Effects of Resistance Training Volume and Variety on Dietary Intake and Mood State in Untrained Subject

Suzette K. Smith

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EFFECTS OF RESISTANCE TRAINING VOLUME AND VARIETY ON DIETARY INTAKE AND MOOD STATE IN UNTRAINED SUBJECT

by

Suzette K. Smith

A Dissertation in Partial Fulfillment of the Requirements for the Degree of Doctor of Public Health in Preventive Care

August 2005
Each person whose signature appears below certifies that this dissertation, in his/her opinion, is adequate in scope and quality as a dissertation for the degree Doctor of Public Health.

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ABSTRACT OF THE DISSERTATION

The Effects of Resistance Training Volume and Variety on Mood State and Dietary Intake in Untrained Subjects

by

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Loma Linda University, Loma Linda California, 2005

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Background: While there is research on the effects of aerobic training on various aspects of mood state and nutrient intake, little is known of the effect of resistance training on these variables.

Purpose: To examine the effects of resistance training (RT) volume and variety on total energy (kcal) and macronutrient intake, and mood states in a healthy, untrained population.

Method: The investigation was part of a prospective experimental study examining the effects of three RT protocols on body composition and strength. An initial 102, healthy, untrained male and female participants, ages 20-40, were recruited, and randomized into one of three groups with differing RT volumes and varieties: (1) One set of eight different resistance exercises, 8-12 RM, (2) Three sets of the same eight different resistance exercises, 8-12 RM, or (3) One set of 24 resistance exercises, including the
original eight from groups one and two, with an additional 16 exercises. All groups were required to exercise 2x/week the first eight weeks and 3x/week for the remaining 16, for a total of 24 weeks. At baseline and at weeks 12 and 24, subjects completed a 3-day diet record and a 65-item Profile of Mood States (POMS) questionnaire.

Results: There were no significant differences in total energy (kcal), macronutrient intake, mood states or Total Mood Disturbance (TMD) scores between groups, over time. However, across groups, there was a trend for reductions in total energy intake from baseline to week 24 (148 kcals/week), for an overall reduction of approximately 3,500 kcals or the energy equivalent of one pound of body fat. There were trends towards decreases in all negative mood scores and TMD, with increases in the only positively weighted mood score, vigor.

Conclusions: These results indicate that differences in RT volume or variety do not appear to have a distinct influence on mood state, macronutrient percentage or total energy intake in a healthy, untrained population. Thus, emphasizing diet and mood benefits of different RT regimens is not warranted.
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CHAPTER 1
INTRODUCTION

A. Statement of the Problem

In the United States today, lifestyle practices are major contributors to the leading causes of death and disability (National Center for Health Statistics, 2000). Low levels of physical activity and an environment that promotes excessive food intake also play key roles in the high prevalence of cardiovascular disease and obesity (DeJong, Sheppard, Lieber & Chenoweth, 2003; Epstein & Roemmich, 2001; French, Story & Jeffery, 2001; Kuczmarski, Flegal, Campbell & Johnson, 1994; McInnis, 2003; Schultz & Schoeller, 1994: Stear, 2003; Wang, et al, 2002). These and other chronic diseases and conditions currently account for at least seven out of every 10 deaths and 60 percent of medical care expenditures (DHHS, 1999) and those that do not cause death often result in disability, decreasing the quality of life and impacting mental health status in a large percentage of these populations.

In the “Global Burden of Disease,” the World Health Organization reports that in established market economies such as the United States, mental illness is on a par with heart disease and cancer as a cause of disability (Murray & Lopez, 1996). Approximately 20 percent of the U.S. population is affected by mental illness during a given year representing a significant public health issue. Depression, mood and stress related disorders also have a deleterious impact on the economy, costing the United States over $40 billion each year, both in diminished productivity and in use of health care resources. In the workplace, depression is a leading cause of absenteeism and diminished
productivity (Greenberg, Stiglin & Finkelstein, 1993). Stress may be experienced by any person and provides a clear demonstration of mind-body interaction and although only a minority seeks professional help to relieve a mood disorder, depressed people are significantly more likely than others to visit a physician for some other reason (Katon, 1995; Moscicki, 1997; Simon, 2003).

Healthy People (HP) 2010 identifies 10 leading health indicators that reveal the individual behaviors, physical, social and environmental factors that greatly affect the health of individuals and communities and goals for improvement. Three of these 10 directly address physical activity, overweight and obesity and mental health issues (USDHHS: HP 2000 for 2010). The potential of physical activity as a comprehensive preventive health measure is considerable, enhancing quality of life and facilitating many important benefits including increased functional capacity, improved psychological well-being, and a lowered risk for a sizeable range of chronic diseases and preventing premature death (Dupper, 2002; DHHS: Healthy People, 1999; Isomaa, 2003; Kell, Bell & Quinney, 2001; Shepard, 1985; Stear, 2003).

Numerous studies on the physical benefits of exercise demonstrate significant improvements in muscle tone, digestion, nutrition status, body fat loss and blood volume (Folkins & Sime, 1981; Griest et al., 1978; McInnis, 2003; Wang et al, 2000). Resistance training (RT), in particular, has demonstrated many long term beneficial effects including increases in musculoskeletal strength, lean body mass and bone density (Kraemer, Adams, Cafarelli, Dudley, Dooly & Feigenbaum et al, 2002). The majority of studies show RT to have profound effects on the musculoskeletal system, the maintenance of functional abilities, and the prevention of osteoporosis, sarcopenia and low back pain.
(Hruda, Hicks, & McCartney 2003; Yarasheski, 2002; Seguin & Nelson, 2003; Kraemer, Ratamess & French, 2002). In addition, RT may have a positive effect on health risk factors such as insulin resistance, resting metabolic rate, glucose metabolism, blood pressure, body fat and gastrointestinal transit time, factors associated with diabetes, heart disease and cancer (Kraemer, Ratamess & French, 2002; Winett & Carpinelli, 2001). It may also be used as an effective method for weight loss and maintenance, given that an increase in lean body mass can lead to increases in the resting metabolic rate (RMR) (Going et al, 1995).

Increased physical activity also appears to mediate positive psychological changes in mood, well being, self esteem, perceptions of health status and work performance and may reduce the risk of developing depression or lessen the severity of its symptoms (Brugman & Ferguson, 2002; Byrne & Byrne, 1993; DHHS, 2004; Paluska & Schwenk, 2000). Evidence such as this, coupled with mounting interest in health and well being, has contributed to the widespread opinion that physical exercise constitutes a natural, practical, time efficient and inexpensive form of preventive care therapy (Bakal, 1979; DeJong, Sheppard, Lieber & Chenoweth, 2003; Kostka, 2002; Kostrublal, 1976; Sachs & Buffone, 1984; Sparling, 2000; Wilfley & Kunce, 1986).

There are various guidelines for exercise prescription; however, the American College of Sports Medicine (ACSM) has developed a position that “activities involving both aerobic and anaerobic exercise are the most effective methods by which to develop and maintain cardiovascular and muscular fitness in adults” (ACSM, p. 87, 1995; Schweiz, 1993). To date there has been substantial research incorporating aerobic training (AT) in diverse populations, although investigations into the effectiveness and
feasibility of predominately anaerobic, resistance training (RT) have been less numerous and focused more on elite athletes (Kramer, Duncan & Volek, 1998; Judge, Moreau & Burke, 2003; Petibois, Cazorla & Deleris, 2003), healthy men (Fujumura, et al, 1997; Mayhew, Ware, Johns & Bemben, 1997; McCall, Byrnes, Dickenson, Pattany & Fleck, 1996), and the elderly (Evans, 1999; Frischknecht, 1998; Roubenoff, 2000). In recent years, there has been a expansion in RT research including more average, healthy populations (Hass, Feigenbaum & Franklin, 2001; Kraemer, Ratamess and French, 2002), children and adolescents (Faigenbaum, Westcott, Loud & Long, 1999; Guy & Micheli, 2001; Payne, Morrow, Johnson & Dalton, 1997; Southern, Loftin, Udall, Suskind, Ewing & Tang, 1999), women, and the obese (Borg, Kukkonen-Harjula, Fogelhorn & Pasanen, 2002; Hakkinen, 2001; Park, Kwon, Kim, Yoon & Park, 2003; Schmitz, Jensen, Kugler, Jeffery & Leon, 2003), and those with varying degrees of depressive symptoms (Dunn, Trivedi & O’Neal, 2001).

For RT, the American College of Sports Medicine (ACSM) currently recommends a minimum of one set of 8-12 repetitions of 8-10 different exercises for untrained individuals (ACSM, 2000; Kraemer, Adams, Cafrarelli, Dudley, Dooly & Feigenbaum, et al, 2002), although there is debate in the literature as to the effects of multiple sets versus single sets (volume) or single sets of many different RT exercises (variety) on measures of strength, muscle mass and body composition (Wolfe, LeMura & Cole, 2004; Hass, Garzarella, de Hoyos & Pollock, 2000; Schlumberger, Stec & Schmidtbleicher, 2001). What has yet to be investigated is if dietary selection (i.e., total energy (kcal) intake, macronutrient percentage or both) or mood (i.e., alterations mood
state and total mood disturbance) might naturally accompany RT regimens differing in volume, variety or both.

In reference to the growing body of research demonstrating the positive physical effects of RT exercise on both chronic and emerging health problems of the average, healthy individual, further investigation into a potential influence on measures of nutrition and mood would provide a more comprehensive picture of the possible benefits of RT.

B. Purpose of the Study

This study investigated whether RT volume, variety or both affect dietary macronutrient selection and psychological mood state in a group of healthy, untrained individuals.

C. Research Questions

Haddock et al (2001) examined the physical effects of RT on measures of strength, metabolic rate and body composition in a healthy, untrained population randomized into three different RT volume and variety protocols. The following questions were posed to examine possible changes in dietary behaviors (e.g. total energy intake and macronutrient percentages) and psychological measures (e.g. mood states and total mood disturbance) in response to RT volume, variety or both.

1. Does RT volume (1 vs. 3 sets of 8 different exercises), variety (1 set of 24 different exercises), or both influence energy intake (EI) or carbohydrate percentage (CP) in healthy, untrained subjects? It is expected that greater RT volume, variety or both would result in significant increases in energy intake and
shifts in macronutrient percentages due to greater metabolic demands, cognitive reward rationalization or both.

2. Does RT volume, variety, or both influence specific mood states (i.e., tension, depression, anxiety, vigor, fatigue, confusion), or total mood disturbance (TMD) (i.e., addition of all mood scores with vigor weighted negatively) in subjects? It was expected that due to a greater quantity of physical and psychological time invested in training, greater RT volume or variety or would result in significant decreases in negative mood states and TMD, with a potential to increase the only positively weighted mood, vigor.

D. Importance to Preventive Care

The challenge for preventive care specialists is to design and implement practical and effective health education strategies that motivate and sustain positive lifestyle practices. The World Health Organization (WHO) defines health as “a state of complete physical, mental and social well being, and not merely the absence of disease or infirmity” (p. 873, Kell, Bell & Quinney, 2001). Incorporating this perspective, preventive care practice must include a range of strategies that support the mind/body health connection. With this as a core objective, the benefits of incorporating a RT regimen, including positive metabolic consequences of improved body composition (Dechenes & Kraemer, 2002; Kraemer, Ratamess & French, 2002) and possible psychological developments such as reduced stress and anxiety and increased vigor and positive mood (Paluska & Schwenk, 2000) may have a significantly positive impact on overall health status.
A major benefit of RT as an exercise mode is its adaptability to people of different genders, ages and functional capacities (Dechene & Kraemer, 2002; Haas, Feigenbaum & Franklin, 2001; Kraemer, Ratamess, French, 2002). This flexibility offers a means of increasing levels of physical activity for a wide range of the population. If improvements in nutrition and mental health status occurs, it would provide additional evidence that RT is an efficient, comprehensive and cost effective preventive care prescription.
CHAPTER 2
REVIEW OF THE LITERATURE

A. Introduction

In the general population, increasing age, sedentary lifestyle habits and increased caloric consumption contribute to the loss of muscle mass and increases in body fat percentage (Bosy-Westphal Eichhorn, Kutzner, Illner, Heller & Muller, 2003; Kamel, 2003; McCrory, Suen & Roberts, 2002; Jakicic, 2002; Vaughan, Aurlo & Ravussin, 1991). Combined, these factors often result in overweight and obesity, which have been closely linked with numerous diseases including diabetes, hypertension, cancer and heart disease (Albu & Raja-Kahn, 2003; Barten & Furrer, 2003; Bloomgarden, 2003; Bray, 2003; CDC, 2001; NCHS, 2000). In addition, obesity and cardiovascular insufficiency are conditions that can limit mobility and further affect the ability to be physically active (Westerterp & Meijer, 2001). Recent estimates are that 61% of all US adults are considered overweight or obese, an alarming 8% increase from 1991 statistics (CDC, 2001; Koplan, 1999; Wyatt, 2003).

According to the American College of Sports Medicine (ACSM, 1980), physical exercise is divided into three main categories: (1) aerobic capacity and endurance; (2) muscular strength and endurance; and (3) flexibility, coordination and relaxation. Howley (2001) went further, ascribing essential terminology for physical activity and health. He defined two principal categories: occupational physical activity (OPA) and leisure-time physical activity (LTPA). Occupational physical activity is usually referenced to an 8-hour work day, whereas time spent in LTPA is quite variable and
includes all forms of aerobic activity, structured endurance exercise programs, resistance-training programs, and sports. Most health scientists agree that an increase in LTPA can have a positive effect on health status, particularly those variables associated with cardiovascular health, including a lowered resting heart rate, decreases in chronic hypertension and a reduction in overall coronary artery disease risk (Duppert, 2002; Nelson, Jennings, Esler & Korner 1986; Sime, 1987; Sparling, Owen, Lambert & Haskell 2000). There is substantial evidence that both aerobic training (AT) and anaerobic, resistance training (RT) performed on a regular basis can significantly improve other health status indicators including increases in lean body mass and reductions in body fat, blood lipids, blood glucose levels, overweight and obesity (Hu, 2003; Saris, Blair, van Baak, Eaton, Davies, Di Pietro, et al, 2003).

In addition to physical activity, a contributing factor in overall health status is diet. Alterations in caloric balance (i.e., positive for weight gain, negative for loss) and macronutrient percentages (i.e., lower total fat and increased complex carbohydrate) are critical to sustaining a healthy body composition, since the majority of the evidence demonstrates that exercise alone has inconsistent long term effects on weight loss (Melby & Hill, 1999; Tucker, Harris & Martin 1996; Keith, O'Keefe, Blessing & Wilson, 1991).

In conjunction with adequate physical activity and good nutrition, a favorable mental health status contributes considerably to well being. Stress, anxiety dysregulation of mood and the expression of mood, or affect, represent a major category of mental disorders. Because mental health is intrinsically related to all other aspects of health, the consequences of mental health problems (e.g., depression may lead to overeating, which may lead to obesity and, in turn, diabetes) can have far reaching effects. The first
comprehensive Surgeon General’s report on mental health (1999) acknowledges that physical activity appears to relieve symptoms of depression and anxiety and improve mood, in addition to improving health-related quality of life by enhancing psychological well being and improving physical functioning in persons compromised by poor health.

For its positive effects on mood state, mental well being (Shepard, 1997; Watanabe et al, 2001), stress management (McAnn & Holmes, 1984; Salmon, 2001), and the ability to better cope with negative life events (Kobasa, Maddi, Puccetti & Zola, 1985), aerobic training (AT) has historically received the most attention (Hansen, Stevens & Coast 2001; Morgan & Goldstone, 1987). Despite the depth and breadth of aerobic training (AT) research, it stands to reason that any mode of exercise that increases leisure time physical activity (LTPA), including RT, has the potential for conferring beneficial effects on measures of physical and psychological health. This review examines LTPA studies on the effects of both aerobic and anaerobic exercise (i.e., RT) on measures of mood state and dietary intake.

B. Leisure Time Physical Activity and Mood

There is substantial documentation regarding the positive physical consequences of regular leisure time physical activity (LTPA) (Dwyer & Briggs, 1983; Blair, Kohl, Paffenberger, Clark, Cooper & Gibbons, 1989; Martinsen, 2000) where the case for exercise has largely been made as a result of its positive effects on chronic diseases including coronary heart disease, obesity and diabetes. However, the past 20 years has shown increasingly high health care expenditures attributed to psychological disorders, prompting an expansion of research into the role of exercise in improving mental well-being in the general population, upgrading life quality through enhanced self-esteem,
improved mood states, reduced state and trait anxiety, resilience to stress and improved sleep (Fox, 1999; Hughes, Casal & Leon, 1986; Odagiri & Shimonmitsu, 2000; Paluska & Schwenk, 2000; Tsutsumi, Don, Zaichkowsky, & Takenaka, 1998).

From a historical perspective, exercise psychology researchers proposed that the positive impact of regular LTPA was centered on what investigators generalized as “personality constructs”; however, it is now understood that “personality” is a relatively stable entity and not generally responsive to physical activity interventions (Buccola & Stone, 1975; Harting & Farge, 1977; Brown & Wang, 1995). A review of the literature on the relationship of exercise to mental health strongly suggests a link, where physical activity has been reported to reduce depressive symptoms, negative mood states, tension and anxiety, and to improve stress related coping skills and elevate mood (Folkins & Sime, 1978; Lane, Crone-Grant & Lane, 2002; Martin & Dubbert, 1982; Martinsen, 2000; Ransford, 1982). To date, this research suggests that moderate, regular exercise should be considered as a viable means of treating depression and anxiety and improving mental well being in the general public.

Several psychological mechanisms for how exercise affects mood have been proposed. In the developed world, LTPA is seen as a virtue. As a result, the individual who regularly engages in it may get positive feedback from others as well as an increased sense of self worth (Lawlor & Hopker, 2001). In addition, LTPA may function as a diversion from negative thoughts as well as mastery of a new skill (Mynors-Wallis, Gath & Baker, 2000). Positive mood changes with exercise have also been linked to extrinsic motivators including positive social norms related to family and friends, contact with other exercisers, esteem, social support and a positive exercise experience (Courneya &
Intrinsic motivators such as role identity, self-regulation, outcome expectancy value and self-efficacy can also contribute to motivation and intent to exercise (Petosa, Suminski & Horta, 2003).

Biochemical alterations as a result of physical activity, including changes in endorphin and monoamine concentrations, have also been found to bring about positive mood changes and antidepressive outcomes. Measurement of local neurotransmitter release during on-going behavioral changes such as exercise indicate that the release of most neurotransmitters are influenced by exercise (Leith, 1994; Meeusen & De Meirleir, 1995; Thomen, Floras, Hoffman & Seals, 1990).

Emphasis on exercise treatment has frequently occurred in clinical populations or with those having exhibited prior symptoms of anxiety or depression, where improvements are typically more pronounced compared to those of “normal” individuals where changes are generally modest to non-existent (Raglin, 1990; Lennox, Bedell & Stone, 1990). Studies examining LTPA and mental health outcomes in populations at risk (e.g. clinically depressed, the elderly and those with coronary artery disease (CAD) and coronary heart disease (CHD), arthritis, fibromyalgia, etc.) appear to produce greater degrees of antidepressant effects than those in the general population (Berger, 1984; Morgan & Hortsman, 1976; Scully, Kremer, Meade, Graham, & Dudgeon, 1998).

