Assessing the Effects of the Holiday Season on Body Weight, Body Fat Percentage, and Blood Pressure

By

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Abstract

Background

Longitudinal studies among U.S. adults show that average weight gain is 1kg per year. The purpose of this study was to assess the effects of the Holiday Season (Thanksgiving to New Years Day) on changes in body weight, body fat percentage (BF%), and blood pressure (BP) in adults.

Methods

A total of 148 subjects (age 18-65y) were evaluated in November (baseline) and January (follow-up). Data collected at each visit included height, weight, BF%, BP, and resting heart rate (HR). In both visits, subjects were evaluated at the same time of day wearing a hospital gown, were instructed to refrain from vigorous exercise for 12 hours, and fasted for 4 hours prior to testing. BF% was measured using bioelectrical impedance analysis. Statistical significance was set at $p < 0.05$.

Results

From baseline to follow up visits, there were significant increases in body weight (0.78±1.28kg), BF% (0.52±2.27%), systolic and diastolic BP (1.84±10.10mmHg and 2.32±14.20mmHg, respectively), and HR (2.32±11.52bpm). When analyzed by body mass index category, obese subjects showed a significantly greater increase in BF% from November to January compared to normal weight subjects ($p < 0.02$) and trended for a difference compared to overweight subjects ($p = 0.09$).

Conclusions

Adult subjects showed an average increase in body weight of 0.78kg between baseline and follow-up visits. If these subjects gain the national average of 1kg per year, up to 78% of annual weight gain could be attributed to the holiday season. Additionally, obese subjects may be most at risk as they showed the greatest increases in BF%.

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Chapter I

Introduction

Prevalence of Obesity

The prevalence of obesity in the United States (U.S.) continues to be a public health concern with about two-thirds of the adult population being classified as overweight or obese (Ogden et al., 2006; Ogden, Yanovski, Carroll, & Flegal, 2007). Obesity is associated with a number of conditions such as hypertension, dyslipidemia, cardiovascular disease, stroke, diabetes mellitus, musculoskeletal disorders, certain cancers and an increased risk of disability, and thus obese individuals have an increased risk for morbidity and mortality (Bogers et al., 2007; National Institutes of Health, 2000; Vongpatanasin, 2007).

The percentage of overweight and obese people in the U.S. has dramatically increased in the past twenty to thirty years. From 1980 to 2004, the prevalence of obesity increased from 15% to 33% in adults and from 6% to 19% in children (Flegal, Carroll, Ogden, & Johnson, 2002; Ogden et al., 2006; Ogden, Flegal, Carroll, & Johnson, 2002). From 1999 to 2004, the prevalence of overweight has increased from 14% to 17% in children (Ogden et al., 2006). In addition to higher rates of overweight and obesity, the costs of obesity are considered to be quite high. Although there are not many quality economic evaluations of obesity, direct medical costs of obesity in the U.S. were estimated to be more than $92 billion in 2002 (Finkelstein, Fiebelkorn, & Wang, 2003). In 1989, U.S. adults spent more than $30 billion on weight loss programs and products (1993). This number is thought to have increased dramatically in the past twenty years to a staggering $61 billion dollars in 2009 according to Marketdata Enterprises Inc (Marketdata Enterprises Inc., 2011). The prevalence and increase in obesity is not confined to the U.S. alone. It is estimated that one in every six people worldwide is already obese or overweight (Benjamin, 2005; Ganapati M, 2005). The social, economic, and health implications, of an increasingly overweight and obese society are yet to be determined.

A longitudinal study among U.S. adults shows that average weight gain is 1kg per year (2.2 pounds per year) (Lewis et al., 2000). This gradual and consistent weight gain appears to begin with early adulthood and has led to the phenomenon termed “creeping obesity.” This implies that most adults do not become obese over a short period of time. Instead, it is believed that small amounts of weight gain each year over a long period of time (15-30 years) results in substantial weight gain. More recently, a few studies have shown that the majority of annual weight gain in adults occurs during short periods of time rather than consistently over the 12 months of a year (Phelan et al., 2008; Yanovski et al., 2000).

The time between Thanksgiving and New Years Day is thought to be one of those critical periods of time that could lead to substantial weight gain among adults and has been termed “holiday weight gain” (Phelan et al., 2008) (Yanovski et al., 2000). However, there is some controversy as to how much weight gain actually occurs during this period of time. Reports and articles in the popular press have claimed anywhere from a 3.2 to 4.5kg (7-10 pounds) increase in body weight between Thanksgiving and New Year's Day (CNN Interactive, 1995; Texas Medical Association, 1998); however, this data are not from a credible scientific source. Scientific studies published about holiday weight changes have found the amount of weight gain to have ranged from 0.37kg to 0.5kg in adults and 0.30kg to 0.78kg in school-aged children during the holiday season (Yanovski et al., 2000; Branscum, Kaye, Succop, & Sharma, 2010; Hull, Radley, Dinger, & Fields, 2006). Small changes in body weight or body composition may appear insignificant in relation to the worldwide obesity epidemic; however, if the average American gains 1kg per year, small increases in weight that may occur during the holiday season could be an critical component of yearly weight gain. Therefore, if the phenomenon of "holiday weight gain" does indeed exist, it could be an excellent target for an intervention to prevent weight gain and ultimately prevent overweight and obesity.

The purpose of this study was to assess the effects of the holiday season (Thanksgiving to New Years Day) on changes in body weight, body fat percentage and blood pressure in adults. Further, we wanted to determine if regular exercise would have an impact on changes in our outcome variables. We hypothesized that there would be a significant increase in body weight and body fat percentage and no change in blood pressure between baseline and follow-up visits. We also hypothesized that individuals reporting regular exercise would have smaller increases in body weight and body fat percentage compared to sedentary individuals.

Chapter II

Obesity

Assessment and Classification

The condition of obesity is characterized by excess body fat and may put a person at increased health risk. Excess body fat is accumulated when the body's energy expenditure is less than caloric intake. Although there is no clinical obesity range for degrees of excess body fat, there is a generally recognized indirect measure of body fatness called the weight-for-height index or body mass index (BMI) (Lyznicki, Young, Riggs, & Davis, 2001).

BMI is an easy, inexpensive and reliable classification method for the general population and is defined as a person's weight in kilograms divided by the square of the person's height in meters (kg/m^2) (Lyznicki et al., 2001). BMI was recognized in 1997 by the International Obesity Task Force convened by the World Health Organization as a standard classification of adult overweight and obesity (World Health Organization, 1998). It also was adopted by the Expert Panel on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults convened by the National Heart, Lung, and Blood Institute of the National Institutes of Health in 1998 (National Institutes of Health, 2000). Standard classifications of BMI calculations are as follows: a BMI less than 18.5kg per m^2 is underweight; a BMI of 18.5 to 24.9kg per m^2 is normal weight; a BMI of 25.0 to 29.9kg per m^2 is overweight; a BMI of 30.0 to 34.9kg per m^2 is obesity class I; a BMI of 35.0 to 39.9kg per m^2 is obesity class II; and a BMI of 40.0kg per m^2 or higher is extreme obesity or obesity class III (World Health

Organization, 1998). Obesity measurement in children and adolescents is more challenging as ever-changing body sizes and compositions during normal growth occur. Generally, assessments of obesity include measuring and calculating a child's BMI and comparing them to age and sex specific target values and charts (Lyznicki et al., 2001).

A high BMI traditionally indicates excess body fatness; however, BMI has limitations as does any anthropometric measurement. Frankenfield et al. (Frankenfield D.C., Rowe W.A., Cooney R.N., Smith J.S., & Becker D., 2001) discuss some of the limits of using BMI to predict body composition and detect obesity. They found that BMI accurately classified individuals as obese when compared to bioelectrical impedance criterion (body fat of at least 25% in men and 30% in women). However, 30% of men and 46% of women who were not obese by BMI criterion had obese levels of body fat. Prentice and Jebb (Prentice & Jebb, 2001) illustrated a variety of conditions such as ageing and athletes, in which BMI is shown to provide misleading information regarding body fat. In regard to athletes, Prentice and Jebb (Prentice & Jebb, 2001) also showed how erroneous data could be if BMI was used to estimate body fat in American football players and Olympic shot-putters. Witt and Bush's (Witt KA & Bush, 2005) conclusions are similar in that BMI frequently classifies muscular individuals as overweight even when their skinfold measurements do not indicate as such. Ode et al. (Ode, Pivarnik, Reeves, & Knous, 2007) concluded that BMI should be used cautiously when classifying fatness in college athletes and nonathletes. They reported there is a need for different BMI classifications for overweight in these populations.

Alternatively, individuals with overt muscle wasting may have a healthy weight lower than the BMI classifications adopted by the World Health Organization (Han, Sattar, & Lean, 2006). Ageing is shown to be accompanied by an increase in the ratio of body fat and lean body mass, even as BMI is maintained so the relationship between BMI and body fat is age-dependant (Prentice & Jebb, 2001). Current standards of BMI classification do not take into account advanced age and could therefore be erroneously classifying the elderly. Svendsen et al. (Svendsen, Haarbo, Heitmann, Gotfredsen, & Christiansen, 1991) point out anthropometry equations are usually developed in populations of young healthy adults and are not always accurate in elderly subjects. There is a need for easy to perform, inexpensive methods for determining body fatness in various population groups. At this time BMI, although not without limitations, remains a tool used across many disciplines to help classify body fatness. Although not always used as a measure of obesity, waist circumference is sometimes believed to be the best anthropometric predictor of visceral fat. It is useful in health promotion situations as an indicator of health risk. Waist circumference levels are broken down into male and female as well as high, increased, and low health risk. The categories for men include: a waist circumference at or below 94cm are assigned low health risk; a waist circumference between 94cm and 101.9cm are assigned an increased health risk; and a waist circumference equal to or above 102cm are assigned a high health risk. The categories for women include: a waist circumference at or below 80cm are assigned low health risk; a waist circumference between 80cm and 87.9cm are assigned an increased health risk; and a waist circumference equal to or above 88cm are assigned a high health risk. Health risk associated with increased waist circumference includes risk for type 2 diabetes, coronary heart disease, or hypertension. Individuals with an increased waist circumference also have a higher risk for developing diseases and complications including dyslipidemia, shortness of breath, and poor quality of life. Interestingly, these risk factors apply to individuals with a normal BMI and elevated waist circumference (Han et al., 2006).

Prevalence in the USA

Obesity in the United States has been a topic of concern as obesity rates continue to rise. It was estimated that in 2007-2008 approximately 72.5 million adults were obese (Flegal, Carroll, Ogden, & Curtin, 2010). In 2000, a Healthy People 2010 objective was established to attempt to reduce the prevalence of obesity to 15% in the US (Sherry et al., 2010). There are several different groups that have data regarding obesity prevalence in the US. According to the U.S. Department of Health and Human Services' Centers for Disease Control and Prevention, no state has reached to Healthy People 2010 goal as of 2007. They used 2009 Behavioral Risk Factor Surveillance System data to update estimates of national and state level obesity prevalence. Overall they estimated the prevalence at 26.7% with states ranging from 18.6% to 34.4%. Greater prevalence of obesity was observed in the South and Midwest. One limitation of this data is that height and weight were self-reported.

The National Health and Nutrition Examination Survey (NHANES) is also used to determine obesity prevalence in the US. The NHANES includes a series of cross-sectional surveys beginning in 1960. According to their data, obesity prevalence appeared to have been stable in the US from 1960-1980; however, a sharp increase in the 1980’s and 1990’s was revealed (Flegal et al., 2010). According to their studies, the prevalence of obesity for adults aged 20 to 74 years increased by 7.9 percentage points for men and 8.9 percentage points for women between 1976 and 1994. Prevalence increased by 7.1 percentage points for men and 8.1 percentage points for women between 1988 and 2000. If trends continued at the same rate, an expected increase of 6 to 7 percentage points would be expected between 1999 and 2009 for men and women (Flegal et al., 2010). However, between 1999 and 2008 there was an increase of only 4.7 percentage points for men and a non-significant increase of 2.1 percentage points for women. This data indicates that the increase in prevalence seen previously in our nation may not be continuing at a similar level, especially for women. Their study suggests that the prevalence may have begun a relatively stable period of time as seen previously in our nation’s history (Flegal et al., 2010).

