect a specification error given increasing departures from normality. At moderate univariate skewness of two and at kurtosis of seven, Curran et al. found 6% bias and 100% rejection of the model using chi-squared as the statistic with N of 500. At severe univariate skewness of three and kurtosis of twenty-one, Curran et al. found 18% bias and 100% rejection of the chi-square with N of 500. Another finding was that as the severity of the nonnormality increased, the greater the corresponding loss of power. Therefore one must plan to include additional subjects in the study to compensate for loss of statistical power from nonnormal data (Curran et al.).

Once multivariate normality was assessed, a two-step approach was used to test the proposed theoretical model. First, the measurement model as depicted in Figure 7 for each latent variable was tested to determine the fit of the model to the data.

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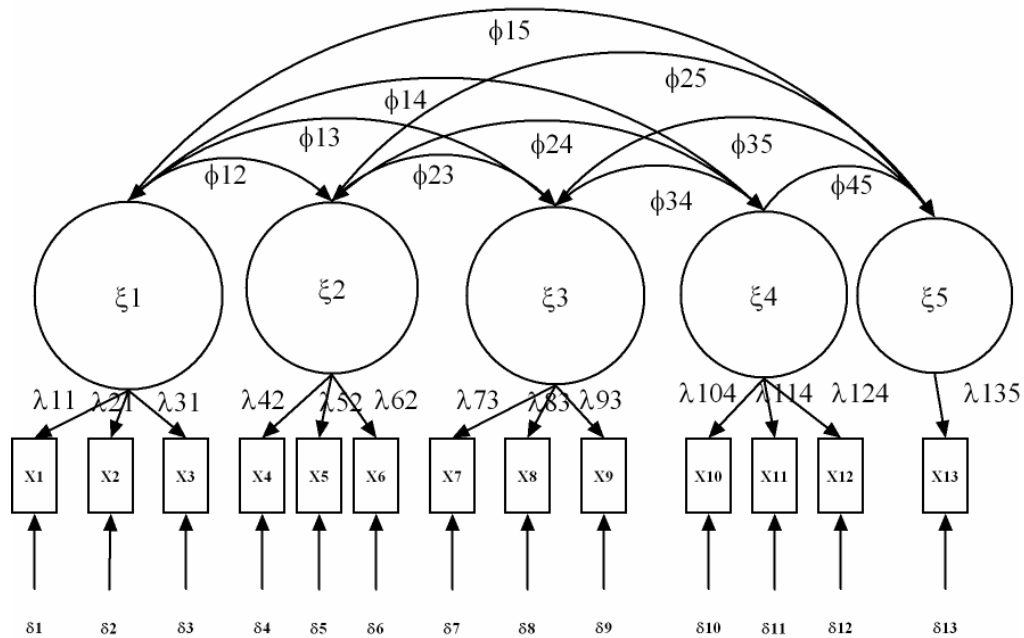
Figure 7. *Measurement Model.*

　　Based on the assessment of each measurement model's fit to the data,
appropriate modifications were undertaken to improve measurement model fit.
The first step was undertaken based on the recommendation of Kelloway (1998)
that if the final model does not fit the data, measurement model misfit could be
ruled out as a source of the misfit of the model to the data, and attention could be
focused on improving model fit through the modification of structural parameters.

Measurement Model

　　A measurement model is one in which the posited relations of the
observed variables to the underlying constructs is specified (J. C. Anderson &
Gerbing, 1988). When building measurement models, the use of multiple
indicators is preferred because the meaning given to the underlying construct is
less ambiguous with more details; therefore at least two indicators are desired

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and at least four are preferred (J. C. Anderson & Gerbing). If an indicator

estimates only one construct, it is unidimensional and loads on only the one

construct; however if it is multidimensional and loads on more than one

construct, it is correlated with the other indicators and becomes problematic in

interpretation of meaning (J. C. Anderson & Gerbing). The relationship between

an indicator and its underlying construct can be expressed algebraically:

$X = \Lambda\ \xi + \delta,$

where X is a vector of observed variables, Λ is a matrix of factor loadings relating

the observed measures to the underlying construct $\xi,$ and δ is a vector of

random measurement error (J. C. Anderson & Gerbing). Alternatively the

patterns could have been specified as follows and maintained the same

measurement model:

$Y = \Lambda\ \eta + \varepsilon$.

There were five latent variables and thirteen indicators for those constructs.

There were 35 parameters to be estimated, using 56 degrees of freedom in the

measurement model.

   Validity and reliability of measurement model. Evidence for validity of the

indicators used to represent the constructs was assessed by methods described

by Diamantopoulos and Siguaw (2005). First, all indicator loadings were

examined for significance (at $p < .05$ or better), as indicated by significant t-

values. The error variances were examined next; insignificant error variances

may indicate specification error (Diamantopoulos & Siguaw). Because of the

difficulty in comparing the validity of different indicators, which use different

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scales and which possibly had different reference scales from others' analyses, the magnitudes of the completely standardized loadings were also inspected.

Evidence for reliability of the indicators used to represent the constructs was assessed also by methods described by Diamantopoulos and Siguaw (2005). First the square multiple correlations (R^2) were assessed because they showed the proportion of variance in each indicator that is explained by its underlying latent variable (Diamantopoulos & Siguaw), and a higher R^2 denotes higher reliability. Next a composite reliability value for each latent variable was calculated to assess construct reliability using the following formula:

$$\rho_c = (\Sigma\lambda)^2 / [((\Sigma\lambda)^2 + \Sigma(\theta)]$$

where ρ_c was the composite reliability, λ was the indicator loading, θ was the indicator error variances of the δs or εs, and Σ was the summation over the indicators of the latent variable (Diamantopoulos & Siguaw). A ρ_c value of greater than 0.6 provided evidence that the indicators were reliable measurements of the construct. And finally, a complementary measurement of composite reliability was calculated, which was the average variance extracted (ρ_v). This showed the amount of variance that was captured by the construct in relation to the amount of error variance. It was calculated by the following formula:

$$\rho_v = (\Sigma\lambda^2) / [\Sigma\lambda^2 + \Sigma(\theta)]$$

where λ was the indicator loading, θ was the indicator error variances of the δs or εs, and Σ was the summation over the indicators of the latent variable (Diamantopoulos & Siguaw). It was desirable for the value of ρ_v to be at least

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0.50 or above to show that a substantial amount of the variance in the indicators was captured by the construct versus that accounted for by measurement error.

Structural Models

Once an acceptable fitting measurement model for each latent variable was obtained, the full models were tested using structural equation modeling implemented through LISREL (Joreskog & Sorbom, 2005). Structural parameters, the relationships between latent variables, were expressed as a series of equations and these equations transformed into an instruction set for the analyses.
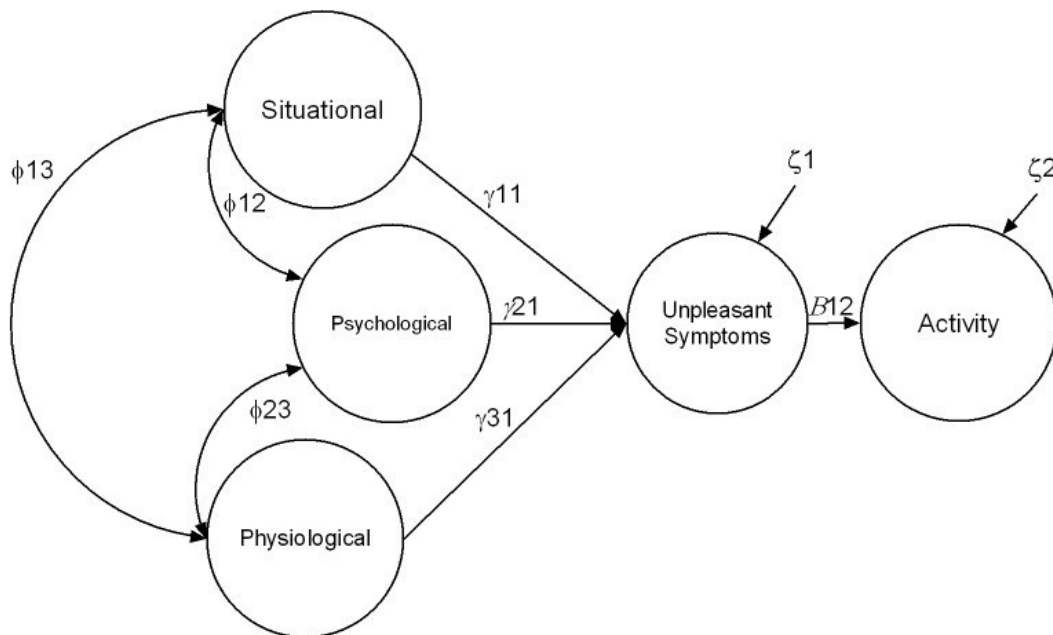
Figure 8. *Structural Model 1.* Path diagram depicting the structural relations for the theory of unpleasant symptoms

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As depicted in Figure 8, there were three latent exogenous variables and two latent endogenous variables. The structural model had 32 parameters that had to be estimated and 59 degrees of freedom.

A structural model is one which specifies the posited causal relations of the estimated constructs. The structural relationship can be expressed as an equation as follows:

$$\eta = \boldsymbol{B}\,\eta + \Gamma\xi + \zeta\,,$$

where η represents the vector of endogenous constructs, ξ represents the vector of exogenous constructs, $\boldsymbol{B}$ represents the matrix of coefficients for the effects of the endogenous constructs on one another, Γ represents the matrix of coefficients for the effects of the exogenous constructs on the endogenous constructs, and ξ represents the vector of residual errors in the equations and random disturbance terms.
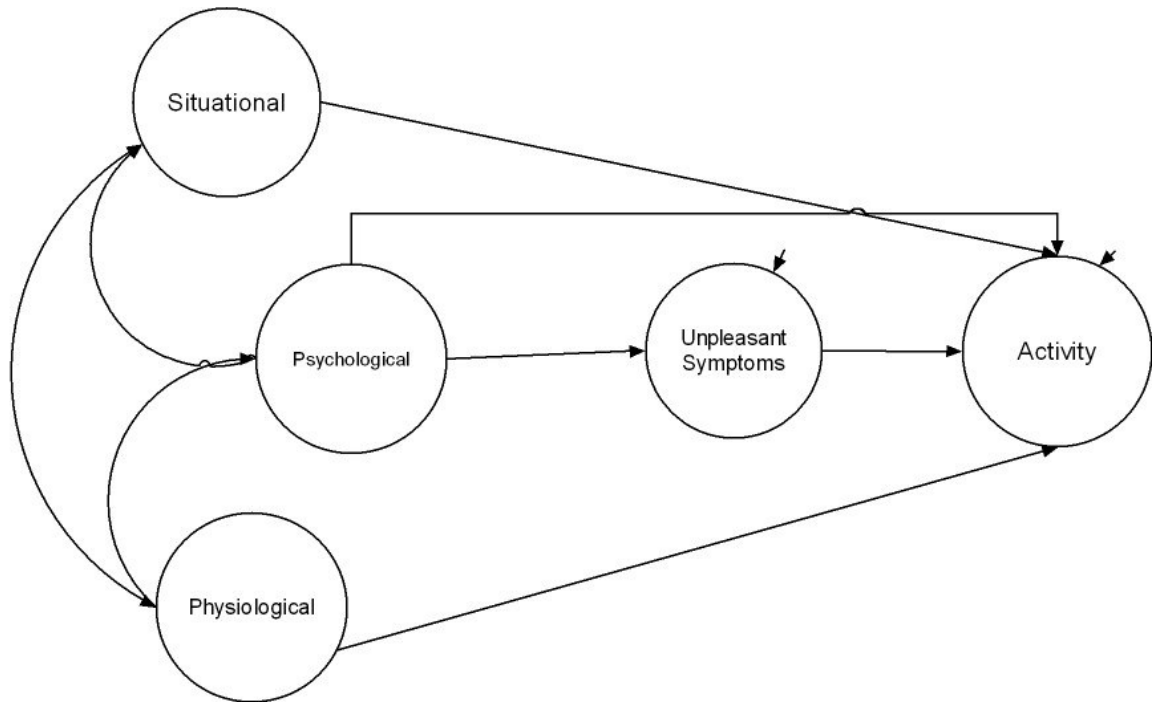
Figure 9. *Structural Model 2.* Path diagram depicting the structural relations for

the hypothesized model that altered the theory of unpleasant symptoms

As depicted in Figure 9, there were two latent exogenous variables and

three latent endogenous variables. The structural model had 32 parameters that

had to be estimated and 59 degrees of freedom.

Assessment of structural models. Assessment of the structural models

involved determining where the theoretical relationships specified in the models

were indeed supported by the data. This involved three steps: a) examine the

signs of the parameters to see if they matched the hypothesized direction, b)

examine the magnitudes of the parameters to determine if they were significantly

different from zero, and c) examine the R^2 to determine how greatly it explained

the joint power of the hypothesized antecedents (Diamantopoulos & Siguaw,

2005)

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Assessment of the fit of the model to the data was evaluated using comparative fit indices as recommended by Beckstead (2002a; 2002b; 2005; 2006).and through other authors (J. C. Anderson & Gerbing, 1988; Diamantopoulos & Siguaw, 2005; Jaccard & Wan, 1996; Kelloway, 1998). If model modifications were necessary, these were undertaken only if theoretical and statistical evidence can justify such a modification.

<div align="center">Model Modifications</div>

Overview of Model Specification Methods

Modifications can be to the measurement model or the structural models. The measurement model can be modified by changing the patterns of the loadings or by changing the measurement error matrices. The structural model can be modified by changing the path coefficients from fixed to free or vice versa, or by altering the relationships of the correlations of the disturbance terms. Reducing the parameters to be estimated produces a more parsimonious model, which inevitably results in an increase of the degrees of freedom and the chi-square statistic (Diamantopoulos & Siguaw, 2005). However first adding parameters to be estimated, although at the cost of parsimony, will decrease the chi-square statistic and improve model fit. The recommended method is to first improve the fit of the model prior to improving parsimony (Diamantopoulos & Siguaw).

Model modifications in covariance structure analysis can be problematic because the stability or consistency of model modifications over repeated samples is threatened (R. C. MacCallum, Roznowski, & Necowitz, 1992).

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Another concern is the issue of cross-validation, or how well that modified model fits an independent sample from the same population (R. C. MacCallum et al., 1992). Because of the capitalization on chance, using the data-driven process of model specification reduces the generalizability of the model to other samples and to the population (R.C. MacCallum et al., 1992).

Modifications of an initial model to improve fit has too often been done when sample sizes were too small, when too many modifications were used, and modifications were not justified on substantive grounds (R. C. MacCallum et al., 1992). MacCallum et al. drew repeated samples from a large population and demonstrated that unless *n* is quite large, the fit of the final model becomes dependent on matters of sampling.

Therefore MacCallum et al. (1992) heartily endorsed a different method of finding an adequate fit to the model. Based on their advice, two models were planned a priori. The testing of the specific aims incorporated testing both of the models that were selected a priori based on the literature of the theoretical concepts. The central hypothesis of this research was that the relationships as depicted in the proposed theoretical models (see Figures 1 and 2) would be reproducible in data from women of ages 18 to 25. These hypotheses are represented algebraically as

$\Sigma = \Sigma(\theta)$,

where Σ represents the observed population covariance matrix, θ is the vector of model parameters, and $\Sigma(\theta)$ represents the covariance matrix implied by the model (Kelloway, 1998).