It is thought that in these at risk populations, exercise and physical activity are seen as a potentially beneficial, distracting tactic rather than an adjunctive strategy in its own right. Therefore this form of therapy is considered a choice and an individual responsibility rather than an imposed course of treatment (Faulkner & Biddle, 2002).
Since it is estimated that about 50% of the population are affected by a mental disorder during their lifetime and that the most common forms are mood and anxiety disorders, the costs for the standard forms of therapy are medication and various forms of psychotherapy are escalating and the health care system will never be able to meet the need for treatment in this large group of patients. Hence, the development of effective, low cost, self-help strategies is important (Martinsen, 2000).

Lawlor and Hopker (2001) conducted a meta-regression analysis of randomized, controlled trials of exercise prescription and the management of depression. They found compliance with medication management is often inadequate among those diagnosed with clinical depression. Their review revealed that although exercise may be efficacious in reducing symptoms of depression in the short term, poor study quality, brevity of follow up, the use of mostly non-clinical volunteers and the long term nature of treatment makes its true effectiveness largely unknown. Salmon (1990) observed that depressed patients often have to contend with an absence of motivation to tackle simple features of life's daily routines, much less activities such as running or aerobics. For this reason, the depressed patient may become overwhelmed with another daily task and neglect an exercise prescription whereas for the average, healthy individual experiencing moderate stress, or those having mild depressive symptoms, the potential role of LTPA as treatment and prevention may be underestimated.

Bouchard (1986) found that physical responses and adaptations to exercise training appear to have strong genetic components. He makes the case that mental health improvements based on subjective psychological parameters may not be dependent on objective measures of improved fitness, such as strength, flexibility or body composition,
but rather on a genetic component. La Porte and his colleagues (1983) found that in a group of healthy, untrained subjects, psychological improvements were attributed to an introduction to, or increase in exercise, rather than any objective measure of improved fitness. Plante (1999) went further, examining the possibility that some of the positive psychological results associated with LTPA may occur from the mere “experience” of trying to get fit, or believing that one is fit, rather than from measurable increases in fitness. In a review of LTPA studies, Moses, Steptoe, Matthews and Edwards (1989) state “If positive mental changes result in all exercise groups regardless of protocol then benefits might be present, to varying extents, in all programs (p. 59). This is an argument for the importance of including some form of physical activity in all health promotion interventions.

C. Psychological Analysis Methods and Considerations

Previous investigations into exercise treatment and psychological status have implemented a variety of tools to assess treatment and outcome. Several instruments have been used, depending upon the type of treatment and population. Studies on anxiety and depression in both clinical and non-clinical populations have mainly used the Beck Depression Inventory (BDI), Center for Epidemiologic Studies Depression Scale (CES-E), State Trait Anxiety Inventory (STAI), Mental Health Inventory (MHI), Positive and Negative Affect Schedule (PNAS) and the Spielberger State Anxiety Inventory (S-Anxiety). College or non clinical populations studied for stress and personality traits have used the Tennessee Self-Concept Scale (TSCS), Daily Hassles Scale (DHS) and General Well-Being Schedule (GWB). For studying mood, the Brunel University Mood Scale (BUMS), and the Profile of Mood States (POMS) (Cramer, Nieman & Lee, 1991;
Gowans, DeHueck & Abbey, 2002; Lane & Lane, 2002) have been used in both clinical and non-clinical populations. For this study, the POMS was selected for ease of application, economical scoring option and its emerging use in sport and exercise related research (Lane & Lovejoy, 2001; McNair, Lorr & Droppleman, 1971; Le Unes, Hayward, & Daiss, 1988).

In the last two decades, this self-reported psychological inventory has been used to assess transient, distinct mood states, and has been shown sensitive enough to detect mood changes in relation to a wide variety of therapies (Lorr, Daston & Smith, 1967). Although similar in purpose to other mood and mental health assessment instruments used in standard psychological research, the POMS has had two extensive bibliographies specifically documenting its relevance in sport related research (Le Unes & Egeberg, 1988; Snow & Le Unes, 1994).

The POMS assesses six affective mood states (tension, depression, anger, vigor, fatigue and confusion) by having subjects rate 65 adjectives on a five-point scale from "not at all" to "extremely" in terms of subjective feelings over a span of the past week or seven days. Based on responses, scores are obtained for subjects on mood states of tension/anxiety, depression/dejection, anger/hostility, vigor/activity, fatigue/inertia, and confusion/bewilderment. These six scales show adequate reliability and internal consistency indexes greater than .70 (Shachman, 1983). A "total mood disturbance" or TMD score may also be calculated. This measure reflects a generalized negative affective mood or total stress state for either acute or delayed (hours to weeks) effects of treatment by addition of all mood scores, with vigor/activity weighted negatively.
In a review of exercise research using the POMS, it has customarily been implemented in controlled, clinical situations recording acute changes in mood following a single bout of aerobic exercise. Markoff, Ryan and Young (1982) and Williams and Getty (1986), postulate that the acute activation of beta-endorphins during exercise could account for any immediate changes in mood, thus the POMS given at a later time may not be sensitive to mood change in response to exercise. Since habitual exercise is recognized as the most effective course to physical improvements, the study of possible mood changes might yield psychological alterations unique to long term programs.

D. Aerobic Leisure Time Physical Activity and Mood

A majority of investigations into mental health outcomes of aerobic training (AT) support its anti-depressive and anxiety reducing properties, substantiating the claim that mood improvements are associated with this mode of exercise (Brugman & Ferguson, 2002; Byrne & Byrne, 1994; Dunn, Tivedi & O’Neal, 2001; Paluska & Schwenk, 2000). Clinicians and researchers have employed AT as an alternative treatment for depression and anxiety related disorders, although many studies have addressed its effects in subgroups with less serious mental health issues. Reviews of clinical samples does suggest that AT is better than no treatment, and not significantly different in effectiveness from other forms of treatment, including psychotherapy (Dishman, 1994). Furthermore, AT appears to reduce state anxiety and depression in a general manner, although these changes tend to be transient in nature and AT must be repeated on a consistent basis for mood enhancement, transient or otherwise (Bahrke & Morgan, 1978; Blumenthal, Williams, Needels & Wallace, 1982: DiLorenzo, Bargman, Stucky-Ropp, Brassington, Frensch & LaFontaine, 1999; Wilson, Berger & Bird, 1981).
When examining effects of AT (or other related exercise treatment) on mood state, research is commonly quantified by several mediating factors that may include physical condition (current training status, VO₂ max, body fat percentage, etc), past and/or present physical and psychological disease (symptomatic or asymptomatic), exercise mode (cycling, running, walking, dance, swimming) and intensity (maximal or submaximal). For best results, participants should be evaluated prior to treatment and a baseline for both physical and mental health status established before investigating any relationships between physical change (increases or decreases in VO₂ max, body fat percentage and strength) and psychological change (general mood state, optimism, temperament, vigor, etc.).

A German pilot study investigated the short-term effects of AT in patients experiencing major depressive episodes lasting an average of 35 weeks (according to DSM IV criteria). Patients who walked on a treadmill 30 minutes/day for 10 days had significant reductions (p ≤ .05) in both subjective and objective depression scores. The authors concluded that in major, symptomatic depressive disorders, moderate intensity AT can produce substantial improvements in a relatively short time (Dimeo et al, 2001).

In a study of healthy participants, Steptoe and Cox (1988) examined the acute effects of AT on mood in female medical students. They showed high-intensity exercise (pedaling on a stationary bicycle against a load of 2 Kp/100 W for two, 8 minute trials) led to increases in tension/anxiety and fatigue, whereas positive mood changes (vigor and exhilaration) were only observed following low-intensity exercise (pedaling on a stationary bicycle against a load of .5 Kp/25 W for two, 8 minute trials). In a study that compared two levels of high intensity AT in trained female runners, Gondola and
Tuckman (1983) showed that vigorous AT (sub-maximal exertion) rather than exhaustive (maximal exertion) was most favorable for short-term, positive mood enhancement.

In a longer term study examining low intensity AT in healthy, untrained subjects, Cramer, Neiman and Lee (1991) found that moderate AT (5, 45-min sessions/week) of brisk walking decreased anxiety levels from baseline, with significantly lower stress scores at six weeks (p ≤ 0.05). However, by the 15th week of walking, initial mood improvements were not sustained. This suggests that low intensity AT, performed over longer periods may not retain initial increases in positive mood. Likewise, Lennox, Bedell and Stone (1990) found after 13 weeks of moderate intensity AT (40-60% maximum) in normal, non-depressed men and women, although subjects demonstrated significant improvement in physical fitness, there were no significant changes in either positive or negative mood. They contend that exercise does not appear to have any long-term beneficial effect on the mood of non-depressed individuals. In opposition, DiLorenzo et al (1999) studied long-term effects (12-24 weeks) of moderate intensity bicycle ergonometry (40-60% max.) in a healthy population. They found that in a 12 week AT fitness program, subjects experienced significant improvements (p<0.05) in mood state (vigor, exhilaration, etc.) and fitness (higher VO₂ max, lower heart rate, etc.) over a control group of non-exercisers. At one-year follow-up, physiological and psychological benefits remained significantly improved from baseline. This study showed that not only did the participants experience positive mood alterations during the study, improvements were sustained.
These studies and others suggest that in healthy, trained and untrained populations, AT using higher intensities (>60% of maximal capacity) may induce a negative mood state whereas moderate or lower intensities (<60% of maximal capacity) may have positive mental health outcomes, at least in the short term. Evidence also suggests low to moderate intensity AT programs, typically less physically strenuous and mentally demanding, may promote better initiation and maintenance (Dishman, Sallis & Orenstein, 1985; Sallis et al, 1986). In addition, moderate activity appears to be more readily maintained over a life span, whereas participation in vigorous activity can be sporadic or declines dramatically with age (Sallis et al., 1985; Dishman, 1994).

In studies with depressed, male, post-myocardial infarction patients involved in distance running (Kavanaugh, Shepard, Tuck, & Qureshi, 1977), and suicidal female college students in aerobic dance therapy (McCann & Holmes, 1984), researchers demonstrated that while there was evidence that exercise was effective in improving symptoms in both groups, it is unclear whether the effect was on the primary depressive state or through other mechanisms such as recovering from, or dealing with, these life threatening situations (Byrne & Byrne, 1994). In these groups, the distraction of physical activity, or simply the ability to engage in it, may have amplified a positive mood response. Nonetheless, it appears to be a positive form of therapy in these populations.

Simons and Birkimer (1988), in a review of factors predicting effects of AT on mood, found that in first time participants (with or without depressive symptoms), psychological improvement was predicted more by a lower baseline mood state than by any changes in physical measures, demographic ratings, beliefs or expectations regarding physical fitness. This may be, in part, owing to previously diagnosed or subclinical
symptoms particularly sensitive to any form of diversionary techniques, treatments or attention. In general, studies involving the clinically depressed have focused on improving baseline symptoms, therefore statistical comparisons to asymptomatic, healthy populations is somewhat difficult (Byrne & Byrne, 1994). However, it serves to highlight the importance of considering baseline mood and subsequent mood scores on all participants.

There are differences of opinion regarding AT and mood state. Some researchers believe that only higher intensity AT regimens, sufficient to produce a substantial increase in fitness, can positively affect mood state, while others demonstrate no relationship between objective measures of endurance fitness (e.g. oxygen use, blood pressure, etc.) and psychological effects (e.g. tension, anxiety, vigor, fatigue, etc.) (Hughes, 1984; King, Taylor, Haskell & DeBusk, 1989). In some studies, baseline mental and physical health status are considerable factors for researchers since clinically depressed and/or very sedentary participants may experience a significant improvement over lower baseline measures compared to healthier populations.

Taken as a whole, the effects of AT on mood state are contradictory, depending on factors including study population, baseline health status, AT mode or intensity and length of investigation. It is widely accepted that AT should be a lifelong endeavor; however, it appears that over extended periods of time it may have a diminished psychological effect. Given that a vast majority of the population could derive physical benefits from small to moderate increases in LTPA, and short term mental health improvements have repeatedly been found, more studies examining the effectiveness, practicality and comprehensive nature of exercise, particularly RT, are needed.

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E. Anaerobic Leisure Time Physical Activity and Mood

The differentiating factor regarding aerobic (with oxygen) and anaerobic (without oxygen) exercise is the degree of oxygen dependent energy pathways skeletal muscle cells require to sustain work intensity. In the initial seconds of explosive activity, the cell must produce energy without oxygen or “anaerobically.” Immediately thereafter, oxygen is readily available “aerobically” by the circulatory system, a much more efficient and productive energy pathway. As exercise activities are gradually increased, the body is forced to become more efficient in the ability to take up and use oxygen (i.e., increased “volume of oxygen maximum” or “VO₂ max”). Resistance training, performed at low to moderate intensities (<40-60% VO₂ max), is considered a type of anaerobic LTPA. Training at this pace will not dramatically improve VO₂ max; however; RT at lower intensities does have a profound effect on measures of strength and body composition (MacArdle, Katch & Katch, 1996).

It is recognized that to significantly improve certain measures of physical fitness (i.e., increased VO₂ max), a consistent moderate to high intensity AT program is required, although evidence has repeatedly shown that to achieve positive mental health benefits, physical activity need not be of higher intensity or exhaustive (Daley & Huffen 2003; McLafferty, Wetzstein & Hunter, 2004; Moses, Steptoe, Matthews, & Edwards, 1989; Steptoe & Cox, 1988). Most public health exercise guidelines have primarily promoted daily steady-state aerobic training (AT). This mode largely enhances cardiorespiratory fitness, where research on body composition and the musculoskeletal system shows that measurable results can likely be obtained in two, low to moderate intensity, 15- to 20-minute training sessions a week, results with less frequency and intensity than a
comparable AT regimen (Winett & Carpinelli, 2001). Since resistance training (RT) has also shown physical benefits with lower intensities and frequencies (Takarada & Ishii, 2002; Delecluse, Colman, Roelants, Verschueren, Derave, Ceux, et al, 2004) the possible effects of RT on dietary selection and mood need examination.

Effective RT involves precise, controlled movements for each major muscle group and does not typically require the use of heavy resistance. Since low to moderate intensities of RT can be performed at a slower pace, there are distinct advantages for populations unwilling or unable to participate in aerobic LTPA (typically higher intensities, of longer duration and/or without sufficient rest periods.) After accounting for initial health status and program design variables (frequency, duration, intensity, volume and rest intervals), functional and physiologic adaptations to RT are similar across gender and age, although there are differences in the absolute magnitude of that adaptation (Deschenes & Kraemer, 2002).

Raglin, Eksten and Garl (1995) conducted a study that examined mood state in male varsity basketball players during pre-season AT and RT conditioning. After five weeks of high intensity RT and sprinting exercises, mood state scores at baseline, weekly intervals and two weeks post training indicated that intensive training was associated with significant ($p \leq 0.05$) increases in stress, tension and anxiety, that returned to baseline only after a reduction in training intensity. The authors suggest a possibility that negative mood disturbances can be associated with high intensity training due to the intensity and amount required for shorter time periods in sport conditioning situations; however, this is not what typically occurs when those in the general public take on a program of physical activity.
O'Connor, Bryant, Veltri & Gebhardt (1993) found that a group of healthy women doing 30 minute sessions of six different RT exercises, with similar volumes (3 sets, 10 repetitions) but differing intensities (40%, 60% & 80% of 10 repetitions maximum, RM). Those in the 60% and 80% RM groups had significant short term reductions (p ≤ .05) in state anxiety from pre-exercise values at both 90 and 120 minutes post bouts. This suggests that in healthy women, RT of greater intensity may be a factor in short term anxiety reductions. Tsutsumi, Zaichkowsky, & Takenaka (1998) compared moderate (low weight) and high (heavy weight) intensity RT protocols on mood and anxiety in sedentary older women. It was only the moderate intensity (low weight) RT that reduced general state anxiety and significantly improved positive mood (vigor) (p ≤ .05) when compared to no RT controls. Auchus & Koslow (1994) investigated a similar, moderate intensity RT regimen on depressed subjects in a clinical setting. All participants demonstrated improvements in objective measures of musculoskeletal strength and cardiovascular endurance, while scores on a self-rated depression scale showed that depressive thoughts significantly decreased and there was no worsening of previous symptoms.

Perhaps positive mental health outcomes, assuming they exist, are due in some measure to the lower intensity and methodical pace at which RT can be performed. This pace may provide the participant an opportunity to engage in stress-reducing cognitive activities such as meditation or conversation, which can positively affect mood (King, Barr-Taylor & Haskell, 1993). Other features of exercise that are thought to exert a general, positive influence on mood are mastery (White, 1959), self-efficacy (Bandura, 1977), and distraction (Bahrke & Morgan, 1978). Although not addressed specifically in
In this study, it is conceivable that these cognitive factors, apart from the physical activity itself, are partially responsible for any positive changes in mood state (Leith & Taylor, 1991).

Although the mechanisms mediating the psychological effects of exercise are still unknown, trends do emerge. Benefits appear to be more pronounced when the exercise is of a lower to moderate versus high intensity and/or when the participant has a more negative baseline mood state. Moses, et al (1989) postulated that mood may be positively influenced by simply initiating and participating in LTPA, rather than any particular mode or quantitative fitness improvements. Since the current body of evidence for low to moderate exercise shows considerable health benefits and no psychological harm (Bouchard, et al, 1989; Dishman, 1994), it is of considerable interest to find out if there are mood related advantages or disadvantages to different volumes and varieties of low impact, highly adaptable RT in a healthy, untrained population.

F. Leisure Time Physical Activity and Diet

Diet plays a fundamental role in health status, more so as rates of overweight and obesity steadily increase. The availability of calorically dense, highly palatable and inexpensive foods, coupled with the sedentary lifestyle habits common today often leads to a shift in body composition from lean to fat tissue (Cullinen & Caldwell, 1998). In order to correct these trends, a negative energy state must be induced by either restricting energy input, increasing output or, ideally, a combination of the two. Segal and Pi-Sunyer (1991) clarified this when they concluded that exercise alone, without caloric restriction, is probably insufficient to yield significant fat loss except in individuals who are extremely motivated. As a result, moderate dietary restriction in combination with an
increase in LTPA is routinely recommended (Jakicic, et al, 2001; Shepard, 1985; Tucker, 1996; Tremblay & Almeras, 1995).

It is well-known that substantial caloric restriction without exercise can cause significant declines in resting metabolic rate (RMR) primarily due to decreases in lean body mass (Apfelbaum, Bostsarron & Lacatis, 1971) and long term sedentary behavior alone can cause a decline in RMR, once again relative to decreases in lean body mass and increases in fat stores (Poehlman, 1989; Mole, 1990). Since RMR accounts for 60-70% of the body’s total daily energy expenditures, any decline diminishes the body’s absolute capacity to burn a substantial amount of calories. To counter these metabolic alterations that often favor obesity, Stunkard (1983) pointed to the vital role of LTPA in acute energy expenditure and in the building and maintenance of lean muscle mass. Over time, favorable shifts in body composition can slow or reverse age related declines in lean tissue, RMR, and adipose tissue deposition. However, these alterations do have a dietary component where caloric intake and macronutrient selection have a significant impact.