Prevalence Worldwide

In 2005, the World Health Organization (WHO) projected approximately 1.6 billion adults (age 15+) were overweight, and at least 400 million were obese globally(World Health Organization, 2006). They believe these numbers will increase to about 2.3 billion and more than 700 million respectively by 2015. Obesity was once believed to be a problem only in high-income countries; however, overweight and obesity are also on the rise in low and middle-income countries with more concentrated increases in urban areas. Countries and regions reporting an increased obesity rate include Canada, Latin America, and Europe (England, Spain, Netherlands) (Belanger-Ducharme & Tremblay, 2005; Berghofer et al., 2008; Filozof, Gonzalez, Sereday, Mazza, & Braguinsky, 2001; Reilly & Dorosty, 1999; Schokker, Visscher, Nooyens, van Baak, & Seidell, 2007; Martinez, Moreno, & Martinez-Gonzalez, 2004). As obesity rates rise worldwide, it is more important than ever for researchers to identify areas in which we can attempt to prevent weight gain and in turn obesity.

Financial Burden

Obesity, overweight, and subsequent health problems have a negative impact on workforce productivity through both indirect and direct costs (Centers for Disease Control and Prevention, 2010). Direct costs may include preventative, diagnostic and treatment of obesity where as indirect costs relate to morbidity and mortality. A review article by Trogdon et al. (Trogdon, Finkelstein, Hylands, Dellea, & Kamal-Bahl, 2008) divided research studies on the indirect costs of obesity into six categories; absenteeism, disability, premature mortality, presenteeism, workers' compensation and total indirect costs (Trogdon et al., 2008). Absenteeism was defined as "…time away from work owing to obesity…," and was the most common measure of indirect cost (Trogdon et al., 2008). Studies from this review report that obesity is associated with a higher probability of absenteeism. This review estimated the annual cost of obesity-attributable absenteeism for the United States ranged from $3.38 billion to $6.38 billion or an estimated $79 to $132 per obese person. The economic impact of absenteeism from obesity is not confined to the United States alone. Costs of absenteeism were estimated to be $155 million in France and $44.8 billion in China.

Disability is the second major category of time away from work (Trogdon et al., 2008). It is defined as time away from work that involved a disability claim or disability payments. The review by Trogdon et al. (Trogdon et al., 2008) found obesity to be a significant predictor of disability in studies which adjusted for confounding variables. Interestingly enough, one study found that waist circumference was a significant predictor of disability while body mass index was not. Premature mortality that is related to obesity effects the economy through lost earnings and life insurance costs to employers. In the United States, the indirect costs associated with lost earnings were $30 billion and the indirect costs associated with life insurance costs was $2.53 billion from 1993 to 1994.

Reduced productivity at work, also called presenteeism, has been studied to see if obesity increases the inefficiency of the workforce. Results of the three studies reviewed by Trogdon et al. (Trogdon et al., 2008) are mixed. One study found obese individuals to be 98.5% as productive as non-obese individuals

(Burton et al., 2005). Another found that obesity was not significantly correlated with quantity, quality, overall job performance, or extra effort. Conversely, another found that costs attributable to obesity in the United States were $9.1 billion (Ricci & Chee, 2005). Results are also mixed as to whether or not obesity increases workers' compensation costs. Payments made to employees who have suffered a workplace accident or injury is a workers' compensation cost. One study by Ostbye et al. (Ostbye, Dement, & Krause, 2007) found that the rate ratio relative to normal weight for worker's compensation claims was between 1.21 and 1.45. The rate ratio for lost work days ranged from 3.39 to 8.04. The rate ratio for income replacement ranged from 2.95 to 7.71. Conversely, a study by Musich et al. (Musich, Napier, & Edington, 2001) did not show significant differences in obese and non-obese workers' compensation claims. While researchers do not always agree on which is the best method for determining obesity's impact on the workforce, different studies with varying methods of analyzing data should emerge to hopefully give a clearer picture of obesity's impact on the nation.

Obesity has far reaching arms that spread everywhere from workforce to healthcare. Total indirect costs of obesity range from an estimated $448.29 million in Switzerland to $65.67 billion in the United States (Trogdon et al., 2008). In 2003, obese women spent $1457 more per year on healthcare than non-obese women whereas the difference for men is $405 (Bhattacharya & Bundorf, 2009). The medical expenditures attributable to overweight and obesity was estimated to range from $51.5 billion to $78.5 billion in 1998 (Finkelstein et al., 2003). The lifetime medical cost burden of overweight and obesity presented in an article published by Finkelstein et al.(Finkelstein et al., 2008) brings to light how important obesity prevention could be for our nation in terms of saving medical costs as an obese individual's medical costs are higher than costs for normal weight individual. Although there is literature to support increased costs associated with obesity, results of this study showed that with the exception of white women, the costs of overweight are small or nonexistent. When looking at obesity, however, even after adjusting for survival, the lifetime cost for obesity is positive.

Knowing the drain obesity can have on a nation's health care system, policy makers have an incentive to spend funds on obesity prevention measures. An annual investment that eliminated all costs that could be attributed to obesity could cost as much as $740 for white women and still be cost saving. That figure increases to $1040 for obese II and obese III white women. Although data analysis from the most recent years is not available yet, it is clear that obesity has and could continue to pose a tremendous financial burden on the United States and other nations worldwide through direct and indirect costs.

Health Consequences of Obesity

Increased medical cost and spending associated with obesity are in part due to the increased incidence of co-morbidities associated with obesity. These negative health consequences have been well documented and continue to be a topic for current researchers in many fields. The Centers for Disease Control and Prevention has published an article outlining conditions that are increased in overweight and obese individuals (Centers for Disease Control and Prevention, 2011). Their data comes from the National Institute of Health article entitled, "Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults." They list overweight and obese individuals to be at risk for coronary heart disease, type 2 diabetes, cancers (endometrial, breast, and colon), hypertension, dyslipidemia, stroke, liver and gallbladder disease, sleep apnea and respiratory problems, osteoarthritis and gynecological problems (abnormal menses, infertility).

In a systematic review, Guh, et al. (Guh et al., 2009) studied the incidence of co-morbidities related to obesity and overweight using a meta-analysis. They found statistically significant associations between obesity and type II diabetes, all cancers except esophageal and prostate cancer, all cardiovascular disease, asthma, gallbladder disease, osteoarthritis and chronic back pain. They concluded that maintenance of a healthy weight could be important in the prevention of the large disease burden associated with obesity in the future and urged researchers to further explore the biological mechanisms that link overweight and obesity with these co-morbidities.

An earlier study by Must, et al. (Must et al., 1999) measured the prevalence of type II diabetes, gallbladder disease, coronary heart disease, high blood cholesterol level, high blood pressure, and osteoarthritis in overweight and obese Americans. When referenced to normal weight individuals, they found an increased prevalence ratio for all factors except high blood cholesterol. They also found that the prevalence of having two or more health conditions increased with weight status category across all racial and ethnic groups. They emphasized that there is a need for efforts to prevent and treat obesity rather than just its associated co-morbidities. As the number of obese and overweight individuals increases in our nation, so will the incidence of these co-morbidities. As researchers, we have an opportunity to study and develop effective strategies to help decrease the incidence of obesity and hopefully impact the number of people affected by these diseases.

Chapter III

Body Weight

Annual Weight Gain

Although lay press reports vary widely, the average weight gain in adults as reported in scientific journals ranges from 0.2 to 0.8kg per year (Yanovski et al., 2000). Lay articles state that adults gain 5 pounds or more over the winter season; however, no credible sources of this information are available. The term "creeping obesity", although not published in manuscripts, is commonly known among obesity researchers to mean weight that is accumulated slowly over a period of years and even decades. For instance, a 20 year old college student (65kg, 163cm) with a normal BMI that gains 1kg per year would be overweight by age 22, obese by age 35 and morbidly obese by the time he/she is 48 years old. These subtle changes in weight are not noticeable on a small scale, but over time, these small changes in weight make a significant impact on an individual. Battling creeping obesity that is occurring during specific times of year could be an effective way of preventing some obesity occurrences.

Short Term Weight Gain

In order to battle creeping obesity, identifying time periods where individuals are likely to gain weight could be an important first step. Gillis, McDowell and Barr-Or (Gillis L., McDowell, & Bar-Or, 2004) studied overweight youth and their weight during a weight control program. They found that there was a significant gain in percentage of body weight during July-August compared to any other time studied throughout the year. In their study sixty –six percent of subjects gained weight during the summer months. They stated that strategies need to be developed to deal with the summer vacation period as this can affect the overall success of programs.

In adults, other shorter periods of time have been identified that could impede weight loss efforts and/or promote weight gain. Racette et al. (Racette et al., 2008) studied weekend (Friday through Sunday) lifestyle patterns in adults and found that participants had higher dietary intake on Saturdays and lower physical activity on Sundays relative to weekdays (both $p<0.05$). They found that participants consistently gained weight on weekend days (+0.06 ± 0.03kg/d, mean ± SE, $p=0.02$) but not on weekdays (-0.02 ± 0.02kg/d, $p=0.18$). These alterations in lifestyle behaviors on the weekend days contribute to weight gain or cessation of weight loss on weekends. They state that these results provide one explanation of the slow weight loss and difficulty maintaining weight loss observed in other studies.

A study by Haines et al. (Haines, Hama, Guilkey, & Popkin, 2003) found that weekend eating in the United States was linked with greater energy, fat and alcohol intake. This study found that on average American adults (age 19-50 years) consume 115kcal more on a weekend day when compared to a weekday. The amount of energy from fat and alcohol also increases by 0.7% and 1.4% respectively. Although 115kcal may sound like an insignificant amount of energy, the researchers point out that if consumed Friday to Sunday for a year, 115kcal represents almost five pounds of weight gain. Weekend days for adults and summer vacation for youth appear to represent opportunities for intervention to help prevent or slow weight gain during these short periods of time.

Holiday Weight Gain

The phrase “Holiday weight gain” usually represents the time between Thanksgiving Day and New Year’s Day and is thought to attribute to annual adult weight gain. A study conducted in 195 adults showed a mean weight gain of 0.37±1.52kg from mid-November to mid-January, but no body composition data were available (Yanovski et al., 2000). Another study by Watras et al. (Watras, Buchholz, Close, Zhang, & Schoeller, 2007) showed a 0.6kg weight gain increase per month in 20 overweight adults for November and December. One study by Hull et al. (Hull et al., 2006) found a 0.5kg increase in body weight over the Thanksgiving holiday. Waist and hip circumferences were measured to attempt to assess fat patterning changes. Significant declines in waist circumference were found for the entire group, males, females, undergraduates, and normal BMI participants. Another study by Hull et al. (Hull, Hester, & Fields, 2006) studied holiday weight gain in 100 college students (ages 18-40) and found no differences in body weight from pre-Thanksgiving to post-New Year’s. Using dual x-ray absorptiometry, they showed that percent body fat and fat mass significantly increased during that time period while fat-free mass did not change significantly.

A study by Yanovski, et al. (Yanovski et al., 2000) found a 0.18kg weight gain during the fall pre-holiday season (late September or early October to mid-November) and a 0.37kg weight gain during the holiday season (mid-November to early or mid-January) (Yanovski et al., 2000). In subjects who were observed for one year, weight increased an average of 0.32kg during the holiday season and 0.62kg over the one year. These data suggested that a little more than half (0.32kg of the 0.62kg) of the annual weight gain occurred during the six-week holiday season. The authors noted that although this small weight gain may not appear to be clinically significant, their data suggested that the weight loss was not reversed during the spring and summer months and the cumulative effects of yearly weight gain during the holiday season could contribute to a substantial increase in body weight during adulthood.

BMI classification has been shown to have an impact on weight gain and body composition changes during the holiday season. In the study by Yanovski et al, (Yanovski et al., 2000), they also showed that when subjects were categorized as not overweight (i.e. normal weight), overweight, and obese, there was a trend toward a greater likelihood of gaining at least 2.3kg during the holiday season with increasing degree of overweight (Yanovski et al., 2000). Similarly, Hull et al. (Hull et al., 2006) showed no significant increase in body weight for normal weight participants (0.2kg ± 1.6kg), but significant increases in body weight for overweight/obese participants (1.0kg ± 1.1kg). Unfortunately, holiday weight gain is not confined to adults. Branscum et al. (Branscum et al., 2010) found that overweight and obese children gain significantly more weight than their normal weight peers during the holiday season. These studies suggest that overweight or obese are likely to gain more weight during the holiday season than their normal weight peers.

