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THE RELATIONSHIPS AMONG BMI, WAIST CIRCUMFERENCE, WEIGHT LOSS AND HEALTH INDICATORS

THESIS

A thesis submitted in partial fulfillment of the requirements of for the degree of Master of Science in the College of Agriculture, Food and Environment at the University of Kentucky

By

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Lexington, Kentucky

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2015

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ABSTRACT OF THESIS

THE RELATIONSHIPS AMONG BMI, WAIST CIRCUMFERENCE, WEIGHT LOSS AND HEALTH INDICATORS

Current health recommendations encourage weight loss for overweight and obese individuals. However, the importance of weight to health is still unclear. The purpose of this study was to determine the impact of weight loss on overall health in a sample of adults who have completed a 10 or 12 week weight loss intervention. The study sample included males and females (n =99) between the ages of 27 -64 years that had a BMI of 29-45 kg/m^2. The study design is a secondary data analysis of data from two different behavioral weight loss interventions. Both interventions prescribed a reduced calorie diet, increased physical activity, and self-monitoring of diet and physical activity. Of the 99 participants, 28 lost greater than 5% of baseline body weight and saw the most significant changes in waist circumference ($p<0.001$), systolic blood pressure ($p=0.004$), diastolic blood pressure ($p=0.002$), and total cholesterol ($p=0.001$). This group experienced improvements in every lab value tested. More research with larger sample sizes and longer trial periods need to be done in order to strengthen the validity of the weight loss interventions.

Key Words: Weight loss, Waist circumference, BMI

John Robert Rupp

December 11, 2015

THE RELATIONSHIPS AMONG BMI, WAIST CIRCUMFERENCE, WEIGHT LOSS AND HEALTH INDICATORS

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Chapter I

What adult weight best promotes health, minimizes the risk of chronic disease, and increases longevity? This area of inquiry has engaged the interest of the public, health care professionals, and researchers. The consequences of answering this question have profound health, social, and economic implications for individuals and communities. In the United States, the prevalence of overweight individuals and obesity has increased markedly, especially in the past two decades (Gaesser, 2003). Obesity is an important risk factor for diabetes mellitus, cardiovascular disease, stroke, chronic kidney disease, and mortality (Han, S., Kim, K., Kim, K., Na, K., Chae, D., Kim, S., & Chin, H., 2010). Body Mass Index (BMI) is commonly used as an indicator of obesity. It is a calculation using a person's height and weight to determine their health risk. A BMI of 25-29.9 kg/m^2 places an individual in the overweight category, a BMI of 30-39.9 kg/m^2, places an individual in the obese category, and a BMI of 40 kg/m^2 or more places an individual in the morbidly obese category. As of 2013, 35.5% of adults in the United States (U.S.) are overweight and 28.3% are obese (CDC, 2013). This number continues to rise and has spurned research on what has contributed to the obesity epidemic.

Changes in the American dietary and fitness habits, such as over-consumption of calories and an increasingly sedentary lifestyle, have significantly contributed to this epic rise in weight-gain. Since the early 1990s, the average weight of the U.S. adult has increased by about one pound each year, and consequently, the number of Americans on diets has risen drastically (Gaesser, 2003). However, dieting seems to have little impact on the rise of obesity in the United States. Furthermore, several studies have shown that a history of dieting may increase chances for subsequent and significant weight gain. Even if dieting does not lead to obesity, a diet mentality may lead to chronic weight fluctuations (Gaesser, 2003).

Current health recommendations encourage weight loss for overweight and obese individuals. However, the importance of weight to health is still unclear.

Today's society would argue in favor of weight loss. However, some studies have shown that total mortality actually decreases in overweight populations compared to normal and underweight populations (Gaesser, 2003 & Flegal et al, 2013). Instead of focusing on losing weight, research shows that improving cardiorespiratory fitness (Sui, X., LaMonte, M., Laditka, J., Hardin, J., Chase, N., Hooker, S., & Blair, S., 2007), improving heart and muscles fitness (Harvard, 2014), decreasing total cholesterol through exercise (Port, S., Demer, L., Jennrich, R., Walter, D., & Garfinkel, A., 2000), and following a heart healthy diet (Levitan, E., Wolk, A., & Mittleman, M., 2009), can have more impact on overall health.

Problem Statement

Obesity and a sedentary lifestyle contribute to many medical conditions and a decrease in quality of life. Weight loss alone may not be the answer to solving the obesity epidemic.

Purpose Statement

The purpose of this study was to determine the impact of weight loss on overall health in a sample of adults who have completed a 10-12 week weight loss intervention.

Research Questions

1) At baseline, was BMI a good indicator of health based on waist circumference, blood pressure, total cholesterol, HDL, LDL, triglyceride levels, and blood glucose?
2) After a 10 or12 week weight-loss intervention, were weight change and change in waist circumference correlated with a decrease in blood pressure, total cholesterol, triglyceride levels, and blood glucose?
3) After the 10 or12 week intervention, was a weight loss of greater than 5% of baseline body weight associated with greater improvements in health indicators than a weight loss of less than 5% of baseline body weight?

Chapter II

Literature Review

It is not news that Americans are heavier now than ever before. The prevalence of overweight and obese individuals has increased steadily over the past two decades (CDC, 2012). For an adult, obesity is defined as having a BMI of 30 kg/m^2 or higher (CDC, 2012). A study from 2013 showed that almost 40% of adult men and 30% of adult women fall into the overweight category in the United States (Flegal, K., Kit, B., Orpana, H., & Graubard, B. 2013). Changes in the standard American diet, such as over-consumption and, large portion sizes, along with changes in fitness and activity levels, such as increased sedentary lifestyles, have contributed to the obesity epidemic. There are a variety of influencing factors that are believed to impact obesity such as lifestyle choices, sedentary behaviors, over-consumption, family genetics, nutrition knowledge, stress, the built environment for physical activity and the food environment (Aphramor, 2010 & Whitlock, G., Lewington, S., Sherliker, P., Clarke, R., Emberson, J., Hasley, J., N., Qizilbash, R., Collins, & Peto, R., 2009). It is generally accepted that being overweight or obese is associated with having higher risks of mortality. However, the evidence must be closely evaluated.

The idea that overweight and obese individuals have increased all-cause mortality and live shorter lives when compared to their normal-weight counterparts may not be merited. Some studies contradict this idea (Gaesser, 2003 & Flegal et al, 2013). The question remains, is it necessary to be at a normal weight to be healthy?

Due to the increased prevalence of obesity in the United States, more people go on "diets" than ever before. However, these numbers are only increasing as obesity affects more and more Americans. According to one review, several long-term studies on men and women indicate that a history of dieting may increase chances for subsequent and significant weight gain (Gaesser, 2003). Ironically, cutting calories may perpetuate what dieting is trying to cure – obesity. This is due to weight fluctuations (typically defined in research studies as a weight loss or gain of more than 5% body weight) and has been associated with a number of adverse health outcomes. When trying to lose weight, one has to ask themselves what is the purpose of trying to lose weight. Losing weight for the sake of aesthetics or improved health are the main reasons individuals diet (Gaesser, 2003). However, recent research shows that to improve overall health and reduce all-cause mortality, reducing body weight might not be the answer for everyone (Heymsfield & Cefalu, 2013 & Flegal et. al, 2013).