Aerobic LTPA primarily affects metabolic rate by an acute increase in energy expenditure during the activity. A common belief is that exercise can cause increases in appetite and caloric consumption that essentially negates the amount of energy used to perform the activity, although this has yet to be established (Blundell et al, 2003; Donnelly et al, 2003; Franklin & Rubenfire, 1980). Resistance training, although not typically performed at acute levels with high-energy expenditures, can, over time, slow or reverse long term declines in resting metabolic rate (RMR) (60-75% of daily energy needs, incorporating sleep, basal and arousal metabolisms) by facilitating improvements
in the amount of metabolically active tissue which can aid in maintaining or increasing basal metabolic rate (BMR). This can have a long-term effect on energy balance and the potential for overweight/obesity where the number of calories needed to maintain a healthy weight does not diminish as rapidly over time.

Many theories related to exercise and the control of food intake involve bodily macronutrient stores and/or metabolism, where physical activity may influence brain signals for hunger and satiety via peripheral cellular mechanisms. Experimental evidence suggests that these mechanisms have a direct effect on the nervous system and can act as mediating factors in energy expenditure and consumption (Tremblay & Almeras, 1995). Equally intriguing are the theories on exercise and intake where hedonic response to food, visual stimuli, cultural and social factors play a more significant role. Nevertheless, increasing physical activity in a majority of the population is critical for advancing the public health. With a better understanding of the potential dietary changes as a result of different exercise modes, the development of more effective, individualized protocols that address the environmental as well as neurochemical adaptations would be possible.

G. Dietary Analysis Methods and Considerations

In order to accurately measure dietary outcomes of treatment, it is necessary to recognize the limitations in methodology across studies. In a free living population, even the most highly controlled and comprehensive data gathering techniques may not represent true dietary intake, habits and patterns. Several factors consistently have an effect on results including compliance to treatment, environmental conditions, sociocultural factors, food availability and adherence to documentation protocol (Titchenal, 1988). In a review of food intake assessments, Lee-Han, McGuire and Boyd
(1989) concluded that although no single strategy is entirely satisfactory, the method most often used by nutritionists is the "daily, self-reported written food record." Other methods include: precise weighing and measuring, weighted inventories by investigators, diet histories ("usual" intake), diet recalls ("actual" intake), diet diaries, food frequency questionnaires and food checklists (Block, 1982; Fehily, 1983). The primary cautions regarding all methods of dietary assessment involve reliability and validity. Depending on the data gathering method, these can be substantially influenced by the quality of documentation instruction.

Dietary recording requires subjects to keep detailed accounts of everything they ingest, where amounts are typically recorded as standard household measures or by estimation based on model portions. Due to the awareness and effort required by the recording procedure, normal intake patterns and amounts can be misrepresented. A main concern is underestimation and distortion, a situation frequently more pronounced in respondents who are obese and/or eating disordered (Hill, Rogers & Blundell, 1995). Bingham (1994) found that in a normal weight population, under-reporting is not necessarily indicative of conscious bias or disordered eating but a phenomenon known as "impression management." To find favor with the researchers, subjects in his study appeared to under-report fat and sucrose intakes more often than "healthy" nutrients such as vitamin C rich foods.

In a review of dietary intake measurement, Hill, Rogers and Blundell (1995) reported that in nutrition research, no simple and highly accurate methods exist. Most assessments increase awareness and cause subjects to alter or otherwise deviate from normal dietary behaviors. These alterations customarily result in a degree of trade-off
between accuracy (i.e., good measurement of what is actually eaten) and validity (i.e., good measurement of what is usually eaten).

In a study of collegiate swimmers, Burnette et al (1994) analyzed intakes over a two-year period to statistically determine the minimum number of daily food records necessary to estimate an average seven day caloric and macronutrient intake. They found a minimum of three days was required for an estimation within 10 percent (i.e. 90 percent accuracy) of a much longer record keeping period. In addition, Heady (1961) found that in a population of bank clerks, group mean intake values did not vary significantly from day to day as individual values did. He concluded that the usefulness of short-term dietary intake analysis for calculating the mean intake levels of a group, as opposed to individuals, is reasonably well established.

Obtaining measurements of dietary intake in a free-living population is difficult. Even in highly controlled situations, the simple act of manually recording all foods and beverages consumed can alter both routine and spontaneous eating behaviors. This heightened awareness typically prevents a highly accurate representation of dietary content, meal patterns and portion sizes. Although not likely to remedy all bias, strategies to counteract such discrepancies include a blind, numbered identification of diet records, neutral party analysis and detailed initial instruction (Hill et al, 1995).

Although the seven day food record has been a standard practice, studies that have looked exclusively at macronutrient and daily caloric intakes for groups have shown that shorter, three day records are practical and sufficient in representing a valid proxy measure for investigating dietary changes (Lee-Han, McGuire & Boyd, 1989).
H. Aerobic Leisure Time Physical Activity and Diet

A majority of investigations examining the relationship between LTPA and diet have focused on AT, where there appears to be an inconsistent effect. In all exercise related research, differences in duration, intensity, frequency, timing of intervention and study population create considerable variations in total energy expenditure, substrate oxidation and eating behaviors. In the past several decades, AT research has examined various aspects of substrate oxidation (primarily fat and carbohydrate), energy balance (favoring weight loss), aerobic capacity, fitness and to a lesser extent, psychological outcomes. A recent emphasis on energy balance and macronutrient oxidation is likely due to the steady increase in population overweight/obesity and sedentary behaviors, which often result in persistent efforts to lose weight.

In early reviews, Woo and Pi-Sunyer (1985) and Pi-Sunyer (1987) found that promotion of exercise for the treatment of obesity had been based on the double premise that exercise increases caloric expenditures while simultaneously generating metabolic signals that can reduce food intake. This assumption was based primarily on animal studies since the methodological problems associated with measuring human energy intake, expenditure and body composition shifts are great and frequently result in inconsistent and contradictory data. Despite this, and due to the growing problems of obesity and a sedentary lifestyle, human studies on LTPA, diet and interactions with the various metabolic systems remain a popular topic of interest.

Almeras, Lavallee, Depres, Bouchard and Tremblay (1995) found a distinction in post exercise substrate oxidation between subjects based on exercise respiratory quotient (RQ). They observed the dietary intake of men in a sedentary control session meal and a
session meal preceded by a 90-minutes exercise bout at an intensity of 60% maximum volume of oxygen (VO₂ max). They found that in general, mean post-exercise energy and macronutrient intakes are not modified by prolonged vigorous exercise. However, when subjects were subdivided into two groups on the basis of the respiratory quotient (RQ) measured during exercise, men with a low RQ (high fat oxidation) were characterized by a reduced postexercise increase in energy intake relative to the energy cost of exercise (ECE) (i.e., they were more predisposed to be in negative postexercise energy balance compared to those exhibiting a high RQ.) These results show that postexercise energy balance partly depends on the composition of the substrate mix oxidized during exercise.

Typically, it is obese individuals who are known to be high fat oxidizers due to the mass effect of free fatty acid (FFA) mobilization from enlarged adipocytes (Schultz, Tremblay, Wensier & Nelson, 1992). The speculation is that in low exercise RQ (high fat oxidizers) post exercise carbohydrate depletion may be less pronounced. This could presumably lower the risk for elevated postexercise carbohydrate intake, a more sensitive balance, if carbohydrate stores are a predictor of post exercise eating behaviors.

An alternate metabolic system theory was recently published, based on a review examining hepatic regulatory mechanisms during exercise. Lavoie (2002) speculated that during exercise, hepatic glucose production is central to blood glucose homeostasis. For this reason, the liver may send afferent signals to the central nervous system (CNS) and other organs of a diminishing capacity to produce glucose from glycogen. Lavoie claims this feedback system, combined with derivatives of substrate oxidation, hepatic cell volume and other energy related compounds (adenosine triphosphate (ATP) and
phosphorous (Pi)), may work together such that the sensory role of the liver during exercise would be similar to its role in the control of food intake. This may signal appetite and increase intake of carbohydrate to compensate for diminished glucose (simple carbohydrate) availability.

King, Tremblay and Blundell (1997) published a review article that investigated the effects of aerobic LTPA on subsequent food selection. They postulated that the body’s main source of energy during a particular form of exercise (acute bouts using a higher percentage of intra-muscular glycogen versus prolonged sessions relying more on stored triglyceride) would stimulate a drive to obtain that particular nutrient (e.g., carbohydrate or fat, respectively): however, they could find no clear evidence for this. They did find data suggesting that habitual increases in physical activity may be associated with increases in carbohydrate intake, although it was uncertain whether this is biologically driven or the result of a psychological “reward” justification. Ultimately, they concluded that food selection and nutrient intake rely less upon exercise or short acting post-ingestive physiologic responses and more on environmental influences and habitual consumption patterns that are relatively immune to the metabolic demands of exercise.

Although general in nature, King, Tremblay and Blundell (1997) developed three theories for what occurs with energy intake as physical activity is increased: (a) a compensatory effect of increased energy intake for output; (b) an exercise induced suppression of energy intake involving metabolic and/or psychological effects, and (c) an exercise induced alteration in food choice or nutrient selection based on either physiological demand or psychological justification.
In a subsequent review of both interventionist and correlational studies, Blundell and King (1999) came to the conclusion that there is no more than “a rather loose coupling” of expenditure to intake. In a similar analysis and conclusion, van Baak (1999) found that modest decreases in body mass and fat associated with increased aerobic LTPA are only partly compensated for by an increased intake, and this “coupling” is less at lower training intensities.

Melanson, Sharp, Seagle, Horton, Donahoo, and Grunwald, et al, (2002) examined the effect of exercise intensity on 24-hour energy expenditure (EE) and substrate oxidation. Sixteen adults (8 men and 8 women) were studied on three occasions (a sedentary day, a low-intensity exercise day (400 kcal at 40% of VO2 max) and a high-intensity exercise day (400 kcal at 70% of VO2 max.) Both 24-h EE and carbohydrate oxidation were significantly elevated on the exercise days, but 24-h fat oxidation was not different across conditions. They concluded that exercise intensity has no effect on 24-h EE or nutrient oxidation.

Kissileff, et al (1990) used an animal model of exercise induced anorexia to develop a laboratory paradigm for studying the acute effect of exercise intensity on food intake. On each of three consecutive days, groups of obese and non-obese women exercised either strenuously (90 Watts) or moderately (30 Watts) on a cycle ergometer for 40 minutes, or alternately, rested. Post bouts, non-obese women consumed significantly less of a liquid test meal (1.04 kcal/g) 15 minutes after both strenuous and moderate exercise treatments. The obese women did not show a similar distinction, consuming approximately the same amount of the test meal after both the strenuous and
moderate intensity treatments. These researchers demonstrated that only in non-obese women did food intake appear to be reduced immediately after exercise.

Klausen, et al (1999), in a randomized, crossover design examined exercise intensity and 24 hour post bout fat intake in healthy males and females. Twenty-four hours after a single 60-minute bout of low-intensity (30% of VO$_2$ max) or 30 minutes of high intensity (60% of VO$_2$ max) exercise, a breakfast buffet was offered. After low intensity exercise, both groups selected a meal with an energy percentage from fat similar to that of their habitual diet. After high intensity, the groups chose a diet that was 4.2% higher in fat than their habitual diet, a non-significant increase. These researchers suggest that in both males and females, higher intensity exercise increase acute fat intake, but only slightly. Additional studies have shown that individuals exercising at lower intensities exhibit overall higher energy intakes (Dichson-Parnell & Zeichner, 1985) while other studies find that higher intensities can invoke transient anorexia (King, Barr-Taylor, & Haskell, 1983). Once again, the disparity in outcomes suggests that there are more individualized factors at play.

Tremblay, et al (1994) found that when healthy subjects performed a 60-minute treadmill exercise followed by a 48-hour observation with free access to either a low-fat, mixed or high fat diet, substantial (-6.4 MJ) and moderate (-4.5 MJ) energy deficits were only observed in those who consumed the low-fat and mixed diets, respectively. They suggest that habitual increases in energy intake associated with a freely selected high fat diet are sufficient to fully compensate for the energy deficit resulting from the exercise and postexercise energy expenditures. These differences in intake between individuals
suggests once again that environment, access and habitual behaviors may override more sensitive metabolic processes.

Examining exercise and appetite, LLunch, King and Blundell (1998) revealed that in female restrained eaters, exercise increased the perceived pleasantness of food, however, it did not increase the impetus to eat or the total amount consumed. They concluded that exercise could not only help to control short-term appetite in certain populations, but may increase the enjoyment of controlled amounts, thus averting possible long term over consumption. In addition, Blundell and King (1998), in a review of exercise and appetite, noted that several recent studies document that substantially longer exercise bouts did not increase hunger or food intake in normal or obese subjects. Once again, they attribute this effect to a “very loose physiological coupling” of energy expenditure to intake, suggesting that significant compensation may not take place regardless of the exercise protocol. Since increases in LTPA alone often produce disappointing weight loss effects, other factors such as habitual intake patterns, poor food choices, indiscriminate amounts, justification of food related rewards following exercise and miscalculations as to exercise caloric expenditure of a given bout may account for this effect. Thus, it appears that perhaps this “very loose physiological coupling” may have at least some psychological underpinnings. If psychological factors can have an effect on energy and nutrient intake, are there also gender differences?

Westererp et al (1992) examined long-term aerobic regimes (40 weeks) and found that men tended to slightly reduce their intake over time (200-300 kcals) while women increased their intake (200-500 kcals). He concluded that such responses might be gender specific and based on biological and evolutionary differences. Tremblay et al.
(1984) did a similar study and found a significant linear relationship of increased exercise expenditures and compensatory dietary intake in male, but not female, subjects. The differences could be explained by study design where Westererp et al (1992) used long-term aerobic regimes while Tremblay et al (1984) used only acute bouts. Although these methodological differences may have had some influence, it is difficult to form conclusions based on sex differences.

In a recent review article, Blundell, Stubbs, Hughes, Whybrow and King (2003) examined the relationship between aerobic LTPA and appetite control. They determined that LTPA has the potential to modulate appetite by at least three measures: the peripheral satiety signaling system, the adjustment of macronutrient preferences, or food choices and alterations in the hedonic response to food. They found no clear evidence that exercise has an immediate effect of increasing hunger, however, as LTPA becomes habitual, food intake begins to increase in order to provide compensation for about 30% of the energy expended in activity. They contend that this compensation is partial and incomplete, therefore energy expenditures coupled with reductions in energy intake can result in weight loss or control. Upon further review, they found evidence for classifying individuals as energy compensators and non-compensators, based on subsequent weight fluctuations. This observation furthers the complex interplay of psychological and behavioral mechanisms related to LTPA and food regulation.

Despite the contradictory evidence regarding the influence of exercise on diet, there is overwhelming evidence that moderate to vigorous exercise results in considerable physical health benefits (Bouchard, Shepard, Stephens, Sutton & McPhearson, 1989). Food selection and intake vary, and depend on several factors, including genetics, gender,
exercise intensity, duration, biological processes fitness level and body composition. More diverse are issues relating to environmental stimuli, social and cultural values, habitual intake patterns and cognitive perceptions of exercise expenditure and what effect regimens differing in volume, variety or both would have in the long term modulation of these factors.

I. **Anaerobic Leisure Time Physical Activity and Diet**

Anaerobic, strength or resistance training (RT) has experienced a popular resurgence as an effective mode of LTPA. It is an effective means for increasing lean body mass (Mathews & Fox, 1976) and, as long as the total net energy cost of the exercise contributes to a total energy deficit, can contribute to successful long term weight management (Melby & Hill, 1999).

In a review of RT benefits, Tucker (1982) maintains that the rewards are so consistent and overt that few other activities, whether physical, cognitive or social, can offer such tangible results. Although there is extensive evidence regarding the structural and metabolic consequences of a systematic RT program, there is a distinct paucity of data concerning effects of RT on dietary intake.

In a review of physical training, macronutrient balance and body weight control, Tremblay and Bueman (1995) note that in general, the body’s protein and carbohydrate balances are precisely regulated, and during RT, carbohydrate is the preferred fuel source where subsequent energy deficits would come from body lipid stores. In the context of a weight control program, performing moderate resistance training activity and avoiding a diet high in fat (i.e., calorically dense) could accomplish this deficit situation and result in weight loss.
What then, is the amount or type of physical exercise that would have the greatest effect, if at all, on fat intake? It appears that balances in carbohydrate and fat oxidation are critical factors, as both contribute substantially to metabolism both at rest and during exercise (Tremblay & Bueman, 1995). Since the body has a relatively small capacity to store carbohydrate as glycogen, the slower pace and interrupted nature of an initial regimen of RT is not likely to substantially deplete glycogen stores. Consequently, the body may not need to access adipose reserves. As RT persists and due to increases in training capability and proficiency, there may be more of a chronic metabolic demand on glycogen (carbohydrate) stores, a slightly higher protein requirement due to increases in growth and a subsequent need to utilize adipose energy stores resulting in an increase in calories and all macronutrients.

Tremblay, Despres and Bouchard (1985), in a review of mixed exercise training (anaerobic/aerobic) and energy expenditures, concluded increases in energy expenditures tend to be associated with an elevation in food intake in healthy, normal weight, free living individuals. Conversely, Woo et al. (1982) noted that mild to moderate aerobic exercise created a negative energy balance with no compensatory effect in energy intake. Conceivably, the type and duration of exercise could influence an individual’s psychological perception of metabolic energy demands and thus affect subsequent eating behaviors. This suggests that moderate levels of anaerobic exercise, such as those in a RT program, may have a different effect on caloric consumption and macronutrient intake when compared to mixed or strictly aerobic regimes due once again to the slower pace and interrupted nature of RT as opposed to the continuous and faster paced nature of aerobic training (AT).
Ultimately, eating is a set of behaviors associated with subjective feelings and physical experiences influenced by biologic processes (Hill, et al. 1995). De Castro (1996) in his analysis of exercise and nutrition, indicates that the combination of environmental, social and cultural stimuli can exert powerful but short-lived effects on intake; however, physiologic stimuli appear to have a subtle and more persistent influence. He found the that dietary effects of habitual exercise became clear over longer periods of time, producing a cumulative decrease in food intake whereas the effects of random, short-term bouts of exercise resulted in no net deficits.

Tucker, Harris and Martin (1996) examined RT and subsequent macronutrient intake. Dietary changes were recorded in 70 female participants assigned to a 12-week RT program or a control (flexibility) program. Referencing detailed, seven day diet records from baseline, sixth and 12th weeks of training, they found positive changes in total strength significantly related (p< 0.05) to dietary changes in the lifting group. Specifically, as strength increased, dietary fat consumption decreased (34.2% to 30.4% to 29.7%, baseline to 6 weeks to 12 weeks, respectively) and carbohydrate consumption increased (51.4% to 55.8% to 55.6%, baseline to six weeks to 12 weeks, respectively) over those of controls (fat 32.1% to 33.1% and carbohydrate 53.0 % to 52.3%, baseline to 12 weeks, respectively). Changes occurred primarily within the first six weeks of training and were maintained for the duration. Furthermore, those subjects in the lifting group who gained the most strength tended to make greater dietary improvements in terms of reducing fat and caloric intake. Total energy intake was also related to group assignment, where lifters tended to decrease intake (approximately 225/kcals/day baseline to 12w), controls showed no significant change either way. These results
suggest that compared to flexibility training, RT programs may improve diet by increasing carbohydrate intake while decreasing fat and total calories.