Aside from initial BMI status, other predictive factors for holiday weight gain have been suggested. In one study, subjects were asked survey questions about how they perceived stress levels, hunger, or activity during the testing period (Yanovski et al., 2000). The reported changes in physical activity and hunger were both related to holiday weight gain. Subjects who reported they were less physically active or felt more hungry had the most weight gain over the holiday season. Conversely, subjects who reported they were more physically active and reported less hunger over the holiday season actually reported weight loss.

Although most studies have observed behaviors and health parameters during a specific period of time, the following randomized, double blind, placebo-controlled study gave 3.2 g conjugated linoleic acid (CLA) per day or a placebo to overweight adults. They found that the intervention group reduced body fat over 6 months and prevented weight gain during the holiday season (Watras et al., 2007). The placebo group had a higher rate of weight gain when compared to the CLA group during the holiday season and also when compared to their rate of change in the pre-holiday season. The authors suggested that CLA plays a role in mitigating weight gain in the holiday season and may play a role in reducing the cumulative weight gain that occurs with age. This study also showed a significant increase in resting metabolic rate within the CLA group. Physical activity reported decreased by 33% and 40% in the placebo and CLA group, respectively, during the 6 month testing period. Without intervention, the holiday season appears to be a period of time in which individuals have been shown to gain weight or stop losing weight.

Other Factors that Influence Weight Loss

Phelan et al. (Phelan et al., 2008) studied successful weight losers (SWL) who had been successful at losing and keeping body weight off for a long period of time (35kg for 6 years). When compared to normal weight individuals (NW), SWL practiced more extreme weight control behaviors and reported greater practice of stimulus control techniques, dietary restraint, breakfast eating, and exercise over the holidays. SWL reported greater difficulty in controlling their weight, and 38.9% SWL gained >1kg over the holidays versus 16.7% NW. Despite their increased efforts in maintaining weight, SWL seemed to have an increased vulnerability to weight gain over the holidays.

Self-monitoring has been shown to aid in weight loss and maintenance. Boutelle et al. (Boutelle, Kirschenbaum, Baker, & Mitchell, 1999) studied individuals in a long-term cognitive-behavioral treatment program. Their intervention group had additional treatment including phone calls and daily mailings focused on self-monitoring. The intervention group self-monitored more consistently than the comparison group and also lost more weight during the 8 week study (M = -2.0 pounds ± 5.4 vs. M = 2.0 pounds ± 7.7). The decrease in weight was significantly associated with an increase in monitoring.

In the midst of the nation’s battle with obesity and the need for sustained weight loss, it is interesting to look at what subjects think their ideal weight should be. Although most overweight and obese individuals desire to be at a lower weight, these ideal weights are shifting upward one study reports(Maynard, Serdula, Galuska, Gillespie, & Mokdad, 2006). They found that subject's desired weight was 2.3kg higher in 2003 than it was in 1994. Their report indicates that there may be an increased satisfaction or acceptance of a larger body size. Overweight men had desired body weights 4.5% lower than their reported weight; obese men had desired weights about 15% less than their reported weight; overweight women had desired weights about 12% less than their reported weight; and obese women had desired weights about 24% less than their reported weights. If these individuals weighed their desired weight and these data was generalized across the nation, the prevalence of obesity would decrease to 4.4%. By looking at the nation's desire to lose weight as well as how successful weight loss is obtained and maintained, researchers may one day be able to pinpoint practical interventions to reduce or halt weight gain and positively impact national obesity rates.

Physical Activity and Weight Gain

Physical activity and caloric intake are the two most easily recognized factors that can be adjusted to manipulate energy balance, and therefore, body weight. The U.S. Department of Agriculture and the U.S. Department of Health and Human Services have recently released the 2010 Dietary Guidelines for Americans (U.S.Department of Agriculture & .S.Department of Health and Human Services, 2010). In addition to having guidelines for dietary habits, they also make physical activity recommendations for Americans age 6 and older. These recommendations are presented in Appendix A and were adapted from the 2008 Physical Activity Guidelines for Americans. They recommend that children and adolescents have 60 minutes (1 hour) or more of physical activity daily. Adults should have at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) for sustained health benefits. When older adults cannot meet the adult guidelines, they should be as physically active as their abilities and conditions will allow. More details about the guidelines are presented in Appendix A

The guidelines define moderately-intense physical activity as an, "aerobic activity that increases a person's heart rate and breathing to some extent. On a scale relative to a person's capacity, moderate-intensity activity is usually a 5 or 6 on a 0 to 10 scale." They use brisk walking, dancing, swimming, or bicycling on a level terrain as examples of moderate-intensity exercises. Vigorous-intensity physical activity is defined as, "Aerobic activity that greatly increases a person's heart rate and breathing. On a scale relative to a person's capacity, vigorous-intensity activity is usually a 7 or 8 on a 0 to 10 scale." Their examples of vigorously-intense activity include jogging, singles tennis, swimming continuous laps, or bicycling uphill. Muscle-strengthening activity is defined as "physical activity, including exercise that increases skeletal muscle strength, power, endurance, and mass." Examples include strength training, resistance training, and muscular strength and endurance exercises. Bone-strengthening activity is defined as, "physical activity that produces an impact or tension force on bones, which promotes bone growth and strength." Examples include running, jumping rope, and lifting weights. These guidelines published in the 2010 Dietary

Guidelines for Americans are designed to be used in conjunction with other dietary and lifestyle recommendations set forth in the document.

A review by Fogelholm and Kukkonen-Harjula focused on studies associating physical activity and weight gain in white adults (Fogelholm & Kukkonen-Harjula, 2000). Participants were included who had and had not achieved prior weight reduction. Most studies found an inverse association between physical activity and long-term weight gain. The findings were present in studies with and without prior weight reduction success. Observational studies that they reviewed showed that increases in energy expenditure per week of 6300-8400kJ (1500 – 2000kcal) was associated with improved weight maintenance. This 1500 – 2000 kcal/week deficit is more than was prescribed in most of the trials reviewed and is more than participants typically achieved. They noted that adherence to an exercise program is a big challenge, and until new methods to improve adherence to these programs are found, the role of physical activity in the prevention of weight gain is modest. Determining how much physical activity is required to achieve weight maintenance is still in question. Studies show that the weekly amount of prescribed exercise varies from 80 to 300 minutes per week (Fogelholm & Kukkonen-Harjula, 2000). The adherence to the prescription is much less than 100%, especially in long term trials. Fogelholm and Kukkonen-Harjula report that an inadequate amount of physical activity performed by the subjects may be one reason it is challenging to find an effect of physical activity on weight maintenance in clinical trials .

Physical activity is often thought of as scheduled exercise sessions, but can also include non-structured activities. In addition to intentional exercise, leisure time activities and occupational activities burn calories and could play a role in the obesity epidemic (King et al., 2001). A study by King and associates (King et al., 2001) analyzed data collected in the NHANESIII sample including BMI, leisure time physical activity (LTPA), and occupational activity level (OA). According to logistic regression in this study, the likelihood of being obese is 42% (95% CI 0.35, 0.96) lower for those who engage in no LTPA and have high OA when compared to subjects who engaged in no LTPA and have low OA. Similarly, those who have irregular LTPA and high levels of OA are 48% (95% CI 0.32, 0.83) less likely to be obese. Those who have regular LTPA through moderate or vigorous activity are 50% less likely to be obese regardless of OA. This study showed that a high level of occupational activity is associated with decreased likelihood of being obese when confounding variables including gender, age, race-ethnicity, socioeconomic status, smoking status, urbanization classification and alcohol consumption are accounted for. They agree there is little question as to the impact physical activity has on long-term weight management and believe there are positive effects for all different types of physical activity, including structured exercise, LTPA and OA.

Chapter IV

Body Fat Percentage

Classification of Body Fat Percentage

Body fat can be classified into two categories; essential fat and non-essential fat (Christensen & Kushner, 2007). Essential fat is necessary for normal body functions and is stored around vital organs. It is generally accepted that essential fat makes up about 3-5% of total body fat in men and about 8-12% total body fat in women. Non-essential fat deposits in visceral and subcutaneous tissue (Snijder, van Dam, Visser, & Seidell, 2006) (Christensen & Kushner, 2007). A healthy body fat percentage for men ranges from 8-22% and from 20-35% for women.

Body Fat Distribution and Associated Disease Risk

Body fat distribution in addition to body fat percentage has been studied to determine if the location of fat storage may impact health as much as how much fat is being stored. A review article by Snijder et al. (Snijder et al., 2006) stated that abdominal fat in particular is associated with metabolic disturbances and increased risk of cardiovascular disease and type 2 diabetes. They report that the increased abdominal fat accumulation is largely due to the accumulation of visceral (or intra-abdominal) fat. To illustrate this statement, they examined several studies that compare abdominal obesity with disease risk. It can be concluded that a person with a BMI in the normal range can still be at increased risk for metabolic disturbances if the waist hip ratio or waist circumference is increased. A combination of a high BMI and a high waist hip ratio results in a higher risk of an unfavorable metabolic profile, type 2 diabetes, and cardiovascular diseases.

Subcutaneous fat mass stored in the femoral-gluteal region has been shown to be less hazardous as evidenced by a more favorable cardiovascular risk profile (Snijder et al., 2006). This finding may be due to the amount of free fatty acids that different regions of fat release. Visceral fat is more likely to release free fatty acids into circulation which can lead to accumulation in organs such as the liver, muscle, and pancreas whereas the femoral-gluteal region is more likely to take up free fatty acids from the circulation and is less likely to readily release them. Snijder et al. (Snijder et al., 2006) suggest that future studies (including large epidemiological studies) could attempt to include some measure of body fat to capture additional data that could provide additional insights to their area of study.

Chapter V

Blood Pressure

Classification and Prevalence of High Blood Pressure

Blood pressure is typically recorded as two numbers. The first number represents the systolic blood pressure and is a measure of the pressure in your blood vessels when your heart beats or contracts (2010). The second number represents the diastolic blood pressure and is a measure of the pressure in your vessels when you heart rests or relaxes between beats. High blood pressure (HBP) is defined as systolic pressure 140mmHg or greater and/or diastolic pressure of 90mmHg or greater, taking antihypertensive medication, or being told at least twice by a health professional that you have HBP (American Heart Association, 2009). Table 1 presents classifications of HBP or hypertension as presented in the Journal of the American Heart Association (Pickering et al., 2005) HBP is not only higher now than in previous decades, but is continuing to rise at alarming rates. For instance, from 1995 to 2005, the age-adjusted death rate from HBP increased 25.2% and the actual deaths rose 56.4%. In 2005 it was estimated that 73,600,000 American adults have HBP (35,300,000 males, 38,300,000 females) (American Heart Association, 2009).

Table 2. Classification of Hypertension

BP Classification	SBPmmHg*	DBPmmHg*
Normal	<120	<80
Prehypertensive	120-139	80-89
Stage 1 hypertension	140-159	90-99
Stage 2 hypertension	≥160	≥100
*Classification determined by higher BP category		

The prevalence of HBP varies between different age groups. More men (23.2%) than women (16.5%) have HBP until age 45, between ages 45-54 and 55-64, the percentage is similar between genders (Male 53.7%, female 55.8%). Between ages 65-74, the percentage is 64.1% for men and 69.6% for women. After age 74, a much higher percentage of women (76.4%) than men (64.1%) have HBP. HBP is not a concern for adults alone. Childhood and adolescent HBP has been measured and showed that from 1963 to 1988 trends in prehypertension and HBP in children and adolescents was trending downward. However from 1988 to 1999, the prehypertensive group increased 2.3% and the HBP group increased 1%.

HBP prevalence varies between race/ethnic groups as well. The prevalence of HBP in the U.S. among blacks is the highest in the world and continues to increase. From 1988-1994 to 1999-2002, the prevalence of HBP increased from 35.8% to 41.4% in black adults. Rates were especially high in black women at 44.0%. Prevalence among whites increased from 24.3% to

28.1% during the same time periods. Compared with whites, blacks develop HBP earlier in life and their average blood pressures are much higher. Escalating prevalence of HBP is alarming to researchers and clinicians and could pose a need for increased awareness of the risks associated with elevated blood pressure.