Body Mass Index

Body-Mass Index (BMI), is calculated by dividing weight in kilograms by meters squared, and is the most widely accepted tool used to diagnose underweight, healthy weight, overweight, or obese individuals. Individuals fall into categories of underweight (BMI < 18.5 kg/m^2), normal weight (BMI 18.5 kg/m^2 - < 24.5 kg/m^2), overweight (BMI 25 kg/m^2 - < 30 kg/m^2), and obese (BMI > 30 kg/m^2). Obese individuals fall into one of three categories; Grade 1 obesity (BMI 30 kg/m^2 - < 35 kg/m^2), Grade 2 obesity (BMI 35 kg/m^2 - < 40 kg/m) and Grade 3 obesity (BMI > 40 kg/m^2. Higher BMI has been shown to be a risk factor for several causes of death that include ischemic heart disease, stroke, and cancers of the large intestine (Whitlock et. al, 2009). However, there are some drawbacks of using BMI as a health indicator. BMI does not take into account gender, race, age, fitness level, or ethnicity (Heymsfield & Cefalu, 2013). BMI also does not differentiate between lean mass and fat mass (Han et. al, 2010). This limitation is especially problematic with older adults, because they tend to lose fat-free mass and increase fat mass as they age. Epidemiological studies have demonstrated that high BMI, consistent with overweight or obesity, is associated with a greater risk of mortality, but this relationship is not evident in older adults or in patients with chronic disease. Rather, a higher BMI appears to be correlated with a lower risk of mortality in what is known as the "obesity paradox" (Han et. al, 2010). A possible explanation for this reverse correlation is the insensitivity of BMI to actual health status. Nutrition, physical activity, and body composition might be of greater importance in relation to mortality in these populations. The severity of a particular disease state that an individual may have also must be taken into account when examining weight status.

BMI is known to be an imperfect predictor of metabolic risk, however it is a good measure of general adiposity (Whitlock et. al, 2009). Some individuals with normal a BMI have an overweight-obese metabolic pattern. Others can have a normal metabolic pattern but have an obese BMI. Identification of at-risk individuals for overweight and grade 1 obesity is best captured by considering traditional risk factors, including blood pressure, blood lipid levels, and fasting blood glucose. In addition to BMI, waist circumference is recommended in differentiating healthy individuals from overweight and obese (Heymsfield & Cefalu, 2013).

Overweight and obese individuals are more likely to be sedentary and have lower aerobic fitness levels than their non-overweight counterparts. According to the Aerobics Center Longitudinal Study from Dallas, Texas, aerobic fitness levels may mitigate much, if not all, of the risk associated with obesity (Gaesser, 2003). Obese men who are classified as "fit" based on an exercise treadmill test have death rates just as low as lean-fit men, and have death rates one-half those of lean-unfit men. This suggests that fitness is more important than leanness in reducing premature death risk. Additional data from the Behavioral Risk Factor Surveillance System (BRFSS) shows that lack of physical activity is more important than excess body weight as a predictor of cardiovascular mortality (Gaesser, 2003). Gaesser and colleges emphasize the idea that a fit individual that is classified as overweight or obese according to BMI, may have a lower risk of mortality than a normal weight individual who does not perform any physical exercise.

A recent meta-analysis from the Journal of the American Medical Association surveyed over 2.88 million individuals and had surprising results in relation to BMI and all-cause mortality. The authors confirmed significantly increased all-cause mortality among normal weight individuals when compared to overweight individuals. The findings remained consistent even after adjusting for smoking status, preexisting disease, and self-reported vs. measured reporting methods (Heymsfield & Cefalu, 2013). An update from the Center for Disease Control and Prevention (CDC) showed consistent findings. "Even severe obesity failed to show up as a statically significant mortality risk (Aphramor, 2010)." The CDC confirmed previous findings that overweight individuals live slightly longer than people of normal weight. However, they found that individuals in the underweight and severely obese categories (BMI < 18.5 and BMI > 30) have increased mortality risk. Contrary to original thought that individuals in the healthy or normal weight categories would live the longest or have the best overall health, individuals who have a BMI of 25-29.5 appear to have the lowest risk of mortality. Possible explanations include greater likelihood of receiving medical treatment, cardio-protective metabolic effects of increased body fat, and benefits of higher metabolic reserves (Flegal et. al, 2013).

Predictors of Mortality - Cardiorespiratory fitness

The idea that fitness may have more impact on health and longevity than BMI has spurned more research studies. A research study performed in 2007 investigated cardiorespiratory fitness and adiposity as mortality predictors, especially in older adults (Sui et al, 2007). The authors found that fitness is an independent predictor of mortality and morbidity. Participants in the longitudinal study that had died had lower fitness levels, and had more cardiovascular risk factors than survivors. In both age and sex adjusted-analyses, both BMI and waist-circumference were associated with mortality risk and percent body fat and fat-free mass were also related to mortality (Sui et. al, 2007). Furthermore, fitness had a strong inverse association with mortality. Their primary findings were that both fitness and BMI were strong independent predictors of all-cause mortality in adults 60 years or older. Other studies had previously demonstrated that lower levels of fitness are strongly associated with higher risk of all-cause mortality and cardiovascular disease mortality in younger and middle-aged men with various levels of health status (Sui et. al, 2007). The data therefore suggests that fitness levels in older individuals influence the association of obesity and mortality (Sui et.

al, 2007). Results concerning the relationship between mortality and obesity have been inconsistent. However, in the Sui and colleagues study, the age and sex adjusted mortality rate per 1000 person-years was the lowest in the overweight group and the highest in the class 2 obesity group.

Another study investigated resting heart rate, physical activity, and mortality, and found that a high resting heart rate was a significant predictor of mortality (Jensen, M. T., Saudicani, P., Hein, H. O., and Gyntelberg, F, 2013). This study examined only men but similar results could be expected with women. In the fully adjusted model, a resting heart rate in the range of 51-80 beats per minute (bpm) was associated with about a 40-50% increase in risk in mortality, a resting heart rate of 81-90bpm conferred a twofold increase in risk, and resting heart rate over 90bpm conferred a threefold increase in risk of mortality. There was a borderline significant interaction between resting heart rate, smoking status and mortality. Smokers had a higher resting heart rate than non-smokers and higher risk in mortality. The main finding of this study was that resting heart rate was a risk factor of mortality independent of physical fitness (Jensen et. al, 2013). However, physical fitness is known to improve heart health and lower resting heart rates.

Cholesterol and Blood Pressure

Total cholesterol has been shown to be associated with mortality in many epidemiologic studies. The relationship of all-cause mortality and total mortality with cholesterol has been found to be “U” or “J” shaped, or increasing (Cai, J., Pajak, A., Li, Y., Shestov, D., Davis, C., Rywik, S., Li, Y., Deev, A., & Tyroler, H., 2004). For coronary heart disease (CHD) mortality, studies show that the death rate increases as total cholesterol increases (Cai et. al, 2004). A study conducted in 2004 examined populations from four countries (United States, Russia, China, and Poland). Within each cohort, men had higher age-adjusted death rates than women (Cai et. al, 2004). Despite the marked heterogeneity in the distribution of risk factors and mortality rates across countries, the association between total cholesterol and mortality did not differ by country. For cardiovascular disease (CVD) and CHD mortality, the risk of death increased as the cholesterol level increased for men. These findings are similar in women. This study showed that cholesterol is a strong, consistent predictor of mortality from CHD and all CVD. (Cai et. al, 2004).

