

ASSESSING THE EFFECTS OF THE HOLIDAYS ON BODY COMPOSITION AND  
WEIGHT CHANGE USING AIR DISPLACEMENT PLETHYSMOGRAPHY

by

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## ABSTRACT

Assessing the Effects of the Holidays on Body Composition and  
Weight Change Using Air Displacement Plethysmography

by

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Utah State University, 2009

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This study was conducted to determine the change in weight and body composition over a 6-week holiday period. Change in body composition was measured using air displacement plethysmography technology (Bod Pod<sup>®</sup>). Thirteen men and 21 women ranging in age from 23-61 years were participants for this study. Baseline testing occurred the week of Thanksgiving Day (November 24 or 25), and the post-holiday assessment was the week after Utah State University's holiday break (January 5 or 6). Results from a nutrition and exercise questionnaire revealed a significant difference between pre-holiday and post-holiday consumption of vegetables ( $8.6 \pm 8.3$  vs.  $6.2 \pm 4.0$ ), special holiday foods ( $1.6 \pm 1.9$  vs.  $2.5 \pm 2.1$ ), regular soda ( $1.5 \pm 2.2$  vs.  $2.2 \pm 2.6$ ), and social gatherings attended ( $1.6 \pm 1.5$  vs.  $2.2 \pm 1.7$ ). There was also a statistically significant decline in the number of days per week individuals exercised pre-holiday ( $3.7$

$\pm 2.0$  day/week) versus post-holiday ( $2.6 \pm 2.3$  day/week). Despite these differences, there was no statistically significant difference between pre-holiday weight ( $74.0 \pm 17.8$  kg) and post-holiday weight ( $73.9 \pm 18.1$  kg), nor between pre-holiday body fat percentage ( $25.4 \pm 9.0\%$ ) and post-holiday body fat percentage ( $25.4 \pm 8.9\%$ ).

(84 pages)

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# CHAPTER I

## INTRODUCTION

### Background of the Problem

The weeks from Thanksgiving through New Year's Day, to some, are considered to be the "Super Bowl of eating" (Owens, 2006). For many others, the Thanksgiving feast marks the beginning of a very long eating weekend (Cooney, 2006). The holiday parties and family gatherings can make it difficult to stick to a normal routine of exercise and healthy eating. One big meal or special occasion splurge is not overly detrimental to someone who is committed to a healthy lifestyle (Cooney), but it can lead to a pattern of overeating for those who have a hard time staying healthy. Healthy habits can often change during the holiday season. Highly palatable foods are known to be consumed in greater amounts and because special foods are often consumed during holiday periods, overeating may occur. Overeating throughout the holidays could account for an increase in body weight and body fat (Roberts & Mayer, 2000). An increased intake of fat, sugars, and alcohol often takes place as well as a lack of physical activity throughout the Christmas season (Reid & Hackett, 1999; Van Staveren, Deurenberg, Burema, De Groot, & Hautvast, 1986). Outdoor physical activity during this time of year is far less attractive to many people (Andersson & Rossner, 1992; Van Staveren et al.).

The holiday season is a time when cultural and social influences combine to create a high-risk environment conducive to weight gain (Hull, Radley, Dinger, & Fields, 2006). High caloric Christmas food traditions without additional physical activity could lead to weight increases around New Years (Andersson & Rossner, 1992).

Small seasonal fluctuations in calorie intake, physical activity, and body weight were observed in a study done at the University of Massachusetts Medical School (Ma et al., 2006). There were 593 participants that were seen three different times throughout a year where they filled out a 24-hour dietary recall and were interviewed. The results showed that the percentage of calories was highest in the fall and early winter (1958 kcal/day) and lowest in the spring (1942 kcal/day). The peak of physical activity was in the spring (30.7 MET-hr/day) with the lowest level of activity in the winter (29.9 MET-hr/day). The peak of body weight was in the winter (79.0 kg) with the lowest body weight in the spring (78.8 kg). The increase in daily caloric intake and the decrease in physical activity during the winter months led to an increase in body weight in the winter (Ma et al.).

Many magazine articles and gym advertisements suggest that the average person gains between 7-10 lb (3-4.5 kg) over the Christmas holiday. However, a study on holiday weight gain by Roberts and Mayer (2000) found that during the 6-week holiday period from Thanksgiving to New Years, the average weight gain was only 0.37 kg. When the participants were asked how much weight they thought they had gained, most of them assumed around 1.6 kg. This value is three times greater than the measured weight gain. False perception of high weight gain may contribute to the belief that more weight is gained over a holiday period than what actually occurs (Roberts & Mayer).

Somer (1997) wrote an article for *Shape Magazine* that focused on holiday weight gain. People were classified into three “holiday eating personalities.” The first personality was called the “deliberate indulger.” People with this personality type decide to splurge at big holiday meals and worry about their weight when January 2<sup>nd</sup> rolls

around. The second eating personality is the “well-intended binger.” This type of person comes to parties or gatherings with good intentions of not overeating and not gaining a pound, but when faced with the temptation of holiday goodies, the well-intended binger cannot resist. The last holiday eating personality is the “reluctant recluse.” These people will actually skip parties, dinners, and even family gatherings because they are so worried about overeating and gaining weight. They may even do double time at the gym to keep extra pounds off (Somer). Somer’s “holiday eating personalities” article is an example of the concern or worry that people have with regard to gaining weight over the holidays.