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Goodness of Fit Indices

The LISREL program provides several goodness-of-fit indices. The indices used in this analysis are discussed. The minimum fit function chi-square, the root meant square error of approximation (RMSEA), the normed fit index (NFI), the non-normed fit index (NNFI), the comparative fit index (CFI), the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), and the parsimony goodness of fit index (PGFI) are introduced here. The minimum fit function chi-square is unlike the more familiar use of the chi-squared statistic. With structural equation models, the goal is to equate the estimated covariance matrix implied by the model and the population covariance matrix gathered from the empirical data. Equality between those two matrices indicates a perfect fit. Departures from this perfect fit are determined by various fit indices and by examining the residual discrepancies between the observed and implied covariances (Ratner, Bottorff, & Johnson, 1998). A small nonsignificant chi-squared provides evidence that the specified model and the empirical data are congruent rather than different. The chi-squared statistic is sensitive to sample size; therefore when using sample sizes large enough to support using LISREL, the chi-squared statistic is often rejected as a function of the sample size (Boyd et al., 1988; Ratner et al.).

Marsh et al. (1988) noted three types of indices; the stand-alone indices will be discussed first. The stand-alone indices include the chi-squared test statistic, the x^2 / df ratio, LISREL's root-mean-square residual (RMR), GFI, and adjusted GFI. As noted above, the x^2 is sensitive to sample size; this is because the formula for x^2 involves N in the calculations (Marsh et al.). In contrast, the

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RMSEA focuses on the discrepancy between Σ and Σ (θ), while taking *df*, or model complexity, into account. Values indicative of good fit are those under 0.05; values between 0.05 and under 0.08 indicate a reasonable fit; values between 0.08 and 0.10 are of mediocre fit; and values > 0.10 indicate poor fit (Diamantopoulos & Siguaw, 2005). While others label the values differently (see Kelloway, 1998), generally the value of less than 0.05 is desired. Accordingly, LISREL provides a test of significance of the RMSEA that indicates whether the RMSEA is significantly different from 0.05. The 90% confidence intervals are also provided; thus reporting RMSEA is advantageous (Kelloway).

The RMR by Joreskog and Sorbom is the square root of the mean of the squared residuals; its range depends upon the type of matrix used in the approximations. If correlation matrices are used, the range is 0 to 1; however if covariance matrices are used, the range starts at zero but can exceed one, with no upper bound noted (Marsh et al., 1988); therefore the interpretation of the RMR is more difficult. Accordingly, LISREL provides a summary measure of the standardized residuals (the residuals divided by their estimated standard errors); this summary measure, the standardized RMR, is indicative of acceptable fit if it is less than 0.05 (Diamantopoulos & Siguaw, 2005).

The GFI is another commonly reported index. It is based on the ratio of the sum of the squared discrepancies to the observed variances, thus as the observed variances increase, so does the GFI. It ranges from 0 to 1, with values greater than 0.9 indicating that the data fits well (Kelloway, 1998). The GFI is an absolute fit index in that it directly assessed how well the predicted covariance

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Σ(θ) from the parameter estimates reproduces the sample covariance Σ from the empirical data. According to Kelloway, GFI is generally recommended as the most reliable measure of absolute fit. The GFI normally ranges from 0 to 1; higher values indicate better fit, with values of at least 0.90 preferred (Diamantopoulos & Siguaw, 2005). The GFI is independent of sample sizes and it is possible for it to be negative (Marsh et al., 1988). The AGFI is similar to the GFI in that it adjusts the GFI for degrees of freedom, thus penalizing the use of additional parameters. It too generally ranges from 0 to 1 but can be negative (Marsh et al.).

Comparative or relative fit indices show how much better the model fits compared to a baseline model. The comparative fit indices do not compare against a perfect model; instead, they compare to a known poor model (usually the null or independence model, see Kelloway, 1998). The NFI, NNFI and the CFI are all relative fit indices, with CFI being the one most often reported in the literature (Diamantopoulos & Siguaw, 2005). The NNFI range starts at zero and can exceed the value of one, whereas the NFI and CFI range from 0 to 1. In both, higher values indicate better fit, with values of at least 0.90 preferred (Diamantopoulos & Siguaw; Kelloway, 1998). The NFI shows the percentage improvement over the baseline null/independence model; with an NFI of .90, the model is 90% better fitting than the null/independence model. Its counterpart is the PNFI, in which lower values are expected in relation to the NFI (Kelloway). These indices are provided in the next chapter for results.

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Aim 1

In the first model, the unpleasant symptoms domain was posited to be the sole mediator variable between the independent psychological, situational and physiological factors and the outcome activity factor. The first aim was to test if this model would be reproducible in data from women of ages 18 to 25.

Aim 2

The second aim was to determine if modifying the model to emphasize the psychological domain as a partial mediator between the exogenous variables and both unpleasant symptoms and physical activity would provide a better fit than the model without the added mediation. Based upon the prior research in the social-cognitive models of exercise, it was anticipated that model 2 would be reproducible in the data with improved goodness of fit indices.

Power Analysis Post Analyses

Using the method described Diamantopoulos and Siguaw (2005), power analysis was done. This power value indicated the probability that a false null hypothesis, or an incorrect H_0, would be rejected, where the null hypothesis was specified as $H_0: \Sigma - \Sigma(\theta) = 0$ or as its equivalent $H_0: \Sigma = \Sigma(\theta)$. MacCallum et al.(1996) provided the syntax in the appendix of their article for calculating post-hoc power. Kim (2005) provided the syntax in the appendix of the article for calculating the needed sample size based upon the non-centrality delta for the anticipated model. This analysis was also done post-hoc to validate the power analysis.

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Risks to Subjects

Human subject involvement. Data were collected from a randomly selected sample of 464 active students who were enrolled in the University of South Florida's information system. The sample were female of any ethnicity but primarily Caucasian, African American or Hispanic according to the ethnic profile of USF, and ranged in age from 18 to 25. See Table 3 for the ethnic profile of USF.

Sources of materials. Data for this study were provided by students through completion of an Internet-based survey using a university-provided program called Ultimate Survey®. Survey questions were put into Ultimate Survey® using various formats as needed. Formats included dichotomous yes/no questions, matrices of questions all using the same scale, individual questions with rating scales, multiple choice options, and options to fill in their own answers. Selected demographic data were obtained to assist with interpreting results. Invitations were sent out to email lists of participants. Each participant received a link to the Ultimate Survey® URL. The survey was designed to allow each participant to take the survey only once and the participant's email address was automatically deleted from the invitation list as each survey was completed. This was done automatically by the Ultimate Survey® software mechanism. Mailing list database access was limited through password protection to the PI.

Potential risks. The anticipated risks to subjects were minimal and involved psychosocial concerns. If a subject had experienced particularly strong

fatigue or had experienced feelings of pain related to exercise, feelings of uneasiness might have returned when the participant completed the survey. This risk was anticipated to be minimal and transient, and was no greater than those experienced during a recall of the events to a colleague at school.

Adequacy of Protection against Risks

Recruitment and informed consent. Subjects were recruited through a direct emailing of the URL link to the actual survey. A waiver of signed consent was obtained from the IRB since a signed consent document would have been the only permanent link of a subject to their responses. The required elements of informed consent were delivered in the cover page included in the survey batch online.

Protection against risk. While the risks to participants were anticipated to be minimal, there was a potential likelihood that some subjects would experience transient feelings of unpleasantness as they recalled their exercise experiences. Participants were notified of this potential risk through the cover letter.

The collected data were anonymous in that no personal identifying information was collected. The actions of deleting the participants' survey number from the invitation list upon completion of the survey and of completing all data collection prior to commencing data transfer was an additional safeguard to protect the anonymity of responses. Participants were reminded in the cover letter and throughout the survey forms to avoid providing any information that could potentially identify them in their responses. If identifying information was discovered at the time of data entry, this information was obliterated.

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Potential Benefits of the Proposed Research

Participants did not derive any direct benefits from their participation in this study. An incentive in the form of a chance at winning one of two separate $100 checks was offered to all those invited via the initial contact letter and reiterated in subsequent letters. Participants may have derived some personal satisfaction with participating in a study of an important topic to the general health of the public. Nursing professionals, health service administrators, and policy makers are anticipated to derive the indirect benefit from the results of this study since these results added to the body of knowledge related to exercise science and began to fill a gap in the knowledge about gender-specific processes leading to positive health practices.

<div align="center">Inclusion of Women, Minorities, and Children</div>

Women were the focus of the study. It was anticipated that the racial/ethnic distribution of responses would closely correspond to the distribution of USF students, as indicated by the data from USF (2006b, see Table 5).

Participants between the ages of 18 to 21 qualified as children according to the guidelines published by National Institutes of Health (1998). Adolescents were included in this study, therefore children are included.

<div align="center">102</div>

Table 5

Targeted/Planned Enrollment Table

Targeted/Planned Enrollment: Number of Subjects

Ethnic Category	Total
Hispanic or Latina	50
Not Hispanic or Latina	446
Ethnic Category: Total of all subjects	496
Racial Categories	
American Indian/Alaska Native	4
Asian	40
Native Hawaiian or other Pacific Islander	2
Black or African American	70
White	380
Racial Categories: Total of all Subjects	496

CHAPTER FOUR

Results

Overview of Analytic Strategy

This chapter presents the results of the research. Sample characteristics of participant are presented first, followed by a description of the preliminary analysis. These included assessment of data quality, bivariate relationships, and the measurement models. Problems initially encountered with the fit of the measurement models are addressed, as are the steps undertaken to deal with these problems.   These are followed by hypothesis testing, in which each research aim is addressed sequentially. Finally the power analysis is presented.

Participant Characteristics

Five hundred nineteen female students completed the study. The mean age of the participants was 21.57 (SD = 2.01; range 18 – 25). Of the 480 participants who completed the racial demographics, 76.9% (n = 399) were Caucasian/White, 9.8% (n = 51) were African Black or Caribbean Black, 0.2% (n = 1) were Native Indian or Alaskan Indian, 0.4% (n = 2) were Hawaii or Pacific Islanders, 5.2% (N =27) were Asian, and 6% (n = 27) identified themselves as other. For ethnicity, 11.1% (n = 58) were Hispanic. Among those (n = 39) who identified their ethnicity as other, 10.2% (n =4) were African, 30.7 (n =12)

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identified themselves as 'American', 41.0% (*n* = 16) were West Indian, and 17.9% (*n* = 7) were of mixed heritage.

Preliminary Analysis

   Data quality. Five hundred nineteen students completed the study, which was a response rate of 9.0% from among 5733 deliverable emails distributed. Another 56 (10.7%) were deleted listwise from analyses due to missing data and/or invalid or implausible responses. Specifically, 5% (*n* =3) provided data with more than 25% of the responses missing; 7% (*n* = 4) reported exercise hours or minutes but not the days per week; 22% (*n* = 12) reported days of exercise but no hours or minutes; 1% (*n* =1) reported implausible high amounts of time spent exercising (greater than 16 hours of exercise per day); 5% (*n* =3) reported implausible low amounts of time spent exercising (0 minutes per week); 56% (*n* =31) did not answer the single-item question about exercise capacity; and 4% (*n* = 4) reported implausible answers for the loneliness scale which demonstrated a probable response bias on reverse scored items. The data from one participant were notable for more than one of the aforementioned errors, summing to 57 erroneous observations among 519 females.

   Of the 463 participants whose data lacked discernible errors and were therefore included in the data analyses, 79% (*n* = 364) were Caucasian/White, 9% (*n* = 43) were African Black or Caribbean Black, 1% (*n* = 1) were Native Indian or Alaskan Indian, 1% (*n* = 2) were Hawaii or Pacific Islanders, 5% (*n* =23) were Asian, and 6% (*n* = 27) identified themselves as other. The average age for

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the sample was 21.57 years (SD = 2.01 years). Ethnic identities included 11% (*n* = 51) Hispanic, 79% (*n* = 368) Non-Hispanic, and 9% (*n* = 44) others.

Available data for the 56 participants who were excluded listwise are reported to address concerns about respondent bias. Significance testing of comparisons between the included versus non-included participants are summarized. The average age of the excluded participants was 21.30 (SD = 1.94 years). Excluded and included participants were similar by all racial categories and by age. The data from both groups were compared. The only variable on which these groups differed significantly was the total health status scale , which was significantly lower among the 56 females whose data were excluded (*M* = 74.02, *SD* = 35.99, t = 2.29, *df* = 516, *p* = .022). Thus it appeared that the 56 females who were excluded from the analysis were generally comparable to the 463 females were included in the analyses.

In this data, 13 variables had severe univariate skewness and one had severe univariate kurtosis, as assessed by Curran et al. (1996) criteria for z scores. Table 6 provides the tests for univariate normality in this study. Severe multivariate skewness was present but no severe multivariate kurtosis was present, again using Curran et al.'s criteria.

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Table 6

Univariate Normality Z-Scores

Variable	Skewness	*p* value	Kurtosis	*p* value
SE1	4.369	0	-1.93	0.054
SE2	-0.707	0.48	-4.718	0
SE3	-0.376	0.707	-6.567	0
EXP1	-9.777	0	6.074	0
EXP2	-8.511	0	4.882	0
EXP3	-7.808	0	3.654	0
G1	2.822	0.005	-5.099	0
G2	2.593	0.01	-5.064	0
G3	4.328	0	-1.72	0.085
L1	10.907	0	5.448	0
L2	11.87	0	6.404	0
SS1	1.688	0.091	-14.333	0
SS2	2.423	0.015	-6.316	0
SS3	2.739	0.006	-23.137	0
AGE	1.011	0.312	-8.92	0

Note. SE = Self-efficacy; EXP = Expectations; G = Goals; L = Loneliness;

SS = Social Support;

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Table 6 (Continued)

Variable	Skewness	*p* value	Kurtosis		*p* value
SFTOT	-7.662	0	3.746		0
RPC	4.826	0	3.15		0.002
US11	3.767	0	-0.124		0.901
US12	4.248	0	-1.085		0.278
US21	8.08	0	2.368		0.018
US22	3.045	0.002	-1.309		0.191
PA	9.942	0	5.174		0

Note. SE = Self-efficacy; EXP = Expectations; G = Goals; L = Loneliness;

SS = Social Support; SFTOT = Perceived health; RPC = Rating perceived

capacity; US = Unpleasant Symptom; PA = Physical Activity.

One possible solution to these violations of normality could have been to use a different method of estimation such as WLS. Weighted lease squares estimation would have required an absolute minimum same size equal to k (k-1) / 2 variables, where k is the number of variables (Diamantopoulos & Siguaw, 2005), therefore this sample size was adequate. However since the use of WLS has been found problematic even in sample sizes of 1000, the solution was to depend upon the robustness of ML estimation to departures from normality. Accordingly, the ML method was selected as the most appropriate one to use in this set of data. The findings of Olsson et al. (2000) support this method, as ML was better at detecting misspecification errors at higher nonnormality.