In addition to cigarette smoking, raised blood cholesterol and diabetes, elevated blood pressure is a well-established risk factor for developing coronary heart disease (CHD) and stroke (Gray, L., Lee, I., Sesso, H., & Batty, D., 2011). Current medical treatment of hypertension aims to lower systolic blood pressure, for all ages and both sexes, to a resting value lower than 140 mm Hg (Port et al, 2000). The sixth report of the Joint National Committee on the Detection, Evaluation, and Treatment of Hypertension (JNC/6) recommends that normal systolic blood pressure is less than 120 mm Hg (Port et. al, 2010). The Framingham Heart Study was instrumental in establishing this current viewpoint.

Like other physiological risk factors, individuals with elevated blood pressure in early adulthood tend to have higher values later in life. In a particular male student cohort, high blood pressure measured around 20 years of age was associated with increased risk of CHD mortality up to 50 years later. Hypertension in middle age was associated with an increased risk of total mortality of 57% in this particular study (Gray et. al, 2011). Hypertension status in middle age was also associated with a 2-fold increased risk of CVD and a doubling of the risk associated with stroke mortality. Research leads us to believe that if one's blood pressure is pre-hypertensive or hypertensive in early adulthood, this trend typically leads into late adulthood as well (Sui et. al, 2007). Furthermore, hypertension increases the risk for CHD, CVD, stroke and increased total mortality. These results lend weight to implementing blood-pressure lowering strategies early in life.

A review of the Framingham study found some interesting associations between systolic blood pressure and all-cause and cardiovascular mortality. The data showed that the relation between systolic blood pressure and all-cause mortality is not strictly increasing. However, the risk is unrelated to systolic pressure to at least the 70th percentile for age and sex, but sharply increases with blood pressure higher than the 80th percentile (Port et. al, 2010). Since systolic blood pressure increases steadily with age, but at different rates in men and women, the threshold is age and sex dependent. Other findings showed that blood pressure higher than 170 mm Hg were associated with significantly higher risk of all-cause and cardiovascular mortality (Port et. al, 2010).

Insulin Resistance

In the general population, insulin resistance is associated with multiple risk factors for CVD, including abdominal obesity, lipid abnormalities, and type 2 diabetes mellitus (Li, Y., Zhang, L., Gu, Y., Hao, C., & Zhu, T., 2013). Furthermore, hyperinsulinemia has been found as an independent predictor of ischemic heart disease. The role of hyperinsulinemia as a risk for CHD and CVD is complex because of the close physiologic links of hyperinsulinemia and the underlying insulin resistance with other risk factors such as obesity, impaired glucose tolerance, dyslipidemia, and elevated blood pressure (Pyorala, M., Miettinen, H., Laakso, M., & Pyorala, K., 2000). The Helsinki Policeman Study of 2000 was one of the first prospective studies to demonstrate the association between hyperinsulinemia and CHD and stroke. Results from the study found that with increasing A1C insulin, there was an increasing trend for age, obesity, blood pressure, cholesterol, triglycerides, and glucose variables, but a decreasing trend for maximal oxygen uptake and the proportion of physically active men (Pyorala et. al, 2000). The proportion of cardiovascular deaths to all deaths increased with increasing insulin. In the age-adjusted model, hyperinsulinemia was significantly associated with increased all-cause, cardiovascular, coronary, and cerebrovascular mortality during the 10 year follow-up. However, during the 22 year follow-up these results weakened (Pyorala et. al, 2000).

Findings from a study that focused on insulin resistance as a predictor of CVD in patients on peritoneal dialysis found that insulin resistance is related to several CVD risk factors, obesity, inflammation, and is the central pathophysiologic process of metabolic syndrome (Li et. al, 2013). However, survival studies on patients on dialysis have shown that a high BMI is associated with an improved survival rate. This is another case of the obesity paradox in which having what is considered an unhealthy weight according to the BMI, actually improves one's survival rates. This may be due to the positive effect of having extra weight as a metabolic buffer. Insulin resistance is a modifiable risk factor and reduction of insulin resistance may lower CVD risk and improve survival rates in the general population (Li et. al, 2013).

Longevity

Lifestyle factors including physical activity, smoking, alcohol consumption, and dietary habits in men and women in relation to longevity is an important area of research. A small cohort study examining at a group of Ashkenazi Jewish individuals who were living independently at age 95 or older was conducted in order to shed some light on how these factors play a role in longevity. In response to the participants' beliefs about what might have contributed to their longevity, responses included "good" genes, healthy diet, busy or active life, less smoking and drinking, good luck, and spirituality (Rajpathak, S., Liu, Y., Ben-David, O., Reddy, S., Atzmon, G., Crandall, J., & Barzilai, N., 2011). It has been suggested that lifestyle factors play a larger role in human longevity than do genetic factors. Although interaction with the environment is important, and a healthier lifestyle may enhance lifespan, the presence of longevity genes in people with exceptional longevity, counter the presence of disease-associated genes (Rajpathak et. al, 2011). More research in how genetics and lifespan are related is needed.

There is evidence that indicates that many of the more prevalent weight-related health problems, such as high blood pressure, elevated cholesterol and triglyceride levels, insulin resistance, and glucose intolerance, can be improved independently of weight loss (Gaesser, 2003). Exercise can have positive effects on these values even when weight loss is not achieved. Lowered blood pressure, in particular, can be achieved after a single exercise session and is largely independent of weight loss. Similar results can be found in dietary patterns. The Dietary

Approaches to Stop Hypertension (DASH) diet has been clinically proven to reduce blood pressure by simply changing diet, without weight loss (Gaesser, 2003).

Overweight and obese individuals typically, have elevated cholesterol and triglyceride levels, commonly believed to increase risk of developing cardiovascular disease. Physical exercise can also improve blood lipid levels independently of changes in body weight. Improvements in insulin sensitivity and blood lipids as a result of aerobic exercise have been documented even in persons who actually gained body fat during the intervention (Gaesser, 2003).