More and more people in the United States are becoming overweight and obese. This problem is costing Americans \$70 billion in health care costs and is responsible for over 300,000 deaths a year in the U.S. (Allison, Fontaine, Manson, Stevens, & VanItallie, 1999). In fact, heart disease, of which obesity is a major risk factor, was the leading cause of death in America in 2007. Not having control over one’s weight can be detrimental to an individual’s health and can contribute to many diseases. Current evidence suggests that weight gain in the United States occurs disproportionately during the winter holiday period compared with other times of the year, and may be an important contributor to the rising prevalence of obesity (Roberts & Mayer, 2000). However, much of the information about weight gain during a holiday period has been presented only in magazines; few scientific studies have been devoted to this phenomenon.

### Purpose of the Study

The purpose of this study was to examine changes in body mass and body composition over the holiday season. Specifically, the aims of this study were (a) to

determine changes in body mass and body composition in adults over the 6-week holiday season (Thanksgiving through New Year's holidays), and (b) to determine if a change in diet and exercise occurred over the 6-week holiday season.

### Research Questions

The five research questions of this study were:

1. Did the weight and fat mass of participants change significantly during the 6-week holiday season?
2. Did people's eating and drinking habits change over the holidays?
3. Did exercise regimens change during the weeks of Thanksgiving to New Year's Day?
4. Was holiday weight change related to body mass index (BMI)?
5. Was there a difference in weight change and fat mass change between men and women during the holiday period?

### Research Hypotheses

The five hypotheses for this study were:

1. A gain of fat mass as well as a gain in weight will occur over the 6-week period.
2. Caloric intake will increase over the holidays.
3. Participants will exercise less over the 6-week holiday season.
4. Participants with a BMI  $\geq 25$  kg/m<sup>2</sup> will gain more weight than those with a healthy BMI.

5. Men will experience a greater weight gain and fat mass gain compared to women during the holiday period.

### Limitations of the Study

It is anticipated that the following limitations impacted the results of the study. The study was not blind. The participants knew the purpose of the study and that they were going to have their body composition evaluated after New Year's Day. This knowledge may have caused them to change their typical holiday eating and exercise behavior. Also, there may have been selection bias in the sampling. Although the study was open to all, those volunteering to have their weight and body composition measured were likely already interested or concerned about their health and the changes that might accompany unhealthy behaviors over the holidays.

### Delimitations of the Study

This study was delimited to the following:

1. A sample of male and female adults living in the Cache Valley area who were not currently college students.
2. Pregnant women were not allowed to participate in the study due to irregular body composition and body mass index (BMI).

### Assumptions of the Study

The assumptions of this study were:

1. The participants were honest in the completion of the nutrition and exercise assessment over the 6-week period.
2. The instruments used in the study were valid and reliable.

### Definitions of Terms

The following technical terms were used throughout the thesis:

1. Body mass index (BMI): The ratio of body weight (kg) to height (m) squared; a crude classification of weight and an index of obesity.
2. Air displacement plethysmography (ADP): The technology used in the Bod Pod<sup>®</sup> to estimate body volume; a densitometry method that uses pressure-volume relationships.
3. Fat mass: All lipid in the body.
4. Fat-free mass: The combined mass of the body of everything that is not fat (muscle, bone, skin, organs, etc.).

## CHAPTER II

### REVIEW OF LITERATURE

#### Introduction

The purpose of this literature review was to provide information that has been researched and written on body composition and weight gain over the holiday season. Much of the research that has been done on this topic resulted from testing participants from late November (Thanksgiving) to early January (New Year's Day). The majority of the literature included research that focused primarily on holiday weight gain among undergraduate and graduate level college students. Studies regarding weight gain over the holidays that tested adults aged 23-65 years were limited.

Weight gain has become a serious problem in the United States, and rapid weight gain that might occur during the holiday period could be a contributing factor to the overall obesity epidemic. This literature review focuses on six areas pertinent to this study; (a) weight gain during the holiday season, (b) reasons for holiday weight gain, (c) susceptibility to weight gain over the holidays, (d) health risks involved with obesity, (e) the Bod Pod<sup>®</sup> for assessing changes in body composition, and (f) prevention of weight gain over the holiday season.

#### Weight Gain During the Holiday Season

The media commonly report that 5 lbs of body weight is gained over the holiday season, and some people are susceptible to gain up to 10 lbs (Vantresse, 2007).

According to a magazine article, eating the wrong types of food such as holiday cookies

and desserts, along with a greater consumption of alcoholic beverages can cause people to gain between 7-12 lbs over the holidays (Somer, 1997). However, these reports are from the popular media rather than scientific sources.

A review of the scientific literature reveals that the majority of adults gain about 1 lb during the holidays, rather than the 5 lbs or more estimated by the popular media (Roberts & Mayer, 2000). Healthy individuals are likely to gain 0.9 lb during the holidays, but overweight people may end up gaining 5 lbs. Overweight and obese people are also less likely to shed those extra pounds after the holiday season (Phelan et al., 2008). College students may also be at risk for holiday weight gain. It is reported that some students gain more than 2 lbs over the holidays, and they have a hard time losing the extra weight come January (Hull, Radley, et al., 2006). Although the amount gained appears to vary, the 6-week period between Thanksgiving and Christmas is a common time for weight gain (Roberts & Mayer).