Risk Associated with Elevated Blood Pressure

HBP increases your risk of having heart disease and stroke, the first and third leading causes of death in the United States (2010). According to the National Heart Lung and Blood Education Program for Prevention, Detection, Evaluation and Treatment of High Blood Pressure, “The relationship between BP and risk of CVD (cardiovascular disease) events is continuous, consistent, and independent of other risk factors” (U.S.Department of Health and Human Services, 2003). The higher the BP, the higher the incidence of heart attack, heart failure, stroke, and kidney disease.

Blood pressure and overweight/obesity

The Framingham Heart Study estimated that excess body weight accounted for approximately 26% of HBP in men and 28% in women (Schmieder & Messerli, 1993). They reasoned that obese individuals have an increase in vascular resistance due to the increase in fatty tissue. Poirier et al. (Poirier P et al., 2006) reported that obese subjects are 6 times more likely to be hypertensive than lean men and women (Poirier P et al., 2006). The NHANES III study reported that the prevalence of HBP increased progressively among BMI groups. Among men the prevalence of HBP increased from 15-42% between normal weight (BMI ≤25kg/m^2) and obese (BMI ≥30kg/m^2) individuals. Women showed a similar pattern with HBP prevalence increasing from 15-38% between the same BMI groups. Interestingly, these trends were similar among white, black and Mexican Americans of both genders. They noted that increases in blood pressure are greatest among obese individuals with abdominal obesity distribution.

Chapter VI

Assessment of Health Parameters

Assessment of Body Weight

Body weight is easily obtained without complex equipment and is used worldwide for calculating BMI. Several large studies including the National Health and Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS) use either measured or self reported weight as part of their data collection. As mentioned previously both national surveys indicate that obesity is continuing to rise in the United States (Flegal et al., 2010; Mokdad et al., 2001).

Assessment of Body Fat Percentage

Numerous methods are available for measuring BF percentage (Snijder et al., 2006). Depending on the aim of the study and resources available, different measurement techniques are appropriate. Resources available to researchers such as financial resources, availability of equipment, and time can sometimes dictate what method is used in a particular study. Sample size can also be a factor as some methods are costly and/or require time to complete that would be more difficult with a larger sample size.

Hydrodensitometry

Also referred to as underwater weighing, hydrodensitometry is one of the most accurate methods of measuring body composition and often times, accuracy of other methods are validated by its results (Nelms M, Sucher K, & Long S, 2007). Up until very recently, it was referred to as the gold standard for measuring body composition (Mahan & Escott-Stump, 2008). Although accurate, underwater weighing has many disadvantages and limitations. Facilities capable of performing such tests are not readily available (Nelms M et al., 2007). It can also be difficult for subjects to perform the test as they must be completely submerged in water and expel all air out of their lungs (Christensen & Kushner, 2007; Nelms M et al., 2007). Reference equations used with this method were developed based on Caucasians and may need adjustment for use with other ethnicities. In addition, there is a possibility of over-estimation of body fat mass as residual lung volume must be corrected for and is difficult to estimate. Although very accurate in determining total body fat, this method is not capable of measuring fat distribution in the body (Snijder et al., 2006).

Dual X-ray Absorptiometry

Dual X-ray absorptiometry was developed initially to measure bone mineral content and density (Nelms M et al., 2007) and is now considered the gold standard of body composition assessment. It functions by scanning the body with photons at different energy levels. Absorption of the different photons is measured and the absorption rate of the different body tissues are used to calculate percentages of the tissues in different body compartments. This assessment tool may not be accurate in extremely obese subjects (Whitney & Rady Rolfes, 2005). Although this method does expose the participant to radiation, the amount for an entire body composition analysis is equivalent to 24 hrs of background radiation (Mahan & Escott-Stump, 2008). Although originally designed to measure bone density, Dual X-Ray absorptiometry remains the most accurate measure available for use today.

Bioelectrical Impedance Analysis

Bioelectrical Impedance analysis (BIA) has been referred to as, "…a precise, rapid, safe, portable, and noninvasive method of assessment (Nelms M et al., 2007)." Although different types of analysis instruments exist for BIA, the basic principle remains the same. The human body is composed mostly of water in which an electric current can flow (Dehghan & Merchant, 2008). Adipose tissue is less conductive than muscle tissue or bone and BIA measurement uses this principle to estimate body composition. During testing, a low frequency, alternating electrical current is administered at one extremity of the body and measured at another. The less conductive adipose tissue adds resistance to the current. The rate at which the current passes can be measured and calculated into body composition data including body cell mass, fat-free mass, fat mass, and total body water.

Many predictive equations have been developed to help estimate total body water, fat-free mass and body cell mass using age, sex, height and race. These equations however are population specific and are only useful when your study group is similar to the reference population. Food and beverage intake can effect BIA measurement; however the desirable amount of fasting time prior to measurement is not clearly defined in the literature yet. Studies testing BIA several times per day and studies looking at different amount of fasting times did not have consistent results. Testing occurred anywhere from one hour to 12 hours prior to BIA testing and results overestimated by as much as 1.5kg fat-free mass and underestimated as much as 5kg fat-free mass (Dehghan & Merchant, 2008).This review article suggested an overnight fast prior to BIA measurement as a standardized technique.

Exercise has also been shown to affect BIA measurement. Moderate and intensive exercise can change the measured impedance because increased blood flow to skeletal muscle decreases resistance which results in decreased impedance. For example, jogging or cycling for 90-120 minutes decreased impedance resulting in a 12kg oversestimation of fat-free mass according to Abu,et al. (Abu Khaled et al., 1988)

Skinfolds

Skinfold measurements are used to estimate fat in subcutaneous tissue. It involves measuring a double fold of skin and subcutaneous adipose tissue (excluding muscle tissue). Sites for the test include chest, triceps, subscapular, midaxillary, suprailiac, abdomen, thigh and calf. The more sites that are used, the more accurate the assessment (Mahan & Escott-Stump, 2008). Accuracy also varies depending on the skill and consistency of the clinician. Skin fold measurement techniques from Krause's Food and Nutrition Therapy are outlined in Table 2 of the Appendix. The accuracy of skinfold measurements as a predictor of subcutaneous fat decreases with increasing obesity. Although more accurate methods for body composition exist, it is popular as it is easy to administer, is non-invasive and requires minimally expensive equipment. Equipment needed includes calipers and a tape measure.

Air Displacement Plethysmography

Air displacement plethysmography estimates body composition by measuring air displacement (Whitney & Rady Rolfes, 2005). A person sits inside a chamber while sensors determine the amount of air displaced by the person's body. Often marketed under the name Bod Pod, this form of assessment uses air instead of water and is typically more comfortable for the subject than hydrodensitometry (Christensen & Kushner, 2007). This test takes about five minutes to complete but has limitations as well. It is not portable and depending on the model, can be very costly.

There are many factors that can potentially affect the accuracy of different anthropometric measurements. It is important to note that equations used to calculate anthropometric measurements were developed using healthy subjects and is therefore not as accurate for individuals in a diseased state. Hydration state and fluid shifts can also affect the accuracy of body composition. The expertise of the technician can also impact results and therefore it is recommended to have the same person perform the test every time.

Comparing Assessment Methods

Research has shown that among the two-component body composition measurement options, hydrostatic weighing is the most precise at 3%. BIA was found to be less precise at 5% and skinfold tests ranged from 5-10% depending on the administrator's skill (Roubenoff & Kehayias, 1991; Christensen & Kushner, 2007). The Bod Pod has shown to be similar in accuracy to the hydrostatic weighing (Christensen & Kushner, 2007). DXA is a three-component model and has been found to slightly overestimate body fat percentage when compared to the Bod Pod in normal-weight individuals. Although all methods for measuring body fat have error rates, this type of assessment is best used when measuring change as opposed to focusing on a specific number to be achieved. Body fat measurement can be a useful tool to track changes over time an outpatient setting but the method used will depend on the financial burden, space and desired application.

Chapter VII

Measurement of Blood Pressure

Arterial blood pressure has been and remains an important indicator of a person's state of health (Perloff D et al., 1993). It is used as a part of every comprehensive physical assessment as a screening tool. Ideally, intra-arterial blood pressure is taken with a catheter, although this method is only practical in hospitalized patients. The most common method of measurement is the indirect method in which the pressure required to collapse the artery in the upper arm or leg is determined using a sphygmomanometer. An occluding cuff is inflated above arterial pressure and the cuff is deflated and the pressure is noted when arterial pulse waves also called Korotkoff sounds appear and disappear as blood flow through the artery resumes.

There are five phases of Korotkoff sounds. Phase one and phase five correspond to systolic and diastolic blood pressure respectively. Phase one sound is the level at which the first sound is observed and this systolic pressure reflects the maximum pressure generated during each cardiac cycle. Phase five marks the level of pressure at which the sound disappears completely and reflects the pressure when the artery is no longer compressed and blood flow is completely restored. This diastolic pressure is representative of the resting pressure between cardiac contractions.

Equipment needed to measure blood pressure manually includes a stethoscope and a sphygmomanometer. The sphygmomanometer is comprised of a manometer and an inflation system. Automated devices are also available to measure blood pressure by either auscultatory or oscillometric techniques. Some concerns are present regarding devices that measure blood pressure on the finger or wrist as they are sensitive to position and wide fluctuations in blood pressure can result. Doppler signal can also replace the stethoscope and is useful in taking infant blood pressure or in situations in which the auscultatory signal is difficult to hear.

As highlighted in previous pages, the prevalence of obesity poses numerous negative health consequences for our population. The trend for increasing obesity rates shows the need for additional research to be done to attempt to identify ways to combat this trend. Short term and holiday weight gain is an area that researchers and clinicians alike may be able to identify interventions to halt or slow holiday weight gain and hopefully battle creeping obesity for future generations. Our study is designed to assess the effects of the holiday season (Thanksgiving to New Years Day) on changes in body weight, body fat percentage, and blood pressure in adults. Further, we wanted to determine if regular exercise would have an impact on changes in our outcome variables.

Chapter VIII

Research Design and Methods

Hypothesis

We hypothesized that adult subjects would have a statistically significant increase in body weight and body fat percentage between the baseline and follow-up visit; adult subjects would not have a statistically significant change in blood pressure or heart rate between the baseline and follow-up visit; adult subjects who are overweight or obese would have more significant increases in body weight and body fat percentage than normal weight individuals between baseline and follow-up visit; and adult subjects that exercise regularly would have significantly smaller increase in their body weight and body fat percentage than that of non-exerisers

Subjects

Male and female subjects were recruited for this study by word of mouth, electronic announcements and fliers posted in and around Texas Tech University (TTU) and Dimmitt, Texas. The ages of subjects ranged from 18 – 65 years (mean of 33.5 ± 13.7 yrs). Most subjects lived within a 50 mile radius of Lubbock or Dimmitt, Texas. This study was approved by the Institutional Review Board at Texas Tech University, and written informed consent was obtained from each subject prior to testing. All subjects were screened for entry into the study based on the following exclusion criteria. Subjects were excluded if they were younger than 18 years of age, older than 65 years of age, had lost or gained more than 5% of their body weight in the past three months, were planning to lose weight between the baseline and final testing, were planning to begin or change an exercise routine between the baseline and final testing, were taking any medications that could alter their metabolic rate or hydration status, had any chronic diseases that could alter their metabolic rate or hydration status, were currently pregnant, lactating, or planning on becoming pregnant before the conclusion of the study, or had a pacemaker, internal functional electronic stimulation device or any other medical device that could be affected by the bioelectrical impedance analysis.

All research materials used during subject recruitment and data collection were entitled "short-term changes in health parameters" as we did not want participants altering their holiday eating or activity patterns because of their involvement of this research study. Holiday weight or the holiday season was not discussed until after follow-up visits had occurred.

Protocol

Eligible subjects were seen on two occasions, once in mid-November (within two weeks of the Thanksgiving holiday) and again 7-10 weeks later in early January (within two weeks of New Years Day). Prior to each visit, subjects were instructed to have no moderate to vigorous exercise for 12 hours before their visit and no food or drink for 4 hours before their visit. Following those instructions, subjects arrived at the Human Nutrition Lab (HNL) for testing procedures. Measurements obtained at each visit included height to the nearest 0.1cm using a portable PEAMI-101 stadiometer unit (Perspectives Enterprises, Portage Michigan, US) weight to the nearest 0.1kg using a standardized scale

(Series 400 KL, Continental Scale Corporation, Bridgeview, Illinois, US), body fat percentage using a bioelectrical impedance scale (Tanita Corporation of America Inc., Arlington Heights, Illinoise, 60005 US) and resting blood pressure and heart rate using an automated blood pressure cuff (Prosphyg 760, American Diagnostic Corporation Hauppauge, NY 11788 US). All measurements were taken with subjects wearing undergarments and a hospital gown with no shoes. This was done to eliminate potential changes in body weight due to the potential for different clothing to be worn at each visit. Subjects were asked a series of questions including information on recent and current eating habits and exercise habits.