Weight Cycling

The physical and psychological consequences of weight cycling, that is, the fluctuations in body weight due to dieting, and the debate over who should and should not attempt to lose weight have received increasing attention (Simkin-Silverman, L., Wing, R., Plantinga, P., Matthews, K., & Kuller, L., 1998). It has been hypothesized that weight cycling may affect metabolic rate, increase the risk of CHD, and have negative psychological consequences. Research has suggested that an association between weight cycling and the increased risk of CVD mortality, but it is unclear whether this association is a function of involuntary or voluntary weight loss (Simkin-Silverman et. al, 1998). Although most of the early studies suggested that weight variability, loss, and cycling were associated with an increased risk of mortality or morbidity, findings from more recent studies have not been consistent (Field, A., Malspeis, S., & Willett, W., 2009). A study conducted in 1995 surveyed 497 normal-weight and overweight men and women on weight cycling history and measures of well-being, depression, eating self-efficacy, and life events. Weight fluctuations were defined in terms of whether participants considered themselves as being a " yo-yo" dieter. The study found that females were more likely than males to be "yo-yo" dieters as were obese individuals compared to normal-weight individuals. The results indicated that regardless of weight status, individuals who were "weight fluctuators" reported lower levels of general well-being and lower eating self-efficacy. No differences in depression, however, were found between fluctuators and nonfluctuators (Simkin-Silverman et. al, 1998). A study that examined 44,882 middle-aged or older women in the Nurses' Health Study from 1988-1992 found that approximately 7% of women were mild weight cyclers and 1.5% were severe weight cyclers (Field et. al, 2009). Weight cycling was positively associated with BMI at baseline. Approximately 40% of the non-cyclers were overweight or obese compared to 74% of the mild cyclers and 87% of the severe cyclers. In addition, cycling status was inversely associated with physical activity. Conclusions from the study include that the association of severe cycling and death due to CVD was stronger than the association with all-cause mortality, particularly for recent weight cycling. More importantly, weight cycling was not strongly related to all-cause mortality or CVD mortality. Weight cycling was not predictive of CVD or total mortality (Field et. al, 2009). Although this study found that repeated intentional weight losses were not predictive of greater all-cause or CVD mortality, other studies have had contradicting results. Limitations to most of the studies on weight cycling and predictors of mortality do not account for intentional versus unintentional weight loss.

Improving Fitness

In Western countries, the prevalence of CVD and related disabilities remains high. These diseases are associated with excess body mass and fat, poor physical fitness, elevated blood pressure, insulin resistance, and abnormal serum lipid profiles (Viela, B., Silva, A., Barbosa de Lira, C., & Andrade, M., 2015). These abnormalities are mainly caused by unhealthy lifestyle behaviors, such as smoking, poor diet, excessive alcohol intake, and sedentary behaviors. For the general working population, an unhealthy lifestyle not only affects the risk of CVD and other chronic diseases but may also lead to major disadvantages in the workplace itself. Insufficient physical activity is negatively associated with physical work capacity and is positively associated with the amount of time spent on sick leave. One way to improve workplace efficiency and the health of the employees is to implement a workplace fitness and education program (WFEP) intervention. This consists of a set of physical and educational practices drawn from work activities that is performed during working hours. The WFEP is aimed at counterbalancing the body structures that are commonly used at work, strengthening muscles not typically used at work, and providing muscle relaxation and strength and an increase in knowledge about physical exercise and impact of sedentary lifestyle on health (Viela et. al, 2015). A particular WFEP recruited participants from a chemical industry in Sao Paulo, Brazil. The WFEP consisted of a physical exercise program, five times per week. Each session lasted 15 minutes. On Mondays and Wednesdays, participants underwent 10 minutes of muscular endurance training to the lower limbs using exercises such as squats, extensions, flexion, adduction, and abduction of the lower limbs and strengthening of the calf muscles. At the end of the session, 5 minutes of lower limb stretching was performed. On Tuesdays and Thursdays, the participants underwent a similar regimen on their upper limbs. On these days, they also performed abdominal muscle-strengthening exercises. On Fridays, participants engaged in 15 minutes of sporting activities such as soccer, volleyball, and basketball. All of the training sessions were supervised by exercise instructors (Viela et. al, 2015). The aim of this particular study was to see if these training sessions helped improve the participant's flexibility and related health. The hope was that by improving the health and flexibility of the workers, they would also improve work efficiency. The results of the study demonstrated that a WFEP is an effective way to improve worker body composition, muscular flexibility, and strength for industrial workers. Not only did this work program help improve worker strength, flexibility, health and body composition, it also helped economically, however the extent of which was not included in the study (Viela et. al, 2015).

Another way to improve heart and muscle fitness, according to a Harvard Health Letter, is simply to take the stairs whenever possible. Stair climbing has many physiological benefits. It burns twice as many calories as walking and it engages a number of different leg muscles including the gluteus, buttocks, hamstrings, quadriceps, and soleus muscles in the calves (Harvard, H., 2014). This activity helps build muscle strength and new bone. It also strengthens the heart and lungs. According to the article, stair climbing reduces the risk for heart disease by lowering blood pressure and cholesterol, reducing stress levels, and aiding in achieving or maintaining a healthy weight. This activity is great especially for someone just starting a physical exercise regimen and trying to lose weight. Stair climbing at a workplace, gym, or at home for 30 minutes a day, Monday through Friday can help one reach the recommended physical activity level (Harvard, 2014).

DASH Diet

Dietary patterns, food choices, and sedentary lifestyles have been associated with risk factors for heart failure (HF) (Levitan et al, 2009). The Dietary Approaches to Stop Hypertension (DASH) diet may contribute to prevention of HF in some cases. The DASH diet emphasizes high intake of fruits, vegetables, whole grains, low-fat dairy products, resulting in high potassium, magnesium, calcium, and fiber consumption, moderately high protein consumption, and low total and saturated fat consumption (Levitan et. al, 2009). In a recent study, women with the highest values of a score designed to measure consistency with DASH had a 24% lower risk of coronary heart disease and an 18% lower risk of stroke (Levitan et. al, 2009). In this study of over 36,000 women who participated, women in the top quartile of DASH scores ate, on average, 3.0 servings of fruit, 3.5 servings of vegetables, 5.1 servings of whole grains, 1.6 servings of low-fat dairy products, 0.1 servings of sweetened beverages, and 0.8 servings of red or processed meat per day (Levitan et. al, 2009). During the 7 years of follow-up, women who developed HF tended to be older, have a higher BMI, more likely to be current smokers, and have a history of hypertension and high cholesterol. Although studies examining DASH diet and association to HF, myocardial infarctions, and stroke, are limited, and results have varied across studies, the general trend is that a healthy dietary pattern like the DASH diet, are associated with a reduced rate of myocardial infarctions, reduced blood pressure, and total cholesterol (Levitan et. al, 2009).

HAES

A program that is a non-weight centered approach to improving overall health called Health at Every Size (HAES) is gaining in popularity. HAES advocates adopt a weight-neutral approach to lifestyle changes where the primary goal is shifted from achieving weight change to modifying health behaviors (Aphramor, 2010). Outcome measures relate to metabolic fitness. Blood pressure, cholesterol, exercise levels, and psychological parameters are examined. The research indicates that significant improvements in metabolic measures can be achieved independent of weight loss. There are four key tenets of HAES that set it apart from conventional healthy weight interventions. First, it is weight neutral (weight loss is not the primary goal). Second, it teaches people to rely on internal signals and to eat intuitively, not when socially acceptable or based off of external cues. Third, it encourages positive self-esteem in people of all shapes and sizes. Finally, HAES challenges size discrimination (Aphramor, 2010).