Yanovski et al. (2000) concluded that the average weight gain among Americans during the holiday season was 1 lb. This study measured body weight in 195 adults on four different occasions. Each participant's body weight was measured using an electronic scale every 6-8 weeks between the months of September and March. The results of this study found that a participant's weight increased little between Thanksgiving and New Year's Day (Yanovski et al.). The subjects did, however, feel as though they had gained four times as much weight than they actually had.

A study of 27 people in Liverpool, UK revealed similar but slightly greater increases in weight during the Christmas season. Pre-holiday measurements of weight, body mass index, biceps, triceps, waist circumference, blood pressure, and cholesterol

were compared to post-holiday measurements. Reid and Hackett (1999) found that the mean weight increased (0.93 kg; 1.4%). Twelve subjects gained more than 1 kg, and four subjects gained more than 2 kg. They also found significant increases in biceps skinfold and waist circumference measurements. The group of participants was relatively lean and a significant increase in weight occurred in a short period of time. The reasons for the weight gain were unknown but overeating, alcohol consumption, and inactivity were likely to have been the main factors.

Hull, Radley, et al. (2006) conducted a study on the effects of the Thanksgiving holiday on weight gain. Ninety-four male and female college students attending the University of Oklahoma participated in the study. The participants' body weights were recorded during two different periods, the first being the week prior to the Thanksgiving holiday and the second being 5-7 days following the holiday. The average span of time between measurements was 13 days. Hull, Radley, et al. found a significant increase in body weight between visit one and visit two among the entire group of participants (72.1 kg vs. 72.6 kg;  $p < 0.05$ ). The majority of participants increased their body weight by 1 lb over the Thanksgiving holiday. The study also suggested that Thanksgiving holiday represented a critical period for weight gain and obesity (Hull, Radley, et al.).

Another study by this same research team at the University of Oklahoma found that, on average, body weight did not significantly increase from pre-Thanksgiving to post New Year's Day (Hull, Hester, & Fields, 2006). The study included 100 male and female students. Data were collected on the students three different times. The first data collection took place the week prior to Thanksgiving, the second was taken 5-7 days after the Thanksgiving holiday, and the third data collection occurred after New Year's Day.

They measured the students' body compositions using dual-energy x-ray absorptiometry (DXA) (Hull, Hester, et al., 2006). Their results found 31 subjects had gained weight and 32 subjects had actually lost weight while the weight of 19 subjects stayed the same. On average, participants' body weights did not increase significantly from Thanksgiving ( $71.3 \pm 14$  kg) to New Year's ( $71.2 \pm 15$  kg;  $p = 0.71$ ).

Although the results of this study indicated a non-significant weight gain over the holidays, total fat mass increased over the holiday season in most of the subjects, specifically in the trunk region. Percent body fat increased from Thanksgiving to New Year's ( $25.9 \pm 9$  % fat to  $27 \pm 9$  % fat;  $p < 0.01$ ). This rise in fat mass coincided with a decrease in fat-free mass as well. Total fat mass among participants increased from Thanksgiving ( $18.3 \pm 8$  kg) to New Year's ( $19.1 \pm 8$  kg). Total fat-free mass decreased from Thanksgiving ( $47.7 \pm 12$  kg) to New Year's ( $48.3 \pm 11$  kg). The common belief that people gain a significant amount of weight over the holidays was not supported by this study even though 15% of their sample gained more than 2.0 kg of body weight.

#### Reasons for Holiday Weight Gain

Throughout the holiday season, people often become more sedentary, eat more, drink more, and exercise less (Ziebland, Robertson, Jay, & Neil, 2002). One day of over eating should not be too detrimental, but the real problem occurs when a single-day Thanksgiving binge stretches until the New Year, which is often the case (Burros, 1997). Filling up on an extra 3,500 kcals on Thanksgiving Day doesn't mean it will all go to one's hips; much of it is burned off as heat (Burros). Minimal damage to a person's weight can be done on just one day of overindulgence. Burros believes that a 3 lb weight

gain the morning after is deceptive. A gain of 3 lb could be the result of sodium and fluid retention (Light, Koepke, Obrist, & Willis, 1983).

It is not necessarily what is eaten on Thanksgiving that is the problem, rather it is a pattern of subconscious eating over the entire holiday season that is of great concern. A lot of people's holiday time is spent around food and eating. This contributes to individuals absorbing more calories than they burn through activity over the holiday season (Verplanken & Faes, 1999). The holiday season can lead to a decrease in willpower, and good intentions are often pushed aside when it comes to food (Verplanken & Faes). The holidays often put individuals in high risk situations for weight gain due to an increase in high fat, high calorie foods, an increase in stress, and a decrease in exercise (Phelan et al., 2008). An increase in energy intake during the holiday period may have been the reason for an increase in weight throughout the winter among Dutch women in a prior study (Van Staveren et al., 1986). Individuals were also more physically active in the spring and summer than in the winter.

The study found that there were small seasonal fluctuations in body weight and the time spent doing physical activity also fluctuated with seasonal change (Van Staveren et al., 1986).