After their baseline visit, subjects were scheduled for their follow-up visit to take place in early January after New Year's Day. Their second visit was scheduled for the same time of day as their baseline visit and they were to follow the same instructions as before their baseline visit. Subjects reported to the HNL where the same measures from the baseline visit were obtained. Additional data collected at the follow up visit included a series of questions evaluating what holidays they celebrate during the months of November, December, and January, and also how they celebrate these holidays (regarding eating and exercise).

Statistical Analysis

Statistical analysis was performed using SAS version 9.2 statistical package (SAS Institute Inc, Cary, NC). Descriptive statistics including mean, range, standard deviation, and standard error were calculated for all outcome variables. A paired t test was used to determine if there were significant differences between baseline values and values at the follow-up visit for height, weight, body composition, resting heart rate and blood pressure. The data were divided into exercisers and non-exercisers based on the subjects' answers on the surveys asked at the baseline and follow-up visits. A paired t-test was used to determine if there were significant differences between the groups in weight change, body composition change, resting heart rate change, and blood pressure change in either of the two groups. The data also were divided into three categories based on initial BMI categories (determined from their baseline height and weight measurements). A paired t test was used to determine if there were significant differences in weight change, body composition change, resting heart rate change, and blood pressure change in any of the groups. An analysis of variance (ANOVA) was used to examine between group differences for the changes in all outcome variables. BMI categories were assigned using baseline height and weight. Finally, Pearson Correlation Coefficients were used to determine if there was an association between baseline body weight, BF%, or age and changes in outcome variables. Statistical significance was set at $p<0.05$.

Chapter IX

Results

Subject Characteristics

Subjects that met all inclusion criteria and completed both study visits totaled 148 subjects(48 males and 100 females). Descriptive characteristics from our convenience sample are presented in Table 2. Initial blood pressure and HR values are close to optimal according to guidelines set by the American Heart Association (American Heart Association, 2009).

Table 2. Baseline Demographic Characteristics of Sample (n=148)

Variable	All Subjects n=148	Males n=47	Females n=101
Age (yr)			
Mean	33 ± 13	32 ± 12	34 ± 14
Range	18-65	18-61	18-65
Sex (%)		32%	68%
Race or Ethnic Group			
Black	3%	6%	2%
Hispanic	11%	6%	11%
White	80%	81%	80%
Other	5%	6%	5%
Weight (kg)			
Mean	71.7 ± 16.9	81.1 ± 14.7*	67.2 ± 16.2
Range	43.3 - 121.2	58.6 – 116.4	43.3 – 121.2
Height (cm)			
Mean	168.8 ± 9.0	177.6 ± 7.6*	165.2 ± 16.3
Range	152.4 – 194.0	154.0 – 194.0	152.4 – 180.8
BMI (kg/m^2)			
Mean	25.1 ± 5.5	25.7 ± 4.1	24.9 ± 6.0
Range	17.3 - 44.6	18.6 – 34.8	17.3 – 44.6
<25 (normal weight) (%)	57%	44%	63%
≥25 but <30 (overweight) (%)	26%	40%	20%
≥30 (obese) (%)	17%	16%	17%
Body Fat (%)			
Mean	25.2 ± 10.2	17.3 ± 7.4*	29.0 ± 9.1
Range	5.4 – 53.4	5.4 – 34.5	14.1 – 53.4
Diastolic Blood Pressure (mmHg)			
Mean	76. 5 ± 11.9	78.8 ± 11.3	75.3 ± 12.1
Range	48 – 131	59 – 99	48 – 131
Systolic Blood Pressure (mmHg)			
Mean	123.0 ± 17.0	129.1 ± 11.7*	120.1 ± 18.4
Range	75 – 176	96 - 149	75 – 176
Resting Heart Rate (bpm)			
Mean	70.5 ± 11.9	68.8 ± 12.2	71.4 ± 11.7
Range	43 – 104	43 - 104	44 - 102

Values presented as Means ± SD or %.
*Indicates significant difference between males and females $p<0.05$

Anthropometric Data

The changes in body weight, BF%, SBP, DBP and HR between our baseline and follow-up visits for all subjects can be found in Table 3. Significant increases were found in all subjects for body weight, BF%, SBP, DBP and HR during the holiday season. For male subjects alone, there were significant increases in body weight and BF%. In female subjects alone there were significant increases in body weight, DBP and HR. There were no significant differences in the changes in any variable between men and women. There were no significant differences found for height in any subject group.

Table 3. Changes in measured variables from pre- to post- Holiday Season (n=148)

Variable	All Subjects n=148	Male n=47	Female n=101
Wt (kg)	+0.78 ± 0.11*	+0.96 ± 0.17*	+0.69 ± 0.13*
BF% (%)	+0.5 ± 0.2*	+0.8 ± 0.3*	+0.4 ± 0.2
SBP (mmHg)	+2.3 ± 1.2*	+3.0 ± 1.9	+2.0 ± 1.5
DBP (mmHg)	+1.8 ± 0.8*	+2.0 ± 1.4	+1.8 ± 1.0*
HR (bpm)	+2.3 ± 1.0*	+1.6 ± 2.1	+2.7 ± 1.0*

Data are presented as mean ± SEE
(*) indicates significant change from pre-to post- Holiday season of at least $p<0.05$

BMI Category

We also divided and analyzed the data based on the following BMI categories: BMI <25kg/m^2 (normal weight), BMI 25 – 29.9kg/m^2 (overweight), and BMI ≥30kg/m^2 (obese) (Figures 1-6). A few subjects had BMIs lower than 18.5.

Although these subjects would normally be categorized as underweight, we included them in the normal weight category because of their small number compared to the other categories (5 compared to 82, respectively). Subjects in all three BMI categories had significant weight gain during the testing period ($p<0.001$); however, only the BMI ≥30 category showed a significant increase in BF% ($p<0.01$). Obese individuals had a significant increase in SBP ($p<0.01$), and there was a trend for difference between the obese and normal weight categories ($P=0.06$). There were no significant changes in DBP or height from any BMI category, but we did find a trend for difference from baseline to follow up for DBP in the overweight BMI category ($p=0.07$).

When we compared changes in each variable between the BMI groups, we found that the change in BF% in the obese group was significantly greater than in the normal weight group ($p<0.05$), and there was a trend for a difference between the obese and overweight group ($p=0.07$). No significant differences were found between groups for other variables.

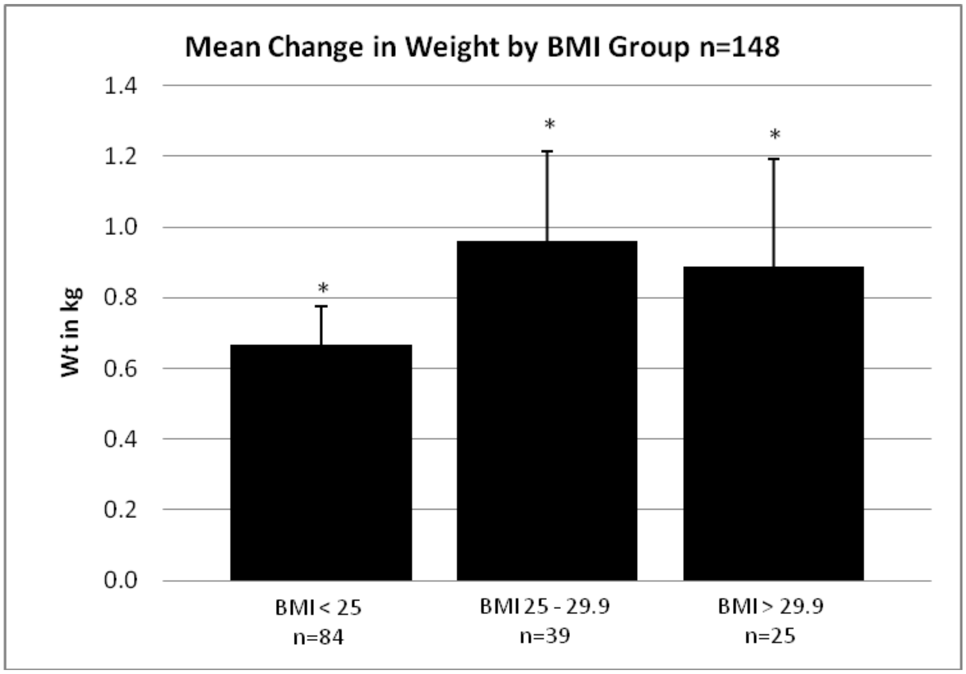

Figure 1. Changes in Weight from Pre- to Post- Holiday Season by BMI Category
Subjects in all BMI categories had significant weight gain during the testing period.
(*) indicates significant change from pre to post holiday season of at least $p<0.05$

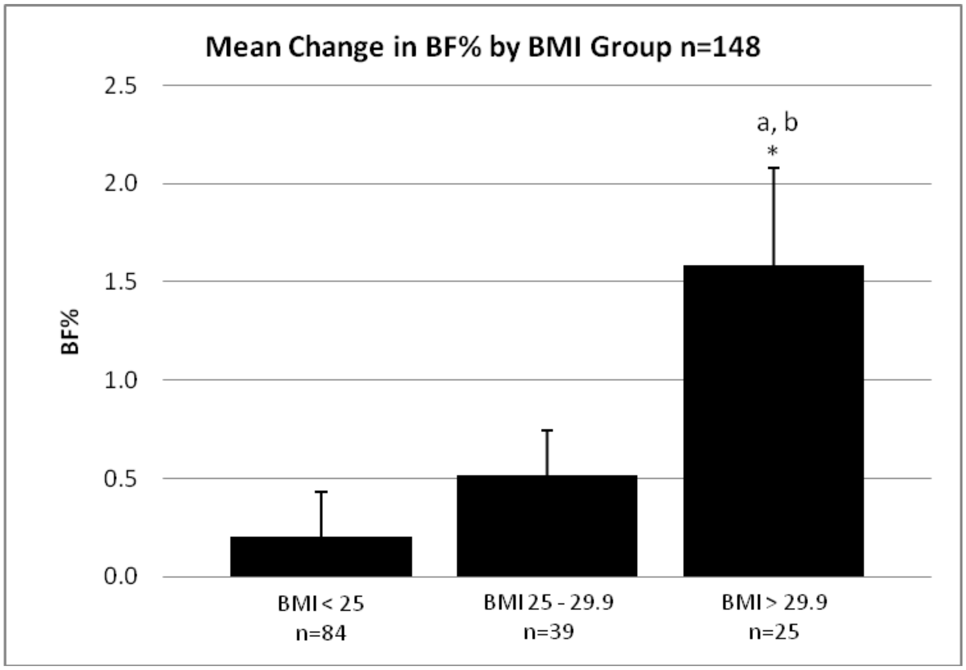

Figure 2. Changes in BF% as determined by intial BMI group.
(*) indicates significant change from pre to post holiday season of at least $p<0.05$
a = significant difference between obese and normal weight groups ($p<0.05$)
b = trend for a difference between obese and overweight groups ($p=0.07$)