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Original Assessment of Bivariate Relationships

Bivariate correlational analysis was used to make an initial assessment of the relationships amongst the constructs, whereupon significant problems were noted. Each latent construct had up to three indicator variables, and while the indicator variables for any given construct were significantly correlated, the magnitudes of the correlations were not strong enough to demonstrate a single underlying construct. The correlations within any given construct were under 0.500 magnitudes. This indicated that the constructs were too broad and had to be narrowed.

Original Assessment of Measurement Model

Due to the indicator-construct links as originally posited, the initial measurement model failed to pass the criteria for analysis. For example, at least one of the lambda values was negative (an impossible answer). Thus while the goodness of fit indices for the measurement model at first appeared to be of mediocre fit, these values could not be trusted due to the illogical lambdas.

Failure to pass the original assessment of the measurement model meant that further analysis could not be done. Hence the theoretical constructs were reviewed, and while keeping the same indicator variables already collected from the participants, the structural models were rearranged. For example, the psychological latent variable was too broad; it was split into three different constructs: a) self-efficacy, b) expectations, and c) goals, which are congruent with the constructs of Bandura's self-efficacy theory (Bandura, 2004). The three scales that originally had been combined as indicators for the psychological

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latent variable were further subdivided so that one scale (Exercise Self-efficacy Scale by Shin et al., 2001) provided the indicators for self-efficacy, one scale (Outcome Expectations for Exercise scale by Resnick et al., 2001) provided the indicators for expectations, and one scale (Exercise Goals Scale by Rovniak et al., 2002) represented goals. Most of the subscales were based upon factor analyses provided by the authors. While the overall theory of unpleasant symptoms remained unchanged, it now had three latent and narrower psychological variables instead of its broad psychological one. Similar changes were made for the other constructs. See Table 7 for a summary of the changes, and Figures 15 and 16 for graphic depiction of the changes in the theoretical models.

The changes in the theoretical models also required changes in the aims of this research. Originally the intent had been to test model 1 (the theory of unpleasant symptoms as depicted by Lenz, 1995; 1997) and then to test model 2, which altered the theory of unpleasant symptoms to permit partial mediation. Conceptually, the broad factors as depicted in the theory of unpleasant symptoms became theoretical domains. For instance the psychological domain contained three factors; the situational domain contained two factors, the physiological domain contained three factors, and the unpleasant symptoms contained two factors. Accordingly, the measurement model and the structural models were altered.

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Table 7

Regrouping of Indicators and Constructs

Original Construct	Original Indicators	New Construct	New Indicators
PSYCHOLOGICAL	PS1	SELFEFF	SE1
	PS2		SE2
	PS3		SE3
		EXPECT	EXP1
			EXP2
			EXP3
		GOALS	G1
			G2
			G3

Note. SELFEFF = Self-efficacy; EXPECT = Expectations. PS1 = Exercise Self-efficacy Scale; PS2 = Outcome Expectations for Exercise Scale; PS3 = Exercise Goals Scale. SE1 = ((q11 + q12 + q13 + q16 + q17 + q18)/6) of the Exercise Self-efficacy Scale; SE2 = ((q4 + q8 + q10 + q14 + q15)/5) of the Exercise Self-efficacy Scale; SE3 = ((q1 + q2 + q3 + q5 + q6 + q7 + q9)/7) of the Exercise Self-efficacy Scale. EXP1 = sum (q1 to q3); EXP2 = sum (q4 to q6); EXP3 = sum (q7 & q8) of the Outcome Expectations for Exercise Scale. These were reverse scored into a positive direction to be consistent with the other indicators in same construct.G1 = sum (q1 to q3); G2 = sum (q4 to q6); G3 = sum (q7 to q10) of the Exercise Goals Scale.

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Table 7 (Continued)

Original Construct	Original Indicators	New Construct	New Indicators
SITUATIONAL	S1	LONELY	Lonely1
	S2		Lonely2
	S3	SOCSUPP	SS1
			SS2
			SS3
PHYSIOLOGICAL	PH1	AGE	Age
	PH2		
	PH3		
		HEALTH	SFTOT
		RATEXCAP	Excap

Note. LONELY = Loneliness; RATEXCAP = Rating of Exercise Capacity. S1 =

UCLA Loneliness Scale (UCLA-8); S2 = Social Support for Exercise Scale; S3 =

Multidimensional Scale of Perceived Social Support

L1 = sum (q2, q3, q11) of the UCLA-8; L2 = sum (q14, q17, q18) of the UCLA-8.

SS1 = = sum (q1 to q3) of the Social Support for Exercise Scale; SS2 = sum (q4

to q6) of the Social Support for Exercise Scale, and SS3 = q13 of the Social

Support for Exercise Scale. SFTOT = sum of transposed factors from SF12-v12*

*each dimension was altered by reducing the number of questions; EXCAP =

Rating of Perceived Capacity.

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Table 7 (Continued)

Original Construct	Original Indicators	New Construct	New Indicators
UNPLEASANT SYMPTOMS	US1	FATIGUE	Fatsub1
	US2		Fatsub2
	US3		
		PAIN	Painsub1
			Painsub2
EXERCISE	EX	ACTIVITY	PA

Note. US1 = Chalder Fatigue Scale; US2 = the West Haven-Yale

Multidimensional Pain Scale. US11 = ((sum (q1 to q3)) + (sum (q6 to q8))) of the

Chalder Fatigue Scale; US12 = q9 of the Chalder Fatigue Scale; US21 = (sum

(q1, q7, q12)) of the West Haven-Yale Multidimensional Pain Scale; US22 =

(sum (q6, q18, q20) of the West Haven-Yale Multidimensional Pain Scale.

EX and PA both = International Physical Activity Questionnaire in its entirety.

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Final Assessment of Bivariate Relationships

Bivariate correlational analysis was repeated with the newly narrowed constructs. All of the indicators within each given construct were correlated at a magnitude of at least 0.600 except for one indicator (painsub2). All of the correlations were in the anticipated direction as well. Based on this new bivariate correlational analysis, the decision was made to continue assessing other aspects needed for the preliminary analyses. Consult Table 8 for the new bivariate correlations with corresponding means and standard deviations.

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Table 8

Bivariate Correlations

	SEI	SE2	SE3	EXP1	EXP2	EXP3
SE1	1					
SE2	0.742**	1				
SE3	0.755**	0.762**	1			
EXP1	0.264**	0.242**	0.279**	1		
EXP2	0.342**	0.315**	0.354**	0.764**	1	
EXP3	0.252**	0.209**	0.263**	0.770**	0.717**	1
G1	0.406**	0.353**	0.371**	0.215**	0.333	0.235
G2	0.366**	0.365**	0.351**	0.229**	0.327**	0.255**
G3	0.411**	0.383**	0.403**	0.246**	0.353**	0.273**
L1	-0.025	-0.055	-0.088	-0.065	-0.065	-0.108*
L2	-0.077	-0.102*	-0.154**	-0.141**	-0.143**	-0.141**
SS1	0.086	0.027	0.043	0.043	0.060	0.184**
SS2	0.182**	0.109*	0.149**	0.092*	0.111*	0.225**
SS3	0.127**	0.069	0.095*	0.109*	0.134**	0.168**

Note. SE = Self-efficacy; EXP = Expectations; G = Goals; L = Loneliness;

SS = Social Support;

* Correlation significant at the 0.05 level (2 tailed)

**Correlation significant at the 0.01 level (2 tailed)

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Table 8 (Continued)

	SEI	SE2	SE3	EXP1	EXP2	EXP3
AGE	0.078	0.084	0.063	0.092*	0.105*	0.017
SFTO	0.237**	0.253**	0.230**	0.119*	0.169**	0.097*
RPC	0.358**	0.361**	0.382**	0.173**	0.295**	0.187**
US11	-0.246**	-0.208**	-0.256**	-0.106*	-0.114*	-0.127**
US12	-0.192**	-0.158**	-0.190**	-0.101*	-0.061	-0.139**
US21	-0.066	0.000	-0.032	-0.035	-0.040	-0.011
US22	-0.202**	-0.171**	-0.199**	-0.081	-0.082	-0.070
PA	0.246**	0.250**	0.224**	0.091	0.188**	0.140**
Means	21.712	26.241	35.428	12.652	12.469	8.240
SD	13.645	11.886	17.153	2.378	2.414	1.735

	G1	G2	G3	L1	L2	SS1
G1	1					
G2	0.758**	1				
G3	0.727**	0.786**	1			
L1	-0.101*	-0.095*	-0.114*	1		
L2	-0.095*	-0.090*	-0.134**	0.613**	1	

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

* Correlation significant at the 0.05 level (2 tailed)

**Correlation significant at the 0.01 level (2 tailed)

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Table 8 (Continued)

	G1	G2	G3	L1	L2	SS1
SS1	0.154**	0.161**	0.149**	-0.183**	-0.154**	1
SS2	0.248**	0.263**	0.285**	-0.144**	-0.141**	0.800**
SS3	0.147**	0.163**	0.202**	-0.118*	-0.128**	0.596**
AGE	0.051	0.003	0.029	-0.033	-0.043	-0.050
SFTO	0.132**	0.174**	0.173**	-0.114*	-0.230**	0.000
RPC	0.270**	0.227**	0.260**	-0.064	-0.081	0.077
US11	-0.157**	-0.133**	-0.189**	0.240**	0.340**	-0.095
US12	-0.101*	-0.102*	-0.103*	0.254**	0.325**	-0.079
US21	-0.019	0.029	0.021	0.079	0.096*	0.043
US22	-0.062	-0.042	-0.128**	0.252**	0.414**	-0.050
PA	0.205**	0.223**	0.247**	-0.013	-0.087	0.059
Means	7.786	7.562	9.108	10.437	10.394	8.423
SD	3.445	3.286	3.960	4.800	5.304	3.764

Note. SE = Self-efficacy (SE rescaled by 10^{-1}). ; EXP = Expectations; G = Goals; L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12v2 (using approximately half the questions in each dimension); RPC = Rating perceived capacity; US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

* Correlation significant at the 0.05 level (2 tailed)

**Correlation significant at the 0.01 level (2 tailed)

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Table 8 (Continued)

	SS2	SS3	AGE	SFTOT	RPC	US11
SS2	1					
SS3	0.647**	1				
AGE	-0.010	-0.029	1			
SFTO	0.016	0.060	0.008	1		
RPC	0.151**	0.114*	-0.046	0.299**	1	
US11	-0.148**	-0.050	-0.041	-0.484**	-0.176**	1
US12	-0.103	-0.017	-0.008	-0.301**	-0.124**	0.620**
US21	0.090	0.063	-0.023	-0.434**	-0.081	0.303**
US22	-0.058	-0.036	0.023	-0.333**	-0.095*	0.426**
PA	0.125**	0.045	-0.152**	0.143**	0.227	-0.134
Means	8.149	2.695	21.583	67.351	8.909	14.998
SD	3.367	1.451	2.037	13.331	3.042	4.305

	US12	US21	US22	PA
US12	1			
US21	0.647**	1		
US22	-0.010	-0.029	1	
PA	0.016	0.060	0.008	1
Means	2.11	0.390	0.803	4.096
SD	0.844	0.379	0.370	3.813

Note. SE = Self-efficacy (rescaled by 10^{-1}); EXP = Expectations; G = Goals; L = Loneliness (rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12v2 (using

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approximately half the questions in each dimension); RPC = Rating Perceived

Capacity; US = Unpleasant Symptom; PA = Physical Activity (times 1000^{-1}).

* Correlation significant at the 0.05 level (2 tailed)

**Correlation significant at the 0.01 level (2 tailed)

Final Assessment of Measurement Model

Validity and reliability. Evidence for validity of the indicators used to

represent the constructs was assessed by methods described by

Diamantopoulos and Siguaw (2005). First of all, indicator loadings were

examined for significance (at $p < .05$), as indicated by significant t – values. The

measurement model with standardized values is depicted in Figure 10. All of the

lambda parameters that were freed for estimation were significantly different than

zero. Because of the difficulty in comparing the validity of different indicators,

which use different scales, the relative magnitudes of the completely

standardized loadings were also inspected. Standardization is advantageous in

that it facilitates recognition of improper estimates (Diamantopoulos & Siguaw).

The factor loadings or λ_x are displayed in Table 9. All λ_x values (completely

standardized) were .68 or above with the one exception, and as expected from

the bivariate correlational analysis, that was for the pain indicators. These λ_x

values indicated that 20 of the 22 indicators loaded highly on their respective

latent factors.

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SELFEFF1 0.26
SELFEFF2 0.26
SELFEFF3 0.23
EXPECT1 0.20
EXPECT2 0.26
EXPECT3 0.28
GOAL1 0.30
GOAL2 0.20
GOAL3 0.23
LONELY1 0.57
LONELY2 0.12
SSEX1 0.29
SSEX2 0.09
SSEX3 0.53
AGE 0.00
SFTOT 0.00
EXCAP 0.00
FATSUB1 0.18
FATSUB2 0.53
PAINSUB1 0.72
PAINSUB2 0.57
METMWEEK 0.00

SELFEFF 1.00
EXPECT 1.00
GOALS 1.00
LONELY 1.00
SOCSUP 1.00
AGE 1.00
HEALTH 1.00
RATEXCAP 1.00
FATIGUE 1.00
PAIN 1.00
ACTIVITY 1.00

0.86
0.86
0.88
0.89
0.86
0.85
0.84
0.90
0.88
0.66
0.94
0.84
0.95
0.68
1.00
1.00
1.00
0.90
0.69
0.53
0.66
1.00

Chi-Square=306.26, df=158, P-value=0.00000, RMSEA=0.045

Figure 10. *Measurement Model Results.*

Note. The correlations amongst the latent variables were not shown in an effort to maximize the visibility of the diagram. Lambdas and theta-deltas are completely standardized. SE and SELFEFF = self efficacy; EXP and EXPECT = expectations; G = goals; L and LONELINESS = loneliness, SS and SOCSUPP = social support; SFTOT = perceived health scale; RPC and RATEXCAP = rating perceived capacity; US = Unpleasant symptoms; PA = physical activity

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Table 9

Measurement Model: Completely Standardized λ$_x$ Coefficients

Indicator	λ$_x$	Latent Variable
SE1[a]	.862	SELFEFF
SE2	.862	
SE3	.880	
EXP1[a]	.893	EXPECT
EXP2	.858	
EXP3	.850	
G1[a]	.839	GOALS
G2	.896	
G3	.877	
L1[a]	.656	LONELY
L2	.936	
SS1[a]	.841	SOCSUPP
SS2	.952	
SS3	.685	
AGE[a]	1.00	AGE

Note. SE and SELFEFF= Self-efficacy; EXP and EXPECT = Expectations; G =

Goals; L = Loneliness; SS and SOCSUPP = Social Support

[a] used as marker indicator for that construct, with scale set to 1

Table 9 (Continued)

Indicator	λ_x	Latent Variable
SFTOT[a]	1.000	HEALTH
RPC[a]	1.000	RATEXCAP
US11[a]	.905	FATIGUE
US12	.685	
US21[a]	.528	PAIN
US22	.658	
PA[a]	1.000	ACTIVITY

Note. SFTOT = perceived health status (SF12v2 portions); RPC and RATEXCAP

= Rating of perceived capacity; US = Unpleasant Symptom;

PA = Physical Activity. [a] Scale was set to 1 on this indicator.