Likewise, Ma et al. (2006) found that more calories from fat and saturated fat were consumed during the fall and early winter months of the year. The results of the study also showed that the amount of time spent exercising per day was less during the winter months when compared to the spring and summer months (Ma et al.).

A prior study looked at seasonal variation in food intake and physical activity and found that less fat was eaten during the summer months (37.2 % of energy) compared to

the winter months (39.4 % of energy). The participants mean body weight tended to increase in the winter and decrease in the summer (Van Staveren et al., 1986). They found that more time was spent exercising during the summer months (17 min more/day) than the winter months. There was also less sitting time in the summer (15 min less/day) than in the winter (Van Staveren et al.).

An increase in alcohol consumption can also lead to extra calories and can lower your inhibitions when it comes to food choices (D'Arrigo, 2007). There are people that think eating and drinking too much on just one day can ruin their diet, and they may as well enjoy themselves over the holidays. This can lead to excessive overeating (Montague et al., 1997). The bad part about this is if someone keeps overeating, the body can become predisposed to store those extra calories as fat (Montague et al.). Gorin, Phelan, Wing, and Hill (2004) found that individuals who dieted more strictly on weekdays but did not diet on weekends or holidays were more likely to gain weight over a year's time.

Klesges, Klem, and Bene (1989) looked at the effects of dietary restraint, obesity, and gender on holiday eating behavior. They had their participants keep a food journal the week of Thanksgiving holiday and found that dietary intake increased over the Thanksgiving holiday. Also, men generally ate more than women. The average caloric consumption on Thanksgiving Day for all of the individuals was between 2,500 kcal and 3,000 kcal (Klesges et al.). A report from the American Council of Exercise claims that Americans consume close to 3,000 kcals and 229 grams of fat during a typical Thanksgiving meal ("Hard to believe," 2006).

Winter months and cold weather may affect body weight due to many changes in food intake, mood, and physical activity. An increase in body weight over the cold weather months may also be due to colder temperatures and shorter amounts of daylight (Hull, Hester, et al., 2006). Other factors for holiday weight gain include changes in stress levels, change in activity level, and an increase in the number of parties attended (Yanovski et al., 2000). Being sedentary and dropping a normal exercise routine around the holidays can increase the odds of a person gaining weight (Craig, Bauman, Phongsavan, Stephens, & Harris, 2006). Longer eating durations, easy access to food, eating in the presence of others, and increased portion sizes all contribute to holiday weight gain (Hull, Radley, et al., 2006). The combination of abundant food, seasonal stress, and a reduction in physical activity appears to be the factors that contribute most to holiday weight gain.

Not eating anything all day until a late Thanksgiving meal can also contribute to holiday weight gain. Under eating the morning of Thanksgiving can lead an individual to compensate and eat more at Thanksgiving dinner (Burros, 1997).

#### Susceptibility to Weight Gain over the Holidays

According to US dietary guidelines, the Body Mass Index (BMI) classifies a person's weight (Fields et al., 2001). The classifications are listed in table 1.

In a study spanning the Thanksgiving holiday, Hull, Radley, et al. (2006) reported no significant increase ( $p > 0.05$ ) in body weight in people who had a normal BMI. However, overweight and obese participants had a significant increase in body weight. Their weight increased from 85.2 kg to 86.2 kg ( $p < 0.05$ ). This study concluded that

overweight and obese people are at an increased risk of greater weight gain over the Thanksgiving holiday.

Table 1

*Body Mass Index (BMI) Categories*

Category	BMI (kg/m <sup>2</sup> )
Underweight	> 18.5
Normal Weight	18.5-24.9
Overweight	25-29.9
Obese	<30

An individual who is overweight or obese could gain up to 5 lb during the holidays but the average person may gain less than a pound (Yanovski et al., 2000). The likelihood of gaining 5 lb over the holidays is relatively high if someone is already overweight (Roberts & Mayer, 2000). In a study done by Phelan et al. (2008), participants who were overweight or obese had a high risk of gaining 2.3 kg over the holiday season. They were also more likely to have greater fluctuations in their weights and less likely to recover from the holiday weight gain than normal weight individuals. An article written by Vantreese (2007) also indicated that people who were already overweight tended to gain the most weight over the holiday season.

An advanced age might also make a person more susceptible to holiday weight gain. It is often more difficult for elderly people to avoid weight gain due to bad eating habits and a lack of physical activity (Goldberg & King, 2006). As the body ages, there is potential to lose muscle mass which can make it easier to gain fat with age (Goldberg

& King). People also burn calories at a slower rate as their body ages partly due to their metabolism slowing.

### Health Risks Involved with Obesity

Approximately 66% of Americans are overweight and 32% are obese in the United States (Ogden et al., 2006). Obesity is classified as having a BMI  $\geq 30$  kg/m<sup>2</sup> and is associated with many health risks as well as chronic diseases (Fields et al., 2001). Obesity has adverse effects on a person's health and longevity (Sowers, 1995). It is responsible for approximately 300,000 deaths a year with \$70 billion in healthcare costs (Allison, Fontaine, Manson, Stevens, & Vanltallie, 1999). The rapid rise in obesity is due more to changes in our environment and society such as overeating and lack of physical activity rather than genetics or other biological causes. Some health risks linked to obesity include cardiovascular disease, hypertension, diabetes, asthma, stroke, and osteoporosis (Mokdad et al., 2003). Colon cancer, breast cancer, and cancer of the kidney have all been linked to a lack of exercise and obesity (Ziebland et al., 2002). Other risk factors among overweight adults include gallstones, certain cancers, dyslipidemia, musculoskeletal problems, and high cholesterol levels (Fields et al., 2001).