Although evidence shows that RT effectively increases lean muscle mass and strength, its effects on energy balance and regulation of body weight appear to be predicated on changes in body composition (e.g., increases in lean muscle mass) rather than by the direct energy costs of the RT (Poehlman & Melby, 1998). Subsequent dietary intake may also cause food-related cues to seem more important than exercise related signals (Pi-Sunyer & Woo, 1985).

It is clear that percentages of energy substrates at use during both AT and RT exercise (primarily carbohydrate and fat) depend on numerous factors including intensity and duration, food intake before and after exercise, composition of the diet, environmental conditions, gender and training status. How the body regulates interactions between carbohydrate and fat are still incompletely understood (Jeukendrup, 2003). More elusive are the interactions of exercise substrate utilization and eating behaviors. There appears to be enormous inter-individual variations, despite low intra-individual variation. More research is required to determine if there are significant interactions between RT volume, variety, and macronutrient selection where the potential to positively influence health status through a combination of improved strength, body composition and subtle dietary improvements could be of value to preventive care.

J. All Leisure Time Physical Activity, Mood and Diet

Few studies have simultaneously examined a possible three-way interaction of nutrition, mood and obesity. Those that have typically focused on acute aerobic exercise
in athletes and longer-term weight management in predominately obese or overweight female populations, where there does not appear to be any consistent associations.

Keith, O'Keeffe, Blessing and Wilson (1991) studied alterations in macronutrient intake and mood state in elite female cyclists. The cyclists were randomized into different diet groups containing low, medium or high carbohydrate ratios. Diets were administered in random order, and each subject consumed each of the three diet treatments at some point in the investigation. At the end of each weekly diet treatment, subjects rode on a cycle ergometer at 80% VO\textsubscript{2} max until fatigued. Cyclists continued light training during the diet treatments. Following each diet treatment and immediately prior to the fatiguing cycle ergometer ride, cyclists completed a POMS questionnaire to assess mood state. There were no significant differences between medium and high carbohydrate groups; however, low carbohydrate intake in conjunction with training adversely affected mood state. These results suggest acute, negative mood alterations with low carbohydrate, pre-exercise meals in trained individuals exercising to fatigue. Although this study used elite athletes, it does imply a connection between exercise, macronutrients and mood.

Stetson, Schlundt, Sbrocco, Hill, Sharp and Pope-Cordel (1992) evaluated the psychological effects of aerobic conditioning in 40 moderately obese, sedentary women participating in a 12-week behavioral weight loss program. Participants were randomly assigned to a no-exercise or moderate walking condition and a hypocaloric diet. Emotional impact of the treatment was assessed in two ways: (1) Subjects reported subjective mood prior to each eating episode and (2) a self-reported psychological instrument (SCL-90-R) was administered before and after the program. Exercisers lost
more weight and body fat than non-exercisers. Both groups of subjects showed numerous improvements in mood as a result of participating in the weight loss program. Exercise had no specific differential effect on emotions as measured by daily mood ratings or the SCL-90-R. Although exercisers lost more weight and body fat than non-exercisers, exercise per se had no specific differential effect on emotions or mood and did not appear to add appreciably to the psychological benefits of losing weight.

Wadden, Vogt, Andersen, Bartlett, Kuehnel, & Foster, et al (1997) studied the effects of 48 week aerobic and RT program on appetite, mood, body composition and resting energy expenditure (REE) in obese women randomly assigned to one of four treatment conditions: diet alone, diet plus aerobic training, diet plus RT, or diet combined with aerobic and RT. All participants received the same group behavioral program and were prescribed the same dietary protocol. Exercising participants were provided three supervised exercise sessions per week for the first 28 weeks and two sessions weekly thereafter. Across the four treatment groups, participants achieved a mean weight loss of 16.5 +/- 6.8 kg at Week 24, which decreased to 15.1 +/- 8.4 kg at Week 48. There were no significant differences among conditions at any time for changes in weight, body composition, appetite or mood, indicating that in this group of obese women, neither aerobic or RT exercise resulted in significant dietary or mood changes.

Rippe, Price, Hessm, Kline, DeMers and Damitz, et al (1998) examined the effects of a 12-week, self selected hypocaloric diet, increased physical activity and group support weight loss program on psychological well being in moderately overweight women. Eighty women aged 20-49 years weighing between 20-50% above 1983 Metropolitan Life Insurance Tables, were randomly assigned to a weight loss intervention
(6279 kJ/week of physical activity, 33,258-41,462 kJ/week diet and weekly meetings) or served as controls. Subjects were tested on physical and quality of life measures pre and post 12 week intervention. The intervention group lost significant (p<0.001) body weight (kg) and body fat (%) compared to controls (-6.07 +/- 4.01 kg vs. 1.31 +/- 1.28 kg; 36.8%-32.5% vs. 36.2%-36.0). Similarly, physical activity levels also improved significantly (p<0.0001) in the intervention group (4.4 +/- 2.3 vs. 0.6 +/- 1.3; on NASA 0-7 scale). The authors concluded that in moderately obese females, increased activity, a self-selected hypocaloric diet, and group support are an effective combination for weight loss and psychological benefits.

In a similar study, without a group support component, Nieman, Custer, Butterworth, Utter and Henson (2000) studied the effects of 12 weeks of exercise training (five 45-minute walking sessions/week at 60% to 75% maximum heart rate) and/or moderate energy restriction (1200 to 1300 kcal/day) on mood in middle age (45.6 +/- 1.1 years) obese women. Subjects were randomized to one of four groups: (1) control; (2) exercise; (3) diet; and (4) exercise and diet. Psychological variables were measured in all subjects pre study, at three weeks, and again post study. They found that moderate energy restriction combined with exercise training, compared to control or diet only, improved general well-being scores.

Stewart et al (2003) took a different approach when, without any intervention, they looked at associations between existing levels of fitness, activity, fatness, health-related quality of life and mood in healthy, older (55-75 years) adults. Aerobic fitness was assessed by maximal oxygen uptake during treadmill testing, muscle strength by a one-repetition maximum, habitual activity by questionnaire, fatness by dual-energy x-ray
absorptiometry, and body mass index. Health-related quality of life was assessed by
the Medical Outcomes Study (SF-36), and mood by the Profile of Mood States (POMS).
They determined that higher aerobic fitness was associated with more desirable
outcomes, as indicated by the lower POMS anger and total mood disturbance scores and
by bodily pain, physical functioning, vitality, and physical component scores. Increased
fatness was associated with less desirable outcomes, as indicated by the higher POMS
anger, depression, and total mood disturbance scores and by the bodily pain, physical
functioning, role-emotional, role-physical, social functioning, vitality, and physical
component scores. Higher physical activity was associated with an increased POMS
score for vigor and decreased SF-36 scores for bodily pain. Strength was not related to
health-related quality of life or mood. Aerobic fitness was the strongest predictor of the
SF-36 score for vitality and the POMS score for total mood disturbance, whereas fatness
was the strongest predictor of the POMS anger score and the SF-36 bodily pain, physical
functioning, and physical component scores. They concluded that “even in the absence
of regular exercise and a weight-loss diet, relatively small amounts of routine physical
activity within a normal lifestyle, slight increases in fitness, and less body fatness are
associated with a better health-related quality of life and mood.” (p. 994)

Williams, Sunwit, Babyak and McCaskill (1998) found that in obese women,
personality and normal mood variation assessment prior to dietary intervention might
help to elucidate individual variations to treatment. For this investigation they looked at
normal emotional functioning (versus psychopathology) and the moderating effect of
neuroticism and extraversion on mood state in 40 obese women on a hypocaloric diet.
Participants completed weekly measures of negative and positive affect and measures of
anxiety and depression (Beck Depression Inventory [BDI]) at pre-mid-, and post diet. Results indicated that average negative and positive affect scores were each uniquely related to post diet BDI scores. Neuroticism was significantly related to negative affect during the diet and post diet BDI scores, and neuroticism and extraversion interacted to predict positive affect during the diet. The results suggest that assessment of personality and normal mood variation may be useful additions to weight-loss intervention and research.

The interaction of macronutrient intake, LTPA and mood is an area that has received little attention, and studies examining these interactions in average, healthy populations may result in data that can be used to encourage regular LTPA participation by highlighting any additional mental health and/or nutritional benefits.

K. Summary of Literature Review

Participating in any systematic LTPA program appears to affect certain measures of nutrition status and mental well being, however, the evidence is mixed and mechanisms are not clearly understood. The specific effects RT volume and variety has not yet been examined, and more research is needed to determine how and to what degree the average, healthy individual can benefit. Although it is recognized that RT alone will not lead to rapid loss of body fat, it does have several advantages that are shared with other types of LTPA. These include the positive nature of the prescription, the conservation and building of lean muscle tissue and establishing a positive lifestyle habit. Specifically, knowledge of how RT may modulate other health status parameters such as nutrition and mood, we will be better equipped to develop practical and comprehensive preventive care approaches.
CHAPTER 3

METHOD

A. Design

The current investigation was part of a prospective experimental study by Haddock, Marshak, Mason and Smith (2000). Study participants were randomly assigned to one of three RT protocols differing in volume, variety or both. At baseline and weeks 12 and 24, participant's basal metabolic rate (BMR), body composition and strength were measured. At the same intervals and coinciding with physiological testing appointments, participants completed a POMS questionnaire and turned in a 3-day diet diary corresponding to that week. Depending on randomization, training schedules included 2 sessions of 30-60 minutes of RT per week for the first 8 weeks, and increased to 3 sessions of similar length, per week, for the remaining 16 weeks of the study. The following describes the three RT study groups:

**Group 1:** Low volume (LV) One set of 8-12 repetitions to volitional fatigue or repetitions maximum (RM) using eight resistance exercises (an approximate 20-minute session).

**Group 2:** High volume (HV) Three sets of 8-12 RM, using the same eight exercises performed by Group 1 (an approximate 60-minute session).

**Group 3:** High volume and variety (HVV) One set of 8-12 RM, using the same eight exercises performed by Groups 1 and 2, plus an additional 16 different exercises for one set of 8-12 RM (an approximate 60-minute session).
B. Study Participants

According to a power analysis, with three groups, a medium effect size, and an alpha of 0.05, a minimum of 15 total participants per group was required for significance (Cohen, 1992). Due to study content, protocol and time commitments, a 40-50% attrition rate was anticipated. To allow for this, and to secure a minimum completing the study, an initial recruitment 35 per group, or 105 participants, was required.

One hundred and one male and female participants were recruited from the students, faculty, and staff of Loma Linda University and Medical Center through the following methods: pay check announcements, school bulletin boards, weekly departmental student/staff/faculty meetings, information flyers, oral announcements in classes and word of mouth. Participants were matched by gender to assure equal representation across groups. The Institutional Review Board (IRB) for Loma Linda University granted approval for the study.

All training was done on campus at Loma Linda University’s event facility, Drayson Center. This structure hosts a 5,800 square foot, state-of-the-art training and conditioning section, complete with free weights and a variety of RT equipment. At recruitment, each participant was required to verify facility membership and access.

C. Inclusion Criteria

1. All participants were available for approximately seven hours of testing during the three weeks of baseline instruction and testing, and four hours each at weeks 12 and 24.

2. All participants were required to verify the ability to adjust personal schedules to include two sessions of 30-60 minutes of RT per week for the first
eight weeks, and increase this to three sessions of similar length, per week, for the remaining 16 weeks of the study.

3. All participants were classified as apparently healthy according to ACSM classification (ACSM, 1995). They were not to take any nutritional supplements or make any specific dietary manipulations (i.e., creatine monohydrate, herbal diet aids, and commercial or covert weight loss schemes) which could influence their response to training. Those on prescription blood pressure, heart or diabetic medications were excluded.

4. All participants were between the ages of 20 and 40 years. All females were premenopausal.

5. All participants verified no involvement in a consistent RT program during the prior six months. A consistent program was defined as RT one or more times per week. Aerobic activities were not considered an exclusion factor.

6. All participants agreed to discontinue any current weight loss or weight gain strategies and refrain from any deliberate or covert dietary changes for the duration of the study. Each participant was instructed to eat spontaneously and to appetite satisfaction.

D. Procedures

After recruitment, screening and enrollment, a total of six baseline appointments were made by each participant:

1. A one-hour familiarization meeting at the Drayson Center gym facility introduced subjects to the 24 different exercises they would be tested on, regardless of group training protocol.
2. A one-hour oral instruction and written demonstration by a Registered Dietician (RD) outlining protocol for completing all dietary records and the psychological assessment instrument, Profile of Mood States (POMS).

3. A basal metabolic rate (BMR) measurement using a metabolic cart (Sensormedics Vmax29 Canopy system, Sensormedics, Yorba Linda, CA), a three-part body composition evaluation using a hydrostatic tank, seven-site skin fold caliper measurement and a Tanita™ bioelectrical impedance assessment (BIA), and an 11-site circumference measurement. At this appointment, a baseline POMS score was also obtained and the baseline 3-day diet diary was submitted.

4. A one-hour, one-on-one personal training session by an American College of Sports Medicine (ACSM) certified Health and Fitness Instructor (HFI). This session included detailed study protocol and exercise demonstrations. A record of participant's individualized ergonomic equipment settings was made. Each session concluded with confirmation by the trainer of correct form, understanding of RM and safety techniques.

5. At the last two baseline appointments, investigators measured each participant's baseline eight repetition maximum (RM) on all 24 exercises. To avoid undue muscle soreness and fatigue, the 24 exercises were divided into two 45-minute sessions of 12. Participants were randomized into the three groups: low volume (LV), high volume (HV) and high volume and variety (HVV) and were supplied with a bound training diary reflecting group assignment.
protocol sheets (See Appendix A.) They were instructed to record weights and repetitions for each exercise and to turn in this sheet each week for personal accountability and study tracking.

The two subsequent assessment appointments (See Appendix A) for strength, BMR, and body composition at weeks 12 and 24 were made by participants at weeks 10 and 22 respectively, when turning in weekly training reports (See Appendix B). The 3-day dietary diaries (See Appendix C) were handed over and POMS evaluations (See Appendix D) completed at each of the 12 and 24-week BMR/body composition appointments.

E. Measuring Instruments and Data Collection

In order to determine if RT volume and/or variety have an effect on diet and mood, instruments designed to measure and categorize the data were necessary. Three day written dietary intake records and the Profile of Mood States (POMS) (Lorr, Daston & Smith, 1967; McNair & Lorr, 1964) questionnaires were completed at baseline and at 12 and 24 weeks to assess the effects of RT volume and variety among groups, across time.

The diet records were used to analyze any changes in macronutrient and energy intake during the study period. Participants were required to turn in a three day, hand written dietary intake record at baseline and again at 12 and 24 weeks. Baseline diet recording sheets were supplied at a preliminary familiarization meeting where a Registered Dietician (RD) gave detailed instructions for accurate completion. These were collected at the first body composition appointment. The remaining two, three-day dietary intake records were bound in each participant’s exercise training journal at weeks
12 and 24, to be turned in at scheduled BMR appointments. An independent investigator (RD) blind to group assignment used the Nutritionist V computer program (version 2.2, 2000, N-squared Computing, San Bruno, CA.) for all dietary analyses.

The Profile of Mood States questionnaires (POMS) (Lorr, Daston & Smith, 1967) were used to analyze potentially chronic changes in mood state during the study, at baseline, 12 weeks and again at 24 weeks. This self-reported personality inventory has been widely used in investigations to assess transient, distinct mood states, and is sensitive enough to detect mood changes in relation to therapy. Recently, it has become a popular and useful psychometric instrument in sport related research. The 65-item questionnaire requires approximately three to five minutes to complete and was administered at baseline, 12 and 24 weeks, coinciding with scheduled BMR appointments.

F. Data Analysis

Repeated measures ANOVA was applied to all data including POMS scores, macronutrients and total kcals at baseline and weeks 12 and 24. The research questions and the methods used to answer them are as follows:

1. Does resistance training volume and/or variety have an influence on macronutrient and/or total energy intake of participants? By analyzing baseline, 12 and 24-week three-day food records, any changes in the total energy (kcal) and/or macronutrient intake percentages were determined among study groups, across time, with age and gender as covariates. Repeated measures ANOVA was used to determine where differences occurred.
2. Does resistance training volume and/or variety have an influence on mood states of subjects? By analyzing POMS scores from baseline to termination of the study, any changes in mood state were quantified between study groups and across time with gender and age as covariates. Repeated measures ANOVA was used to determine where differences occurred.
CHAPTER 4
PUBLISHABLE PAPER #1

Resistance training volume and variety have no effects on energy or macronutrient intake: A prospective experimental study

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Abstract

Background
Resistance training (RT) is recognized as the most reliable mode of physical activity for increasing lean body mass and strength, however little is known about its subsequent effects on dietary intake, a factor in favorable body composition change. The purpose of this study was to examine the effects of RT volume and variety on total energy intake and macronutrient percentages in a healthy, untrained population.

Methods
Participants (N = 55) were university employees and students randomly assigned to weekly RT exercise. The protocols were (1) low volume (LV): one set of 8 exercises for an average of 20 minutes, (2) high volume (HV): 3 sets of the same 8 exercises for an average of 60 minutes, or (3) high volume/variety (HVV): the same 8 exercises plus 16 more for one set of 24 exercises, for an average of 60 minutes. Three day written diet diaries were completed at baseline, and weeks 12 and 24. Dietary analyses were performed using a general, linear repeated measures ANOVA model to analyze sample means for the effects of exercise training volume or variety and treatment interactions across groups on all dependent variables with gender and age as covariates. Correlations were done on both macronutrients and kcals collapsing groups, over time.

Results
There was no significant effect of time, RT group membership, or a time x group interaction on measures of macronutrient percentage or energy intake. From baseline to 24w, there were negative correlations across groups between changes in carbohydrate and fat (r = -.77, p ≤ .0001) and between changes in protein and energy (kcals) (r = -.34, p ≤ .01). Across groups there was a slight, non significant decrease in energy intake from baseline to 24 weeks, averaging 148 kcal/week, for a total of 3,552 kcals, or the energy equivalent of one pound of body fat.

Conclusion
These results indicate no significant differences in total energy intake or macronutrient percentages across the three RT groups over time. Overall, greater interindividual changes were observed, suggesting factors other than the metabolic effects of RT have an impact on dietary outcomes.

Background
In a majority of the population, easy access to calorie dense, highly palatable and inexpensive foods coupled with advancing age and sedentary lifestyle habits have contributed to body composition shifts favoring increases in body fat and a loss of lean.
muscle mass (1-6). These changes often result in overweight and obesity which are closely linked with numerous disorders including diabetes, hypertension, cancer and heart disease, conditions that limit mobility and further affect the ability to be physically active (7). To prevent or mitigate this, excess body fat must be reduced and lean body mass maintained or increased by lowering energy intake (EI), raising energy expenditures (EE) or ideally, a combination of the two (8-10). Due to the alarming rise in obesity and sedentary habits in the US, where 61% of adults were overweight or obese in 1999 (11), it would be advantageous to investigate exercise protocols that may lead to positive dietary changes.

Most research to date regarding exercise and food intake has focused on aerobic activities, where several theories have been proposed but consistent evidence of an effect has yet to be found (12-19, 5). Strength or resistance training (RT) has received far less attention, although it is widely recognized as the most effective method available for maintaining and increasing lean body mass, countering declines in the resting metabolic rate which accounts for 60-70% of total daily energy expenditures (20). If positive dietary changes, such as restriction of energy intake (EI) or modification of macronutrient percentages (MP) were potential consequences of RT, determining the most effective protocol would be another step towards attenuating the current obesity and sedentary lifestyle dilemma.