Next the error variances were examined; nonsignificant error variances

may indicate specification errors (Diamantopoulos & Siguaw, 2005). The δ of the

loneliness subscale 2 was the only non-significant error variance among the 22

indicators.

Next the reliability of the indicators used to represent the constructs was

assessed. First the squared multiple correlations (R^2) were assessed. The

proportions of variance in each non-marker indicator that was explained by its

underlying latent variable ranged from .279 (pain subscale 2, as expected from

its lambda), to .907 (social support for exercise subscale 2, as expected from its

error variance) with 13 of 18 non-marker indicators having R^2 greater than .70.

With the exception of the pain subscale 2, all of the R^2 were at least .400.

Finally the composite reliability value for each latent variable and its related average amount of variance extracted was calculated according to the formulas by Diamantopoulos and Siguaw (2005) given in the method section. A composite reliability (ρ_c) greater than .60 provided evidence that the indicators were reliable measures of the construct. Next the average variance extracted (ρ_v) was calculated to reveal the amount of variance that was captured by the construct in relation to the amount of error variance. A value for ρ_v of at least .50 or above showed that a substantial amount of the variance in the indicators was captured by the construct versus that accounted for by measurement error.

Table 10 provides both the composite reliabilities and the average variance extracted for each of the constructs. As expected from the reported values of λ_x, the composite reliabilities were above .60 with one exception, the latent variable of pain. Likewise, the amount of variance extracted for each of the constructs exceeded the desired .50 with the same exception, pain. In summary, the composite reliabilities and the composite average variances extracted for the constructs were reliable. Only pain was slightly below the desired limits.

Table 10

Composite Reliabilities and Average Variance Extracted

Latent Variable	ρ_c	ρ_v
SELFEFF	.901	.766
EXPECT	.900	.752
GOALS	.903	.760
LONELY	.784	.652
SOCSUPP	.869	.612
AGE	1.000[a]	1.000[a]
HEALTH	1.000[a]	1.000[a]
RATEXCAP	1.000[a]	1.000[a]
FATIGUE	.780	.644
PAIN	.522	.355
ACTIVITY	1.000[a]	1.000[a]

Note. ρ_c = Composite reliability*;* ρ_v = Amount of variance abstracted; [a] Scale was fixed to 1 on the single indicator of this latent variable. SELFEFF = Self-efficacy; EXPECT = Expectations; SOCSUPP = Social Support; RATEXCAP = Rating of Exercise Capacity.

   Interrelations among latent factors. Standardized covariances among the latent variables were examined in the measurement model as well, and are presented in Table 11. All of the correlations were in the direction hypothesized.

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Table 11

Standardized Covariances among Latent Variables (N = 463)

Variable	SELFEFF	EXPECT	GOALS	LONELY	SOCSUPP	
SELFEFF	1					
EXPECT	0.37	1				
GOALS	0.497	0.356	1			
LONELY	-0.135	-0.171	-0.135	1		
SOCSUPP	0.157	0.160	0.298	-0.176	1	
Variable	SELFEFF	EXPECT	GOALS	LONELY	SOCSUPP	
AGE	0.085	0.086	0.028	-0.046	-0.022	
HEALTH	0.275	0.147	0.186	-0.239	0.019	
RATEXCAP	0.423	0.246	0.285	-0.088	0.147	
FATIGUE	-0.303	-0.149	-0.195	0.42	-0.155	
PAIN	-0.246	-0.112	-0.078	0.507	-0.006	
EXERCISE	0.276	0.154	0.259	-0.086	0.115	
Variable	AGE	HEALTH	RATEX	USYM1	USYM2	ACTIVITY
AGE	1					
HEALTH	0.008	1				
RATEXCAP	-0.046	0.299	1			
FATIGUE!	-0.04	-0.52	-0.192	1		
PAIN	0.009	-0.612	-0.148	0.699	1	
ACTIVITY	-0.152	0.143	0.227	-0.147	-0.035	1

Note. SELFEFF = Self-efficacy; EXPECT = Expectations; SOCSUPP = Social

Support; RATEXCAP = Rating of Exercise Capacity

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Goodness of fit. The fit of the measurement model was evaluated using several criteria as described in the methods chapter. For the first criterion, that of the chi-squared statistic, the measurement model was rejected (x^2 = 312.855, *df* = 158, *p* < .001). However, other fit indices suggested that the model adequately fit the data (RMSEA = 0.0451; CFI = 0.978; GFI = 0.943; AGFI = 0.909; RMR = 0.0378; and PGFI = 0.589). These data tentatively suggested that the rejection of the model was primarily attributable to the larger sample size. In addition, the ratio of x^2 to *df* was 1.98, which met the conventional criterion of the ratio of x^2 to *df* being under two.

Assessment of Structural Models

Because of the restructuring of the latent variables described earlier in this chapter, the structural models were respecified to accommodate 11 latent variables. These changes were depicted in Figures 11 and 12 below. Corresponding to changes in the hypothesized structural models, the aims of the study were expanded to include the increased number of latent variables but otherwise remained the same.
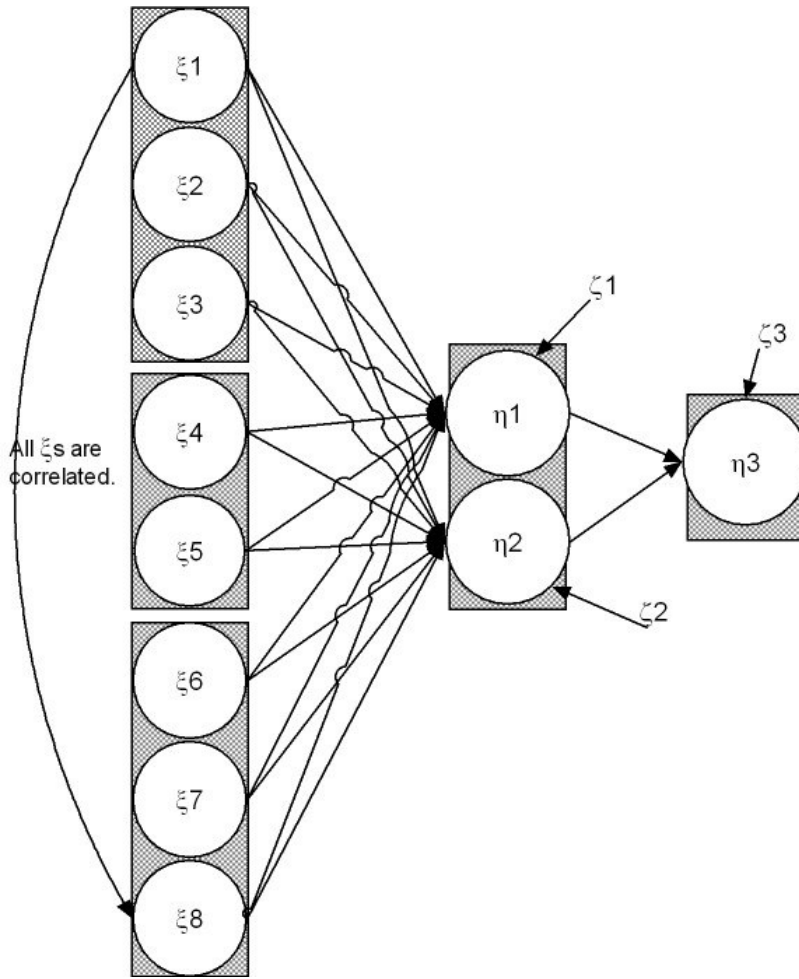
Figure 11. *Revised Model 1 Path Diagram.*

Note The theory of unpleasant symptoms; path diagram depicting the structural
relations among 11 latent variables. Shaded boxes outline the original
psychological, situational, physiological, unpleasant symptoms, and activity
domains as described by Lenz et al. (1997). $\xi1$ = SELF-EFFICACY; $\xi2$ =
EXPECTATIONS; $\xi3$ = GOALS; $\xi4$ = LONELINESS, $\xi5$ = SOCIAL SUPPORT; $\xi6$
= AGE; $\xi7$ = HEALTH and $\xi8$ = RATING OF EXERCISE CAPACITY; $\eta1$ =
Fatigue; $\eta2$ = PAIN (Pain); $\eta3$ = ACTIVITY. All ξs are correlated.

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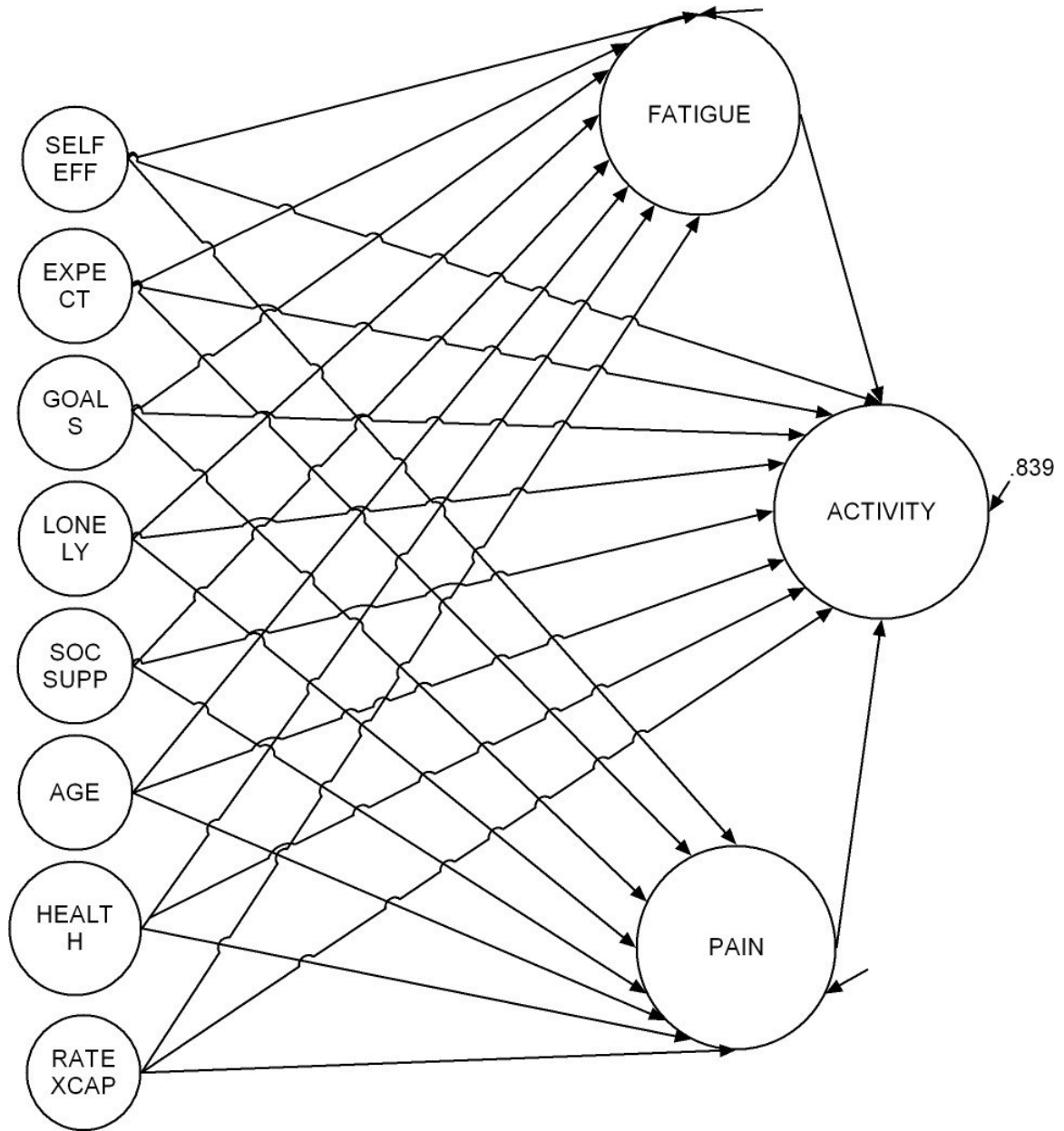
Figure 12. *Revised Model 2: Path Diagram.* Correlations amongst ξs not shown

for clarity of the diagram.

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Hypothesis Testing

The central hypothesis of this research was that the relationships as depicted in the proposed theoretical models (see Figures 11 and 12) would be reproducible in data from women of ages 18 to 25.

Assessment of Model Fit

Aim 1

In the first model, the unpleasant symptoms domain was posited to be the sole mediator variable between the independent psychological, situational and physiological factors and the outcome activity factor. The first aim was to test if this model would be reproducible in data from women of ages 18 to 25.

Using the x^2 statistic as the criterion, the first model was rejected ($x^2 =$ 400.120, *df* = 167, *p* < .001). However, other fit indices provided evidence that model 1 adequately fit the data (GFI = 0.926, AGFI = 0.889, CVI = 0.966, RMSEA = 0.0554, and standardized RMR = 0.049).

The completed structural model in Figure 13 contains the standardized path coefficients (γ and β) and disturbances (ζ). The disturbances communicate the proportion of unexplained variance ($1 - R^2$) in the endogenous variables or sources of influences on the endogenous variables depicted in the model.