Hull, Hester, et al. (2006) also point out the health risks associated with an increase in trunk fat mass. Cardiovascular disease, type 2 diabetes, and early mortality are all risk factors associated with an excess amount of trunk fat mass. They found that "although body weight did not change, the impact of the holiday season played a crucial and deleterious effect on the shift of central body fat" (p. 48), (Hull, Hester, et al.).

Actual body weight may not have changed because many participants had a rise in fat mass but a decrease in fat-free mass.

Weight gain can also put an individual at risk for developing cardiovascular disease and type 2 diabetes (Yanovski et al., 2000). In a study that focused on the development of diabetes, the risk for diabetes was substantially increased in those individuals who had a BMI of 25 kg/m<sup>2</sup> and above (Sowers, 1995). An increase of 10 lb in men and women between the ages of 40-60 years increased their chances of developing diabetes. Decreasing physical activity with advancing age may play a role in weight gain and can also lead to the development of diabetes mellitus (Sowers, 1995).

Visser, Bouter, McQuillan, Wener, and Harris (1999) looked at low grade systemic inflammation measured with serum C-reactive protein (CRP) levels in overweight and obese participants. Human adipose tissue releases the proinflammatory cytokine interleukin 6 (IL-6) and, in healthy humans, is released into the circulation. The release of IL-6 from adipose tissue may induce low-grade systemic inflammation in people with excess body fat. CRP is a sensitive marker for systemic inflammation. A level of CRP higher than normal has been associated with an increased risk of heart attacks, ischemic stroke, peripheral arterial disease, and coronary heart disease.

Obese men and women were two and three times more likely to have elevated CRP levels compared to people of normal weight (Visser et al., 1999), putting them at risk for the diseases stated above. Women who are overweight are also much more susceptible to developing gallstones than their leaner peers, and men are more susceptible to heart disease and high cholesterol levels (Fields et al., 2001). The risk of developing diabetes, gallstones, hypertension, colon cancer, heart disease, and stroke increase as a

person's BMI increases. Men and women with a BMI between 22 kg/m<sup>2</sup> and 25 kg/m<sup>2</sup> are at a greater risk than people with a BMI less than 22 kg/m<sup>2</sup> to develop at least one of these diseases (Fields et al.).

### The Bod Pod<sup>®</sup> for Assessing Changes in Body Composition

There are many different ways to measure body composition with some being more accurate than others. A commonly used laboratory method to estimate fat and fat-free mass is air displacement plethysmography (ADP). This method uses the same principle of densitometry as the classic “gold standard” method of hydrostatic weighing (Ball, 2005). The ADP device used in this study is called the Bod Pod<sup>®</sup>. Air displacement is used to determine body volume and subsequently body density, after which fat mass and fat-free mass can be estimated (Nies, Chen, & Vander Wal, 2004).

The Bod Pod<sup>®</sup> has a unique egg shape and it provides a quick, simple, noninvasive measurement of body composition, which benefits both the researcher and the participant (Dempster & Aitkens, 1995). Figures 1a and 1b show the Bod Pod<sup>®</sup>.



*Figure 1a.* The Bod Pod<sup>®</sup>

From “[www.googleimages.com](http://www.googleimages.com)”, 2008.



*Figure 1b.* The Bod Pod<sup>®</sup>

From “[www.googleimages.com](http://www.googleimages.com)”, 2008.

The Bod Pod<sup>®</sup> is accurate and is more convenient than hydrostatic weighing. The average reported standard error for the Bod Pod<sup>®</sup> is between 1.8-3.0% BF (Ball, 2005). In a study done by Anderson (2007), reliability of the Bod Pod<sup>®</sup> was found to be high over a 3-day period  $r = 0.98$  ( $p < 0.01$ ). The Bod Pod<sup>®</sup> is also a fast test to perform taking about 5 min to complete (Anderson). According to a study in *Medicine and Science in Sports and Exercise*, the Bod Pod<sup>®</sup> was reliable in assessing body fat percentage ( $p < 0.05$ ) and required minimal technical expertise (Collins et al., 1999). Kilduff, Lewis, Kingsley, Owen, and Dietzig (2007) conducted a study on the reliability of five different body composition methods including ADP. They found there was an excellent test-retest correlation among all five methods ( $p < 0.001$ ).

Ballard, Fafara, and Vukovich (2004) did a study comparing the Bod Pod<sup>®</sup> to DXA in Division II female collegiate athletes. The purpose of this study was to evaluate the reliability and validity of ADP to DXA. Their results showed no difference between the two measurements (ADP =  $22.5 \pm 5.5\%$ ; DXA =  $22.0 \pm 4.7\%$ ,  $p = 0.10$ ). The results also determined that ADP was a reliable measure of body fat ( $r = 0.96$ ,  $p < 0.001$ ). Because ADP has such a high reliability it would be a good measure to track change in body composition (Ballard et al.).