For RT, the American College of Sports Medicine (ACSM) currently recommends a minimum of one set of 8-12 repetitions of 8-10 different exercises for untrained individuals (21-22), although there has been debate in the literature as to the effects of multiple sets versus single sets (volume) or single sets of numerous different
RT exercises (variety) on measures of strength, muscle mass and body composition (23-25). What has yet to be investigated is if dietary change (i.e. total energy (kcal) intake or macronutrient percentage) might naturally accompany RT regimens differing in volume, variety or both. If so, this might be another reason to encourage RT in an at-risk population.

The main energy substrates (carbohydrate and fat) are oxidized simultaneously both at rest and during RT exercise, although their relative contribution to the fuel mix depends on numerous factors including intensity and duration, acute intake, chronic diet composition, environmental conditions, gender and training status (26-27). Although there is a large amount of stored energy in adipose tissue, carbohydrate (as circulating blood glucose, muscle and liver glycogen) is preferred during acute bouts of exercise, although due to a limited storage capacity it can be rapidly depleted. Thus, from a physiological standpoint, increases in RT volume, variety or both may bring about greater acute post exercise EI (i.e., via carbohydrate, fat or both) to compensate for lowered muscle and liver glycogen stores and lower circulating blood glucose levels. In addition, increased energy needs associated with a higher BMI can also influence a greater post exercise EI (15).

Several researchers agree that habitual increases in physical activity may be associated with increases in carbohydrate intake, although they suggest uncertainty on whether it is biologically driven (lowered blood glucose and/or glycogen stores) or the result of a psychological reward justification for their efforts, or a combination of the two (28). The ambiguity suggests that food selection and nutrient intake may rely less upon exercise or short acting post-ingestive physiologic responses and more on environmental
influences and habitual consumption patterns that are relatively immune to the metabolic demands of exercise. This represents what some have found to be “a rather loose coupling” of expenditure to intake (29-31).

Evidence shows that RT increases muscular strength and endurance, where energy balance and regulation of body weight appear to be predicated on changes in body composition (e.g., increases in lean muscle mass) rather than by the direct energy costs of the resistance exercise (32). What effects the physical and psychological demands of exercise (i.e., RT) have on eating behaviors remains incompletely understood (14, 26, 33-34). The purpose of this study was to determine if RT volume, variety or both has an effect on total EI or macronutrient percentage in a healthy, untrained population.

Method

Participants

Participants were recruited from the students, faculty, and staff of Loma Linda University and Medical Center, 25-45 years of age, untrained (i.e., not involved in RT within six months prior to the study) and apparently healthy (35). All females were premenopausal.

One hundred one (n=101) participants originally volunteered to participate; 55 subjects completed the study. Despite the different demands of the three treatment protocols in terms of volume, variety or both, there was no significant difference in attrition across cohorts or study conditions.

Protocol

Participants were randomly assigned to one of three experimental groups: Group # 1: Low volume (LV) which involved one set of 8-12 repetitions to volitional fatigue
using eight resistance exercises (an approximate 20-minute session); Group #2: High volume (HV), which involved three sets of eight-12 RM, using the same eight exercises performed by Group #1 (an approximate 60-minute session); and group #3: High volume and variety (HVV), which involved one set of 8-12 RM, using the same eight exercises performed by Groups #1 and #2, plus an additional 16 different exercises, for one set of 8-12 RM (an approximate 60-minute session). All participants were given specific training instructions and checked for form and safety by an American College of Sports Medicine (ACSM) certified practitioner. The participants exercised 2x/wk for the first eight weeks, increasing to 3x/wk for the remaining 16 weeks, for a total of 24 weeks. The average age of those completing the study was 30.6 (+/- 0.9 years). Weekly progress reports of weight lifted and repetitions completed for each exercise were required and checked to determine protocol compliance.

**Dietary Assessment**

Three-day written intake records (36-38) including two week days and one week end day were used to analyze changes between groups in energy intake (EI) and macronutrient percentage (MP) at baseline and weeks 12 and 24. All dietary analysis was done using Nutritionist V (39).

**Data Analysis**

A general, repeated measures ANOVA model was used to analyze sample means for the effects of resistance exercise training (LV, HV, HVV) and time (baseline-middle-end) for both energy intake (EI) and macronutrient percentages (MP). Both age and gender were included as covariates. The Greenhouse-Geisser correction of degrees of
freedom was applied when appropriate due to rejection of Mauchly's test of sphericity (p= .012).

Results

Despite different RT volume and variety protocols, there were no significant effects on either EI or MP across groups or time (p>0.05). Table 1 shows repeated-measures ANOVA results for all three groups controlling for age and gender. There was no significant difference for EI (p=0.447) or macronutrient intake (fat p= 0.739, protein p=0.922, carbohydrate p=0.461) across groups, baseline to 24 weeks.

Table 1 also shows that there was no significant effect of time (baseline, 12 weeks, 24 weeks) for EI (p=0.731) or macronutrient intake (fat p=0.840, protein p=0.508, carbohydrate p=0.628) and no significant interaction between the exercise groups and time for EI (p=0.889) or macronutrient variables (fat p=0.531, protein p=0.687, carbohydrate p=0.781).

Table 2 shows the repeated measure ANOVA summary for all three groups baseline to 24 weeks. Despite varying RT volume and variety protocols, there were no significant differences in energy intake across groups at baseline, 12 or 24 weeks, evidenced by the overlapping 95% confidence intervals. Table 1 also shows no significant MP differences across groups evidenced by overlapping confidence intervals between each group for protein, carbohydrate, and fat intake.

Table 3 shows the repeated measures ANOVA summary of results for EI and MP for all groups at baseline, 12 weeks, and 24 weeks. Across groups, there were no significant EI differences at baseline or weeks 12 or 24 as evidenced by the overlapping 95% confidence intervals. Across groups, there were no significant macronutrient intake
differences at baseline, or weeks 12 and 24, as evidenced by the overlapping 95% confidence intervals.

Table 4 shows correlations for macronutrients and EI across study groups. From baseline to 24 weeks there was a negative correlation across groups between changes in carbohydrate and fat \((r = -.77, \ p \leq .0001)\) and between changes in protein and energy (kcals) \((r = -.34, \ p \leq .01)\).

Although there was a slight decrease in total EI across all groups (average 148 kcals/week) from baseline to week 24, this was not significant \((p = .73)\) due to wide interindividual variations (across groups baseline average of 2,500 kcal, while individuals spanned a decrease of 2,065 kcals at 12 weeks to an increase of 757 kcals by week 24). Over the course of the study however, this decrease across groups represents an average net caloric deficit of 3,552 kcals over 24 weeks, the energy equivalent of one pound of body fat.

**Discussion**

A better understanding of the physiological and psychological dynamics involved with exercise and eating behaviors is critical for achieving or maintaining an optimal body composition. The present investigation is the only one to date measuring the effects of different RT volume and variety protocols on diet in a healthy, untrained population. While metabolic mechanisms and psychological motivation exist for increased energy intake (EI) and carbohydrate percentage with greater energy expenditures (EE), this did not occur in the present study \((p \geq .88\) and \(p \geq .78\), respectively). Although not significant, there was a slight trend across all groups for lower EI from baseline to week 24 \((-148.3/\text{kcals})\). These results indicate that despite differences in the average number
of minutes spent RT per week (180 for HV/HVV versus 60 for LV) over a six month period, participants did not significantly alter dietary intake based on the RT group assignment. These results substantiate the notion that increases in energy expenditure (EE) do not necessarily lead to increases in energy intake (EI), thus supporting the “weak coupling” theory, where individual compensatory behaviors are shown to be partial and incomplete (40-41).

A recent review article on exercise and appetite control found no clear evidence that exercise has an immediate effect of increasing hunger; however, as exercise becomes habitual food intake begins to increase in order to provide compensation for about 30% of the energy expended in activity, which can result in weight loss or control (42). Statistically, the authors also found justification for classifying individuals as “energy compensators” and “non-compensators” based on data regarding EI, exercise and body weight fluctuations. A possible explanation for this has recently been proposed, implicating interplay of both physical and neurological stimuli. Sensitivity to reward (STR) is a personality trait firmly rooted in the neurobiology of the mesolimbic dopamine system (43). This was described as a trait construct that facilitates the ability to derive pleasure or reward from natural reinforcers such as food. Researchers speculate that those with this STR trait, which combines a neurochemical process with a behavioral outcome, may be at higher risk for overeating and overweight. This may result in certain individuals using food as a “reward” after exercise, especially in the US where palatable, inexpensive and calorically-dense food is plentiful (44). This could help to explain why, in many individuals, food related cues may be more important in the decision to consume than more subtle exercise related metabolic signals (45).
From a metabolic standpoint, we reasoned that the extended time commitment exercising the HV/HVV protocols (average 60 minutes) would deplete muscle glycogen to a greater extent than the LV protocol (average 20 minutes), resulting in an physiological drive to increase EI, primarily via carbohydrate. In support of this, physically active middle age men self selected a diet higher in carbohydrate content than sedentary controls (46). Other researchers found similar results in both physically active lean and untrained women (47-48). In an extensive review of exercise and diet studies, other investigators concluded that increases in training EE tend to be associated with elevations in total EI; however, our data did not support this (49).

From a psychological perspective, it was theorized that the greater amount of time and effort required to complete RT of higher volume, greater variety or both, might evoke compensatory rationale or reward justification for increasing overall EI through the typically more desirable macronutrients, carbohydrate and fat. A study found that sedentary women who participated RT did not increase EI (p = .28) but did improve macronutrient percentages by decreasing fat (p = .0002) and increasing carbohydrate (p = .0016) (49); however, the current study did not show a similar effect (10).

Although RT exercise of greater volume, variety or both could be used to justify increases in both EI and carbohydrate percentage, results of the current study as well as a majority of similar medium and long term investigations do not substantiate a convincing link (50-52). These results can have significant public health implications, particularly in untrained populations who desire an improved body composition, yet do not have the inclination to RT for longer periods of time or with complicated regimens. In terms of strength and body composition changes, high volume or high volume with variety RT
appears to have little or no advantage over a significantly lower volume, low variety RT regimen (53). Since the physical outcome measures (body weight, composition, circumferences and BMR) across groups are similar (53), and there appears to be no dietary changes with more extensive RT protocols, advocating a moderate RT regimen to those beginning a program is not only practical, but prudent. This is particularly relevant for untrained individuals who might be easily overwhelmed by larger amounts of exercise in the preliminary stages of health behavior change. In addition, over longer periods of time exercise alone may not be enough to overcome the social, cultural and environment stimuli that can influence dietary intake. If there are significant, positive dietary changes as a result of RT exercise, they may only be present in volumes and/or varieties that an average population could not physically or psychologically adhere to.

What may help to further elucidate dietary change in response to RT would be longer-term studies, using middle to older age populations and those with sedentary controls. By engaging in RT, these populations could maintain or increase lean body mass, positively affecting basal metabolism and measures of strength. Coupled with evidence from this study that that there are no naturally occurring dietary advantages to greater amounts of RT exercise, and that the most modest regimen is effective for increasing strength, flexibility and body competition, the potential for long term compliance and thus avoidance of overweight and obesity is considerable.

Summary/Applications

Based on the results of this investigation, it appears that untrained individuals on ad libitum diets who engage in RT differing in volume, variety or both over a 24 week period show no significant changes in either total EI or macronutrient percentage. These
results are notable, as training time differences between groups was substantial (20 vs. 60 minutes). These data further dispel commonly held views that exercise either induces a physiological need to restore energy expended or generates a psychological food related reward justification.

A major shortcoming for integrated treatment has been the public’s perception of how increases in exercise affect eating behaviors. This incomplete understanding limits our ability to create effective RT exercise prescriptions that could generate reciprocal nutrition benefits.

A considerable limitation in free-living dietary outcomes research is the potential for bias in dietary assessment. The relatively simple, straightforward task of recording all food and beverages consumed greatly increases awareness, which may affect the amount and type normally eaten. Although there are researchers who believe that habitual exercise can be a stimulus for a subtle but persistent effect on controlling EI (54-55, 58), evidence consistently shows that until an individual makes a conscience effort to modify dietary intake, factors other than the subtle metabolic effects of exercise, including social, cultural and environmental cues may determine what and how much is consumed. For this reason continued research in various RT protocols and the psychological factors that determine eating behaviors will help to further clarify the information base and provide for more practical and comprehensive health maintenance programs.

Conclusions

These results indicate that regardless of RT volume, variety or both, there were no significant across groups EI or MP alterations. This study also provides evidence for the existence of greater interindividual variability in eating behaviors. It appears that despite
significantly different amounts of time and physical effort required in RT group assignment, it is possible that interactions involving complex psychobiologic processes, perhaps influenced by social, cultural and environmental stimuli, had a greater influence on food consumption. With the high availability of inexpensive, energy dense yet nutrient poor foods, previously “silent” genetic variants, or neurobiologically based personality traits that render some individuals more sensitive to food related rewards, may be triggered and thus lead to obesity (43, 55, 58).

Future research examining the relationship between RT exercise and eating behaviors should involve the evaluation of individual responses. This would involve identifying, combining or developing instruments that measure possible psychobiologic interactions with training and EI. Outcomes derived from examining physical, psychological and environmental factors may lead to a more complete understanding of possible connections, and provide information for developing RT programs that can have reciprocal nutrition benefits in diverse populations.

Competing Interests
None declared.

Authors' Contributions

SKS designed the nutrition component, participated in collection and analysis of the data and drafted the manuscript. BLH conceptualized and designed the main experiment and provided significant advice and consultation regarding the manuscript. HHM participated significantly in the data analysis and provided significant advice and
consultation regarding the manuscript. BR participated in the editing of the manuscript.

All authors read and approved the final manuscript.

Acknowledgements

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TABLE 1: Repeated-measures ANOVA summary of test result on macronutrient changes by study group and time, and study group and time interaction.

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‡ Greenhouse-Geisser adjustment to df used, due to rejection of Mauchly's test of sphericity (p. = .012).
Note the p-values listed in the table above are slightly lower than the unadjusted values.
TABLE 2: 24-week mean macronutrient and total kcal intake for RT study groups over time

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<th>Group</th>
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<td>57.19 (54.32, 60.07)</td>
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<td>1962.84</td>
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<td>57.62 (54.54, 60.71)</td>
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<td>HVV</td>
<td>2021.78</td>
<td>14.93 (13.66, 16.20)</td>
<td>55.10 (52.06, 58.15)</td>
<td>31.05 (28.23, 33.87)</td>
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TABLE 3: Mean macronutrient and total kcal intake across time for all groups combined

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<th>%Fat</th>
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<td>(14.06, 15.72)</td>
<td>(55.03, 59.61)</td>
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<td>24 Weeks</td>
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</tr>
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<td>(1781.63, 2038.77)</td>
<td>(14.20, 15.99)</td>
<td>(53.93, 58.28)</td>
<td>(28.49, 32.58)</td>
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TABLE 4: Correlations of change in macronutrients from baseline to 24 weeks

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<td>% Carbohydrate and % Fat</td>
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<td>% Fat and Total Kcal</td>
<td>.057</td>
<td>.683</td>
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References


44. CDC: Surgeon General’s call to action to prevent and decrease overweight and obesity, 2004.


CHAPTER 5
PUBLISHABLE PAPER #2

THE EFFECTS OF RESISTANCE TRAINING VOLUME AND VARIETY ON MOOD STATE

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Abstract

Objective

To examine the effects of resistance training (RT) volume, variety, or both on mood state in a healthy, untrained population.

Methods

Participants (N = 55) were university employees and students randomly assigned to weekly RT exercise. The protocols were (1) low volume (LV): one set of 8 exercises for an average of 20 minutes, (2) high volume (HV): three sets of the same 8 exercises for an average of 60 minutes, or (3) high volume/variety (HVV): the same 8 exercises plus 16 more for one set of 24 exercises, for an average of 60 minutes. Profile of Mood States (POMS) questionnaires were completed at baseline, and weeks 12 and 24. Analyses were performed using repeated measures ANOVA model to analyze sample means for the effects of exercise training volume or variety and treatment interactions across groups on all mood variables, with gender and age as covariates.

Results

There was no significant effect of time, RT group membership, or a time x group interaction on measures of individual mood scores or total mood disturbance scores.

Conclusions

These results indicate that over time, there are no significant differences in mood state or total mood disturbance across three RT groups differing in volume, variety or both. Despite the lack of significant differences across groups, by the 24th week of the study all participants demonstrated slight reductions in negative, and increases in positive, mood states.

Author Keywords: Profile of Mood States (POMS); resistance training (RT); volume; variety.
INTRODUCTION

The World Health Organization’s “Global Burden of Disease” reports that in established market economies such as the United States, mental illness is on a par with heart disease and cancer as a cause of disability (Murray & Lopez 1996). During a given year, approximately 20 percent of the U.S. population is affected by mental illness, including depression, mood and stress related disorders, representing a significant public health issue and a deleterious impact on the economy, costing the United States over $40 billion each year in diminished productivity and use of health care resources. In the workplace, depression is a leading cause of absenteeism and diminished productivity (Greenberg, Stiglin & Finkelstein, 1993; Wittchen, 2002) where a minority seeks professional help to relieve a mood disorder and most are likely to visit a physician for some other reason (Katon, 1995; Moscicki, 1997; Simon, 2003).

Treatments for mood disorders frequently include pharmacological interventions as well as cognitive therapy, although mounting data show that something as simple as an increase in physical activity appears to mediate positive psychological changes in mood, well being, self esteem, perceptions of health status, improved work performance, and may reduce the risk of developing depression or lessen the severity of its symptoms (Brugman & Ferguson, 2002; Byrne & Byrne, 1993; DHHS, 2004; Hassem, Koivula & Uutela, 2000; Paluska & Schwenk, 2000).

Previous research investigating the potential effect of physical exercise on various psychological characteristics typically found equivocal results (Byrne & Byrne, 1993; Guszkowska, 2004). Although there has been considerable research on aerobic training (AT) and mood, investigations involving anaerobic, resistance training (RT) have been
less numerous. However, in recent years there has been a expansion in psychology and RT, including a focus on average, healthy populations (Hass, Feigenbaum & Franklin et al, 2001; Kraemer, Ratamess & French, 2002), children and adolescents (Faigenbaum et al, 1999; Guy & Micheli, 2001; Payne, Morrow, Johnson & Dalton 1997; Southern et al, 1999), older adults (McLafferty, Wetzstein & Hunter, 2004), women and the obese (Borg, Kukkonen-Harjula, Fogelhorn & Pasanen, 2002; Hakkinen, 2001; Park et al, 2003; Schmitz et al, 2003), and those with varying degrees of depressive symptoms (Dunn, Trivedi & O’Neal, 2001).