Summary

Population aging, obesity, physical inactivity, and over-consumption of food are notable public health challenges. By 2030, 22% of the US population, or 70 million individuals, will be 65 years or older. Approximately 32% of Americans are obese, and the vast majority of US adults do not engage in regular physical activity (Sui et. al, 2007). A high proportion of adults tend to have levels of functional capacity that are low enough to increase mortality risk. Levels of physical activity and functional aerobic capacity both decline with age while obesity rises with age. Statistics lead us to believe that the average American will be older and more obese or will become obese over the next 15 years. As stated previously, it is generally understood that having an overweight or obese BMI is associated with an increased risk of mortality. This is true for the general population, however there are exceptions. Individuals that have chronic disease such as chronic kidney disease actually have a higher survival rate when overweight or obese (Li et. al, 2013). Also, elderly individuals (60+) have a lower mortality rate when overweight or obese than normal-weight counterparts. This is known as the obesity paradox (Han et. al, 2010). BMI is a relatively good predictor of all-cause mortality and health, but it is not 100% reliable. From the research, it appears that an individual's body composition, nutrition level, and waist circumference are better indicators of overall health and well-being than BMI. BMI does not account for age, gender, race, ethnicity, fitness level, and does not differentiate between fat-free (lean) mass and fat-mass. BMI also is an imperfect indicator of metabolic risk. For example, an obese man who is physically active has a lower mortality risk than a normal-weight man who never engages in physical activity. Therefore, cardiorespiratory fitness may have a larger role on mortality than previously thought.

There are many factors that help in predicting mortality risk. Blood pressure and cholesterol are a couple of the more well-known and accepted predictors of mortality. A high blood pressure and abnormal lipid profile contributes greatly to the risk of CVD, stroke, CHD, and all-cause mortality. Lifestyle factors such as smoking and physical inactivity contribute to the risks of developing these diseases as well. Research has found that having high blood pressure and abnormal lipid profiles in early adulthood sets the pattern for having chronic diseases later in life and increases the chance of early mortality (Gray et. al, 2011). Insulin resistance is another detrimental predictor of mortality that is closely related to obesity and CVD. Although it is not as positively associated to mortality as blood pressure and cholesterol, hyperinsulinemia has been found to be a predictor of ischemic heart disease (Pyorala et. al, 2000). One of the more mysterious predictors of mortality is the area of demographics. It is known that women outlive men on average but endure more deleterious health outcomes (Doblhammer & Hoffmann, 2009). It is unclear the impact race, ethnicity, and environmental effects have on mortality but they do play a role. Another predictor of mortality that is gaining attention due to the obesity epidemic is weight cycling. It was theorized that chronic weight cyclers would have greater mortality risk and negative psychological well-being (Simkin-Silverman et. al, 1998). Results from studies on this topic have been inconsistent and it is unclear the impact weight fluctuations have on mortality and morbidity risk.

The idea that exercising regularly and eating a healthy diet seems simple enough but there are many confounding variables that play a part. It is generally accepted that by engaging in aerobic exercise at least 150 minutes a week lowers the risk for developing heart disease (Harvard, 2014). After research, cardiorespiratory fitness could outweigh BMI as a more reliable indicator of mortality. Even if an individual falls into the "healthy" weight category on the BMI scale, if that person goes not engage in physical activity, that person is still at risk for developing chronic diseases. To combat this, work environments are employing WFEP that implement a regimen of physical exercise and educational material for their employees to try and increase their health and workplace efficiency (Viela et. al, 2015). There are many other ways to improve heart and muscle fitness such as taking the stairs whenever possible and by walking 30 minutes a day, five times a week. Certain diets (DASH) and programs (HAES) have been developed in attempts to improve physical and mental health. Research is still being conducted on how to best combat the obesity epidemic but it appears there are answers.

Chapter III

Methodology

Study Design

The study design is a secondary data analysis of data from two different behavioral weight loss interventions, one lasting 10 weeks and one lasting 12 weeks. Both interventions prescribed a reduced calorie diet, increased physical activity, and self-monitoring of diet and physical activity. The same variables were measured in both studies and the data were therefore collapsed for this analysis.

Study Setting

The two studies were conducted in Lexington, Kentucky at the University of Kentucky. The first intervention was conducted in 2011 and the second in 2014.

Instruments

Weight was taken on a digital scale and height was measured on a wall-mounted stadiometer by trained study personnel at the University of Kentucky CR-DOC clinic. Participants wore a hospital gown with no shoes for weight and height measurements. Waist circumference was measured over the hospital gown at the umbilicus two times and the average taken. Blood pressure was measured once in the seated position with a digital blood pressure monitor. A fasting venous blood sample was also taken to be analyzed for blood glucose, total cholesterol, triglycerides, LDL-C, and HDL-C.

Study Sample

The study sample included only overweight and obese males and females. The samples for this study were males and females between the ages of 27 -64 years that had a BMI of 29-45 kg/m^2. The total sample size was 99; 50 from the 12 week study and 49 from the 10 week study. Exclusion criteria included: a medical diagnosis of orthopedic or joint problems that might have prohibited regular exercise; reported heart problems, chest pain, faintness or dizzy spells; hospitalization for a psychiatric disorder within the last year; a history of anorexia or bulimia nervosa; a medical diagnosis of cancer (except skin cancer) or HIV; pregnant, nursing or planning to become pregnant within the study period; less than 9 months post-partum; and weight loss of ≥ 10 pounds in the last six months.

Data Analysis

Data were analyzed using Statistic Package for the Social Sciences (SPSS) software. Descriptive statistics were used to characterize participants at baseline. Correlations were conducted using Pearson's R. Alpha was set at 0.05 for all tests.

Chapter IV

Results

The initial sample consisted of 99 participants aged 27-64 years old. Of these participants, 84.8% (n=84) were female and 15.1% were male (n=15). The mean age was 45.3 (9.5) years.

Figure 1: Gender of participants who completed the study

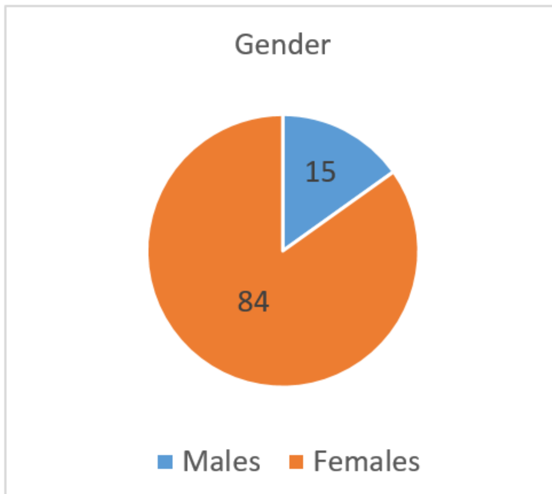

Figure 2: Age of participants who completed the study

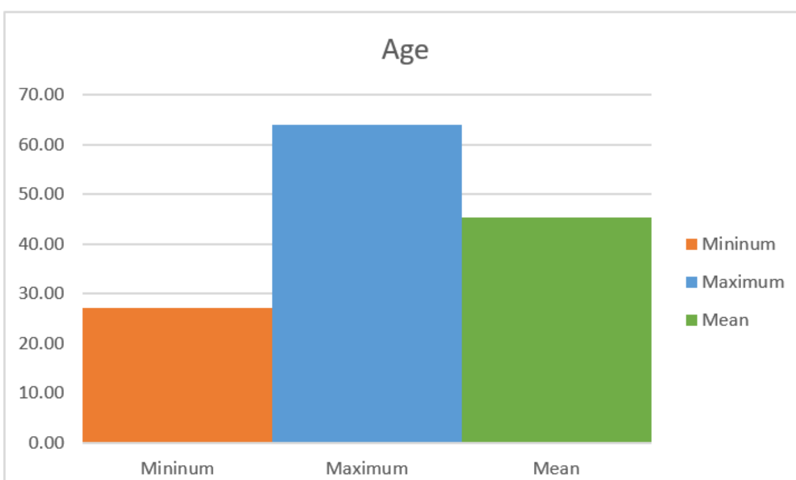

Table 1: Baseline lab values for participants who completed the study

Health indicator (units of measure)	N= number of participants	Minimum	Maximum	Mean	Standard deviation
Body Mass Index (kg/m^2)	99	29.3	45.1	35.8	4.20509
Waist circumference (inches)	99	34.5	58.15	43.2113	4.61309
Systolic blood pressure (mmHg)	99	104	170	128.9798	12.83807
Diastolic blood pressure (mmHg)	99	57	98	78.5960	9.70895
Total Cholesterol (mg/dL)	99	131	332	200.1212	35.19516
HDL (mg/dL)	99	27	107	53.21	15.556
LDL (mg/dL)	99	36	201	120.31	31.678
Triglycerides (mg/dL)	99	36	425	133.03	76.216
Fasting Glucose (mg/dL)	99	83	203	100.88	18.569