The validity of ADP was tested in a study that compared different methods for measuring body composition change to DXA. This study tested children between the ages of nine and thirteen (Elberg et al., 2004). All of the methods they compared were highly correlated with DXA ( $p < 0.001$ ). Air displacement plethysmography performed better than the other two methods that were compared. Elberg et al. suggested that ADP could be useful for measuring change in body composition.

Another study comparing the Bod Pod<sup>®</sup> to underwater weighing found a 1% fat difference between the two, which was not significant ( $p > 0.01$ ). The study showed a high level of agreement between the Bod Pod<sup>®</sup> and underwater weighing (Fields, Hunter, & Goran, 2000). Mahon et al. (2007) compared the measurements of ADP, hydrostatic weighing, DXA, and deuterium oxide dilution in a study. An ANOVA was used to assess differences in mean composition. They found no differences among the four methods.

The intra-class correlation coefficients for the test-retest and next-day reliability of the Bod Pod<sup>®</sup> used in the present study were 0.99 and 0.98, respectively. There were 10 college students from Utah State University tested over a 2-day period. The individuals were tested two consecutive times on one day, and then returned for another test the following day. The mean differences in %BF between test-retest and next-day measurements were not significant ( $p > 0.05$ ). These are indicators that the Bod Pod<sup>®</sup> used in the present study was reliable. However, the *SDs* of the test-retest (1.4% BF) and next-day (1.8% BF) measurements were substantially greater than the test-retest reliability *SD* of 0.4% BF reported by McCrory, Molé, Gomez, Dewey, & Bernauer (1998). This suggests that the variability of the Bod Pod<sup>®</sup> used in the present study may be greater than previously thought. If this is the case, the precision of the Bod Pod<sup>®</sup> is placed into question limiting the ability to detect small but significant changes in %BF.

### Prevention of Weight Gain over the Holiday Season

The holiday season can be a tough time to avoid gaining weight but it is not impossible. Planning out an exercise regimen and a healthy eating schedule can help

keep excess pounds off. People need to take time to stop and think about what and how much they are eating. The holiday season does not need to be an excuse to eat everything in sight.

A recent article gives a few suggestions for keeping holiday pounds off. D'Arrigo (2007) has suggested not skipping meals and not depriving oneself. Skipping meals can lead to an individual feeling famished by the end of the day, leading to overeating and bad food choices. Using a small plate reduces caloric intake due to smaller portions. Keeping food servings in mind at holiday parties can help with portion control (D'Arrigo). Eating at a slower pace can help an individual's brain catch up with what she is putting in her mouth. Another method for weight gain prevention is talking to others at the table and taking conscious breaks from eating (Cooney, 2006). Cutting calories during the holidays can also help keep weight in check. A study on promoting long-term weight control found that participants who kept to a regular diet regimen throughout the week and year were more likely to maintain their weight around the holidays better than those who dieted strictly on the weekdays but not during the holiday season (Gorin et al., 2004). There are also sources online that can help an individual maintain a healthy weight during the holidays. Web-chat and e-mail newsletters can help from Thanksgiving to New Year's (Squires, 2007).

A scientific study that involved behavioral intervention such as phone calls and daily mailings to help individuals control their weight over the holiday season found that the intervention group was able to self monitor more consistently than the control group. They were also able to manage their weight during the holidays while the control group gained weight over the holidays (Boutelle, Kirschenbaum, Baker, & Mitchell, 1999).

One other action that a person can take to prevent weight gain over the holidays is to exercise. Changes in physical activity are important for weight management as well as staying healthy. Exercise increases the mitochondrial content and respiratory capacity of muscle fibers. This adaptation to endurance exercise allows muscles to utilize muscle glycogen and blood glucose at a slower rate. It also causes a greater reliance on fat oxidation and less lactate production during exercise of a given intensity. These adaptations can play a big role in the large increase in the ability to exercise for longer periods of time (Holloszy, 1982).

Physical activity is very important for keeping healthy. Being physically active does not need to be strenuous in order to achieve healthy benefits. Performing simple activities such as walking, gardening, shoveling snow, or just taking the stairs rather than the elevator can be beneficial to an individual's health.

The American College of Sports Medicine has recently updated the physical activity guidelines for weight loss and weight management. They recommend getting physical activity of moderate intensity for 150-250 min/wk with an energy equivalent of 1200-2000 kcals/wk. This amount of exercise seems adequate to prevent weight gain greater than 3% in most adults and it may result in weight loss (Donnelly et al., 2009). Increased exercise duration over the holidays can reduce the risk of weight gain over the holiday season (Klesges et al., 1989).

### Summary

This chapter reviewed literature on holiday weight gain, reasons for holiday weight gain, susceptibility to weight gain, health risks, prevention of weight gain, the

Bod Pod<sup>®</sup>. Different methods were used in studies done by other researchers such as skinfold measurements, DXA, and hydrostatic weighing. Many researchers found that the average amount of weight gain over the holidays is 1-2 lb. Reasons for holiday weight gain included splurging on high fat foods, overeating, attending social gatherings, and decreasing physical activity. The research discussed in this literature review found that participants with a BMI  $\geq 25$  were more likely to gain weight over the holidays than those individuals of normal weight.