The first comprehensive Surgeon General’s report on mental health (1999) acknowledges that physical activity appears to relieve symptoms of depression and anxiety and improve mood. The potential effect of physical exercise on attenuating negative mood is highly attractive considering the large number of people in modern society who suffer from physical problems having some type of psychological origin (Morgan & Goldston, 1987). This, coupled with the popular and mounting interest in preventive care, has contributed to the widespread opinion that physical exercise constitutes a natural, practical, time efficient and inexpensive form of therapy (Bakal, 1979; DeJong et al, 2003; Kostka, 2002; Kostrublal, 1976; Sachs & Buffone, 1984; Sparling, 2000; Wilfley & Kunce, 1986). The aim of this investigation was to determine whether differences in mood state and total mood disturbance exist between groups assigned RT programs differing in volume, variety or both.
METHOD

Subjects

A total of one hundred and one male and premenopausal female subjects were recruited from the students, faculty, and staff of Loma Linda University and Medical Center, 25-45 years of age, untrained (i.e., not involved in RT within six months prior to the study) and apparently healthy (ACSM, 1995). All females were premenopausal. With 55% retention rate, there was no significant difference in attrition across cohorts or study conditions.

Study Design

The investigation was a prospective experimental study where participants were randomly assigned to one of three experimental groups: Group # 1: Low volume (LV), which involved one set of 8-12 repetitions to volitional fatigue (RM) using eight resistance exercises (an approximate 20-minute session); Group # 2: High volume (HV), which involved three sets of 8-12 RM, using the same eight exercises performed by Group #1 (an approximate 60-minute session); and Group # 3: High volume and variety (HVV), which involved one set of 8-12 RM, using the same eight exercises performed by Groups #1 and #2, plus an additional 16 different exercises, for one set of 8-12 RM (an approximate 60-minute session). All participants were given specific training instructions by an American College of Sports Medicine (ACSM) certified Health and Fitness Instructor (HFI). The participants exercised two times per week for the first eight weeks, increasing to three times per week for the remaining 16, for a total of 24 weeks.
Measures

The Profile of Mood States (POMS) questionnaire was used to assess mood at baseline, 12 and 24 weeks of the study. The POMS assesses six affective mood states: tension/anxiety (T), depression/dejection (D), anger/hostility (A), vigor/activity (V), fatigue/inertia (F), and confusion/bewilderment (C). It also calculates a Total Mood Disturbance (TMD) score, by addition of all scores with vigor/activity weighted negatively. By rating 65 adjectives on a five-point scale from "not at all" to "extremely" in terms of subjective feelings in the past week or seven days, higher scores indicate a heightened state for a given variable. All POMS sub scales exhibit evidence of both construct and predictive validity and have demonstrated internal consistency reliabilities of approximately 0.90 (McNair, Lorr & Droppleman, 1971) and > 0.70 (Shachman, 1983).

Results

Table 1 shows there the time difference of test results on all POMS parameters and Total Mood Disturbance (TMD) scores for the effects of resistance exercise training volume, variety, or both (LV, HV, HVV) and time (baseline, 12 and 24 weeks), as well as treatment and time interactions, with age and gender as covariates. There were no significant alterations in mood for any of the seven parameters (T, D, A, V, F, C, TMD) from baseline to weeks 12 and 24. Table 2 shows range of changes in mood state with negative changes overall for all negative mood states but vigor, the positively weighted state. Even though these changes did not reach statistical significance, it does show a trend. Table 3 shows intercorrelations of POMS between B-24 weeks with vigor.
significantly negatively correlated with five of the six negative mood states. Thus, all but confusion and anger were negative, indicating stable mood states over time.

DISCUSSION

Research into the connection between psychological health and exercise has often been at an anecdotal level, describing the “feel good effect” participants often report after exercise (Biddle & Murtrie, 1991; Ntoumanis & Biddle, 1999). Subsequently, the study of the effect of physical activity on mood has incorporated assessment tools and testing protocols that produce more quantitative data (Byrne & Byrne, 1994; Leith & Taylor, 1991; Meyer & Broocks, 2000). Although not reaching statistical significance, these results offer some indication that if there is a true effect of RT on mood states, it would be in a desirable direction and it does not appear likely to be contingent on either RT volume, variety or both.

Despite the lack of a significant group or time effect, it appears that both the time consuming high volume protocol (HV) (eight exercises, three sets of eight-12RM, 60 minutes) and complicated high volume and variety (HHV) (24 exercises, one set of eight-12 RM, 60 minutes) were no more effective in decreasing negative or enhancing positive mood that the low volume (LV) (eight exercises, one set eight-12RM, 20 minutes). This suggests that if there are psychological advantages to RT, it appears that a modest amount has the potential for improvements. This is notable since a conservative RT program can be classified in the “low to moderate intensity” exercise range (ACSM, 1991), and are typically preferred by most middle and older aged adults and sedentary individuals (Iverson et al., 1985; King, Taylor, Haskell & DeBusk, 1990). These findings add
support to the opinion that exercise need not be lengthy, vigorous or uncomfortable to achieve some measure of psychological benefit (Steptoe & Cox, 1988).

In terms of physical activity, RT is typically a solitary endeavor in which the individual is in control of form, pace and rest intervals, while in organized sport and competition activities they usually are not (Williams & Getty, 1986). Although not measured in this study, a reasonable explanation could be that resistance training may provide an opportunity to engage in stress-reducing cognitive activities including meditation or conversation that can positively affect mood (King, Barr-Taylor & Haskell, 1993). Tharion, Harman, Kraemer and Rauch (1991) found that in novice lifters there was good compliance, lower attrition and a positive mood increase with a basic, five repetition, three minute inter-set rest period RT routine. Conceivably, perhaps the combination of a simple protocol, self set pace and rest intervals allowed for conversation or meditation that could be partially responsible for any positive changes in mood state (Leith & Taylor, 1991).

In studies examining the link between physical activity and mood state, numerous methodological problems have been identified regarding exercise-induced biochemical and/or psychological relationships and their measurement (Margraf, Ahlers & Roth, 1986). Some investigators have found that predominately aerobic activities are more likely to influence transient mood change since acute aerobic work increases both plasma epinephrine and norepinephrine levels, and higher sodium lactate concentrations (Galbo, Holst & Christensen, 1975; Peronnet, 1986; Steptoe & Cox, 1988). Collectively, these physiologic responses may induce acute stress and anxiety states and, as a consequence, elicit higher negative mood state scores, particularly when assessments are taken
immediately post exercise. However, when assessments are administered at later intervals (one to several hours), simple dissipation of lactate and catacholamines may result in calming effects that functionally decrease negative and/or increase positive mood scores. For the present investigation, the lack of significant findings may be due, in part, to the anaerobic nature of RT, the 24 week study length, >24 hour timing of assessment administration, or simply the lack of a large effect with this type of exercise intervention.

Although the POMS is a standardized instrument with recognized validity and reliability, mood state can be transient and often influenced by a range of individual and environmental variables that cannot be assessed. Although the POMS has been recently used more in sport research (LeUnes & Burger, 1998), it was originally designed for clinical populations and may be less sensitive to psychological changes in a normal population (Byrne & Byrne, 1994). Its high reliability also may reflect a relative lack of sensitivity to mood change and thus, may not adequately assess fluctuating affective states (Buros, 1978; Lichtman & Poser, 1983). One factor to consider is the timing of administration. All subjects in this study completed the POMS questionnaires between 5:30 and 8:00 am, after a 12 hour fast, required for a following metabolic measurement. The early hour, coupled with likely lowered blood sugar levels could have had a negative influence on mood state, or at least a “suppressing” of any positive mood effects as measured by the POMS. A second factor to consider was the 12-week intervals between assessments. The POMS was administered three times during the 24 week intervention and this may not have been frequent enough to detect fluctuations in mood due to the exercise, however if there were a significant group effect of RT volume or variety, there
should have been a change from baseline. Ultimately, free-living conditions inherent in studies of this nature reflect the fundamental reality that there may be countless variables that have greater influences on mood state than incorporating a systematic RT program.

Another reason for the lack of significant mood affects could be that only a certain percentage of the population may be able to derive a positive mood effect from structured exercise activity. Pistacchio, Jackson and Weinberg (1990) theorized there may be a certain psychobiologic profile for those who experience a positive post-exercise effect that differs from those who do not. After an extensive review of the literature, they concluded that no overall psychobiologic profile could be developed at this time, although the question remains as to why some individuals appear to have more positive responses to exercise than others do. In this study, although not significant, there were individuals within each group who appeared to show a greater decreases in negative mood and associated increases in positive mood, however these trends were not significant.

On a related tract, Bouchard (1986) found physiological responses to training appeared to have strong hereditary components, although this has not yet been proven for psychological parameters. Simons and Birkimer (1988) found mood enhancement was predicted more by initial mood state than by psychological or demographic ratings, beliefs, expectations or improvement on physical indices. Alternatively, Moses et al (1989) found that mood may be positively affected by the simple increase in physical activity rather than by initial mood or any improvements in quantitative measures of fitness. The common factor in these results indicates that perceptions of mood enhancement may depend less on physical improvements than on initial mood or an
increase in physical activity, were, if subjective psychological benefits were to correlate with objective measures of fitness, mood change may be significant only in those individuals with greater increases in physiological measurements. The main study by Haddock et al (2000) found no significant correlation between physiological changes and mood states across or within collapsed group data implying that RT volume or variety appeared to have no effect on mood state. This supports data by Moses, Steptoe, Mathews and Edwards (1989) suggesting that if psychological changes appear in all groups regardless of protocol, then benefits might be present, to varying extents, in all exercise programs.

At present, it appears that neither a psychobiologic or hereditary component can fully explain if, why or how an individual may derive mood benefits from exercise training, although personal preference for type and amount will vary greatly. Also, mood benefits often appear primarily in depressed populations (Lane & Lovejoy, 2001). Also, since the present study was conducted indoors, with RT exclusively, these conditions may not have been selected by those who enjoy the outdoors, organized sports or principally aerobic activities such as walking, hiking, biking or running. Although there are significant physiologic differences between aerobic and anaerobic protocols, Stawicki (1997) found that in a randomly assigned group of college students with seasonal affective disorder, anaerobic exercise was at least as good as aerobic exercise in increasing positive and decreasing negative moods. With this in mind, practitioners may need to consider exercise protocols specifically designed to meet the individual preferences in order to facilitate long-term adherence and potential mood benefits. Although the current study indicated that resistance training protocol did not have a
significant impact on mood state, only group x time for vigor showed an increase. This suggests that resistance training of any volume, variety or both may have some degree of positive effect on mood that may include the positive nature of the prescription, beneficial body composition changes and the establishment of a constructive lifestyle habit that may help to enhance motivation for maintaining an exercise routine.

Conclusion

Despite the positive impact on both physical and mental health, relatively few people participate in RT exercise. The results of this investigation may provide the health practitioner a compelling argument for reluctant participants by indicating that a simple, time efficient RT program has no greater mood benefit than those significantly more complex and time consuming. Wear the literature does suggest that those with mild to moderate depressive symptoms appear to respond better to exercise interventions, the positive nature of the prescription and the physical benefits do point to the need for further study with more diverse mental health conditions. In addition, further investigation on RT and mood state would closely control for initial mood state, and the potentially influential effects of various cohort, social and interindividual effects.
**TABLE 1: Repeated-measures ANOVA summary of test result on mood state by study group and time, and study group and time interaction**

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<td>TENSION</td>
<td>Group</td>
<td>199.34</td>
<td>2</td>
<td>99.67</td>
<td>1.481</td>
<td>.238</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>26.29</td>
<td>2</td>
<td>13.14</td>
<td>.611</td>
<td>.545</td>
</tr>
<tr>
<td></td>
<td>Group*Time</td>
<td>76.35</td>
<td>4</td>
<td>19.09</td>
<td>.888</td>
<td>.474</td>
</tr>
<tr>
<td>VIGOR</td>
<td>Group</td>
<td>104.32</td>
<td>2</td>
<td>52.16</td>
<td>1.033</td>
<td>.364</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>22.20</td>
<td>2</td>
<td>11.10</td>
<td>.695</td>
<td>.502</td>
</tr>
<tr>
<td></td>
<td>Group*Time</td>
<td>137.41</td>
<td>4</td>
<td>34.35</td>
<td>2.151</td>
<td>.081</td>
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<tr>
<td>TMD</td>
<td>Group</td>
<td>3585.4</td>
<td>2</td>
<td>1792.7</td>
<td>1.308</td>
<td>.280</td>
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<tr>
<td></td>
<td>Time</td>
<td>446.53</td>
<td>2</td>
<td>223.26</td>
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<td>.639</td>
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<tr>
<td></td>
<td>Group*Time</td>
<td>669.29</td>
<td>4</td>
<td>167.32</td>
<td>.337</td>
<td>.852</td>
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</table>

‡Within-subjects analysis of ANGER mean score differences: Greenhouse-Geisser adjustment made to df, due to rejection of Mauchly’s test of sphericity (p. = .012).
TABLE 2: Profile of mood states mean range of change over time

<table>
<thead>
<tr>
<th></th>
<th>B-12 weeks ~ Range</th>
<th>12-24 weeks ~ Range</th>
<th>B-24 weeks ~ Range</th>
</tr>
</thead>
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<tr>
<td>Tension (0-36)</td>
<td>-1.77</td>
<td>-15 to 11</td>
<td>-.23</td>
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<tr>
<td>Depression (0-60)</td>
<td>.19</td>
<td>-22 to -26</td>
<td>-2.68</td>
</tr>
<tr>
<td>Anger (0-48)</td>
<td>-1.79</td>
<td>-26 to 13</td>
<td>-.38</td>
</tr>
<tr>
<td>Vigor (0-32)</td>
<td>.60</td>
<td>-14 to 14</td>
<td>1.52</td>
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<tr>
<td>Fatigue (0-28)</td>
<td>-.28</td>
<td>-14 to 23</td>
<td>-1.11</td>
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<tr>
<td>Confusion (0-28)</td>
<td>-.70</td>
<td>-14 to 11</td>
<td>-.04</td>
</tr>
<tr>
<td>Total Mood Disturbance (TMD)</td>
<td>-4.72</td>
<td>-68 to 76</td>
<td>-6.38</td>
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</tbody>
</table>
### TABLE 3: Profile of mood states change scores correlations B-24 weeks (N = 55)

<table>
<thead>
<tr>
<th></th>
<th>Tension</th>
<th>Depression</th>
<th>Anger</th>
<th>Vigor</th>
<th>Fatigue</th>
<th>Confusion</th>
<th>Total Mood Disturbance</th>
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</thead>
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<tr>
<td>Tension</td>
<td>.542*</td>
<td>.366**</td>
<td>-.290*</td>
<td>.682**</td>
<td>.539**</td>
<td>.768*</td>
<td>.732**</td>
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<tr>
<td>p-value</td>
<td>.000</td>
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<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Depression</td>
<td>.732**</td>
<td>-.417**</td>
<td>.485**</td>
<td>.545**</td>
<td>.865*</td>
<td>.000</td>
<td>.000</td>
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<tr>
<td>p-value</td>
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<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Anger</td>
<td>-.263</td>
<td>.302*</td>
<td>.057</td>
<td>.028</td>
<td>.235</td>
<td>.719*</td>
<td>.000</td>
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<tr>
<td>p-value</td>
<td>.057</td>
<td>.000</td>
<td>.057</td>
<td>.028</td>
<td>.090</td>
<td>.000</td>
<td>.000</td>
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<tr>
<td>Vigor</td>
<td>-.517**</td>
<td>-.328*</td>
<td>.000</td>
<td>-.016</td>
<td>-.585*</td>
<td>.000</td>
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<tr>
<td>p-value</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.016</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Fatigue</td>
<td>.503**</td>
<td>.732*</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.658*</td>
<td>.000</td>
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<tr>
<td>Confusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p-value</td>
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<td></td>
<td></td>
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</tbody>
</table>

** Correlation significant at the 0.01 level (2-tailed)
* Correlation significant at the 0.05 level (2-tailed)
References


CHAPTER 6
OTHER FINDINGS

A. Resistance Training and Diet

Although there were no significant differences between groups, across time, on measures of macronutrient percentages or energy intake, there were trends worthy of note. Looking across groups at mean averages of macronutrient percentages at baseline (Protein 14.6%, Fat 29.9% and Carbohydrate 57.2%), 12 weeks (Protein 14.7%, Fat 29.5% and Carbohydrate 57.6%) and 24 weeks (Protein 14.9%, Fat 31% and Carbohydrate 56.2%), all measures were very close to the American Dietetic Association’s (ADA) recommended daily intake ranges (Protein 12%, Fat 30% and Carbohydrate 50-60%) (ACSM, ADA, CDA, 2000). It may be that although recruiting was for an untrained population, participants were drawn from a health and science community and may have had a basic understanding of good nutrition practices.

Looking at total energy intake across groups and over time, baseline to 12 weeks showed an average drop of 192 kcals/day; however, by the 24th week this deficit had dropped to 44 kcals/day, for a net decrease of approximately 148 kcals/week for the entire study period. In terms of energy balance, this represents a net deficit of approximately 3,552 calories over the study period, or the energy equivalent of one pound body fat.
B. Resistance Training and Mood

From a practitioner's perspective, post intervention, there was the expectation that participants would continue with regular adherence to the prescribed RT program or a similar one own of their. To this end, all protocols were designed to be an quantity that might reasonably be accomplish without making significant lifestyle changes (20 to 60 min, three times per week.) It was acknowledged that during the study, commitment to researchers and scheduled fitness testing was considerable motivation for compliance. Although not statistically significant, there were positive outcomes across groups and over time that suggested a reasonable incentive to continue; however at a three and six month follow up phone interviews, anecdotal information suggests that a majority of the participants did not continue with a course of RT.
CHAPTER 7
DISCUSSION

A. Resistance Training and Diet

The present investigation is the only one to date measuring the effects of different RT volume and variety protocols on diet in a healthy, untrained population. While metabolic mechanisms and psychological motivation exist for increased energy intake (EI) and carbohydrate percentage with greater energy expenditures (EE), this did not occur in the present study (p > .88 and p > .78, respectively). Although not significant, there was a slight trend across all groups for lower EI from baseline to week 24, averaging 148 kcals/week, or the energy equivalent of one pound body fat. These results suggest that despite differences in the average number of minutes spent RT per week (180 for HV/HVV versus 60 for LV) over a six month period, participants did not significantly alter dietary intake based on the RT group assignment, substantiating the notion that increases in energy expenditure (EE) do not necessarily lead to increases in energy intake (EI), supporting the “weak coupling” theory, where an individual’s compensatory behaviors are shown to be partial and incomplete (Blundell & King 1998; King, Tremblay & Blundell, 1997).

Reviews on exercise and appetite control have found no clear evidence that exercise has an immediate effect on hunger; however, as exercise becomes habitual intake may increase, compensating for up 30% of the energy expended in activity, which may result in weight loss or control (Blundell, et al, 2003). Expanding on that, Davis, Strachan & Bekson, 2004, found that individuals could be classified as “energy
compensators” and “non-compensators” based on a personality trait rooted in the neurobiology of the mesolimbic dopamine system known as “sensitivity to reward” (STR). This characteristic may determine an individual’s ability to derive pleasure or reward from natural reinforcers such as food. They suggest that those with this trait, which combines a neurochemical process with a behavioral outcome, may be at higher risk for overeating and overweight since the use of food as a “reward” after exercise and food related cues may be more important in the decision to consume than the more subtle exercise related metabolic signals not to (CDC, 2004; Pi-Sunyer & Woo, 1995).