In model 1, FATIGUE had a significant total effect on ACTIVITY (*t* = - 2.784, *β* = - 0.178). In contrast to fatigue, PAIN did not have a significant effect on ACTIVITY. Next the squared multiple correlations for the Y variables were examined for model 1. Only two of five indicators for the endogenous variables explained at least 70% of their latent variables. Respectively, fatigue subscale 1

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and physical activity explained 81.4% and 98.3%. Next the squared multiple correlations for the X variables were checked. All of the squared multiple correlations for the X variables were above 70% with the exception of two x variables: loneliness subscale 1 and social support for exercise subscale 3. For the entire SEM, PAIN had the most variance explained (R^2 = 56.1%) and FATIGUE had the second most amount of variance explained (R^2 = 41.8%). Unfortunately however, model 1 only explained 3% of the variance for ACTIVITY.
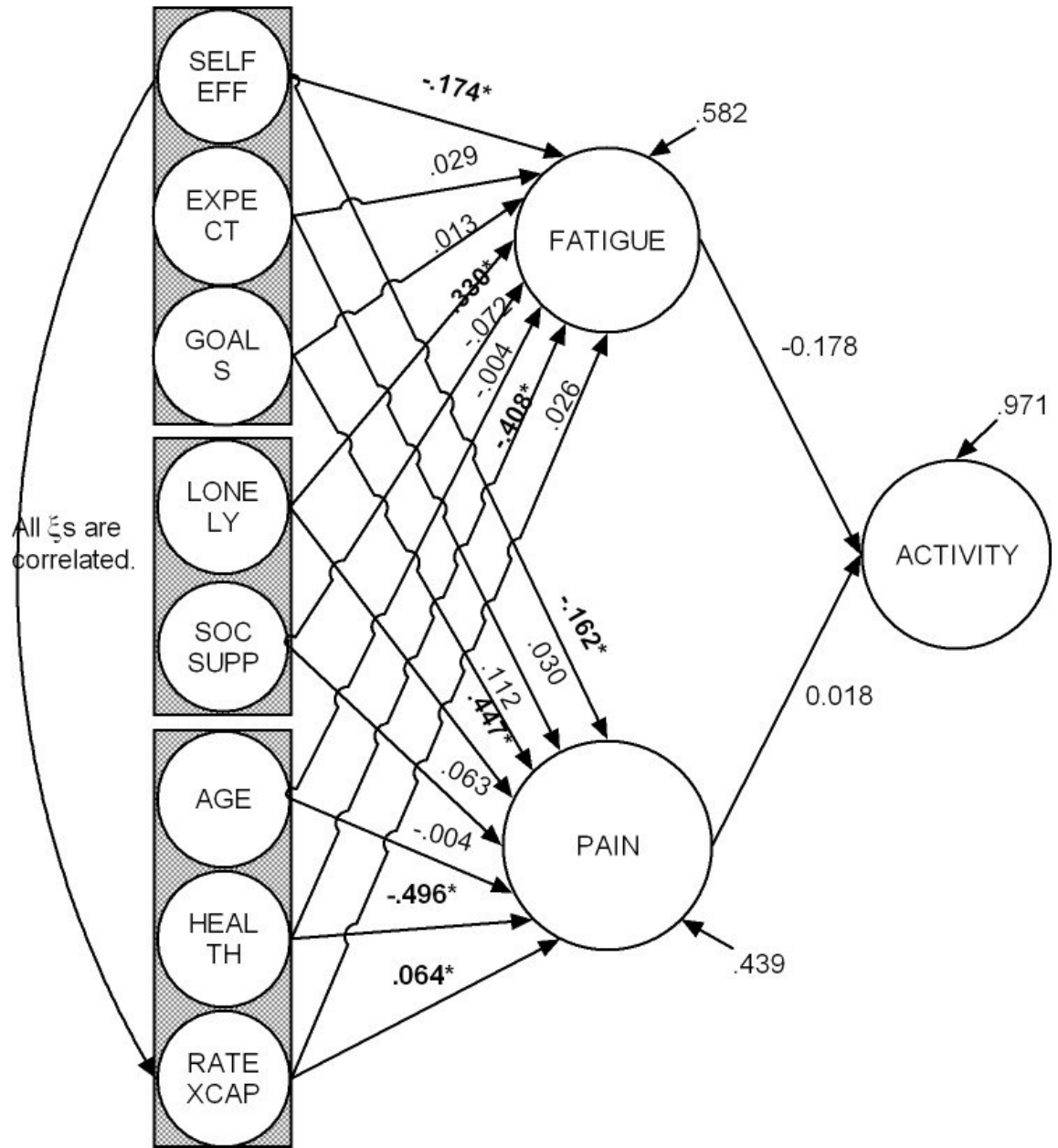
Figure 13. *Completed Structural Model 1.*

Note. Path coefficients and disturbances are completely standardized;

Correlations amongst ξs not shown for clarity of the diagram.

Aim 2

The second aim was to determine if altering the model from a fully mediated model to a partially mediated model would improve the fit of the model. Based upon the prior research in the social-cognitive models of exercise, it was anticipated that model 2 would be reproducible in the data with improved goodness of fit indices.

As in model 1, model 2 was statistically rejected (x^2 =341.520, *df* = 159, p = .000). The ratio of the x^2 to the df was 2.14. The other fit indices showed that model 2 fit the data adequately (GFI = 0.938, AGFI = 0.901, CVI = 0.973, RMSEA = 0.0493, and standardized RMR = 0.10).

The completed structural model in Figure 14 contains the standardized path coefficients (γ and β) and disturbances (ζ) for model 2. The disturbances communicate the proportion of unexplained variance ($1 - R^2$) in the endogenous variables or sources of influences on the endogenous variables depicted in the model.

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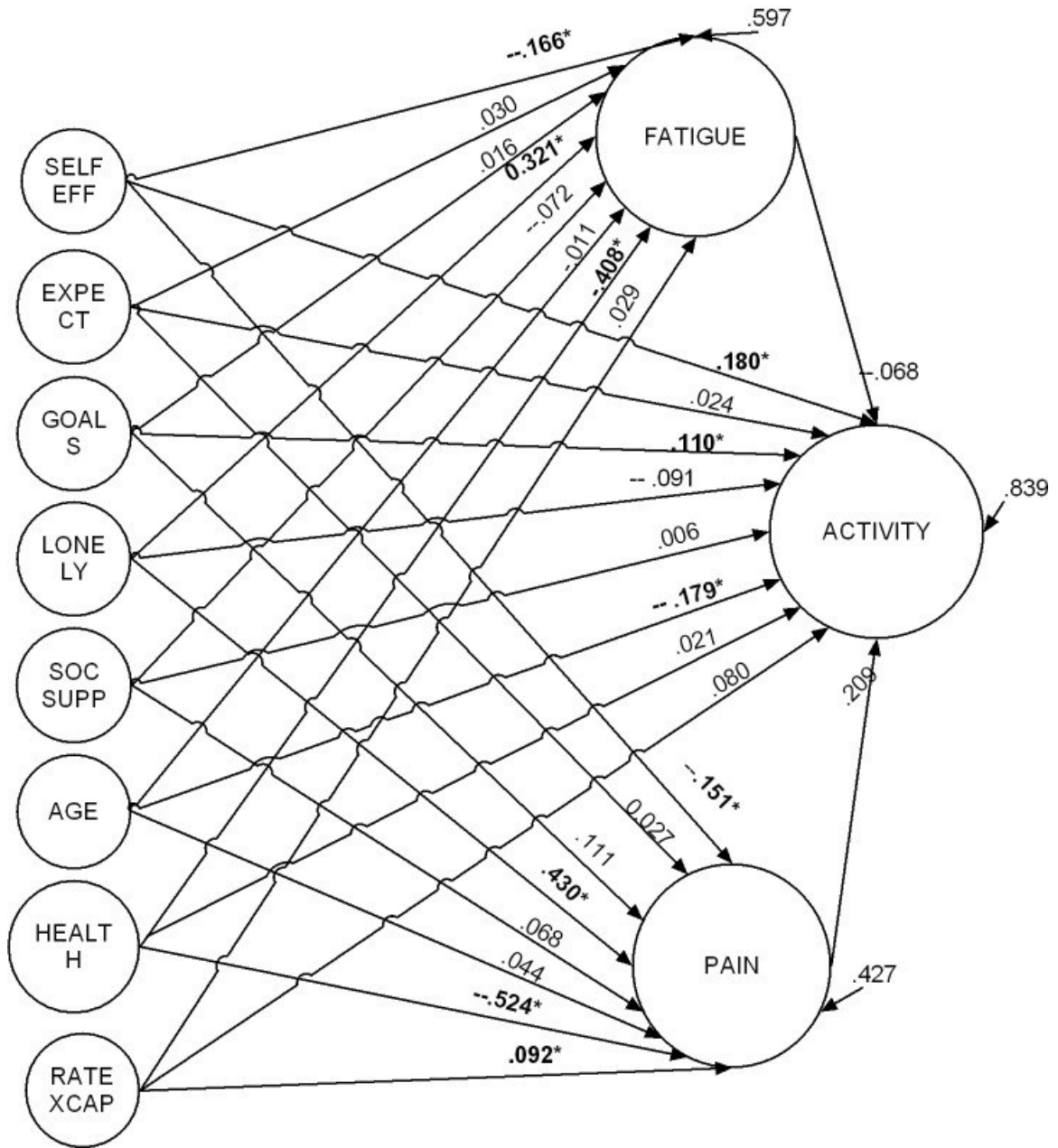
Figure 14. *Completed Structural Model 2.*

Note. Path coefficients and disturbances are completely standardized. All

ξs are correlated. * Statistically significant

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Fatigue. In model 1 fatigue had a significant total effect; however, in model 2 after controlling for effects of other variables, FATIGUE had a non-significant total effect on ACTIVITY ($t = -1.038$; $\beta = -0.068$).

Pain. In model 2, PAIN still had a non-significant total effect on ACTIVITY ($t = 1.637$, $\beta = 0.209$). The direction of the relationship of PAIN on ACTIVTY was just the opposite than that which had been anticipated. It had been hypothesized based upon the model that PAIN would have a negative effect on ACTIVITY and would be of small magnitude. Instead it had a positive effect of moderate non-significant magnitude. This led to the suspicion that there might be a suppressor variable inflating the effect of pain. According to Tabachnick and Fidell (2000) either one of two criteria indicates that a suppressor variable is present: a) the absolute value of the simple correlation of the IV and DV is smaller than the beta weight for the IV, or b) the signs of the simple correlation and the beta weight are opposite. Both of these criteria were met for PAIN as the IV on ACTIVITY. PAIN was negatively correlated with ACTIVITY ($r = -0.014$, $\beta = 0.209$).

Indirect and total effects of independent variables. The total effects of the eight KSI on FATIGUE in model 2 were examined. Three were significant: a) SELF-EFFICACY ($t = -2.885$), b) LONELINESS ($t = 6.209$), and c) HEALTH ($t = -8.876$). Next the total effects of the eight KSI on PAIN were examined. As with FATIGUE, SELF-EFFICACY, LONELINESS and HEALTH all had strong effects on PAIN. However, the strongest total effects of KSI on either FATIGUE or PAIN were those of HEALTH on FATIGUE and PAIN.

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Next the non-standardized and completely standardized Γ matrices in model 2 were examined for their indirect and total effects on ACTIVITY; all eight of the indirect effects of the IVs on ACTIVITY were non-significant. However three of the eight total effects of the IVs on ACTIVITY were significant (SELF EFFICACY, GOALS, and AGE), with AGE having the largest total effect ($t = -3.817$, $\beta = -0.169$) followed by SELF-EFFICACY ($t = 2.624$, $\beta = 0.159$) then GOALS ($t = 2.272$, $\beta = 0.132$). This change in significance from non-significant indirect effects to significant direct effects provided evidence that the mediating effects of FATIGUE and PAIN were too small in these data from this population to support the fully mediated model of unpleasant symptoms.

One curious finding was that for four of the variables, the total effect on ACTIVITY was *smaller* than the indirect effect. The only way this can happen is for a reversal of signs to occur, causing a direct effect that is the largest of all three effects. The four variables were SELF-EFFICACY, LONELINESS, AGE, and HEALTH. SELF-EFFICACY and AGE each had significant total effects on ACTIVITY. This also provided evidence that the mediating effects of FATIGUE and PAIN were too small in these data with this population to support the full mediational model depicted by Lenz et al. (1997) in the theory of unpleasant symptoms.

Squared multiple correlations. Model 2 was the better fitting model of the two models for the theory of unpleasant symptoms. The squared multiple correlations amongst the Y and X variables were checked. These results were essentially the same as found in model 1, with pain subscale 2 (mental pain)

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explaining the least amount of variance in its latent variable (R^2 = 29.3%) and metabolic equivalents per min per week explaining the most (R^2 = 98.3%). No major differences were noted for the X variables from those found in model 1, with all the R^2 being greater than 0.700 with the same two exceptions, loneliness subscale 1 and social support for exercise subscale 3. For the entire SEM, PAIN had the most variance explained (R^2 = 57.3%).and FATIGUE had the second most amount of variance explained (R^2 = 40.3%). The R^2 for ACTIVITY had a larger change than anticipated between model 1 and model 2. As seen in Figure 15, the R^2 went from 3% to 16% between model 1 and model 2. Part of this unusual increase in R^2 perhaps is explained by the inflated effect of PAIN due to the presence of a suppressor variable. Without further testing to isolate the specific suppressor variable, it is difficult to interpret. This finding warrants further research.
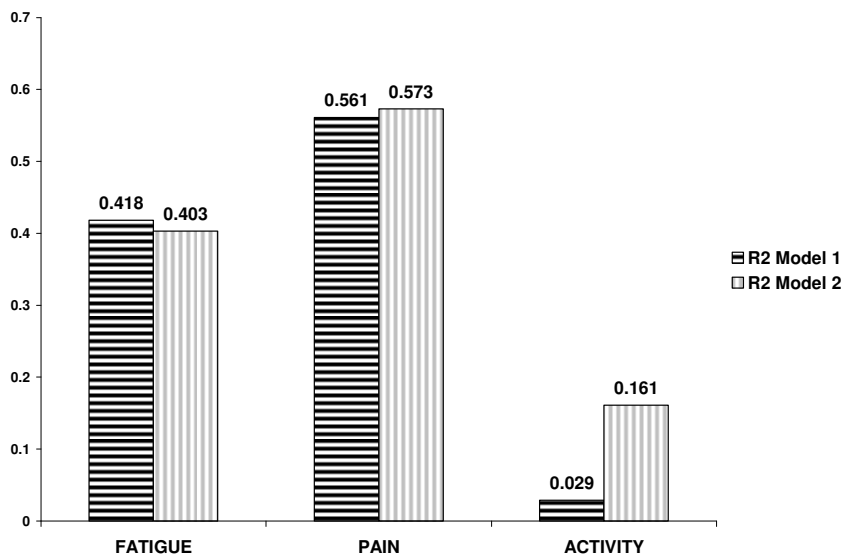
Figure 15. *Squared Multiple Correlations.*

Model Modifications

Based upon the methods described by Diamantopoulos and Siguaw (2005), model modifications were examined as a way to further improve an already well-fitting model (model 2). Model modifications were undertaken only if they were theoretically driven, not purely data driven. As noted by Diamantopoulos and Siguaw, data driven modifications capitalize too much on chance.

Model Two Diagnostics

Focusing first on improving the model fit as suggested, the standardized residual statistics and model indices were examined. Of all the elements in the residual covariance matrix, the stem-leaf plot showed 11 data elements with absolute values greater than 4.00. The majority of the residuals were clustered between -2 and + 2. Of those larger residuals, 7 were positive and 4 were negative. The residuals ranged from -6.6 to 5.8. Large positive residuals indicate the need for adding paths to correct underfitting of the model, and large negative residuals indicate the need for eliminating paths to correct overfitting of the model (Diamantopoulos & Siguaw, 2005).

Next the Q plot of the normal probability of the residuals was examined. It showed a slight shallow departure from the expected 45 degree angle with non-linearity on one end (as expected from the univariate analysis).

Model 2 modification indices (MI) and standardized expected parameter changes (SEPC) were examined next. A modification index reflects the potential decline in x^2 value if a previously fixed parameter is freed to be estimated.

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Modification indices greater than 3.84 ($df = 1$, $α = .05$) are considered large. Among these data, the largest modification index for the Λ_Ys was that for adding path from FATIGUE to the pain subscale 2 (MI = 24.970, SEPC = 0.109. The largest modification index for the Λ_Xs was that for expectations subscale 3 to SOCIAL SUPPORT (MI = 20.870, SEPC = .139). Adding a beta path from FATIGUE to PAIN and one from PAIN to FATIGUE would change the x^2 value by 27.797 each, with an SEPC of 0.028.