There are many health risks involved with weight gain such as type 2 diabetes, obesity, gallstones, cardiovascular disease, hypertension, and heart attack. Prevention of weight gain is important to reduce the risk of the health problems above. This can be done by exercising regularly over the holiday, sticking to meal plans, making wise food choices, and getting support from the internet groups.

The Bod Pod<sup>®</sup> uses air displacement plethysmography to determine %BF of individuals. The validity and reliability of the Bod Pod<sup>®</sup> has been compared to hydrostatic weighing. It is less invasive and easier to use for both the researcher and the participant.

## CHAPTER III

### METHODOLOGY

#### Chapter Overview

The purpose of this study was to determine if there was a significant change in weight and body composition over the holiday season. This chapter provides an overview of the methodology and statistical analyses that were followed for conducting the study. These procedures were followed closely. This chapter includes: (a) research design, (b) study sample, (c) research instruments, (d) the procedures of the study, and (e) statistical analyses.

#### Research Design

This study was a longitudinal, within-subjects research design in which the subjects were tested twice over a 6-week period. All of the testing took place in the Health, Physical Education and Recreation (HPER) Exercise Physiology Laboratory. Height was measured during the first test session and weight was measured during both test sessions for subsequent calculation of BMI. Waist circumference was also measured during both sessions, as well as a Bod Pod<sup>®</sup> estimate of body composition and a nutrition and exercise assessment. The first test of the participants took place on the Monday or Tuesday before the Thanksgiving holiday (November 24-25); the second test was conducted on the Monday or Tuesday following New Year's Day (January 5-6).

## Study Sample

The participants for the study included 37 adults who were living in the Cache Valley area, 15 males and 22 females, ranging in age from 23-61 years. There were no university students involved in this study. Flyers were placed around the USU campus and the Cache Valley area to recruit faculty and staff members of all departments as well as people living in Cache Valley who were not affiliated with USU (Appendix A). An e-mail explaining the study was also written and sent out to all USU faculty and staff (Appendix B). The total number of USU faculty who participated in the study was 13 and the other 24 participants were members of the community. Each individual participating in the study signed a written informed consent that was approved by the Institutional Review Board (IRB) (Appendix C).

## Instrumentation

All of the instruments used in this study were located in the USU HPER Exercise Physiology laboratory. Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer (Seca 216, Seca Corp., Ontario, CA). Weight was measured to the nearest 0.001 kg and body composition was estimated to the nearest 0.1% body fat with the Bod Pod<sup>®</sup> ADP system (Life Measurement, Inc., Concord, CA). The Bod Pod<sup>®</sup> was calibrated according to the manufacturer's guidelines before each testing session. Waist circumference was measured to the nearest 0.1 cm with a flexible anthropometric tape measure with a spring-loaded handle (Gulick, Country Technology, Inc., Gays Mills, WI).

The Bod Pod<sup>®</sup> used ADP to determine the inverse relationship between pressure and volume (Boyle's law) to measure body volume (BV) directly (McCrorry et al., 1998). This BV measurement along with the body mass (BM) measurement (obtained from the Bod Pod<sup>®</sup> scale) was used to determine body density (Db) ( $Db = BM/BV$ ). Body density was converted to body fat percentage (%BF) with the Siri formula (Siri, 1961) for the subsequent determination of the subject's fat mass and fat-free mass.

Although the validity of the Body Pod<sup>®</sup> used in this current study was greater than previous studies, The Bod Pod<sup>®</sup> has good reliability and the validity is comparable to hydrostatic weighing (Anderson, 2007). It is also adaptable to different body types and is easy to use for the researcher and the participants.

The participant also filled out a pre-test (Appendix D) and post-test (Appendix E) nutrition and exercise questionnaire at the beginning of each session.

### Study Procedures

Participants were tested twice; the initial baseline test was on either the Monday or Tuesday before the Thanksgiving holiday and the second test occurred on the Monday or Tuesday following New Year's Day.

The participants were asked to void their bowels and bladders upon entering the lab before any measurements were made. This helped to standardize the procedures and ensure that the following measurements were performed under the same conditions for each testing session. The subject's height was measured to the nearest 0.1 cm while standing erect with the arms at the sides. The study participants were not wearing shoes and were dressed only in the swimsuit or compression shorts that were worn in the Bod

Pod<sup>®</sup> for this height measurement. Waist circumference was measured to the nearest 0.1 cm at the visibly narrowest part of the torso between the last rib and the iliac crest.

Weight was measured to the nearest 0.001 kg on the Bod Pod<sup>®</sup> scale as part of the body composition test. BMI was calculated from the height and weight data (Appendix F).

The subjects were required to wear tight, spandex lycra clothing (swimsuit or compression shorts) along with a swim cap when tested. Subjects wore the same clothing each time they were tested. These requirements contributed to the accuracy of the test. Each test in the Bod Pod<sup>®</sup> took approximately 5-8 min to complete. Thoracic gas volume was predicted rather than measured, and the same value was used for both the baseline and end-of-study tests. The same researcher conducted the Bod Pod<sup>®</sup> test for each subject. The tests required only that the participants sat still and breathed normally for two or three 20-s periods while the Bod Pod<sup>®</sup> door was closed.