At baseline, the mean BMI was 35.8(4.2) kg/m^2. At baseline, only waist circumference and BMI were positively correlated. BMI was not associated with at risk levels of any lab value (blood pressure, triglycerides, cholesterol, blood glucose). Although the population was overweight or obese, they were in normal metabolic ranges except for a few health indicators that were in at-risk levels.

Table 2: Lab values for normal ranges versus baseline and after intervention

Health indicator (units of measure)	Normal Range	Baseline average	After intervention average	P-value
Waist circumference (inches)	Men < 40 Women < 35	45.9 42.7	42.9 41.0	<0.001 <0.001
Systolic blood pressure (mmHg)	< 120	129.0	127.1	0.08
Diastolic blood pressure (mm g)	< 80	78.6	78.1	0.30
Total Cholesterol (mg/dL)	< 200	200.1	189.7	<0.001
HDL (mg/dL)	> 40	53.2	50.5	<0.001
LDL (mg/dL)	< 100	120.3	115.3	0.02
Triglycerides (mg/dL)	< 250	133.0	119.1	0.04
Fasting Glucose (mg/dL)	65 – 95	100.9	100.6	0.81

The participants all fell into overweight or obese BMI categories; however most health indicators were in normal ranges at baseline and follow-up. Mean waist circumference was higher than recommended but that is expected with overweight and obese subjects. Systolic blood pressure was pre-hypertensive but not far from normal. HDL cholesterol was very good and LDL cholesterol was near optimal levels. Overall, the participants showed a normal metabolic profile, with the exception of systolic blood pressure, LDL cholesterol, and fasting glucose.

Table 3: BMI correlations with health indicators at baseline

Health indicator	R-value	P-value
Waist circumference	0.70	<0.001
Systolic blood pressure	0.08	0.42
Diastolic blood pressure	-0.08	0.42
Total cholesterol	-0.05	0.60
HDL	-0.17	0.10
LDL	-0.04	0.68
Triglycerides	0.14	0.16
Fasting glucose	0.09	0.40

At baseline, BMI and waist circumference had the strongest correlation and were statistically significant. No other health indicator was statistically significant (p-value < .05).

Table 4: Waist circumference correlations with health indicators at baseline

Health indicator	R-value	P-value
Body Mass Index	0.70	<0.001
Systolic blood pressure	0.04	0.73
Diastolic blood pressure	-0.01	0.93
Total cholesterol	-0.00	0.99
HDL	-0.19	0.06
LDL	-0.02	0.83
Triglycerides	0.24	0.02
Fasting glucose	0.17	0.10

At baseline, waist circumference and BMI had the strongest correlation and were statistically significant (p-value < .05). HDL cholesterol and triglycerides were also strongly positively correlated with waist circumference.

Table 5: Waist circumference change correlations with change in health indicators over 10-12 weeks

Health indicator	R-value	P-value
Weight	0.83	<0.001
Systolic blood pressure	0.19	0.07
Diastolic blood pressure	0.19	0.06
Total cholesterol	0.40	<0.001
HDL	0.16	0.12
LDL	0.07	0.49
Triglycerides	0.23	0.02
Fasting glucose	0.04	0.69

After the weight loss intervention, the change in waist circumference of the participants was significantly correlated (p-value < .05) with weight change, total cholesterol change, and change in triglycerides. While not statically significant, both systolic and diastolic blood pressures demonstrated trends at p = 0.07, and 0.06, respectively. Changes in HDL and LDL cholesterol and fasting glucose were not significant.

Table 6: Weight change correlations with change in health indicators over 10-12 weeks

Health indicator	R-value	P-value
Waist circumference	0.83	<0.001
Systolic blood pressure	0.25	0.02
Diastolic blood pressure	0.28	0.01
Total cholesterol	0.36	<0.001
HDL	0.15	0.15
LDL	0.74	0.48
Triglycerides	0.12	0.26
Fasting glucose	0.13	0.23

After the weight loss intervention, the weight change of the participants was significantly correlated (p-value < .05) with waist circumference change, total cholesterol change, and both systolic and diastolic blood pressure change. Changes in HDL and LDL cholesterol, triglycerides, and fasting glucose were not statically significant.

Table 7: Comparison of change between greater than 5% and less than 5% weight loss groups

Health indicator	Greater than 5% weight loss (mean ±SD)	Less than 5% weight loss (mean ± SD)	P-value
Waist circumference	-3.77 ± 1.34	0.41 ± 2.17	<0.001
Systolic blood pressure	-1.89 ± 7.75	4.2 ± 11.66	0.004
Diastolic blood pressure	-1.37 ± 4.94	2.78 ± 7.12	0.002
Total cholesterol	-15.00 ± 24.69	6.25 ± 29.40	0.001
HDL	-0.77 ± 7.72	1.18 ± 6.19	0.207
LDL	-2.00 ± 19.29	3.59 ± 24.41	0.250
Triglycerides	-14.62 ± 43.32	4.37 ± 49.80	0.091
Fasting glucose	-2.78 ± 6.29	0.50 ± 8.70	0.044

After the 10-12 week interventions, weight change was positively correlated with a decrease in total cholesterol, systolic and diastolic blood pressure and waist circumference (table 6). Over the course of the study, 28% of participants lost 5% or greater total baseline weight. In the 28% of participants that lost over 5% weight, more significant changes were seen in every health indicator except HDL, triglycerides and LDL cholesterol when compared to the rest of the participants (Table 7). Waist circumference decreased on average by 3.7 inches in the group that lost greater than 5% weight loss. Waist circumference actually increased by 0.4

inches on average, for the majority of participants who lost less than 5% total weight. Total cholesterol dropped significantly in the group who lost 5% or more total weight; by 15 mg/dL on average. Both systolic and diastolic blood pressure dropped by 1.89 mmHg and 1.37 mmHg, respectively, in the group who lost greater than 5% total baseline weight. Systolic and diastolic blood pressure actually increased by 4.2 mmHg and 2.78 mmHg, respectively, in the group who lost less than 5% total baseline weight. A decrease in waist circumference and weight loss was associated with a lower triglyceride count in most subjects. In the group who lost more than 5% total baseline weight, triglycerides decreased by 14.6 mg/dL on average.