From a metabolic standpoint, the extended time commitment exercising the HV/HVV protocols (average 60 minutes) would likely deplete muscle glycogen to a greater extent than the LV protocol (average 20 minutes), resulting in an physiological drive to increase EI. In an extensive review of exercise and diet studies, other investigators concluded that increases in training EE tend to be associated with elevations in total EI however, our data did not support this (Bjorntorp, 1996; Pi-Sunyer & Woo, 1985; Tucker, Harris & Martin, 1996, Tremblay, LeBlanc, Sevigny, Savoie & Bouchard, 1983).

From a psychological perspective, it was theorized that the greater time and effort required to complete RT of higher volume, greater variety or both, might evoke compensatory rationale or reward justification for increasing overall EI. Although this could be used to justify increases in energy intake, results of the current study, as well as a majority of similar medium and long term investigations, do not substantiate a convincing link (King, Appleton, Rogers & Blundell, 1999; Long, Hart & Morgan, 2002; Ravussin, Burnand, Schutz & Jequier, 1986).
These results have significant public health implications, particularly in untrained populations who desire an improved body composition, yet do not have the inclination to engage in long or complicated training sessions. This is important due to data that suggest RT of high volume or high volume with variety appears to have little or no advantage over RT of significantly lower volume and variety regimens, in terms of strength, body composition and BMI changes (Haddock, Blix, Hopp Marshak, & Mason 2001). The question then becomes what occurs over longer periods of time when RT exercise may not be enough to overcome the social, cultural and environment stimuli that influence dietary intake, or where long term dietary changes may only be present in RT volumes and/or varieties that an average population may not be physically or psychologically inclined to accomplish.

Based on the results of this investigation, over a 24 week period, it appears that untrained individuals on ad libitum diets who engage in RT differing in volume, variety or both show no significant changes in either total EI or macronutrient percentage. These results are notable, as training time differences between groups was substantial (20 vs. 60 minutes). These data further dispel commonly held views that exercise either induces a physiological need to restore energy or a psychological food reward justification. Coupled with current study findings that suggest no naturally occurring dietary advantages to greater amounts of RT exercise, and a modest regimen is effective for increasing strength, flexibility and body competition, the potential for long term compliance and possible avoidance of overweight and obesity is considerable.

To date, a shortcoming for integrated treatment has been the public’s perception of how increases in exercise affect eating behaviors. These results indicate that
regardless of RT volume, variety or both, there is no significant differences across groups in terms of dietary change, and evidence suggesting greater interindivdual variability in eating behaviors. Conceivably, it appears that exercise related dietary intake involves a series of complex psychobiologic processes influenced by more immediate social, cultural and environmental stimuli than by longer term, subtle metabolic processes. This, coupled with the high availability of inexpensive, energy dense yet nutrient poor foods, may render some individuals more sensitive to food related cues, regardless of exercise intensity or duration (Davis, Strachan & Berkson, 2004).

B. Resistance Training and Mood

The present investigation is the only one to date measuring the effects of different RT volume and variety protocols on mood state in a healthy, untrained population. While research into the connection between psychological health and exercise has often been at an anecdotal level, describing the “feel good effect” participants often report after exercise (Biddle & Murtrie, 1991; Ntoumanis & Biddle, 1999), the study of the effects of physical activity on mood has recently begun to incorporated assessment tools and testing protocols that produce more quantitative data (Byrne & Byrne, 1994; Leith & Taylor, 1991).

Although the POMS is a standardized instrument with recognized validity and reliability, mood state can be transient and influenced by a range of individual and environmental variables that cannot be assessed. Where it has recently been used more in sports and athletic research (Le Unes & Burger, 1998), it was originally designed for clinical populations and may be less sensitive to psychological changes in a normal population (Byrne & Byrne, 1994). It’s high reliability also may reflect a relative lack of
sensitivity to mood change and thus, may not adequately assess fluctuating affective states (Buros, 1978; Lichtman & Poser, 1983).

One factor to consider is the timing of administration. All subjects in this study completed the POMS questionnaires between 5:30 and 8:00 am, after a 12 hour fast required for a subsequent metabolic measurement. The early hour, coupled with the likelihood of lowered blood sugar levels, could have had a negative influence on mood state, or at least a “suppressing” of any positive mood effects as measured by the POMS. A second factor to consider was the 12-week intervals between assessments. The POMS was administered three times during the 24 week intervention and this may not have been frequent enough to detect fluctuations in mood due to the exercise, however, if there were a significant group effect of RT volume or variety, there should have been a change from baseline. Ultimately, free-living conditions inherent in studies of this nature reflect the fundamental reality that there may be countless variables that have greater influences on mood state than incorporating a systematic RT program of any volume or variety.

In studies examining the link between physical activity and mood state, numerous methodological problems have been identified regarding exercise-induced biochemical and/or psychological relationships and their measurement (Margraf, Ahlers & Roth, 1986). Some investigators have found that predominately aerobic activities are more likely to influence transient mood change since acute aerobic work increases both plasma epinephrine and norepinephrine levels, and higher sodium lactate concentrations (Peronnet, 1986; Steptoe & Cox, 1988). Collectively, these physiologic responses may induce acute stress and anxiety states and consequently, elicit higher negative mood state scores, particularly when assessments are taken immediately post exercise. However,
when assessments are administered at later intervals (one to several hours), simple dissipation of lactate and catecholamines may result in calming effects that functionally decrease negative and/or increase positive mood scores. The lack of significant findings for the present investigation may be due, in part, to the anaerobic nature of RT, the 24 week study length, >24 hour timing of assessment administration, or simply the lack of a large effect with this type of exercise intervention.

Another possibility may be individual preferences for interaction and psychological stimulation in exercise regimens. Resistance training is typically a solitary endeavor in which the individual is in control of form, pace and rest intervals, while in organized sport and competition activities they usually are not (Williams & Getty, 1986). Although not measured in this investigation, RT may provide certain individuals with an opportunity to engage in stress-reducing cognitive activities including meditation or conversation that can positively affect mood (King, Barr-Taylor & Haskell, 1993).

Tharion, Harman, Kraemer and Rauch (1991) found that in novice lifter, there was good compliance, lower attrition and a positive mood increase with a basic, five repetition, three minute inter-set rest period RT routine. Conceivably, the combination of a simple protocol, self set pace and rest intervals allowed for conversation or meditation could be partially responsible for any positive changes in mood state (Leith & Taylor, 1991).

Although this investigation did not demonstrate a significant group effect of RT volume and variety on mood state, means were down for all negative mood states and up for the only positive state, vigor. Although these measures did not reach significance, they do offer some indication that if there is a true effect of RT on mood states, it would
be in a positive direction and does not appear likely to be contingent on either RT volume, variety or both and, even a modest amount has the potential for improvements. This is notable since a conservative RT program can be classified in the “low to moderate intensity” exercise range (ACSM, 1991). Since both lower intensity and volume are typically preferred by most middle and older aged adults and sedentary individuals (King, Taylor, Haskell & DeBusk, 1990), it adds support to the opinion that exercise need not be lengthy, vigorous or uncomfortable to achieve some measure of psychological benefit (Steptoe & Cox, 1988).

Another reason for the lack of significant mood affects could be that only a certain percentage of the population is actually able to derive a positive mood effect from exercise. Pistacchio, Jackson and Weinberg (1990) theorized there may be a certain psychobiologic profile for those who experience a post-exercise positive effect that differs psychologically and biologically from those who do not. After an exhaustive review of the literature, they concluded that no overall psychobiologic profile could be developed at this time, although the question remains as to why some individuals appear to have more positive responses to exercise than others do. In this study, there were individuals within each group who appeared to show a greater decreases in negative mood and concomitant increases in positive mood, however these trends where not significant.

On a related tract, Bouchard (1986) found physiological responses to training appeared to have strong hereditary components, although this has not yet been proven for psychological parameters. Simons and Birkimer (1988) found mood enhancement was predicted more by initial mood state than by psychological or demographic ratings,
beliefs, expectations or improvement on physical indices. Alternatively, Moses et al (1989) found that mood may be positively affected by the simple increase in physical activity rather than by initial mood or any improvements in quantitative measures of fitness. The common factor in these results indicates that perceptions of mood enhancement may depend less on physical improvements than on initial mood or an increase in physical activity, where if subjective psychological benefits were to correlate with objective measures of fitness, mood change may be significant only in those individuals with greater increases in physiological measurements. In the main study, Haddock et al (2001) found no significant correlation between physiological changes and mood states across or within collapsed group data implying that RT volume or variety appeared to have no effect on mood state. This supports data by Moses, Steptoe, Mathews and Edwards (1989) suggesting that if psychological changes appear in all groups regardless of protocol, then benefits might be present, to varying extents, in all exercise programs.

At present, it appears that neither a psychobiologic or hereditary component can fully explain if, why, or how an individual may derive mood benefits from exercise training. Where the present study was conducted indoors with RT exclusively, these conditions may not have been selected by those who enjoy the outdoors, organized sports or principally aerobic activities such as walking, hiking, biking or running. With this in mind, practitioners may need to consider exercise protocols specifically designed to meet the individual preferences in order to facilitate the possibility for long-term adherence and potential mood benefits.
Although the current study indicated that resistance training protocol did not have a significant impact on mood state, the non significant mean decreases in negative mood states and increased vigor suggests that RT of any volume or variety may have some degree of positive effect on mood that may include the positive nature of the prescription, beneficial body composition changes and the establishment of a systematic, positive lifestyle routine. Furthermore, these subtle psychological changes (i.e. reduction of total stress/mood disturbance levels and increases in vigor) may help to enhance motivation for maintaining an exercise routine. The results of this investigation may provide the health practitioner a compelling argument for the reluctant participant by indicating that even the most modest RT program has no greater mood benefit as those significantly longer and more complex. However, these results do point to the need for further study, controlling for initial mood state, as well as other cohort, social, and environmental effects.

C. **Strengths and Limitations**

The paucity of research on both the dietary and psychological outcomes of RT exercise leaves a distinct void in the literature. Recommendations for improving overall health status customarily include incorporating physical exercise, improving diet and attaining and/or maintaining psychological well being (Jakicic, Clark, Coleman, Donnelly, Foreyt, Melanson & Volpe 2001; Rohrer, Rush-Pierce & Blackburn, 2005). Additional research related to the possible effects of RT on these health parameters may help to identify more comprehensive exercise protocols and lifestyle recommendations. Although this investigation did not show specific mental health or nutrition benefits from different volumes and varieties of RT, due to the positive nature of the prescription, the
potential for reciprocal improvements and the documented physical benefits (Haddock, et al 2001), additional research is necessary.

The main strength of this study is the experimental design. This method, though difficult time consuming and inconvenient, is necessary for drawing firm conclusions (Campbell & Stanley, 1963). Experimental studies also provide optimal internal validity due to random assignment to treatment groups. In addition, study duration was a key strength. Many exercise/diet studies of this nature last from 12 to 15 weeks, so at 24 weeks, this one provided a significantly longer period for intervention, observation and testing. The idea was that RT should not be quantified solely on objective measures of strength, BMR or body composition, but in a healthy, untrained population, the physical and emotional efforts necessary to complete a longer-term RT regime may have a positive influence on other aspects of health, including dietary intake and mood state. A considerable limitation was the potential for bias in food intake records. The relatively simple, straightforward task of recording all food and beverages consumed greatly increases awareness, which may affect the amount and type normally eaten (Lee-Han, McGuire and Boyd, 1989). It also may create a situation where the participant wants to appear as if they eat "healthy" to impress investigators (DiLorenzo, Bargman, Stucky-Ropp, Brassington, Frensch, & LaFontaine, 1996). To minimize these effects and encourage truthful recording, all subjects were guaranteed confidentiality and assured analysis would be conducted by an investigator blind to subject identification. A further consideration was an included holiday season, where eating patterns and dietary content typically varies. However, due to the longitudinal design it would be difficult to
completely avoid all seasonal variations. Once again, randomizing participants assured that each group was equally exposed to such confounding factors.

The lack of a control group limited comparison data. A group not engaging in RT yet required to monitor food intake and take the POMS at the same intervals as the other groups would have produced a more comprehensive study. The effects of a sedentary lifestyle on dietary intake and mood state during the same time period could have been used in comparison and perhaps made a better argument for, or against, inclusion of a regular RT exercise regimen.

A notable limitation with the psychological instrument (POMS questionnaire) involved the standard reference period for answers. The questionnaire investigates feelings and mood for “today and the past week,” and may not be indicative of intervening 12 to 24-week fluctuations. For example, academic exam periods may have influenced scores for student participants and the holiday season(s) may have exaggerated various individual scores; however, calculation of the “total mood disturbance score” (TMD), in addition to the separate categories, provided a general indication of change among groups, across time. Randomization assured that each group was equally exposed to confounding factors.

It is widely accepted that exercise in any form must be performed on a regular basis to maintain a positive effect on health status; however, studies involving months or years of periodically monitoring psychological responses to exercise treatment have time delay and recidivism disadvantages (DiLorenzo, et al 1999). Expected, though disappointing, a high drop out rate in the present study may have tainted results. To maximize the number successfully completing the study, pre-screening, weekly
documentation and ongoing moral support were essential. In addition, participants were “eased” into their gym attendance routine. For the first four weeks, only two exercise sessions per week were required, followed by three sessions for the remaining 20 weeks. Investigators can provide comprehensive instruction, guide in execution, and closely monitor participants; however, long-term commitment and compliance to protocol must ultimately be entrusted to participants.

Any investigation involving human subjects that requires adherence to prescribed behaviors and protocols over long periods of time is a considerable challenge. Monitoring compliance, maintaining motivation and taking accurate, timely measurements is difficult, particularly when instruments and procedures may exert independent influences. For this investigation, increased awareness when recording dietary intake, mood assessment timing intervals, seasonal influences and an expected high recidivism were noteworthy limitations. On the other hand, there are study strengths that counter these issues. For example, the experimental design coupled with long-term duration (24 weeks) increased validity. Careful recruitment, thorough screening, individualized training and weekly monitoring considerably enhanced study strength, and participant perceptions of positive changes with RT might have been a considerable, though variable strength in favor of adherence.
CHAPTER 8
CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. Diet

In an average, untrained, healthy population, RT volume or variety had no significant effects on total energy (kcal) or macronutrient intake (protein, carbohydrate or fat), substantiating previous studies indicating a “rather loose coupling” if any coupling at all, of intake to expenditure. Across all groups there were non-significant reductions in energy intake, representing a deficit of approximately 148 kcals/day from 3-day diet measures, baseline to 24 weeks.

In both energy and macronutrient intake measures, there was greater interindividually variability than that across groups. This suggests that regardless of volume or variety, longer term RT may have the potential, in some individuals more than others, to influence nutrition selection.

2. Mood

In an average, untrained, healthy population, RT volume or variety had no significant effects on mood state or TMD scores. Across all groups there were non-significant trend reductions in the negative mood states (tension, depression, anger, fatigue and confusion) and an increase in the lone positive mood state (vigor). In addition, TMD scores (i.e., addition of all mood scores with vigor weighted negatively)
across groups revealed a non significant reduction of approximately 11 points (group mean of 34.11 at baseline to 22.87 at 24 weeks.)

In both individual moods and TMD scores, there was greater variability among individuals than across groups. These trends suggest that regardless of volume or variety, RT may have the potential, in some individuals more than others, to influence mood in a positive direction.

B. **Applications to Preventive Care**

Despite the physical and mental health benefits associated with habitual LTPA, many average, healthy individuals remain sedentary or fail to obtain a daily amount commensurate with optimal health. In a society dealing with increasingly with high levels of stress and below par fitness, Wilfley and Kunce (1986) suggest that exercise prescriptions could have a particularly positive impact on the health. Adapted for the preventive care specialist, and with the results of this study as a reference, these guidelines use RT as not only a form of exercise, but in some individuals more than others, but as a potential means for exerting subtle, positive influences on mental well being and nutrition status.

1. **Highlighting Benefits of Exercise**

The current study's finding of greater interindivudual variability in outcomes, despite group assignment, indicates any RT related nutrition and mental health advantages may vary considerably for each participant. For those primarily interested in physical transformation (i.e., weight loss, muscle definition, strength, balance), discussing the physical consequences of RT, the appropriate energy requirements and basic good nutrition practices is advisable. For those whose primary motivation may be a
diversion from daily stress and anxiety, or to become stronger, more competent and have a new and exciting experience (Berger & Mackenzie, 1980) the potential for improved mental well being and exercise related “existential and centering experiences” can be emphasized (Hendricks & Carlson, 1981, Morgan, 2004; Spino, 1976, 1977).

2. **Individual Variability**

Looking to the interindividual variability in study results, it appears that some individuals may require a supportive, social situation (Brawley, 1979; Heinzelmann & Bagley, 1970; Martin & Dubbert, 1982; Wankel, 1979), while some may prefer solitary activities. Researchers have determined that many exercise participants are decidedly influenced by physical environment, including accessibility, climate and noise conditions (Buffone, Sachs & Dowd, 1984; Sachs, 1984; Teraslinna, Partanen, & Koskela, 1970). Since RT is typically done indoors in a climate-controlled environment, those who prefer outdoor, sport or group activities might find RT less psychologically rewarding, or might not feel as though they are getting enough aerobic work (i.e. calorie burn), which may have an influence dietary selection and mood state in these individuals versus those who might prefer the “indoor gym” environment.

3. **Health Educators as Role Models**

The health educator can have a dramatic impact by serving as a role model (Sachs, 1984). Since the results of this investigation indicated that a modest RT regimen is no more or less influential in terms of nutrition, mood or physical outcomes, the practitioner can practice and advocate a practical and time efficient RT program. A shared belief in the positive nature of the prescription is key.
However subtle and variable, the results of this investigation have added to the knowledge base linking physical activity to other measures of health status, nutrition and mental health. Despite the complex interactions of genetic, psychological and environmental mechanisms, trend evidence from this study enhance the body of evidence suggesting that even the most conservative RT regimens can be considered part of a practical, reliable, efficient and inclusive preventive care practice.

C. Recommendations for Further Research

Although health practitioners agree that incorporating some form of moderate LPTA is prudent preventive care strategy, there is still some debate as to the most practical, effective and sustainable methods. In today’s society, LTPA is considered a virtuous endeavor, were a majority of the population can cite any number of physical, social, psychological or environmental limitations to regular participation. These real or perceived restrictions to exercise are critical considerations when designing and implementing an exercise prescription. For these reasons, further investigation should focus on identifying those barriers specific to RT, and a course of steps to overcome them.