Modifications Made

The addition (freeing) of model parameters was considered. The largest MI was that for adding paths between FATIGUE and PAIN. This made sense theoretically according to the theory of unpleasant symptoms. Because one of the stipulations of SEM is to have not have any non-recursive paths, both of these alterations could not be done simultaneously. Therefore, each path was added separately.

Results from Modifications

Freeing the path from PAIN to FATIGUE did alter the model ($\Delta x^2 =$ 28.665; df = 1); likewise freeing the path from FATIGUE to PAIN altered the model with the same results ($\Delta x^2 = 28.665$; df = 1). Table 12 provides the details of the modification results. Because of the minimal difference in the goodness of fit indices, the modifications were not retained.

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Table 12

Summary of Goodness of Fit Indices for Modified Models

Model Parameter	x^2	*df*	RMSEA	GFI	AGI	SRMR
Model 2	341.520**	159	0.0493	0.938	0.901	0.0548
Pain to Fatigue	312.855**		0.0451	0.943	0.909	0.0378
Δx^2 [a]	28.665	1				
Fatigue to Pain	312.85		0.0451	0.943	0.909	0.0378
Δx^2 [a]	28.165	1				

Note. [a] Δx^2 = Change in x^2 from model 2. RMSEA = Root mean square error of approximation; GFI = Goodness of fit index; AGFI = Adjusted goodness of fit index; RMR = Root mean residual; PGFI = Parsimony goodness of fit index

* *p* < .05

** *p* < .001

Comparisons for ECVI are made amongst the saturated, independent, and estimated models of the same overall model, not across estimated models. Having a smaller value for the estimated model is desirable, but this was not true in this case (ECVI = 1.137; ECVI $_{saturated}$ = 1.031; ECVI $_{independence}$ = 15.494). Because data were collected from only one sampling of the population, further validation was not feasible at this point in time.

Power Analysis

Post hoc power analysis was done according to the syntax provided by McCallum et al. (1996). See appendix R for the SPSS syntax used to calculate the power. This power analysis syntax used specified conditions of alpha = 0.05, RMSEA of null hypothesis = 0.05; RMSEA of alternate hypothesis = 0.08, df, and sample size to calculate the post-hoc power. This power was the power to reject the H_0 given that the H_0 is false. For this study, the power to reject the H_0 given that the H_0 was false for the structural model with 159 degrees of freedom was 1.00. Thus, the probability that the incorrect H0 would be rejected was of ample size. Prior to the study, different sets of guidelines had been used to project the needed sample sizes. A minimum of 400 participants was needed and at least 500 were sought. The final number of participants after listwise deletion and exclusion of inappropriate data was 463. Appendix R provides the syntax used to show that the sample size needed to reach power 0.80 at alpha 0.05 was 125 participants; this syntax was based upon the non-centrality parameter delta

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calculated to be equal to 50. Thus this study was well-powered and rejection of the x^2 was expected based upon the excessive sample size.

Summary

This chapter focused on the results of the research and summarized the data. Preliminary analyses including assessment of data quality for outliers and normality, bivariate relationships, and measurement models were done. Problems noted with the original indicator-construct links were discussed. Models 1 and 2 were revised after the indicator-construct links were re-arranged. After these changes, hypothesis testing was done. Of the two revised models, model 2 had the best evidence of fit. Although modifications were attempted for a third model, and even though the results were better, those results were so minimal overall that the decision was made to not retain the third model. Implications for these findings are discussed in depth in the following chapter, as are plans for future research, suggestions for others, and a brief discussion of lessons learned.

CHAPTER FIVE

Discussion

This chapter discusses key findings and possible explanations associated with those findings, limitations to the study, implications for community health, directions for future research, and lessons learned. Each aim and each research question for this research is discussed sequentially. Findings that are different from established findings in the literature are highlighted in the discussions.

Aim 1: Testing the Theory of Unpleasant Symptoms

The first aim of this research study was to test the theory of unpleasant symptoms as described by Lenz et al. (1997) and to ascertain whether the implied model would be reproducible in the data from the collegiate women of ages 18 to 25. As this appeared to be the first time that the theory of unpleasant symptoms has been tested using structural equation modeling, there were no prior studies with which to compare results. Given that physical activity was used as the performance outcome, it was hoped that the use of SEM would give further credence to the theory of unpleasant symptoms. As indicated by the data, model 1 (the original theory of unpleasant symptoms) adequately reproduced the implied covariance matrix among collegiate women of ages 18 to 25. However, it only explained three percent of the variance in activity.

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As noted in chapter 2, there were several concepts within the theory of unpleasant symptoms that had been tested previously via SEM, such as self-efficacy, self-regulation, and outcome expectations for the psychological domain, social support for the situational domain, and age and health status for the physiological domain. Pain had been studied using SEM as well. It was the combination of these concepts in the theory of unpleasant symptoms that was unique for this study.

Fatigue. The relation of fatigue to physical activity (β = -.178) in model 1 was not surprising. These results were consistent with the conceptual model and were consistent with Garber and Friedman (2003) who found that fatigue was inversely correlated with physical activity among patients with idiopathic Parkinson's disease.

The finding of high levels of fatigue (11.8% passed the screening threshold for fatigue) was surprising, given that the fatigue questionnaire was a chronic fatigue questionnaire geared to physical fatigue as well as emotional fatigue. One possible explanation is that the chronic fatigue scale had a time reference of fatigue within the past month. Another possible explanation is that although the chronic fatigue scale inquired about fatigue in the past month, there may have been some crossover into thinking about fatigue that resulted from exercise. This finding of greater than normal fatigue among collegiate females ages 18 to 25 is a finding that warrants further research.

Another significant finding for model 1 was that fatigue was affected by self-efficacy for exercise (γ = -.174). One plausible explanation for the

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relationship between self-efficacy and fatigue is that by nature of its definition, self-efficacy is the confidence in one's ability to perform despite barriers. This interrelationship between symptom expression and psychological factors highlights the integrated mind/body system and warrants further research in young adult women.

Loneliness also had a strong association with fatigue ($\gamma = 0.330$). This relationship was puzzling. Documentation of a relationship between fatigue and loneliness had not been found in the literature. One possible explanation for the direct relationship between FATIGUE and LONELINESS is that the relationship is a spurious one. And finally, as expected, there was an inverse effect of HEALTH on FATIGUE ($\beta = -0.408$).

Pain. The unusual finding of a *positive* but tiny effect of PAIN on ACTIVITY was not expected; however since the effect was not significantly different from zero, the finding of a positive effect was deemed the function of sampling error. LONELINESS also had a strong association with PAIN ($\gamma = 0.447$). This relationship was puzzling. This relationship between PAIN and LONELINESS had not been anticipated. As with FATIGUE, one possible explanation for the direct relationship between LONELINESS and PAIN is that the relationship is a spurious one. And finally, as expected, there was an inverse effect of HEALTH on PAIN ($\beta = -0.496$). This is consistent with other research.

Aim 2: Testing the Alternative Model 2

Model 2 was a partially mediated model that fit significantly better than model 1. This model explained over 16% of the variance in activity. As expected,

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there were significant relationships between SELF-EFFICACY and ACTIVITY (γ = 0.180) and between GOALS and ACTIVITY (γ = 0.110); however, the relationship between EXPECTATIONS and ACTIVITY was not as strong (γ = 0.024). As expected from the literature, there was an inverse effect of AGE on ACTIVITY (γ = -.179). According to Krumholz et al. (2005) there is a negative relationship between age and activity. The decline in physical activity starts in high school and worsens during young adulthood, which is just before the decade of highest weight gain for women. However, given that this study was done among a restricted age range (age 18 to 25), finding this was the most significant relationship with ACTIVITY was a surprise. One possible explanation is that the older study participants are more likely to be in graduate classes or to be employed, which would leave them less time to exercise.

As noted in chapter 4, there were three major findings that complicated the interpretation of these data. First, the pain effect was puzzling. Second, the pain effect provided evidence for a possible suppressor variable when controlling for other variables that were moderately correlated with PAIN. Third, the reversal of directional signs between indirect and direct effects in four variables was explained by a larger direct than total effect for those variables. The presence of a larger direct effect than a total effect shows that the mediated effect, the indirect effect, is too small to be of consequence. Thus the question came as to whether the mediators (FATIGUE and PAIN for UNPLEASANT SYMPTOMS) are even needed. The psychological domain (SELF-EFFICACY, EXPECTATIONS,

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and GOALS) can be expanded to include SOCIAL SUPPORT, HEALTH, and LONELINESS without detriment to the model.

Implications for Use of the Theory of Unpleasant Symptoms

The model for the theory of unpleasant symptoms as depicted by Lenz et al. (1995; 1997) showed unpleasant symptoms as fully mediating the relationships between psychological, physiological, and situational factors. The data for this study fit the model adequately, and highlighted the importance of unpleasant symptoms in this age group. The direct effects of LONELINESS (γ =.330) on FATIGUE and HEALTH (γ = -.496) were moderately strong; in particular, the direct effect of LONELINESS on FATIGUE was interesting for this population. Likewise, LONELINESS and HEALTH also had moderately strong indirect effects on PAIN (γ = .447 and γ = -.496 respectively). SELF-EFFICACY had a significant and strong direct effect on FATIGUE (t = -3.003, γ = -0.174) and on PAIN (t = -2.139, γ = -0.162). Again, these findings highlight the importance of the mind/body integration.

However, the model 1 as a whole only explained 3% of the variance in ACTIVITY. In stark contrast, model 2 as a whole explained 16% of the variance in ACTIVITY. Allowing the other variables to bypass the unpleasant symptoms of FATIGUE and PAIN by having direct effects on ACTIVITY substantially improved the fit of the model.

Another point worth noting is that the definitions for the factors in the theory of unpleasant symptoms were sometimes ambiguous; for example, social support is listed as both a psychological and a situational factor by Lenz et al.

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(1995). In this study, SOCIAL SUPPORT only explained a small portion of the model (indirect effect = 0.014).

In summary, the theory of unpleasant symptoms (model 1) was adequate when tested in this population. However, the direct effects of PAIN and FATIGUE on ACTIVITY were non-significant in model 1. After controlling for the psychological, situational and physiological variables in model 2, unpleasant symptoms still did not influence exercise activity. The effects of SELF-EFFICACY, LONELINESS, and HEALTH were significant on both FATIGUE and PAIN. However, the evidence from model 2 showed that there were non-significant indirect effects of all eight exogenous variables on ACTIVITY via unpleasant symptoms, yet when allowed to bypass the unpleasant symptoms, the direct effects on ACTIVITY were significant for SELF-EFFICACY, GOALS, and AGE. Thus it appears that the social cognitive model of exercise as described by Bandura (1997; 2004) is a more parsimonious model for explaining individual differences in exercise, at least in this population and age range.

Implications for Nursing Intervention

A complex model of psychological, situational, and physiological predictors of exercise in the presence of unpleasant symptoms of pain and loneliness was tested among collegiate women of ages 18 to 25. In addition to studying more established links among the psychological variables and exercise, this study also examined the previously unexplored mediating role of unpleasant symptoms as posited by Lenz et al. (1995; 1997).

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As the data showed, the theory of unpleasant symptoms fit the observed data but explained little (3%) of the variance in exercise activity. For the first time the relationships of fatigue and of pain to exercise were documented in this population. It has implications for those working with young adults in sports, schools, and in healthcare. First of all, the prevalence of fatigue and pain needs to be acknowledged even among active college women. Recent evidence provided by Rimes et al. (2007) reveals that among adolescents, the point prevalence rate for fatigue was 34%; this study used the same measure of fatigue ('over the last month, have you been feeling much more tired and worn out than usual?) as was used by Rimes et al. It is important to note that this rate did not include those with chronic fatigue or with clinical evidence of chronic fatigue syndrome.

The finding that the psychological variables (SELF-EFFICACY, EXPECTATIONS, and GOALS) partially mediated the relationships of the other variables with ACTIVITY is not surprising given the complex integration of the mind/body system. However, this has strong implications for healthcare providers who are using exercise prescriptions as part of their treatment plans. Incorporating interventions to increase self-efficacy for exercise will facilitate the promotion of exercise as a treatment modality for fatigue. Incorporating interventions to increase self-efficacy for exercise will also facilitate the promotion of exercise for any number of conditions such as obesity (see Fabricatore, 2007).

The findings from this research also have implications for public policy. Fuemmeler, Baffi, Masse, Atienza, and Evans (2007) surveyed 1139 participants

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in the US in 2004 and found that women favor requiring healthcare companies to reimburse for obesity treatment and preventive programs. Suggestions for policy changes included tax incentives to employers to provide exercise facilities. This current research among collegiate women provides evidence that the exercise outcome is affected by psychological, situational, and physiological factors as presented in the theory of unpleasant symptoms. Rather than merely providing exercise facilities, an implication from this research is that all the factors need to be considered simultaneously.

Limitations to the Study

There are a number of limitations to this current study. First, this was a cross-sectional design and causation cannot be established. Second, the Internet-based sampling method only reached those students who elected to read their emails from strangers. Although it allowed for reaching a large number of participants within a very narrow timeframe, the Internet-based sampling method was fraught with problems. Even though the Ultimate Survey system allowed only one response per participant, there was no way to validate who the respondents were. The entire survey was self-report, and due to the nature of the online survey, some of the questions had to be altered in their format from the original survey authors' designs. For instance, the IPAQ questionnaire is based upon a 'fill in the blank' question format. Although the 'fill in the blank' or open response format was allowed in the Internet survey, trial runs with the Ultimate Survey® revealed that responses from the open format were not exported directly into SPSS, and required coding of responses one by one. Because this

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was not feasible, the decision was made to offer the number of hours and the number of minutes for exercise as a drop-down menu.

Another limitation was the failure to include some important variables such as BMI, the existence of co-morbidities (either mental or physical), medication usage, sleep patterns, and hours spent in class or work. Self-report of weight and height would have provided the needed parameters to calculate BMI. Screening for mental co-morbidities such as anxiety or depression, both of which are known to impact fatigue levels (Rimes et al., 2007), would enhance the study.

Other limitations were present as well. The ethnic profile of the respondents did not closely reflect that of the university students as expected, and the ethnic profile did not match that of the surrounding community. This may limit generalizability of the findings. Using a stratified sampling method is one way to remedy this in future studies.

Another limitation of this current study was the original selection of manifest indicators for the latent variables. Data were obtained from all the participants and when bivariate correlational analyses were done, there was not the needed magnitude of correlation among indicators for the same latent variable. Some of the data that were collected were not used as a result. For instance, the situational fatigue scale as an indicator of anticipated fatigue for the physiological factor was not reliable in this sample, with a Cronbach's alpha of only .33. Had a more comprehensive pilot study been done, some of these problems may have been averted.

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Directions for Future Research

As noted in the limitation section, several variables that could have affected the outcome of physical activity were not collected or examined. Future research is warranted to explore the unique findings of this present research in more depth. For instance, the effect of fatigue on exercise needs to be studied to ferret out the difference between anticipated versus chronic fatigue, the effects of sleep deprivation, antecedent anxiety and/or depression, and work schedules. Another direction for research is to explore the phenomenon of pain in this population. Pain did not have a significant effect on exercise for this study. Future research should differentiate between chronic pain, anticipated pain from exercise, and catastrophizing pain. Future research studies could explore methods to enhance self-efficacy for exercise. Extending this research to younger adolescents would be warranted, particularly since a strong effect of age on exercise was found.

