CHAPTER 1: INTRODUCTION
Obesity is defined as an excessive accumulation of body fat (12), and is the result of energy intake exceeding energy expenditure (40). Over the past two decades, increasing numbers of overweight and obese men and women in the United States and around the world have contributed to creating an obesity epidemic. In the United States alone, greater than 50% of adults over the age of 20 are overweight, and approximately 25% are classified as obese according to the World Health Organization (WHO) (24). Parameters have been established by the WHO to classify individuals as overweight and obese. In general, a body mass index (BMI) greater than 25 kg/m\(^2\) is considered overweight and a BMI greater than 30 kg/m\(^2\) is considered obese (24), additionally, a BMI greater than 27 kg/m\(^2\) is associated with an increased risk of morbidity (52). Those individuals with a waist-to-hip ratio (WHR) greater than 0.86 for women and 0.95 for men (1), demonstrate a greater accumulation of fat in the abdominal area and are at an increased risk for disease development (31).

National Institutes of Health (NIH) reported that obesity is strongly correlated with the development of health related disorders such as hypertension, hypercholesterolemia, hyperlipidemia, gallstones, type 2 diabetes, some cancers, and coronary heart disease (CHD) (39). These health related disorders contribute to greater than $500 billion spent annually on obesity related costs (4). Individuals can reduce their risks for developing these obesity-related diseases through weight loss of ten percent of their body weight (29,64).

Each year Americans spend greater than $33 billion on weight control services and products 45. At any given time about 25% of men and 45% of women are trying to lose weight (45). The amount of time and money spent on weight loss efforts has not had an influential effect on slowing the increasing prevalence of obesity. The focus for the treatment of obesity must be
placed on weight management as opposed to weight loss to achieve the best possible weight for health over a lifetime (45).

The American Dietetic Association (ADA) defines weight management “as the adoption of healthful and sustainable eating and exercise behaviors indicated for reduced disease risk and improved feelings of energy and wellbeing.” The ADA has developed three target areas to achieve successful weight management. These include 1.) A moderate change to a healthful diet with increasing consumption of fruits, vegetables, and whole grains, 2.) Learning to eat based on internal cues of hunger and satiety, and 3.) Participating in a minimum of 30 minutes of physical activity daily (45). Dietary intake alterations can be best achieved by setting small attainable goals over time to promote a low fat diet enriched with whole foods (45). Adherence to an exercise program can be accomplished in the same manner, but the ideal exercise prescription to achieve high energy expenditure and fat usage is unknown.

According to the Council on Scientific Affairs, an exercise program in the treatment of obesity should be safe for the participants and promote an increase in energy expenditure, fat loss, maintenance of lean body mass, and greater amounts of activity that can be a lifestyle change (11). Successful and safe exercise regimens that have promoted long term compliance in the obese population have included low impact activities such as walking, swimming, and cycling (71). Although these regimens have proven successful, alternative modes of exercise are currently being researched to determine the optimal exercise program for weight loss and improvements in body composition. These programs include resistance training (RT) and high intensity exercise (HIE) protocols following a lower intensity adaptation and training period.
Statement of Problem

Exercise in addition to dietary modifications plays an active role in the prevention and/or treatment of obesity. Typically, low fat diets with modest calorie restrictions are adequate in promoting gradual weight loss, especially when coupled with an exercise regimen (21,53, 64). However, the best method of exercise for optimal treatment of obesity is yet to be determined.

Previously, low and moderately intensity exercises have been employed as the primary exercise methods for weight loss and decreases in body fat. The rationale is that at low (43,62) and moderate exercise intensities the primary fuel source is fat (44,62). However, when the effects of HIE on fuel utilization are considered, it is possible that HIE may be more beneficial in promoting weight loss and positive alterations in body composition (7,65). A survey of 2500 people by Tremblay et al. (63) suggested that those who participated in more regular vigorous activities maintained lower body fat, and lower WHR than their counterparts not participating in similar activities. In a follow-up study, Tremblay et al. (65) determined that high intensity interval exercise (HIIT) was more beneficial in decreasing body fat than moderate intensity exercise (MIT). Also, HIIT increased the activity of 3-hydroxyacyl dehydrogenase (HADH, a marker of beta-oxidation) greater than MIT training, possibly attributing to a greater decrease in body fat observed after HIIT training. Based on this evidence, it is possible that HIE with or without intervals may be more beneficial as an exercise modality in the treatment of obesity.

It would be a public health benefit to determine the most effective treatment method for obesity. This study is designed to look at the effects of high intensity interval exercise versus moderate intensity endurance exercise in an obese population when dietary intake is modestly reduced. The results of this research will be useful in determining an exercise regimen that will enhance weight management and improve the health status of obese individuals.
Objectives

?? To determine if there is a difference in the change in body fat in obese men in response to HIIT or MIT along with recommended modest energy restriction.