Future research must address the interactions of RT, mood and diet over longer periods of time, including wider age ranges and populations with physical limitations, mild to moderate stress, anxiety and depressive symptoms, or both. Where RT research has shown positive physical results with the relatively small time investment of a single set routine (Hass, Garzarella, de Hoyos & Pollock, 2000; Wolfe, LeMura & Cole, 2004), any complimentary improvements, however subtle, in diet or mental health status could prove a significant advantage for comprehensive preventive care.
REFERENCES


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Appendix A

Exercise Instructions and Group Training Protocol

Following is a list of exercises each group will perform and the major muscle groups worked. All subjects will be tested on each exercise, however, group one and two will only train on the exercises marked under their group. The exercises do not need to be performed in the order in which they are listed.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Major muscles worked</th>
<th>Group #1</th>
<th>Group #2</th>
<th>Group #3</th>
</tr>
</thead>
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<tr>
<td>Bench Press</td>
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<td>Abdominals</td>
<td>X</td>
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<tr>
<td>Lateral pull down</td>
<td>Latissimus dorsi, Biceps</td>
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<tr>
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<td>Biceps</td>
<td>X</td>
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<tr>
<td>Leg press</td>
<td>Quadriceps, Gluteals</td>
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<tr>
<td>Knee extension</td>
<td>Quadriceps</td>
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<td>Leg curl</td>
<td>Hamstrings</td>
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<tr>
<td>Incline press</td>
<td>Pectoralis major, triceps, anterior deltoid</td>
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<tr>
<td>Dumbbell fly</td>
<td>Pectoralis major</td>
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<td>Side raises</td>
<td>Deltoids</td>
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<td>Trapezius</td>
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<td>Partial sit-ups</td>
<td>Abdominals</td>
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<tr>
<td>Knee raises</td>
<td>Abdominals</td>
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<td>Upright row</td>
<td>Rhomboids, Biceps</td>
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<td>Triceps Push down</td>
<td>Triceps, Latissimus dorsi</td>
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<tr>
<td>Back extensions</td>
<td>Gluteals, Erector spinae</td>
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<td>Biceps curl machine</td>
<td>Biceps</td>
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<tr>
<td>Heel raise</td>
<td>Gastrocnemious, Soleus</td>
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<tr>
<td>Leg extensions (right leg)</td>
<td>Gluteals</td>
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<td>Leg extensions (left leg)</td>
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<td>X</td>
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<tr>
<td>Seated heel raise</td>
<td>Soleus</td>
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<tr>
<td>Hip abductor</td>
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</table>
Exercise Descriptions

The following pages give a brief description of each of the exercises that will be performed by the participants. This is not intended to teach the subject how to do the exercise. It is designed to remind the subject of the procedures they went over with the personal trainer during the initial sessions. If after reading the description they still can’t quite remember exactly what to do, they can ask one of the Drayson Center staff members who work in the weight room. There is a floor person available at all times to help the members out with exercises when needed.

The first two groups will get a handout only containing the first eight of these exercises. Only the third group will get the entire list, since they are the only group that will be trained on each exercise.

**Bench Press:** This will be done with the David equipment. Start with the hands at the shoulder level. Extend the arms out away from the body to full extension and then lower the weight back to the starting position. The lift should be done slowly, in a controlled fashion. Extend the arms to the count of two and lower to the count of four.

**Overhead Press:** Use the Trotter equipment for this exercise. The seat height should be placed so that the hand grips are at the shoulder level. Extend the arms over your head to a count of two, then gradually lower to a count of four. Make sure to go through the entire range of motion.

**Abdominal crunch:** Use the Trotter equipment for this exercise. The seat height should be placed so that the pivot point is at the level of the hip. Sitting in the upright position, bend forward at the waist, to the count of two, until the pivot arm touches your knees. Gradually extend back to the resting position, to the count of four. Don’t forget to use the belt on this exercise in order to keep your hips in place.

**Lateral pull down:** Use the pulley system in the free weight room. The knees should be placed under the padded bar in order to keep you seated in the chair. With the arms extended up, pull down on the bar to the count of two until the bar touches your chest. Gradually let the bar back up, to the count of four, until reaching full extension.

**Bicep curl:** This will be a free weight exercise, using the dumbbells. Sitting upright on a bench, hold each dumbbell to your sides with your arms extended down and the palms forward. Keeping your back straight, bend your elbows to a count of two, until you have reached full flexion. Then lower the weights back to full extension to the count of four. Remember to keep your back straight, stomach tight, and the elbows next to your body.
**Leg press:** This will use the Trotter leg press machine. While lying on your back, your feet are against the platform. Adjust so that the knees are at a 90° angle. Slowly extend your knees to the count of two until at full extension. Then slowly bend the knees to the count of four back to the starting position. When reaching fatigue lock out the platform with the catch bar, while in the extended position.

**Knee extension:** Use the Trotter equipment for this exercise. The back support should be positioned so that your knees are lined up with the pivot arm on the machine. The ankle pad should rest on your lower leg, just above the foot. With the feet hanging down off of the seat extend your knees to a count of two, until reaching full extension. Gradually lower the weight to a count of four. Make sure to go through the entire range of motion.

**Leg curl:** Use the Trotter equipment for this exercise. The back support should be positioned so that your knees are lined up with the pivot arm on the machine. The legs should be straight in front of you with the thigh pad over your upper legs, and the ankle pad a little above your heel. Flex your knees to full flexion, to the count of two. Gradually extend the knees to the count of four. Make sure to go through the entire range of motion.

**Incline press:** Use the Trotter equipment for this exercise. The seat height should be positioned so that your shoulders are even with the pivot point on the machine. Extend the elbows to a count of two, to full extension. Then gradually let the weight down to a count of four. Make sure to go through the entire range of motion.

**Butterfly:** Use the David equipment for this. Adjust the seat height so that the elbows are level with the shoulders. Bring the two sides together until the pads touch each other. This should be done to the count of two. Slowly let the weight back down to the count of four. Make sure to go through the entire range of motion.

**Side raises:** Use the Trotter equipment for this exercise. The seat height should be positioned so that your shoulders are equal to the pivot point on the machine. With your upper arms against the pads extend your arms outward, to the count of two, until the elbows are at the height of the shoulder. Gradually lower the weight back down to the count of four.

**Shoulder shrugs:** This will be done with free weights. While standing erect, hold the dumbbells to your side. Slowly, raise your shoulders toward your ears, to the count of two. Gradually lower the shoulders, to the count of four, back to the resting position.
Partial sit up: Use the sit up bench in the room with the treadmills. Put the bench at an angle using the third level from the bottom. While laying on your back your hands can be placed behind your head. Lift with the abdominals, to the count of two, until your head and shoulders are off of the board. The low back should remain in contact with the board. Gradually lower your head and shoulders to the count of four back to the resting position. Make sure to use the hands to support the head only, not to pull on the back of the head. Your chin should not touch your chest. You should perform as many repetitions as you can.

Knee raises: Using the high chair in the treadmill room support your weight with your arms placed on the side rails. Your back should be firmly against the back rest, with the feet hanging below. Slowly lift your knees, to the count of two, to the level of your chest. Gradually lower the legs, to the count of four, until reaching full extension. You should perform as many repetitions as you can.

Upright row: Use the Trotter equipment for this exercise. The seat height should be placed so that the arms can reach straight forward from the shoulders to hold on to the hand grips. The chest pad should be placed so that the arms are completely extended (but not locked at the elbows), when gripping the hand grips. Pull the hands back, to the count of two, until the hands are to the level of the chest. Let the weight back down, to the count of four. Make sure to go through the full range of motion.

Triceps push down: Use the Trotter equipment for this exercise. The seat height should be set so that the hands are gripping the bar just underneath the shoulders. Extend the elbows, to the count of two, until reaching full extension. Gradually bend the elbows, to the count of four, until reaching the starting position.

Back extensions: Use the Roman chair for this exercise. Adjust the foot rest so that the pads are resting on your thighs, and the top of the pad is just below the bend at the hip. With your hands behind your back, slowly lower yourself, to the count of four, until your head is pointed toward the floor. Extend your body, to the count of two, until reaching full extension.

Biceps curl machine: Use the trotter equipment for this exercise. Adjust the seat height so that the arms can rest comfortably on the arm rest straight in front of you and you can reach the hand grips. Bend the elbows to full flexion, to the count of two. Then extend the elbows, to the count of four, to the starting position.

Heel raise: Use the same equipment that you used for the Leg press. The difference is your that the legs should remain straight, but not locked. The ankles are extended to the count of two and then allowed to flex to the count of two.
**Leg Extensions (right and left):** Use the Trotter equipment for this exercise. While standing on the platform the hip should be at the level of the pivot. The leg should rest on the pad just above the knee. The hip should be at about a 90° angle. Pull the leg down, to the count of two, until the leg you are using is equal to the leg you are standing on. Slowly let the leg go back up, to the count of four, to the starting position. The opposite leg is done simply by turning around and doing the same thing with the opposite leg.

**Seated heel raise:** This is done in the free weight room. While seated the thigh pad should rest just above your knees. The ball of the foot is on the platform, with the heels down below. Slowly lift your heels to full extension of the ankle, to the count of two. Then lower your heel, to the count of four, back to the starting position.

**Hip adductor:** Use the David equipment for this exercise. With the legs as far apart as possible, without feeling a stretch, bring the legs together, to the count of two, until the feet touch at the midline of the body. Gradually let the legs go back out, to the count of four, to the starting position.

**Hip abductor:** Use the David equipment for this exercise. Start with the legs together at the midline of the body. Extend your legs outward, to the count of two, as far as you can. Gradually let the legs come back to the starting position, to the count of four.
Appendix B

Training Logs

The following pages give an example of the training logs the different groups will receive. Note that the log is different for each group, as they will be following a different routine. This log will be used to help make sure subjects are sticking with the routine. It will also serve as a guide to the weight to be used when performing the follow up strength testing.
Training Log for Group 1

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<th>Exercise</th>
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</table>
For each exercise listed write down the weight used and the number of repetitions completed. If you used an alternative exercise due to a piece of equipment being out of order, put a star next to the weight. Remember you will only perform two sessions per week until after the repeat testing at 8 weeks.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Session #1</th>
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# Training Log for Group 3

Name_________________________ Week of program________

For each exercise listed write down the weight used and the number of repetitions completed. If you used an alternative exercise due to a piece of equipment being out of order, put a star next to the weight. Remember you will only perform two sessions per week until after the repeat testing at 8 weeks.

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Note: - For the partial sit up, instead of weight list the angle of the bench (1-5)
- For the knee raise, instead of weight put B if the knees were bent, and S if the knees were held straight.
- For the back extension just include the number of repetitions completed.
Appendix C

Study Time Line

The following pages give a basic time line for the study. Note that not all subjects will begin the program at the same time. Approximately 30 subjects will start at a given time (10 per group). We will allow two weeks for testing so that some subjects will start their training one week later. Each testing period will take place over a two week period.
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Appendix D

Informed Consent

In agreeing to participate in this research project I understand that in addition to performing the required exercises I will be asked to go through a variety of testing procedures at the beginning of the study period, and then again following 12 and 24 weeks of the program. The following tests will be performed.

1. Strength testing on 24 different exercises
2. Body composition testing – including underwater weighing, bioelectrical impedance analysis, skinfold measures, and circumference measures.
3. Resting metabolic rate testing with a metabolic cart

I understand that I will go through these tests prior to starting the strength training program. In addition, I will attend a pre testing familiarization session of the strength tests I will perform, approximately one week prior to my testing. This familiarization session will last up to one hour. I understand that the actual testing will require approximately three hours of my time and that the strength testing may be scheduled at a different time from that of the resting metabolic rate and the body composition testing.

Upon completion of the testing, I will be scheduled with a personal trainer to explain the exercise training program. At this time the trainer will work with me on each of the exercises I will perform during the study. The trainer will make sure that I am performing each exercise correctly and safely. I will also be given a written document briefly explaining each exercise. The trainer will review the exercise log with me and show me how it is to be filled out during each exercise session. Following this first session with the personal trainer, all subsequent sessions will be preformed without a trainer. Training will require up to one hour of time each session. During the first eight weeks of training I will exercise two times per week. During the next 16 weeks I will exercise 3 times per week. I understand that these sessions cannot take place on consecutive days, and that I need a minimum of one day of rest between training sessions.

Due to the nature of this study, I understand that I will probably experience some degree of muscle soreness, especially after the initial strength testing and the first several training sessions. I also understand that although every effort will be made to minimize the risk of injury, that possibility does exist. If injury does occur, I agree that any medical cost will be covered through my own private insurance. The researchers will not be responsible for any diagnosis, treatment, or rehabilitation of an injury.

I will benefit from this study in several ways. First I will receive tests of my musculoskeletal fitness, body composition, and metabolism. In addition, I will be provided a strength training program by a personal trainer, and receive the physical benefits of this program. At the conclusion of the study I will be given a copy of the
results of all of the testing performed, so that I will be able to see any changes that have occurred.

I understand that it is my responsibility to comply with the testing and training program. To my knowledge I do not plan on being out of town for more than one week for the duration of the study period. I will keep a record of my work each week in the training log provided. I will then turn this training log in every two weeks. In addition if for any reason, I am unable to comply with the program, I will let the investigator know.

I understand that participating in this study is voluntary and that I may withdraw from the study at any time.

If I have questions regarding any aspect of the program I can call the principle investigator, Bryan Haddock at the Loma Linda University School of Public Health. Finally all questions I have at this time, regarding this study, have been answered to my satisfaction.

Date ___________________________ Signature of Participant

Date ___________________________ Signature of Witness
Appendix E

Loma Linda School of Public Health

Strength Research Study

3 Day Food Record

( ) Male ( ) Female

Phase ( ) I ( ) II ( ) III

Baseline ( ) 12 weeks ( ) 24 weeks ( )
How to record your daily food intake

Each day list all food and beverages consumed at all meals, coffee breaks and snacks. It is best to record the food eaten immediately to insure maximum accuracy and completeness. Remember, this food record will not personally identify you and only one investigator will have access to these records. For this reason it is important to eat all that you normally do, whenever you normally eat it and in whatever quantity you feel like.

The 3 days at baseline, again at 12 weeks and again at 24 weeks may be random or in order but must include:

(1) weekend day,
(1) exercise weekday
(1) non-exercise weekday.

Please remember to mark each day in the box at the top of the food record sheet.

Abbreviations may be used in recording measurements:

<table>
<thead>
<tr>
<th>Tablespoon</th>
<th>Teaspoon</th>
<th>Ounce</th>
<th>Grams</th>
<th>Cup</th>
<th>Slice</th>
<th>Piece</th>
</tr>
</thead>
<tbody>
<tr>
<td>= Tbls</td>
<td>= tsp (3 = 1 Tblsp)</td>
<td>= oz</td>
<td>= g</td>
<td>= c</td>
<td>= sl</td>
<td>= pc</td>
</tr>
</tbody>
</table>
**IMPORTANT**

Do not forget to record the following

<table>
<thead>
<tr>
<th>water</th>
<th>soft drinks</th>
<th>alcoholic beverages</th>
<th>butters (brand)</th>
<th>margarine (brand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gravies</td>
<td>sauces</td>
<td>dressings (kinds)</td>
<td>condiments</td>
<td>candy (brand)</td>
</tr>
<tr>
<td>jams</td>
<td>jellies</td>
<td>sugar</td>
<td>chips</td>
<td>popcorn</td>
</tr>
<tr>
<td>nuts</td>
<td>vitamins</td>
<td>supplements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**How to record your portion sizes**

- **Record as ounces or dimensions:** Meat, fish, poultry, and meat analogs
  - Specify meat cut, chicken part or brand/type of analog

- **Record as fluid ounces:** Beverages: all types including plain water

- **Record as measuring cups:** Potatoes, rice, pasta, grains, cereals (hot or cold)
  - Fruits & veggies (fresh or canned)
  - Soup, casseroles or "mixed" dishes

- **Record as teaspoons or tablespoons:** Jelly, jam, sugar or syrup, sauces, gravies
  - Salad dressings, butter, margarine
  - Condiments & seasonings

- **Record by number & size:** Bread, rolls, bagels (brand), tortillas (kind)
  - (large, medium, small)
  - Raw fruits & veggies (apples, bananas, carrots, celery, etc.)
Shellfish & hot dogs (brand), veggie-steaks, veggie-links
Snack items (nuts, candy, etc)
Potato chips, pretzels, taco chips, etc.

Record by size & measurement:
Pie, pizza, cake, coffee cake, cookies, crackers, etc.
(dimensions & fraction eaten)

How to record “mixed” dishes

For mixed dishes (such as stews, casseroles, etc) or foods eaten out (restaurant, etc) record the total amount eaten and the approximate amount of the ingredients.

Example: 1 cup of beef stew = ½ cup potato
2 oz. lean beef chunks
½ cup peas & carrots
2 T meat gravy

For sandwiches, list all ingredients.

Example: Ham & cheese sandwich = 2 slices whole wheat bread
2 thin slices ham
1 square fat free Borden cheddar cheese
1 leaf lettuce
2 T mayonnaise
1 T Dijon mustard
Instructions for completing your food record

1. Record (X) day of week and it's corresponding date.

2. For "Food source" indicate whether the food was prepared or procured at home or away from home (i.e. a supermarket, fast food joint, restaurant, vending machine, etc.)

3. For "Time" write approximate time the food was eaten such as 7am or 130pm, etc.

4. Name of the food or drink (write in the brand or popular name of the food/drink. Indicate the type such as "whole-wheat", "cracked wheat" "frosted" "plain" etc.)

NOTE: Be sure to write in whether anything was added to the food such as honey, molasses, sugar, gravy, margarine, spread, jam, ketchup, salsa, mustard, Sweet-n-Low®, NutraSweet®, Splenda®, coffee creamers, etc.

5. Do not forget to write in all beverages, especially water that you drink!

6. Description: (write in the specific brand name and whether or not it was canned, fresh or frozen, how it was prepared: boiled, fried, baked, microwave; what type of fat was used in cooking, cooking spray (i.e. PAM®). Was the food breaded, covered with sauce or stuffed?

7. Amount eaten (write in the best measure of the quantity you actually ate!)

8. In "My appetite today" choose between: Not very hungry (NH)

      Moderately hungry (MH)

      Very hungry (VH)


Daily Food Record

Day of Week ( ) Sun ( ) Mon ( ) Tues ( ) Wed ( ) Thur ( ) Fri ( ) Sat

Date: 

Exercise day (y/n) (y/n) (y/n) (y/n) (y/n) (y/n) (y/n) My appetite Today: 

<table>
<thead>
<tr>
<th>Food Source</th>
<th>Time</th>
<th>Name of Food or Drink</th>
<th>Description</th>
<th>Amount Eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Brand name</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fresh, frozen, canned</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preparation method</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Extras: cheese, sauces, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

157
<table>
<thead>
<tr>
<th>Food Source</th>
<th>Time</th>
<th>Name of Food or Drink</th>
<th>Description</th>
<th>Amount Eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Brand name</td>
<td>Cup/oz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fresh, frozen, canned</td>
<td>T/t</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preparation method</td>
<td>fraction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Extras: cheese, sauces, etc.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix F

Profile of Mood States (POMS) Questionnaire Form

**POMS™ Brief Form**

<table>
<thead>
<tr>
<th>Client ID:</th>
<th>Age:</th>
<th>Gender: Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Date:</td>
<td>/ /</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Today's Date:</td>
<td>/ /</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**To the Respondent:**
Below is a list of words that describe feelings that people have. Please read each word carefully. Then circle the number that best describes

- how you have been feeling during the PAST WEEK, INCLUDING TODAY.
- how you feel RIGHT NOW.
- other:

If no box is marked, please follow the instructions for the first box.

<table>
<thead>
<tr>
<th>Item</th>
<th>Not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tense</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. Angry</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. Worn out</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. Lively</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. Confused</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. Shaky</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7. Sad</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. Active</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9. Grouchy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. Energetic</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11. Unworthy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12. Uneasy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13. Fatigued</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14. Annoyed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15. Discouraged</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16. Nervous</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17. Lonely</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18. Muddled</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19. Exhausted</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20. Anxious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>21. Gloomy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22. Sluggish</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23. Weary</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>24. Bewildered</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>25. Furious</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>26. Efficient</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>27. Full of pep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>28. Bad-tempered</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>29. Forgetful</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>30. Vigorous</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

*Please ensure you have answered every item.*