Lessons Learned

For those who want to use an Internet-based survey, study measures should be piloted on line to determine if question formats have to be altered. For this study, SPSS was used to randomly select potential participants from a list of students. Because of the low response rate (9%), a second round of participants was randomly selected by SPSS from the same list of students. It was necessary to double check for duplicity of names in the second randomized list compared to the first randomized list. Sending duplicate invitations to a few participants was

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averted by weeding out the duplicate names; however, for thousands of names, this required use of valuable time.

Another lesson learned (for those budding LISRELites) is that no shortcuts can be taken. When the textbooks such as Diamantopoulos and Siguaw (2005) mandate that bivariate correlation be done first, it is futile to run the measurement model until the relationships within latent variables have been established. It is quite possible for LISREL to give a reasonable fit of the model to the implied data, and yet inspection of the data reveals oddities such as negative variances, negative lambdas, squared multiple correlations greater than one, lambdas greater than one, or correlations that don't make sense. For instance, the correlations among indicators for any given latent variable should be of sufficient magnitude to warrant being considered indicators of the same concept, and they also need to be in the same direction as the other indicators in the concept. For example, the scale for loneliness was designed in such a way that a higher score indicated higher loneliness (more 'bad'); when this was paired with social support, in which a larger number was a 'good' amount of social support, a negative lambda was produced. Because of the reverse coding that had to be done (sometimes to reverse the original reverse coding), meticulous notes of all coding were necessary. It was helpful to keep one syntax file just for data cleaning and coding purposes, and to keep one syntax file for the actual analyses in SPSS.

Another lesson learned is that data are not exported exactly as intended by Ultimate Survey®. For instance, one of the Likert-type scales had points

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ranging from 0 to 5; when it was imported into SPSS, the discovery was made that Ultimate Survey® coded the first response option as 1, the second response option as 2, and so forth. This meant having to recode all the ones into zeros and so on. For the expectations scale, where a smaller number meant higher expectations, Ultimate Survey® still coded the first response as 1 (when it should have been 4). Maintaining a code book is essential.

The data editor from the original data was never saved; each time the data were needed, the file was opened and all the recodes were done at once. This hint spared a lot of grief, as it was necessary to split the data file for statistical purposes as well as to recode variables several times. Files were split to obtain a covariance matrix on each subgroup, for instance. Any files that were split off were saved under a different filename; the original data editor produced by data cleaning and all the recoding was never saved.

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Appendices

Appendix A: Exercise Self-efficacy Scale

How confident are you that you can exercise regularly (3 or more times per week) under the following circumstances? Rate your confidence on a scale of 0% (cannot do it) to 100% (certainly can do it). 50% = moderately certain can do it.

1. When I am feeling tired
2. When I am feeling pressure from work
3. During bad weather
4. After recovering from an injury that caused me to stop exercising
5. During or after experiencing personal problems
6. When I am feeling depressed
7. When I am feeling anxious
8. After recovering from an illness that caused me to stop exercising
9. When I feel physical discomfort with I exercise
10. After a vacation
11.When I have too much work to do
12. When visitors are present
13. When there are other interesting things to do
14. If I don't reach my exercise goals
15. Without support from my family or friends
16. During a vacation
17.When I have other time commitments
18.After experiencing family problems
Note. Compute mean/SD for each subscale as well as for total.
Items 11, 12, 13, 16, 17, 18 = Factor 1 (situational/interpersonal)
Items 4, 8,10,14,15 = factor 2 (competing demands)
Items 1, 2, 3, 5, 6, 7, 9 = Factor 3 (internal feelings)

(Shin et al., 2001)

Appendix B: Outcome Expectations for Exercise Scale

Read the following statements and rate your level of agreement or disagreement.
The scale goes from Strongly Agree to Strongly Disagree
Exercise:

1.	Makes me feel better physically	SA	A	Neither A nor D	D	SD
2.	Makes my mood better in general	SA	A	Neither A nor D	D	SD
3.	Helps me feel less tired	SA	A	Neither A nor D	D	SD
4.	Makes my muscles stronger	SA	A	Neither A nor D	D	SD
5.	Is an activity that I enjoy doing	SA	A	Neither A nor D	D	SD
6.	Gives me a sense of personal accomplishment	SA	A	Neither A nor D	D	SD
7.	Makes me more alert mentally	SA	A	Neither A nor D	D	SD
8.	Improves my endurance in performing my daily activities	SA	A	Neither A nor D	D	SD
9.	Helps to strengthen my bones	SA	A	Neither A nor D	D	SD

Note. SA = 1, A = 2, Neither A nor D = 3, D = 4, SD = 5
Note: Compute mean/SD total. This is the positive subscale (items 1-9) of the revised version OOE-2 which also includes a 4-item negative subscale (not included here).

(Resnick et al., 2001)

Appendix C: Exercise Goals Scale

The following questions refer to how you set exercise goals. Please indicate the extent to which each of the statements below describes you: The scale ranges from 1(Does not describe) to 5(Describes completely); 3 = Describes moderately.

1.	I often set exercise goals	1	2	3	4	5
2.	I usually have more than one major exercise goal	1	2	3	4	5
3.	I usually set dates for achieving my exercise goals	1	2	3	4	5
4.	My exercise goals help to increase my motivation for doing exercise	1	2	3	4	5
5.	I tend to break more difficult exercise goals down into a series of smaller goals	1	2	3	4	5
6.	I usually keep track of my progress in meeting my goals	1	2	3	4	5
7.	I have developed a series of steps for reaching my exercise goals	1	2	3	4	5
8.	I usually achieve the exercise goals I set for myself	1	2	3	4	5
9.	If I do not reach an exercise goal, I analyze what went wrong	1	2	3	4	5
10.	I make my exercise goals public by telling other people about them	1	2	3	4	5

Score by scale mean of all items.

(Rovniak et al., 2002)

Appendix D: UCLA Loneliness Scale (ULS-8)

		Never			Most of the time
2.	I lack companionship.	1	2	3	4
3.	There is no one I can turn to.	1	2	3	4
9.	I am an outgoing person.	1	2	3	4
11.	I feel left out.	1	2	3	4
14.	I feel isolated from others.	1	2	3	4
15.	I can find companionship when I want it.	1	2	3	4
17.	I am unhappy and withdrawn.	1	2	3	4
18.	People are around me but not with me.	1	2	3	4

Note. Reverse score item 9 and 15. Compute sum for scale as well as mean.
Mean score > 2 indicates loneliness; May transform to 0 – 100 scale

(Revised by Hays & DiMatteo, 1987)

Appendix E: Social Support for Exercise Scale

How much support do you receive from participating in regular physical activity from the people closest to you?
1 none at all   2   3   4   5 very much

Rate the frequency with which the people closest to you have done or said the following in the past month:

1. Exercise with you?	1 none 2 3 4 5 very often
2. Offered to exercise with you?	1 none 2 3 4 5 very often
3. Gave you helpful reminders to exercise?	1 none 2 3 4 5 very often
4. Gave you encouragement to stick with your exercise program?	1 none 2 3 4 5 very often
5. Changed their schedule so you could exercise together?	1 none 2 3 4 5 very often
6. Discussed exercise with you?	1 none 2 3 4 5 very often
7. Complained about the time you spend exercising?	1 none 2 3 4 5 very often
8. Criticized you or made fun of you?	1 none 2 3 4 5 very often
9. Gave me rewards for exercising?	1 none 2 3 4 5 very often
10. Planned for exercise on recreational outings?	1 none 2 3 4 5 very often
11. Helped plan activities around my exercise?	1 none 2 3 4 5 very often
12. Asked me for ideas on how they can get me more exercise?	1 none 2 3 4 5 very often
13. Talked about how much they like to exercise?	1 none 2 3 4 5 very often

Note. Compute sum of each subscale (items 1-6 and 13 = factor 2; items 7-12 = factor 1).

(Reis & Sallis, 2005)

Appendix F: Multidimensional Scale of Perceived Social Support

Rate the following statements about your level of disagreement or agreement. The scale ranges from 1 (very strongly disagree) to 7 (very strongly agree).

	Very SD	SD	D	Neither D nor A	A	SA	Very SA
1. There is a special person around when I am in need.	1	2	3	4	5	6	7
2. There is a special person with whom I can share my joys and sorrows.	1	2	3	4	5	6	7
5. I have a special person who is a real source of comfort to me.	1	2	3	4	5	6	7
10. There is a special person in my life who cares about my feelings.	1	2	3	4	5	6	7

Note. Compute mean/SD for this one subscale. These questions represent the 'significant other' subscale (the other 8 questions are identical, except for one = family and another = friends).

(Zimet et al., 1988)

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Appendix G: Rating of Perceived Capacity

Please select the MOST strenuous exercise capacity level that you can sustain for 30 minutes without stopping.

Are you able, for half an hour or more, to:
1.   Sit
2.
3.   Walk slowly
4.
5.   Walk at normal pace / cycle slowly
6.
7.
8.   Jog / cycle
9.
10. Run
11.
12. Run fast / Cycle fast
13.
14.
15. Run very fast (more than 15 km/h)
16.
17.
18. Perform severely difficult elite aerobic training (women)
19.
20. Perform severely difficult elite aerobic training (men)
Note. This is a single-item score.

(Wizen, Farazdaghi, & Wohlfart, 2002)

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Appendix H: SF-12 v2

Question 1	In general, would you say your health is excellent, very good, good, fair, or poor?	Excellent ... Very Good ... Good ... Fair ... Poor ...

Question 2	The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much? First, moderate activities such as moving a table, pushing a vacuum cleaner, bowling or playing golf. Does your health now limit you a lot, limit you a little, or not limit you at all.	Limited a lot ... Limited a little ... Not limited at all ...

Question 3	Climbing several flights of stairs. Does your health now limit you a lot, limit you a little, or not limit you at all?	Limited a lot ... Limited a little ... Not limited at all ...

Question 4	During the past four weeks, have you accomplished less than you would like as a result of your physical health?	No ... Yes ...

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Appendix H (Continued)

Question 5   During the past four weeks, were you
              limited in the kind of work or other regular
              activities you do as a result of your
              physical health?

                                                              No ...
                                                              Yes ...

Question 6   During the past four weeks, have you
              accomplished less than you would like to
              as a result of any emotional problems,
              such as feeling depressed or anxious?

                                                              No ...
                                                              Yes ...

Question 7   During the past four weeks, did you not do
              work or other regular activities as carefully
              as usual as a result of any emotional
              problems such as feeling depressed or
              anxious?   No ...
                                                              Yes ...

Question 8   During the past four weeks, how much   Not at all ...
              did pain interfere with your normal work,   Slightly ...
              including both work outside the home and   Moderately ...
              housework? Did it interfere not at all,   Quite a bit ...
              slightly, moderately, quite a bit, or   Extremely ...
              extremely?

Question 9   These questions are about how you feel   All of the time
              and how things have been with you during   ...
              the past 4 weeks. For each question,   Most of the
              please give the one answer that comes   time ...
              closest to the way you have been feeling.   A good bit of
                                                             the time ...
              How much time during the past 4 weeks   Some of the
              have you felt calm and peaceful? All of the   time ...
              time, most of the time, a good bit of the   A little of the
              time, some of the time, a little of the time, time ...
              or none of the time?   None of the
                                                             time ...

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Appendix H (Continued)

Question 10	How much of the time during the past 4 weeks did you have a lot of energy? All of the time, most of the time, a good bit of the time, some of the time, a little of the time, or none of the time?	All of the time ... Most of the time ... A good bit of the time ... Some of the time ... A little of the time ... None of the time ...
Question 11	How much time during the past 4 weeks have you felt down? All of the time, most of the time, a good bit of the time, some of the time, a little of the time, or none of the time?	All of the time most of the time a good bit of the time some of the time, a little of the time none of the time
Question 12	During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities like visiting with friends, relatives etc? All of the time, most of the time, some of the time, a little of the time, or none of the time?	All of the time ... Most of the time ... Some of the time ... A little of the time ... None of the time ...

(Ware et al., 1996)

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Appendix I: Situational Fatigue Scale

According to your general feelings for the past month, please rate the level of fatigue that you might experience after engaging in the following activities.

0 – no fatigue at all; 5 = extreme fatigue

1. Playing a ballgame for 30 minutes   0   1   2   3   4 5

2. Jogging for 20 minutes

3. Taking a walk for an hour

4. Cleaning house for 30 minutes

5. Reading magazines/paper for 1 hour

6. Watching TV for 2 hours

7. Chatting for 1 hour

8. Shopping for 1 hour

9. Driving for 1 hour

10. Hosting a social event for 30 minutes

11. Doing paperwork for 1 hour (e.g.

    typing, writing, accounting, making

    plans)

12. Meeting for 2 hours

13. Attending a social activity for 1 hour

Note. Items 1-4 = Factor 1 (physical fatigue subscale). Items 5-13 = Factor 2

(Mental fatigue subscale).

(Yang & Wu, 2005)

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Appendix J: Chalder Fatigue Scale

		No or better than Usual	No more than Usual	Worse than Usual	Much Worse than Usual
1.	Do you have problems with tiredness?	1	2	3	4
2.	Do you need to rest more?	1	2	3	4
3.	Do you feel sleepy or drowsy?	1	2	3	4
4.	Do you have problems starting things?	1	2	3	4
5.	Do you start things without difficulty but get weak as you go on?	1	2	3	4
6.	Are you lacking in energy?	1	2	3	4
7.	Do you have less strength in your muscles?	1	2	3	4
8.	Do you feel weak?	1	2	3	4
9.	Do you have difficulty concentrating?	1	2	3	4
10.	Do you have problems thinking clearly?	1	2	3	4
11.	Do you make slips of the tongue when speaking?	1	2	3	4
12.	Do you find it more difficult to find the correct word?	1	2	3	4
13.	How is your memory?	1	2	3	4
14.	Have you lost interest in the things you used to do?	1	2	3	4

Note. Factor 1 = physical fatigue (items 1-8)   Factor 2 a= Mental fatigue (items 9-14).

Shorter version may be used for an 11 item scale (eliminate 5, 12, 14).
An even shorter version has been done using items 1-9.

Score by total sum or by summing the two factors separately.

(Chalder et al., 1993)

Appendix K: West Haven-Yale Multidimensional Pain Scale

Have you in the last month experienced ache, pain, discomfort, or throbbing due to headache, cramps, muscles, joints, or other non-infectious conditions?
Yes/no

7.	On the average, how severe has your pain been during the past week?	0 = None 6 = extremely severe							
		0	1	2	3	4	5	6	
12	How much suffering do experience because of your pain?	0 = no suffering 6 = extreme suffering							
		0	1	2	3	4	5	6	
1.	Rate the level of your pain at the present moment.	0 = no pain 6 = very intense pain							
		0	1	2	3	4	5	6	
18.	During the past week, how irritable have you been?	0= Not at all irritable 6 =extremely irritable							
		0	1	2	3	4	5	6	
20.	During the past week, how tense or anxious have you been?	0 = Not at all tense or anxious 6 = extremely tense or anxious							
		0	1	2	3	4	5	6	
6	Rate your overall mood during the past week.	0 = Extremely low mood 6 = extremely high mood							
		0	1	2	3	4	5	6	

Note. Score by computing mean/SD.