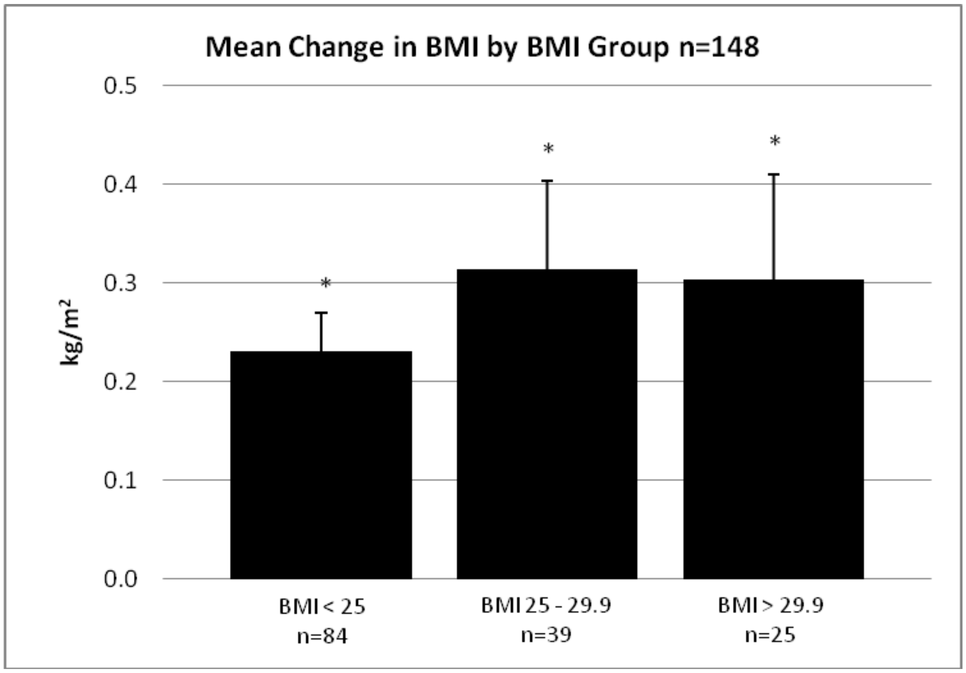

Figure 3. Changes in BMI as determined by intial BMI group.
(*) indicates significant change from pre to post holiday season of at least $p<0.05$

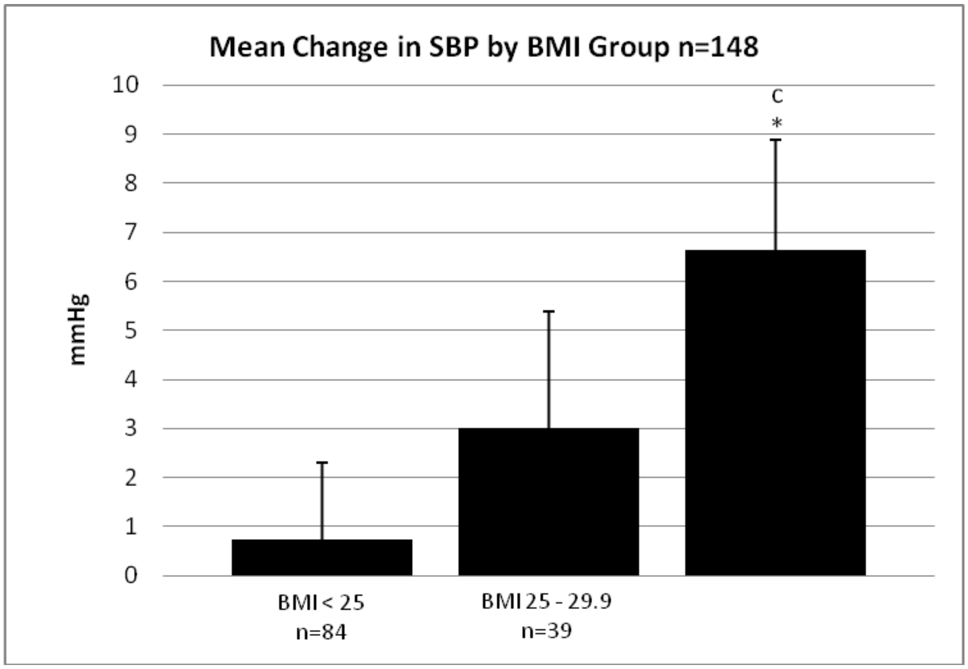

Figure 4. Changes in SBP as determined by intial BMI group.
(*) indicates significant change from pre to post holiday season of at least $p<0.05$
c = trend for a difference between obese and normal weight groups ($p=0.06$)

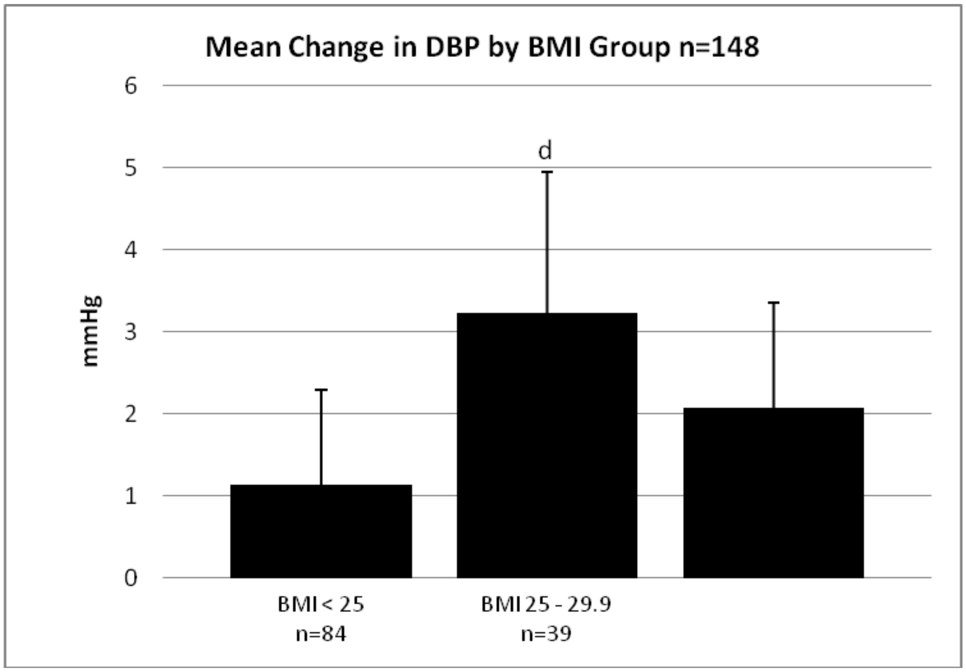

Figure 5. Changes in DBP as determined by intial BMI group
d = trend for a difference from baseline values (p=0.07)

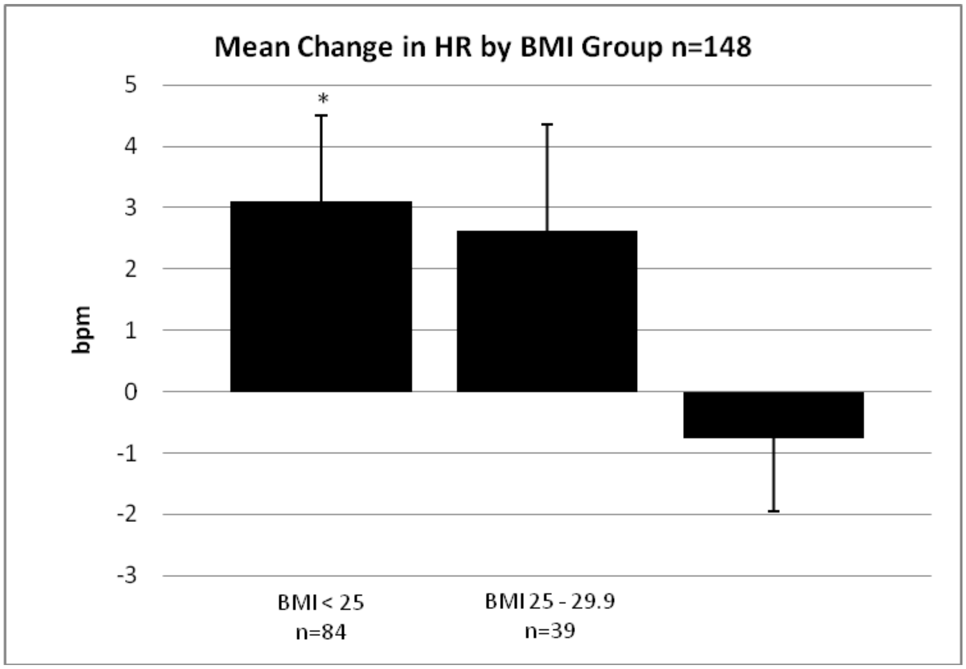

Figure 6. Changes in HR as determined by intial BMI group.
(*) indicates significant change from pre to post holiday season of at least $p<0.05$

Exercisers vs. Non-exercisers

At each visit, subjects were asked a series of questions about their exercise habits or routines. Based on their answers at baseline and follow-up visits, the group was divided into either Exercisers (Ex) or Non-Exercisers (Non-Ex) (Table 3). In order to be classified as an “Exerciser” the individual had to engage in structured exercise for 30 minutes or more at least twice per week. If a subject was exercising at baseline but stopped over the holiday season, they were placed into the Non-Ex group. Alternatively if the subject was not exercising at baseline, but started exercising during the holiday season, they were placed into the Ex group. Data concerning the two groups and their changes in exercise habits pre- and post-holiday are presented in Table 4.

Baseline data for the two groups are presented in Table 5. Overall the Non-Ex group was significantly older and had significantly higher body weight, BMI, BP, and HR at baseline when compared to the Ex group. The changes in outcome variables for the Ex and Non-Ex groups are presented in Figure 2. When divided by exercise status, both groups had significant weight gain and consequently increases in BMI during the holiday season ($p<0.001$). Other significant increases from baseline to follow-up were increases in BF% ($p<0.05$) and DBP ($p<0.01$) in the Non-Ex group and a significant increase in HR for the Ex group ($p<0.04$). The Non-Ex also group showed a trend for an increase in SBP ($p=0.07$). We also compared the changes in each variable between Ex and Non-Ex and found that no statistically significant differences between Ex and Non-Ex existed. However, the change in body weight between Ex and Non-Ex showed a trend for a difference between groups of 0.64±0.1kg vs. 0.96±0.2kg, ($p=0.13$) for Ex vs. Non-Ex, respectively. Additionally, the Non-Ex group in general showed larger increases in weight, BMI, BF%, SBP, and DBP compared to the Ex group. However, none of these differences reached significance, possibly due to inadequate power as there were only 55 subjects in the Non-Ex group.

Table 4. Exercise Habits and Changes in Exercise during the study n=148 (†)

Category	N	(%)
Exercisers	91	61%
Non-Exercisers	55	37%
Changes in Exercise Habits Between Visits		
Less	36	24%
No Change	107	72%
More	3	2%

(†) not all percentages equal 100% due to rounding

Table 5. Demographic Characteristics for Exercisers and Non-Exercisers n=148 (†)

Variable	Exercisers n=91	Non-Exercisers n=55
Age (yr)		
Mean	32 ± 13*	37 ± 14
Range	18 – 65	18 – 61
Sex (%)		
Male	31%	35%
Female	69%	65%
Race or Ethnic Group		
Black	3%	4%
Hispanic	9%	15%
White	80%	80%
Other	8%	2%
Initial Weight (kg)		
Mean	66.5 ± 12.8*	80.4 ± 19.7
Range	43.3-100.5	46.3 – 121.2
Initial BMI (kg/m^2)		
Mean	23.3 ± 3.7*	28.2 ± 6.6
Range	17.9 – 34.8	17.3 - 44.6
<25 (%)	69%	35%
≥25 but <30 (%)	25%	29%
≥30 (%)	5%	36%
Initial Diastolic Blood Pressure (mmHg)		
Mean	74.6 ± 12.1*	79.5 ± 11.2*
Range	48 - 131	62 – 104
Initial Systolic Blood Pressure (mmHg)		
Mean	120.3 ± 16.2*	127.6 ± 17.7
Range	75 - 160	96 – 176
Initial Resting Heart Rate (bpm)		
Mean	68.0 ± 11.2*	74.9 ± 11.8
Range	43 - 102	53 – 104

Data are presented as mean ± SD or %
(†) Not all percentages equal 100% secondary to rounding
(*) indicates significance difference between groups of at least $p<0.05$