Chapter V

Discussion

This study was designed to analyze data from two weight loss studies and examine the significance of an individual's weight loss and change in waist circumference on health using lab values. These lab values included systolic and diastolic blood pressure, total cholesterol, LDL, HDL, fasting glucose, and serum triglycerides. Another focus of this research was to compare changes in BMI and waist circumference to changes in lab values to determine which measure, BMI or waist circumference, was more indicative of overall health.

BMI was hypothesized to be a good indicator of health and is often used as a quick determination of an individuals' health. This study had mixed results that did not support using BMI as an indicator of health. The sample population all fell into the overweight or obese BMI categories. At baseline, the mean BMI was 35.8(4.2) kg/m^2. If this was the only piece of data one was given, one might conclude that this population was not healthy. At baseline, the population as a whole had slightly elevated LDL cholesterol (120.3 mg/dL), close to pre-diabetic glucose levels, and slightly high systolic blood pressure (129 mmHg) but all other lab values fell into normal ranges. There are several issues with using BMI as a health indicator, as it does not take many aspects into account that have impact on health such as gender, race, age, fitness level, and ethnicity (Heymsfield & Cefalu, 2013). BMI also does not differentiate between lean mass and fat mass (Han et. al, 2010).

It was hypothesized that after the weight loss intervention weight change would be positively correlated with a decrease in systolic and diastolic blood pressure, total cholesterol, waist circumference, and triglycerides. After examining the data, change in weight was positively correlated with half of the health indicators. Weight change was significantly correlated with changes in waist circumference (p-value = <0.001), systolic blood pressure (p-value = 0.02), diastolic blood pressure (p-value = 0.01), and total cholesterol (p-value = <0.001). Weight change and waist circumference were always significantly correlated. As weight decreases, waist circumference shrinks and BMI drops. Weight change was significantly correlated with total cholesterol but not LDL and HDL cholesterol. In conclusion with this sample population, as weight decreased, waist circumference, systolic and diastolic blood pressure, and total cholesterol all decreased. Some participants saw decreases in triglycerides, fasting glucose, and LDL cholesterol also, but not all.

A recent article that reviewed the Look AHEAD (Action for Health in Diabetes) Trails, found that weight loss had a beneficial impact on diabetes remission (R.R. Wing for the Look AHEAD Group, 2014). The Look AHEAD Trials was a randomized clinical trial which was designed to examine the long-term effects of weight loss in overweight and obese individuals with type 2 diabetes. Most participants stayed in the study for 9-11 years and on average, lost 6% of baseline body weight. Improvements in the participants' HbA1C, triglycerides, and HDL cholesterol, were observed. In the first year of the study, 11.5% of participants experienced remission of type 2 diabetes. In year 4, 7.3% of participants experienced remission. Similar results have been reported by the National Heart, Lung, and Blood Institute regarding overweight or obese adults. A weight loss of 5-10% is associated with HbA1C reductions and a reduced need for diabetes medications (Unites States Department of Health and Human Services, 2013). Overweight and obese adults with elevated CVD risk can see reductions in triglyceride levels and LDL cholesterol and an increase in HDL cholesterol when a 5-8 kg weight loss is experienced.

A study examined weight loss and diabetes prevention and found comparable results. The Diabetes Prevention Program (DPP) was a clinical trial conducted to determine whether lifestyle intervention or pharmacological therapy would prevent the onset of diabetes with impaired glucose intolerance. (The Diabetes Prevention Program Research Group, 2002). The strategies used in this study proved to be very successful, as the lifestyle intervention resulted in a 58% reduction in the incidence of diabetes.

An internet-based weight loss intervention study that used similar procedural criteria as the DPP study found that with weight loss, improvements in every lab value measured were observed (Webber, K. H., & Rose, S. A., 2013). These included waist circumference, systolic and diastolic blood pressure, blood glucose, LDL, HDL, and total cholesterol. Most significant changes were observed with the participant's waist circumference and total cholesterol. As has been seen in other weight loss studies, health markers that include serum triglycerides, cholesterol, blood pressure and HbA1C have improved with weight loss.

Weight loss and waist circumference were significantly related in this study. It was evident that with a decrease in waist circumference in the participants, not only did weight decrease, but the majority of health markers improved. When waist circumference changed, significant changes were observed in both total cholesterol and triglycerides. When BMI changed, significant changes were observed in blood pressure and total cholesterol.

BMI and waist circumference are commonly used to gauge one's overall health. BMI has drawbacks which have been stated previously. Waist circumference has fewer factors to consider such as race or ethnicity. In this particular study both BMI and waist circumference were similar in indicating the participant's health based on lab values, however, waist circumference was correlated more significantly with the lab values than BMI. Change in systolic and diastolic blood pressure and total cholesterol were both significantly correlated with change in BMI and change in waist circumference. However, change in triglycerides more strongly correlated with change in waist circumference than with change in BMI. This makes sense because when waist circumference is reduced, abdominal obesity and subcutaneous adiposity shrinks, resulting in a lower triglyceride measure.

It was hypothesized that after the weight loss intervention, a weight loss of greater than 5% baseline body weight in the participants would result in greater improvements in health indicators than in the group of participants who lost less than 5% baseline body weight. After examining the data, this proved to be true for the 28% of participants who achieved that level of weight loss. In the group who lost

5% or greater baseline body weight, an average loss of 3.7 inches in waist circumference was observed, compared to an actual gain of 0.4 inches in the group who lost less than 5% baseline body weight. Total cholesterol was another health indicator that had a significant drop in the group who lost more than 5% weight during the intervention. Total cholesterol dropped by 15 mg/dL on average. Both systolic and diastolic blood pressure dropped by 1.89 mmHg and 1.37 mmHg, respectively, in the group who lost greater than 5% total baseline weight. Systolic and diastolic blood pressure actually increased by 4.2 mmHg and 2.78 mmHg, respectively, in the group who lost less than 5% total weight. The change in health indicators in the group who achieved greater than 5% total baseline weight loss was substantially more profound than in the group who did not lose 5% total baseline weight.

Adults who are overweight or obese can improve their health by losing even a small amount of weight, especially if that weight is kept off and maintained. According to The National Institute for Health and Care Excellence (NICE), a commonly stated "realistic" goal is to lose around 5-10% of baseline weight (The National Institute for Health and Care Excellence, 2014). However, the average weight loss from participating in a lifestyle weight management program, like the weight loss interventions conducted in this study, is only around 3% of baseline weight. NICE acknowledges that even losing this small amount of weight is likely to lead to health benefits, particularly if the weight loss is maintained. After analyzing the results from the two weight loss studies, most participants who lost less than 5% baseline weight did not see a significant change in their health values. It appears that losing 5% or greater of baseline weight leads to much greater improvements in overall health. This was the case with the 28% of participants from the two weight loss studies who lost 5% or greater of baseline weight.

This study and others prove that weight loss contributes to healthier living but weight loss by itself cannot be given full credit. Apart from weight loss, many aspects affect health, many of which research is still being conducted to understand fully. Nutrition and diet, physical activity, and lifestyle, are commonly thought to have the most impact on health. However, the built and food environments, cardiorespiratory fitness, focusing on consuming the daily recommended intakes of fruits and vegetables, vitamins and minerals, and exercising daily all play important roles to healthy living.