?? To determine if there is a difference in the change in regional body fat distribution in obese men in response to HIIT or MIT along with recommended modest energy restriction.

?? To determine if there is a difference in the activity of skeletal muscle HADH activity in obese men in response to HIIT or MIT along with recommended modest energy restriction.

Research Hypotheses

The following hypotheses will be tested:

H: High intensity interval exercise in combination with modest energy restriction will promote greater body fat loss than moderate intensity exercise with modest energy restriction.

H: The change in body fat distribution will be greater in those individuals who perform high intensity interval exercise with modest dietary restriction than those who perform moderate intensity exercise with modest dietary restriction.

H: There will be a greater increase in the activity of skeletal muscle HADH activity in those who perform high intensity interval exercise with modest dietary restriction than those who perform moderate intensity exercise with modest dietary restriction.

Delimitations

The investigator set the following delimitations:

?? The subject pool consisted of men aged 18-40 years old with BMI greater than 25 kg/m² and less than 45 kg/m².
The subjects were screened to eliminate those with known health complications such as diabetes, heart disease, hypercholesterolemia, and hypertension.

There were two exercise protocols, HIIT and MIT performed on a cycle ergometer three times per week which may not be representative of the activities performed by obese individuals.

The dependent measures for both treatment groups were diet analysis, body composition, WHR, waist-to-thigh ratio (WTR), waist circumference, and muscle HADH activity.

**Limitations**

The following limitations were inherent in the study design:

- The training period was a total of nine weeks. This may not have been sufficient time to achieve the desired changes.
- Thirteen subjects participated in the study; complete data was collected for 7 subjects.
- The subjects did not serve as their own controls in the study.
- The subjects’ food intake and outside physical activities were not controlled.
- The measurements for the dependent measures were performed in the beginning and end of the study.
- The diet prescriptions were based on the subjects’ height and weight, not their measured energy needs.

**Basic Assumptions**

The investigator made the following assumptions:

- Three-day food records accurately represented the subject’s dietary intake throughout the training period.
- The subjects gave a maximal effort during exercise tests and sessions.
Subjects were not participating in regular physical activity prior to the start of the study.

The subjects maintained proper cadence during the exercise tests and weekly exercise sessions.

The subject population was representative of the population of overweight and obese men.

**Symbols and Definitions of Terms**

- **ATP**: Adenosine triphosphate
- **BMI**: Body mass index
- **FFM**: Fat free mass
- **FM**: Fat mass
- **HADH**: 3-Hydroxyl acyl dehydrogenase
- **HIE**: High intensity exercise
- **HIIT**: High intensity interval exercise
- **LIT**: Low intensity exercise
- **MIT**: Moderate intensity exercise
- **RMR**: Resting metabolic rate
- **TEF**: Thermic effect of food
- **WHR**: Waist-to-hip ratio
- **WTR**: Waist-to-thigh ratio
- **24 h EE**: Twenty-four hour energy expenditure
- **%BF**: Percent body fat
- **Aerobic/oxidative metabolism**: Production of ATP in the presence of oxygen.
**Anaerobic metabolism**
Production of ATP in the absence of oxygen.

**Android obesity:**
An accumulation of adipose tissue in the abdominal region, also known as upper body obesity, and apple shape.

**3-hydroxyacyl dehydrogenase:**
An enzyme marker of beta-oxidation. Catalyzes the oxidation of the $\alpha$-hydroxy group to the ketone.

**Beta-oxidation:**
Oxidation of fatty acid in the mitochondria. A cyclic pathway in which two-carbon units are cleaved one at a time from the carboxyl end of the fatty acid.

**Body mass index:**
Calculated by measuring an individual’s weight in kilograms and dividing it by the individual’s measured height in meters squared. Considered an index of total body fat in men and women and useful in identifying an individual’s possible disease risk. May give a false representation if a large amount of musculature is present.

**Fat free mass/lean body mass:**
Includes protein, water, carbohydrate, and mineral components of the body. May also include essential body fat such as the fat associated with bone marrow, the nervous system, internal organs, cell membranes, and in females the mammary glands and pelvic region.

**Fat mass:**
Remainder of the fat in the body that is not considered part of FFM.

**Gynoid obesity:**
Accumulation of fat in the gluteal femoral region, also referred to lower body obesity, or pear shape.

**Resting metabolic rate:**
Energy expenditure necessary for
support of physiological functions to sustain life.

?? *Thermic effect of food:* Metabolic response to food. Includes the work of digestion, absorption, transport, metabolism, and storage of energy obtained from food.

?? *Twenty-four hour energy expenditure:* The amount of energy expended by the body in a 24 hour period. Includes RMR, TEF, physical activity, and adaptive thermogenesis.