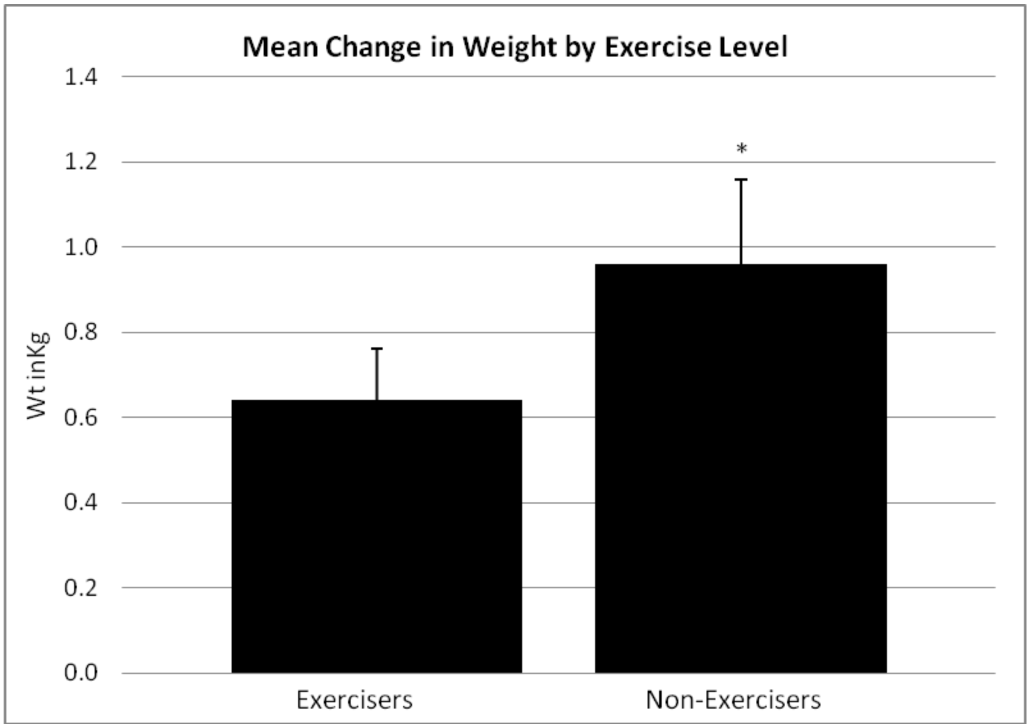

Figure 7. Changes in Weight from Pre- to Post- Holiday Season by Exercise Level
(*) indicates significant differrence from pre to post holiday season at $p<0.05$

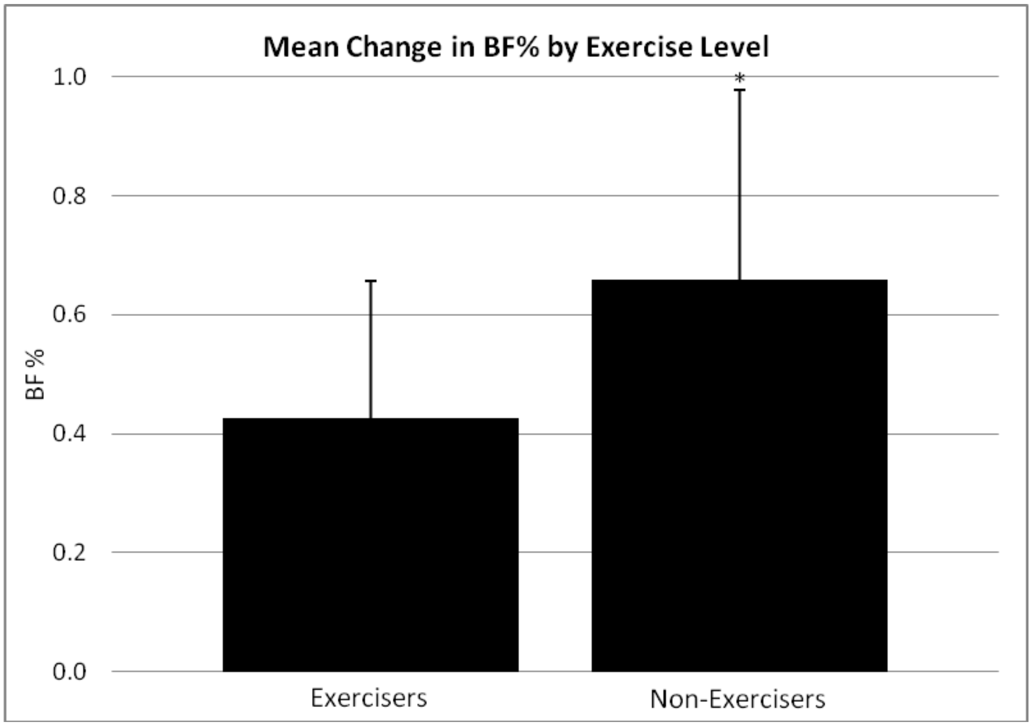

Figure 8. Changes in BF% from Pre- to Post- Holiday Season by Exercise Level
(*) indicates significant differrence from pre to post holiday season at $p<0.05$

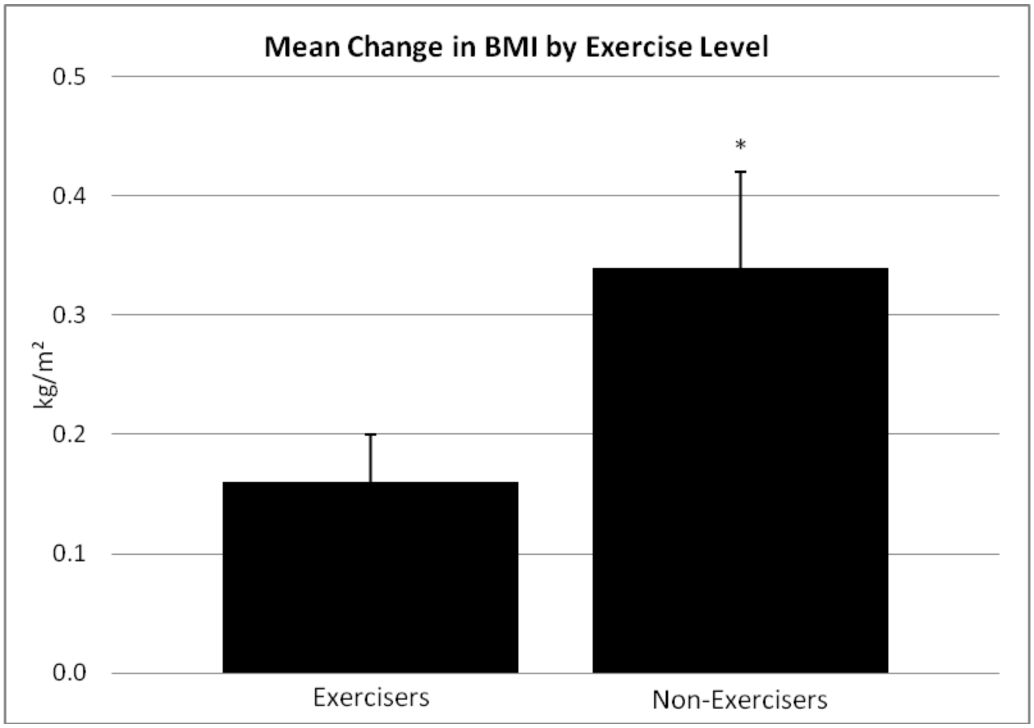

Figure 9. Changes in BMI from Pre- to Post- Holiday Season by Exercise Level
(*) indicates significant differrence from pre to post holiday season at $p<0.05$

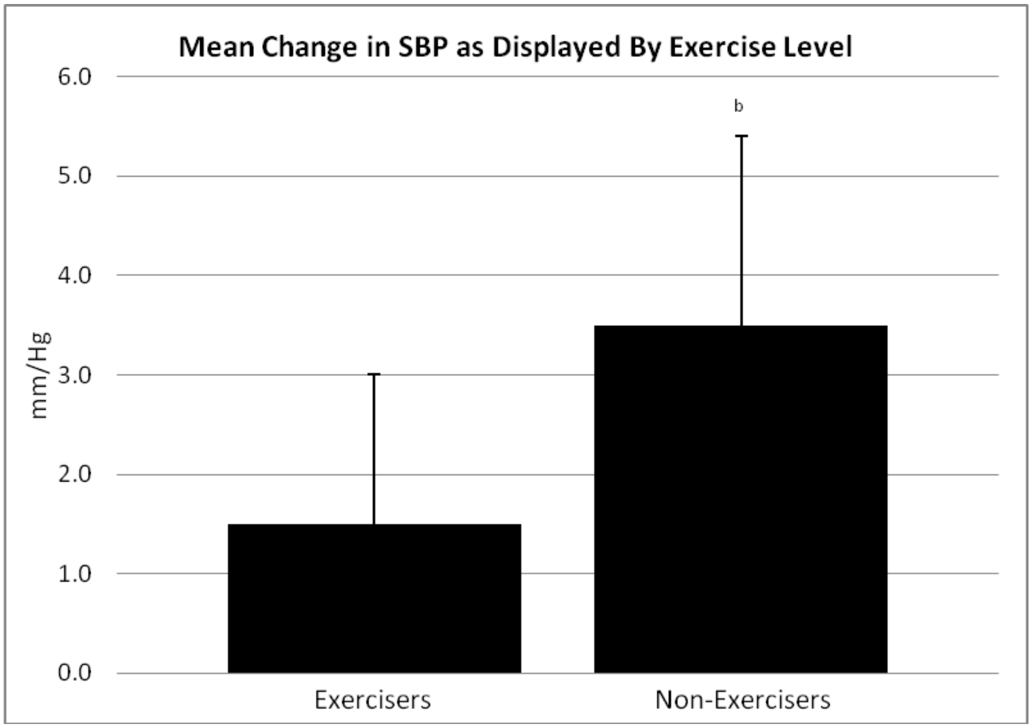

Figure 10. Changes in SBP from Pre- to Post- Holiday Season by Exercise Level
[b] indicates a trend for difference from baseline data of p=0.07

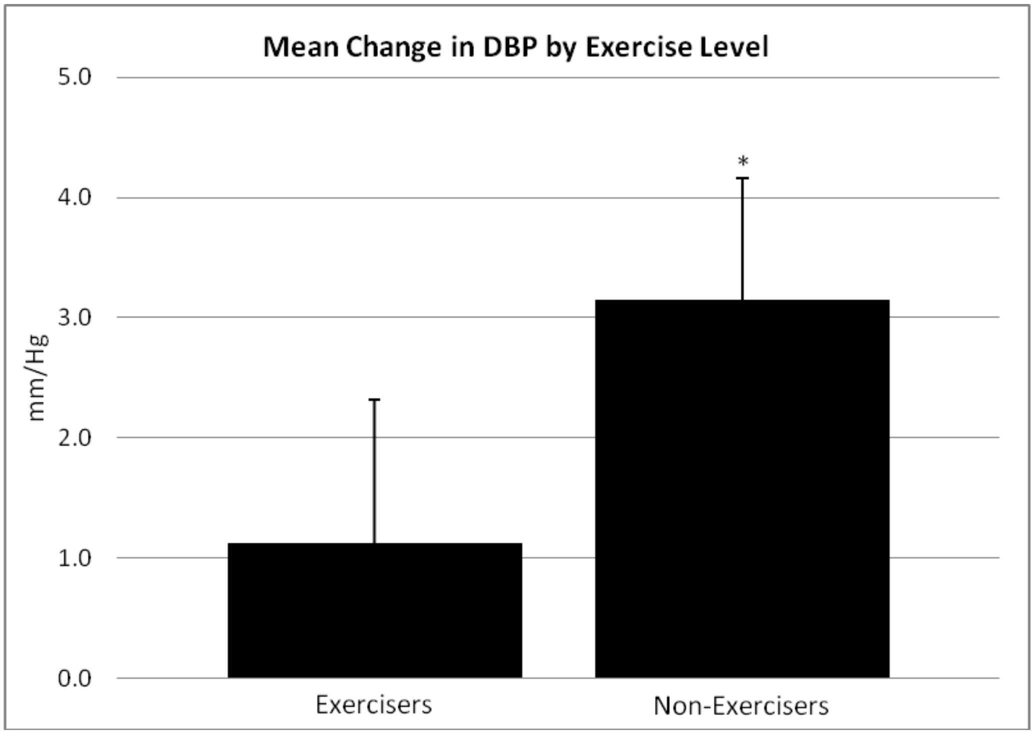

Figure11. Changes in DBP from Pre- to Post- Holiday Season by Exercise Level
(*) indicates significant differrence from pre to post holiday season at p<0.05