Strengths, Limitations and Future Research

The limitations to this study include short study duration, small sample size, and an uneven gender ratio (84% female). The strength of this study was low dropout rate. A possible limitation would be that the two weight loss interventions had different endpoints; one at 10 weeks and the other at 12 weeks.

It was assumed that the blood pressure machine used to measure blood pressure was calibrated and consistent from one use to the next. It was also assumed that the scale used to measure weight was calibrated accurately and the researcher was recording all data correctly.

More research with larger sample size, longer study duration, a more even gender ratio, and larger or smaller gap in age are needed to strengthen the findings. The weight loss intervention analyzed proved to be effective despite the short duration. Every lab value tested decreased on average during the weight loss study.

References:

Aphramor, L. (2010). Validity of claims made in weight management research: A narrative review of dietetic articles. Nutrition Journal, 9(30), 1-9. Retrieved February 25, 2015, from http://www.nutritionj.com/content/9/1/30

Cai, J., Pajak, A., Li, Y., Shestov, D., Davis, C., Rywik, S., Li, Y., Deev, A., & Tyroler, H. (2004). Total Cholesterol and Mortality in China, Poland, Russia, and the US. Annals of Epidemiology, 14(6), 399-408. Retrieved March 13, 2015.

Centers for Disease Control and Prevention. (2012, April 27). Overweight and Obesity. Retrieved from http://www.cdc.gov/obesity/adult/defining.html.

Doblhammer, G., & Hoffman, R. (2009). Gender Differences in Trajectories of Health Limitations and Subsequent Mortality. A Study Based on the German Socioeconomic Panel 1995-2001 With a Mortality Follow-up 2002-2005. Journal of Gerontology: Social Sciences, 65(4), 482-491. Retrieved April 2, 2015.

Field, A., Malspeis, S., & Willett, W. (2009). Weight Cycling and Mortality Among Middle-aged or older Women. Journal of American Medical Association, 169(9), 881-886. Retrieved April 12, 2015.

Flegal, K., Kit, B., Orpana, H., & Graubard, B. (2013). Association of All-Cause Mortality With Overweight and ObesityUsing Standard Body Mass Index Categories A Systematic Review and Meta-analysis. Journal of American Medical Association, 309(1), 71-80. Retrieved February 25, 2015, from http://jama.jamanetwork.com/

Gaesser, G. (2003). Is It Necessary to be Thin to be Healthy? Harvard Health Policy Review, 4(2), 40-46. Retrieved February 25, 2015.

Gray, L., Lee, I., Sesso, H., & Batty, D. (2011). Blood Pressure in Early Adulthood, Hypertension in Middle Age, and Future Cardiovascular Disease Mortality. Journal of the American College of Cardiology, 58(23), 2396-2403. Retrieved March 13, 2015.

Han, S., Kim, K., Kim, K., Na, K., Chae, D., Kim, S., & Chin, H. (2010). Lean Mass Index: A Better Predictor of Mortality than Body Mass. Journal of The American Geriatrics Society, 58(2), 312-317. Retrieved April 2, 2015.

Harvard, H. (2014). Fast way to improve heart and muscle fitness. Heart and Brain. Retrieved April 12, 2015.

Heymsfield, S., & Cefalu, W. (2013). Does Body Mass Index Adequately Convey a Patient's Mortality Risk? JAMA: The Journal of the American Medical Association, 309(1), 87-88. Retrieved February 25, 2015, from http://jama.jamanetwork.com/

Jensen, M. T., Saudicani, P., Hein, H. O., and Gyntelberg, F. Elevated resting heart rate, physical fitness, and all-cause mortality: a 16-year follow-up in the Copenhagen. *Heart*, 99 (2013): 882-887. Group.bmj.com, 2013. Web. 20 Oct. 2015.

Levitan, E., Wolk, A., & Mittleman, M. (2009). Consistency With the DASH Diet and Incidence of Heart Failure. Journal of American Medical Association, 169(9), 851-857. Retrieved March 13, 2015, from http://archinte.jamanetwork.com/.

Li, Y., Zhang, L., Gu, Y., Hao, C., & Zhu, T. (2013). Insulin Resistance as a Predictor of Cardiovascular Disease in Patients on Peritoneal Dialysis. Peritoneal Dialysis International, 33(4), 411-418. Retrieved April 2, 2015.

Port, S., Demer, L., Jennrich, R., Walter, D., & Garfinkel, A. (2000). Systolic blood pressure and mortality. The Lancet, 355, 175-180. Retrieved March 13, 2015.

Pyorala, M., Miettinen, H., Laakso, M., & Pyorala, K. (2000). Plasma Insulin and All-Cause, Cardiovascular, and Noncardiovascular Mortality. Journal of Diabetes Care, 23(8), 1097-1102. Retrieved March 13, 2015.

Rajpathak, S., Liu, Y., Ben-David, O., Reddy, S., Atzmon, G., Crandall, J., & Barzilai, N. (2011). Lifestyle Factors of People with Exceptional Longevity. Journal of The American Geriatrics Society, 59(8), 1509-1512. Retrieved February 25, 2015.

R.R. Wing for the Look AHEAD Group. (2014). Implications of Look AHEAD for clinical trials and clinical practice. Diabetes, Obesity and Metabolism, 16: 1183-1191. Retrieved October 29, 2015.

Simkin-Silverman, L., Wing, R., Plantinga, P., Matthews, K., & Kuller, L. (1998). Lifetime Weight Cycling and Psychological Health inNormal-Weight and Overweight Women. International Journal of Eating Disorders, 24(1), 175-183. Retrieved March 13, 2015.

The Diabetes Prevention Program (DPP) Research Group. (2002). The Diabetes Prevention Program (DPP) Description of lifestyle intervention. Diabetes Care, 25: 2165-2171. Retrieved October 29, 2105.

The National Institute for Health and Care Excellence. (2014). Three per cent weight loss enough to improve health. Practice Nurse, 44(6) 8-8. Retrieved October 28, 2015.

Sui, X., LaMonte, M., Laditka, J., Hardin, J., Chase, N., Hooker, S., & Blair, S. (2007). Cardiorespiratory Fitness and Adiposity as Mortality Predictors in Older Adults. Journal of American Medical Association, 298(21), 2507-2516. Retrieved March 13, 2015, from http://jama.jamanetwork.com/.

Unites States Department of Health and Human Services. (2013). Managing Overweight and Obesity in Adults. National Heart, Lung, and Blood Institute. Retrieved October 30, 2015.

Viela, B., Silva, A., Barbosa de Lira, C., & Andrade, M. (2015). Workplace Exercise and Educational Program for Improving Fitness Outcomes Related to Health in Workers. Journal of European Medicine, 57(3), 235-240. Retrieved April 12, 2015.

Webber, K. H., & Rose, S. A. (2013). A Pilot Internet-Based Behavioral Weight Loss Intervention with or without Commercially Available Portion-Controlled Foods. Obesity 21: 354-359. Retrieved October 30, 2015.

Whitlock, G., Lewington, S., Sherliker, P., Clarke, R., Emberson, J., Hasley, J., N., Qizilbash, R., Collins, & Peto, R. (2009). Body-mass index and cause-specific mortality in 900 000 adults: Collaborative analyses of 57 prosepective studies. The Lancet, 373(1083-1096). Retrieved March 13, 2015.

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