(Kerns, Turk & Rudy, 1985)

The following questions are about exercise frequency and **vigorous** intensity. Vigorous intensity is when your heart rate increases or you can't talk during exercise, or your talking is broken up by large breaths. **Think only about those physical activities that you did for at least 10 minutes at a time.**

1. During the last 7 days, on how many days did you do _vigorous_ physical activities?

_____
days

2. How much time did you usually spend doing _vigorous_ physical activities on one of those days?

____ ____ Hours per day

___ ____ ____ Minutes per day

The following questions are about exercise frequency and **moderate** intensity. Moderate intensity is when your heart beats faster than normal. You can talk but can't sing. **Think only about those physical activities that you did for at least 10 minutes at a time.**

3. During the last 7 days, on how many days did you do _moderate_ physical activities?

_____ days

4. How much time did you usually spend doing _moderate_ physical activities on one of those days?

[____ ____ Hours per day
___ ____ ____ Minutes per day

The following questions are about exercise frequency and **light** intensity. Light intensity is walking at a normal pace. You can talk and sing. **Think only about those physical activities that you did for at least 10 minutes at a time.**

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Appendix L (Continued)

5. During the last 7 days, on how many days did you do _light_ physical activities such as _walking_?

_____ days

6. How much time did you usually spend doing _light_ physical activities such as _walking_ on one of those days?

____ ____ Hours per day

___ ____ ____ Minutes per day

Now think about the time you spent _**sitting**_ on week days during the last 7 days. Include time spent at work, at home, while doing course work, and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. **Think only about those physical activities that you did for at least 10 minutes at a time.**

7. During the last 7 days, on how many days did you spend _sitting_ (that also includes lying down while awake)?

_____ days

8. How much time did you usually spend doing _sitting_ activities on one of those days?

____ ____ Hours per day

___ ____ ____ Minutes per day

Note. Compute minutes spent in each activity level; multiply that by the met min per week for each activity level and then sum the met min level per week total.

_(_Craig et al, 2002; 2005)

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1. How old are you? Please select from the following:
   1. 18
   2. 19
   3. 20
   4. 21
   5. 22
   6. 23
   7. 24
   8. 25
   9. Other

2. With which ethnic / cultural group do you most closely identify?
   1. Hispanic
   2. Non-Hispanic
   3. Other

3. Which 1 or more would you say is your race
   1. Caucasian/white
   2. American Black or Caribbean Black
   3. Native or Alaskan Indian
   4. Hawaii or Pacific Islander
   5. Asian
   6. Other: Please fill in the empty box as needed.

Information for People Who Take Part in Research Studies

Researchers at the University of South Florida (USF) study many topics. We want to learn more about the factors affecting students' decisions to exercise. To do this, we need the help of people who agree to take part in a research study.
Title of research study: The College Exercise Project
Person in charge of study: Sarah Elizabeth Cobb RN MS
Study staff who can act on behalf of the person in charge: Mary Evans PHD
Where the study will be done: Online using Ultimate Survey Internet data collection tools.
Should you take part in this study? *This form tells you about this research study. You can decide if you want to take part in it. You do not have to take part. Reading this form can help you decide.*

You can ask questions: You may call the primary investigator Sarah Elizabeth Cobb RN MS at 813-905-4251 or may email her at **scobb@health.usf.edu**

Why is this research being done? *The purpose of this study is to find out how psychosocial factors affect exercise in young women.*
Why are you being asked to take part? *We are asking you to take part in this study because you are a young female between the ages of 18 and 25; we want to learn about age differences between adolescent women (under age 21) and other young women (age 21-25)*
How long will you be asked to stay in the study?
You will be asked to spend about 20 minutes taking the online survey. There are no study visits.
What other choices do you have if you decide not to take part?
If you decide not to take part in this study, that is okay
How do you get started?
If you decide to take part in this study, you will need to access the study using the URL link that is provided to you in this email for you.
What will happen during this study?
You will be asked questions pertaining to exercise, and will rate how much those items affect your decisions to exercise.
Will you be paid for taking part in this study? *We will not pay you to take the survey. However I will have a lottery for two prizes of $100 each. It will not cost you anything to take part in the study.*
What are the potential benefits if you take part in this study? *We don't know if you will get any benefits by taking part in this study other than knowing you have helped advance the knowledge about decisions to exercise.*
What are the risks if you take part in this study? *There are no known risks to those who take part in this study.*

What will we do to keep your study records private?
Federal law requires us to keep your study records private. The data from the Internet survey will be transferred to a dedicated computer that is kept in a locked cabinet in a locked room. However, certain people may need to see your study records. By law, anyone who looks at your records must keep them confidential. The only people who will be allowed to see these records are:

- The study staff.

- People who make sure that we are doing the study in the right way. They also make sure that we protect your rights and safety:

    o The USF Institutional Review Board (IRB) and its staff, and any other individuals acting on behalf of USF.

    o The United States Department of Health and Human Services (DHHS)

We may publish what we find out from this study. If we do, we will not use your name or anything else that would let people know who you are.

If you decide not to take part: You won't be in trouble or lose any rights you normally have.

What if you join the study and then later decide you want to stop?

- If you decide you want to stop taking part in the study, simply log off from the Internet survey.

If you have any questions about this study or in the event of research related harm, call Sarah Elizabeth Cobb at 813-905-4251.
If you have questions about your rights as a person who is taking part in a study, call USF Research Integrity and Compliance at (813) 974-5638.
Consent to Take Part in this Research Study
It's up to you. You can decide if you want to take part in this study.

I understand that this is research. I have received a copy of this consent form via this cover letter. I understand that my participation in the research is voluntary, and that participation indicates my consent.

Appendix O: Covariances and Variances for Actual Data (N=463)

Variable	SE1	SE2	SE3	EXP1	EXP2	EXP3	G1
SE1	5.16						
SE2	4.00	5.61					
SE3	4.18	4.43	5.99				
EXP1	1.47	1.38	1.65	5.59			
EXP2	1.88	1.82	2.15	4.32	5.72		
EXP3	0.98	0.84	1.08	3.14	2.97	2.97	
G1	3.23	2.93	3.20	1.86	2.81	1.38	12.00
G2	2.74	2.86	2.84	1.87	2.61	1.42	8.58
G3	3.76	3.61	3.95	2.35	3.39	1.85	9.93
L1	0.73	1.06	1.27	1.15	1.04	1.11	1.95
L2	1.24	1.44	2.19	1.98	1.73	1.16	1.80

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

Appendix O (Continued)

Variable	SE1	SE2	SE3	EXP1	EXP2	EXP3	G1
SS1	0.66	0.20	0.30	0.28	0.49	1.22	1.79
SS2	1.39	0.92	1.18	0.67	0.92	1.33	2.77
SS3	0.43	0.26	0.32	0.31	0.46	0.41	0.67
AGE	0.39	0.40	0.35	0.49	0.51	0.07	0.38
SFTOT	10.07	10.58	10.78	5.42	7.28	3.55	7.00
RPC	2.47	2.62	2.81	1.18	2.16	0.96	2.77
US11	2.45	2.26	2.69	1.13	1.30	0.92	2.31
US12	0.39	0.35	0.40	0.20	0.14	0.17	0.27
US21	0.62	0.14	0.34	0.40	0.50	0.12	0.33
US22	1.65	1.53	1.73	0.66	0.81	0.47	0.73
PA	2.18	2.33	2.13	0.79	1.70	0.91	2.65

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

Appendix O (Continued)

Variable	G2	G3	L1	L2	SS1	SS2	SS3
G2	10.81						
G3	10.19	15.73					
L1	1.50	2.59	23.92				
L2	1.56	3.29	18.61	29.60			
SS1	2.04	2.18	3.87	3.69	14.29		
SS2	2.99	3.90	3.19	3.29	10.14	11.29	
SS3	0.77	1.18	1.00	1.39	3.26	3.17	2.10
AGE	0.01	0.21	0.58	0.62	-0.36	-0.02	-0.06
SFTOT	8.04	10.14	21.81	37.05	0.93	2.62	1.24
RPC	2.23	3.16	1.16	1.61	0.94	1.59	0.53
US11	1.84	3.33	6.49	9.57	1.47	2.06	0.30
US12	0.27	0.37	1.15	1.81	0.26	0.31	0.02
US21	-0.29	-0.19	2.15	3.26	-0.76	-1.20	-0.40
US22	0.54	1.90	5.65	9.07	0.69	0.67	0.17
PA	2.87	3.80	0.48	2.04	0.89	1.64	0.28

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

Appendix O (Continued)

Variable	Age	SFTOT	RPC	US11	US12	US21	US22	PA
AGE	4.10							
SFTOT	1.53	249.42						
RPC	-0.30	13.44	9.26					
US11	0.42	35.84	2.23	18.26				
US12	0.02	5.48	0.33	2.24	0.72			
US21	0.25	29.45	0.84	4.72	0.70	14.22		
US22	-0.11	25.17	1.04	6.58	1.13	4.65	13.53	
PA	-1.22	5.80	2.59	2.13	0.33	-1.48	1.37	14.48

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

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Appendix P: Covariances and Variances for Implied Data (N = 463)

Variable	US11	US12	US21	US22	PA	SE1
US11	18.264					
US12	2.236	0.719				
US21	4.719	0.704	14.221			
US22	6.581	1.127	4.654	13.525		
PA	2.129	0.329	-1.479	1.365	14.478	
SE1	2.450	0.391	0.616	1.649	2.175	5.162
SE2	2.258	0.346	0.140	1.531	2.329	3.996
SE3	2.691	0.397	0.342	1.731	2.131	4.183
EXP1	1.128	0.197	0.402	0.663	0.791	1.467
EXP2	1.301	0.140	0.501	0.808	1.704	1.883
EXP3	0.921	0.173	0.120	0.469	0.909	0.981

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

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Appendix P (Continued)

Variable	US11	US12	US21	US22	PA	SE1
G1	2.313	0.267	0.328	0.732	2.650	3.232
G2	1.838	0.267	-0.291	0.542	2.865	2.742
G3	3.331	0.373	-0.186	1.897	3.798	3.757
L1	6.485	1.147	2.150	5.647	0.476	0.725
L2	9.565	1.806	3.255	9.065	2.039	1.237
SS1	1.467	0.256	-0.756	0.687	0.893	0.656
SS2	2.060	0.307	-1.197	0.668	1.640	1.393
SS3	0.295	0.024	-0.399	0.172	0.277	0.431
AGE	0.420	0.024	0.249	-0.109	-1.220	0.389
SF	35.841	5.484	29.446	25.17	5.804	10.071
RPC	2.233	0.333	0.839	1.037	2.591	2.469

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

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Appendix P (Continued)

Variable	SE2	SE3	EXP1	EXP2	EXP3	G1
SE2	5.605					
SE3	4.431	5.989				
EXP1	1.380	1.653	5.590			
EXP2	1.817	2.146	4.323	5.722		
EXP3	0.842	1.084	3.137	2.967	2.972	
G1	2.930	3.202	1.859	2.806	1.384	11.999
G2	2.856	2.840	1.867	2.608	1.423	8.578
G3	3.610	3.954	2.348	3.387	1.848	9.930

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

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Appendix P (Continued)

	G2	G3	L1	L2	SS1	SS2
G2	10.809					
G3	10.194	15.727				
L1	1.502	2.591	23.924			
L2	1.558	3.285	18.614	29.602		
SS1	2.040	2.175	3.867	3.691	14.285	
SS2	2.988	3.897	3.194	3.289	10.135	11.29
SS3	0.770	1.179	0.999	1.391	3.256	3.171
AGE	0.012	0.206	0.581	0.622	-0.363	0.016
SF	8.035	10.144	21.805	37.052	0.932	2.618
RPC	2.225	3.155	1.158	1.613	0.935	1.590

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

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Appendix P (Continued)

	SS3	AGE	SF	RPC
SS3	2.101			
AGE	-0.063	4.103		
SF	1.240	1.528	249.42	
RPC	0.532	-0.299	13.435	9.260

Note. SE = Self-efficacy (SE rescaled by 10^{-1}); EXP = Expectations; G = Goals;

L = Loneliness (L rescaled by 10^{-1}); SS = Social Support; SFTOT = SF12-V2;

US = Unpleasant Symptom; PA = Physical Activity. (PA rescaled by 1000^{-1}).

title 'power estimation for sem'.

compute alpha = 0.05.
compute rmsea0 = 0.05.
compute rmseaa = 0.08.
compute df = 159.
compute n = 463.
compute ncp0 = (n-1)*df*rmsea0**2.
compute ncpa = (n-1)*df*rmseaa**2.
do if (rmsea0<rmseaa).
compute cval = idf.chisq(1-alpha, df).
compute power = 1 - ncdf.chisq(cval, df,ncpa).
end if.

do if (rmsea0 > rmseaa).
compute cval= idf.chisq(alpha,df).
compute power = ncdf.chisq(cval,df,ncpa).
end if.
execute.
list alpha df n power.

List

 ALPHA   DF   N   POWER

  .05   159.00   463.00   1.00

Number of cases read: 1   Number of cases listed: 1

Appendix R: Syntax Used to Calculate Delta and Needed Sample Size

```
comment compute noncentrality parameter delta.
comment create  variables in the data editor.
comment df and power  first.
set mxloop = 1000.
compute #alpha = 0.05.
compute #df = df.
compute #power = power.
compute #crit = idf.chisq(1-#alpha, #df).
compute delta = rnd(#crit - #df).
compute #times = 1.
compute #direc = 1.
compute #amount = 10.
loop.
+ compute delta = delta + #direc*#amount.
+ compute #pow = 1 - ncdf.chisq(#crit,#df,delta).
+ do if (#direc*(#power - #pow) < 0).
+ compute #times = #times + 1.
+ compute #direc = -1*#direc.
+ compute #amount = #amount/10.
+ end if.
end loop if (#times = 8).
execute.
********************************note.
 compute chi= idf.chisq(1-alpha, df).
EXECUTE.
   compute powera = 1- ncdf.chisq(chi,df,delta).
EXECUTE.
  Format delta powera (F8.3).
EXECUTE.
list alpha  delta powera.
List
  ALPHA   DELTA   POWERA
   .05   49.759    .800
Number of cases read:  1    Number of cases listed:  1
compute rmsea = 0.05.
compute n_needed = ((delta - power)/(((rmsea*rmsea)*df)) + 1).
execute.
list alpha delta powera n_needed.
```

List

  ALPHA   DELTA   POWERA N_NEEDED

   .05   49.759   .800   124.17

Number of cases read: 1   Number of cases listed: 1

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About the Author

Sarah Elizabeth Cobb RN received her Bachelor of Science degree Nursing (BSN) from East Tennessee State University in 1976. She worked in the pediatric/ school health/ community health field for the intervening years between graduating with the BSN and starting graduate school at the University of South Florida in 2002. She obtained her Master of Science in nursing (MS) from the University of South Florida in 2005, and completed her Ph.D. in 2007 with an emphasis on pediatrics, children's mental health, and quantitative methodology.