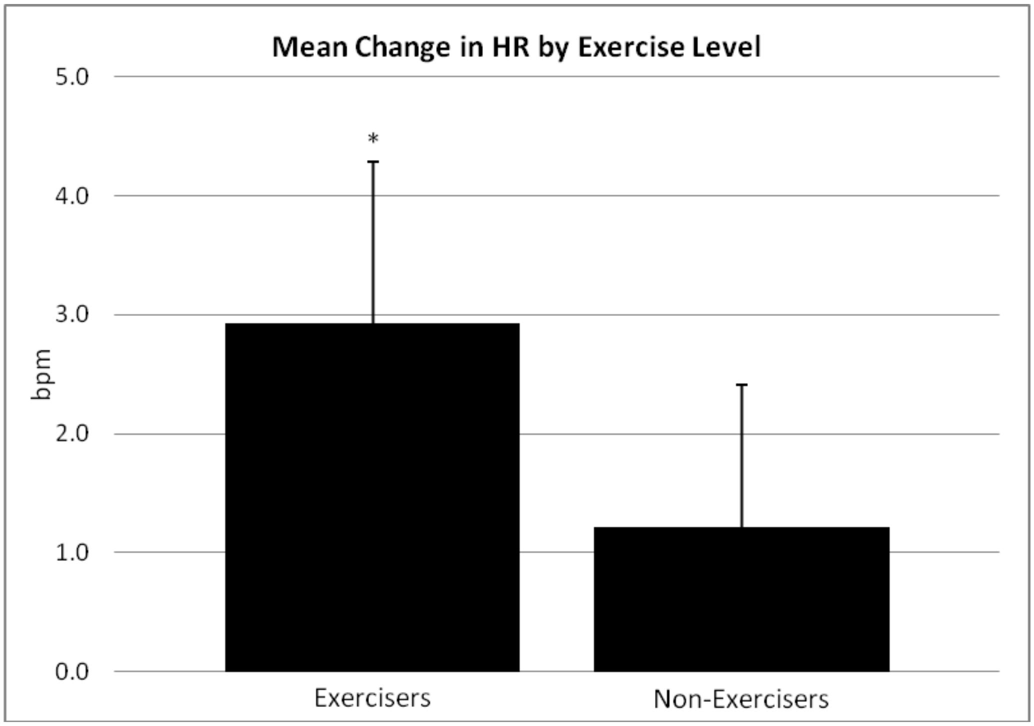

Figure 12. Changes in HR from Pre- to Post- Holiday Season by Exercise Level (*) indicates significant differrence from pre to post holiday season at $p<0.05$

Correlation Analysis

Table 6 shows the correlation matrix for baseline variables. Age at baseline was positively correlated with all variables except change in weight. Similarly, body weight at baseline was positively correlated with all variables. Finally, BMI at baseline was positively correlated with BF% and change in BF% but not change in weight.

Table 6. Correlations between baseline age, body weight, BMI, and BF% and outcome variables. Data are presented as the correlation coefficient (r) on the top line and the p value for statistical significance directly below it.

	Age	Weight	BMI	BF%	Change in Wt	Change in BF%
Age	1.0	0.25 p<0.05	0.32 p<0.05	0.40 p<0.01	0.02 Ns	0.17 p<0.05
Wt		1.0	0.88 p<0.01	0.47 p<0.01	0.20 p<0.05	0.30 p<0.01
BMI			1.0	0.72 p<0.01	0.09 Ns	0.25 p<0.01
BF%				1.0	0.10 Ns	0.06 ns
Change in Wt					1.0	-0.01 ns
Change in BF%						1.0

Chapter X

Discussion

Gaining weight over the holiday season has been recognized in the popular press; however, we wanted to determine the degree of weight change during the holiday season and how that may affect other health parameters. We found significant increases in body weight, BF%, SBP, DBP and resting HR for our subjects during the holiday season. The average weight gain was 0.78kg; however, changes in body weight ranged from -5.8kg to 13.9kg, indicating a large degree of variability in weight change during the holiday season. Age was positively correlated with initial body weight, initial BF%, and change in BF%. Initial body weight was positively correlated with change in weight, and change in BF%. When the data were analyzed by baseline BMI category, all groups had significant increases in body weight, but only the obese group had a significant increase in body fat percentage. Given the fact that only 17% of our subjects were obese (BMI > 30, n=25), we were surprised to find a significant BF% increase in the obese group. This only serves to strengthen the argument that the holiday season most adversely affects individuals that are already obese.

Energy expenditure during the holiday season may be just as important as total energy intake. As a secondary purpose to this study, we wanted to determine if those who exercise regularly would be protected against weight gain during the holiday season. To date, our study is the only holiday season study to have examined the effects of exercise status on outcome variables. When divided by exercise status (exercisers vs. non-exercisers), both groups had significant weight gain during the holiday season. We found no significant differences between the two groups when we looked at the changes in each outcome variable; however the change in body weight between Ex and Non-Ex showed a trend for a difference between groups (0.64±0.1kg vs. 0.90±0.2kg), respectively (p=0.13),. In general, the Non-Ex group showed larger increases in BF%, SBP, and DBP compared to the Ex group, however none of these differences reached significance possibly due to inadequate power as there were only 55 subjects in the Non-Ex group. It is important to note that although both groups gained weight during the holiday season, only the Non-Ex group had significant increases in BF% ($p<0.05$) and DBP ($p<0.01$) suggesting that exercise could have a partially protective effect against body fat accumulation and rises in DBP during the holiday season. Future studies that include more subjects for each category and more rigid criteria for exercise status should be conducted to determine if significant differences between the groups exists. It is also important to note that the Non-Ex group was significantly older and had significantly higher body weight, BMI, BP, and HR at baseline when compared to the Ex group.

Our study reports similar findings to previous studies on holiday weight gain. Yanovski et al. (Yanovski et al., 2000) reported weight gain from mid-November to early January of 0.37±0.1kg. They found less weight gain than we did during the holiday season (0.37kg vs. 0.78kg) but also reported that the weight gain was not reversed during the rest of the year. Other previous studies have been focused on one holiday alone . Andersson and Rossner (Andersson & Rossner, 1992) gathered data over the Christmas holiday and found a mean body weight increase of 0.5kg. Hull, et al. (Hull et al., 2006) gathered data over the Thanksgiving holiday and found a significant increase in mean body weight of 0.5kg as well. These findings suggest that although weight gain over the holiday season may be less than advertised by the popular media, it can still be significant and occurs over a fairly short period of time. The Yanovski et al. (Yanovski et al., 2000) study, in particular, shows that this significant increase in body weight is not reversed and could over time contribute to creeping obesity.

Our results also suggest that the likelihood of gaining more weight over the holiday season increases as the degree of overweight increases. Yanovski et al. (Yanovski et al., 2000) found a similar trend towards a greater chance of major holiday weight gain as the degree of overweight increased. We found similar weight gain in all BMI groups, but our obese subjects did have significantly greater increases in BF% compared to normal weight subjects and trended for significance compared to overweight subjects. We also found that initial body weight was significantly correlated with changes in body weight and BF%. In support of this hypothesis, Hull et al, (Hull et al., 2006) found significant increases in body weight in an overweight/obese group but not in a normal weight group during the Thanksgiving holiday. Knowing that initial body weight is positively correlated with changes in body weight and BF%, and taking into account previous studies, we can conclude that individuals with overweight or obese BMIs prior to the holiday season are at an increased risk for gaining more weight and/or body fat over the holiday season. As mentioned previously, obesity carries with it an increased risk for comorbidities. These significant increases in BF% are alarming as clinicians and researchers are finding associations between truncal adiposity and negative health outcomes. This also highlights the importance of interventions targeted toward this at-risk group.

One potential limitation of this study is that we collected a convenience sample as opposed to a population-based sample. Our sample consisted primarily of Texas Tech University students and staff as well as residents of Dimmitt, TX. It is possible that students and faculty at a university could have priorities for their health that differ from the average American. Our convenience sample also may have included subjects in which not all socio-economical groups were equally represented. Our data is somewhat limited because of our body composition collection technique. Ideally we would be able to analyze pre and post-holiday body composition with a DEXA scanner or Air Displacement Plethysmography, however utilizing the resources available, we used BIA to assess BF%. BIA is a user friendly, portable, non-invasive tool for collecting body composition data; however it does have some inherent limitations. For instance, if the specific testing guidelines were not followed by subjects and a person's fluid status varied from pre to post testing, the results could be less accurate. Hydrostatic weighing is said to have the highest precision in body composition devices at 3%. The BIA technique is less accurate with an error rate just higher at 5% (Christensen & Kushner, 2007). Therefore, our instrument may not have been sensitive enough to detect small changes that may have occurred during the short time-frame of this study. Additionally, we were unable to collect data for more than two visits, therefore we cannot definitively say whether or not our subjects maintained or lost the weight and/or body fat they accumulated over the holiday season.

Our study was able to confirm that there are significant increases in body weight, BF%, and blood pressure over the holiday season in adults. We showed that subjects who were regular exercisers may experience less weight gain during the holiday season, although our data was limited by a low number or exercising subjects. We also found that overweight and obese individuals are at an increased risk for holiday BF% gain. From a practical implications standpoint, the average weight gain of 0.78kg that we found in our study represents a substantial proportion of annual weight gain in U.S. adults. If the weight gain occurring over the holiday season was to be prevented or reduced, it could be possible to decrease the annual weight gain in adults and ultimately decrease the prevalence of obesity. More research needs to be conducted with population-based sample groups who are followed long-term to confirm these predictions; however, it is our hope that this research will provide the springboard necessary to allow for further research of the changes in health parameters that occur during the Holiday Season and how interventions can be developed to prevent these changes.

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Appendix A

Appendix Table 1 – Activity Guidelines for Americans(U.S.Department of Agriculture & .S.Department of Health and Human Services, 2010)

Age	Guidelines
6 to 17 years	Children and adolescents should do 60 minutes (1 hour) or more of physical activity daily. • Aerobic: Most of the 60 or more minutes a day should be either moderate- or vigorous-intensity aerobic physical activity, and should include vigorous-intensity physical activity at least 3 days a week. • Muscle-strengthening: As part of their 60 or more minutes of daily physical activity, children and adolescents should include muscle-strengthening physical activity on at least 3 days of the week. • Bone-strengthening: As part of their 60 or more minutes of daily physical activity, children and adolescents should include bone-strengthening physical activity on at least 3 days of the week. • It is important to encourage young people to participate in physical activities that are appropriate for their age, that are enjoyable, and that offer variety.
18 to 64 years	• All adults should avoid inactivity. Some physical activity is better than none, and adults who participate in any amount of physical activity gain some health benefits. • For substantial health benefits, adults should do at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, it should be spread throughout the week. • For additional and more extensive health benefits, adults should increase their aerobic physical activity to 300 minutes (5 hours) a week of moderate-intensity, or 150 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity. Additional health benefits are gained by engaging in physical activity beyond this amount. • Adults should also include muscle-strengthening activities that involve all major muscle groups on 2 or more days a week.
65 years and older	• Older adults should follow the adult guidelines. When older adults cannot meet the adult guide-lines, they should be as physically active as their abilities and conditions will allow. • Older adults should do exercises that maintain or improve balance if they are at risk of falling. • Older adults should determine their level of effort for physical activity relative to their level of fitness. • Older adults with chronic conditions should understand whether and how their conditions affect their ability to do regular physical activity safely.

Appendix Table 2 – Skin-Fold Measurement Techniques(Mahan & Escott-Stump, 2008)
1) Take measurement on the right side of the body. 2) Mark the site to be measured and use a flexible, nonstretchable tape. 3) The tape measure can be used to locate the midpoints on the body. 4) Firmly grasp the skin fold with the thumb and index finger of the left hand about 1 cm or ½ inch proximal to the skin-fold site, pulling it away from the body. 5) Hold the caliper in the right hand, perpendicular to the long axis of the skin fold and with the caliper's dial face up. Place the caliper tip on the site and about 1 cm or ½ inch distal to the fingers holding the skin fold. (Pressure from the fingers does not affect the measurement.) 6) Do not place the caliper too deeply into the skin fold or too close to the tip of the skin fold. 7) Read the caliper approximately 4 seconds after pressure from the measurer's hand has been released from the lover. Exerting force longer than 4 seconds results in small readings because fluids are forced from the compressed tissue. Measurements should be recorded to the nearest 1mm. 8) Take a minimum of two measurements at each site to verify results. Wait 15 seconds between measurements to allow the skin-fold to return to normal. Maintain pressure with the thumb and index finger during measurements. 9) Do not take measurements immediately after the person has exercised or if the person is overheated because the shift in body fluid makes the result larger. 10) When measuring obese clients, it may be necessary to use both hands to pull the skin away while a second person makes the measurement. If the calipers do not fit, another technique may be required. Data from Lee RD, Nieman DC: Nutritional assessment, ed 3, New York, 2003, McGraw-Hill.