A nutrition and exercise questionnaire was filled out at the beginning of each test session and the answers were used to determine a change in eating and exercise habits from pre-test date to post-test date. This process took no longer than 10 min to complete. Instructions on how to properly fill out the survey were explained to the participants.

The entire evaluation process including height, weight, and waist circumference measurements, the nutrition and exercise assessment survey, and the Bod Pod<sup>®</sup> test took no more than 20 min per session to complete for each subject.

### Statistical Analyses

A power analysis was conducted to determine the number of participants necessary to achieve statistical significance at varying degrees of statistical power. This

study needed 16 participants in order to obtain a power of 0.80. There were 34 participants who completed the study. The actual mean  $\pm$  SD for weight change in the present study ( $0.04 \pm 1.48$  kg) was less than expected; therefore, the post-hoc power analysis revealed that 10,747 participants would have been needed to obtain statistical significance ( $p < 0.05$ ) with this small mean difference. Assuming the observed SD (1.48 kg) and 80% power, the mean difference in body weight would have needed to exceed about 0.7 kg in order to reach statistical significance at an alpha level of 0.05.

A paired  $t$  test was run for each variable of interest to determine if there was a significant mean difference between the two testing sessions for weight, BMI, waist circumference, and %BF. If a significant difference existed, the percent change between trials was calculated to determine the magnitude of change. Paired  $t$  tests were also used to identify significant pre- to post-changes in the nutrition and exercise questions. Independent  $t$  tests were used to identify significant change differences between normal weight and overweight participants as well as between men and women. Pearson product-moment correlations were used to determine if any of the nutrition or exercise questions were related to the changes in weight, BMI, waist circumference, or %BF.

Statistical analyses were conducted using the Statistical Packages for Social Sciences (SPSS, version 17.0) software. The alpha level for statistical significance was set at  $p < 0.05$  for all analyses.

## CHAPTER IV

### RESULTS

#### Chapter Overview

To determine whether individuals gained weight over the 6-week holidays a longitudinal study was conducted between the weeks of Thanksgiving to New Year's Day. Baseline data were from 37 adults between the ages of 23-61 years living in the Cache Valley area who were not university students. Three participants failed to return for the follow-up testing. Two of the participants could not return to the follow-up testing due to work schedules and the third participant was unable to return due to being ill. Thus, 34 people (13 men & 21 women) finished the entire 6-week study for a 92% completion rate.

There were four different variables of interest selected based on an analysis of the literature. Baseline and post-holiday comparisons were made for weight, BMI, waist circumference, and %BF. Answers on a pre-holiday nutrition and exercise questionnaire were also compared to answers on a post-holiday questionnaire. Data collection during the study was used to address five research questions.

#### Research Questions

*Research Question One: Did weight, BMI, waist circumference, and %BF change during the 6-week holiday season?*

The research hypothesis was that body mass and %BF would increase with corresponding increases in BMI and waist circumference over the 6-week period.

Waist circumference increased by about 1 cm, but there were no significant differences between pre- and post-holiday measurements for the other variables (Table 2). Despite no mean difference in weight and %BF, some individuals did have big changes (Figures 2 & 3).

Table 2

*Weight Change and Fat Mass Change Over a 6-Week Holiday Period*

Category	Pre-holidays	Post-holidays	<i>p</i> -values
Weight (kg)	74.0 ± 17.8	73.9 ± 18.1	0.876
BMI (kg/m <sup>2</sup> )	25.3 ± 5.3	25.3 ± 5.4	0.857
Waist (cm)	81.9 ± 12.6	82.9 ± 12.5	0.013*
%BF (%)	25.4 ± 9.0	25.4 ± 8.9	0.974

\* Significant at the  $p < 0.05$  level.

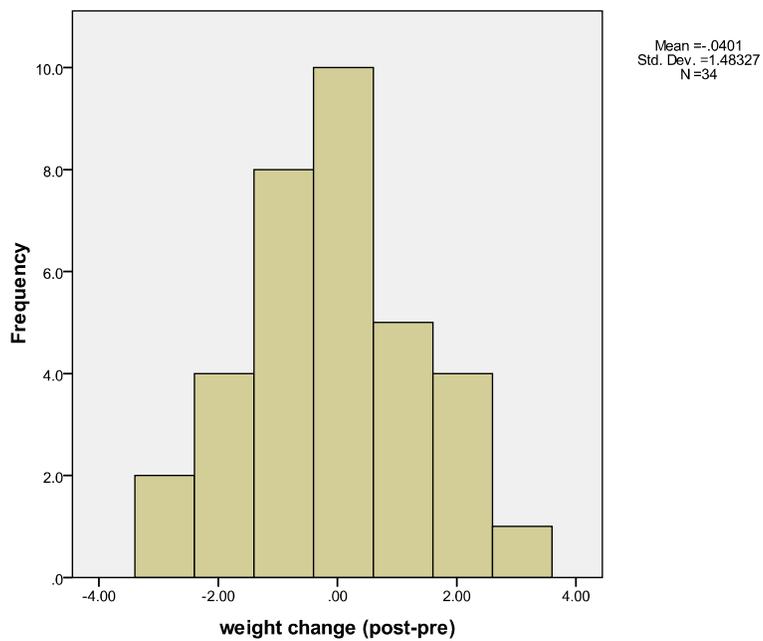


Figure 2. Histogram of weight change.

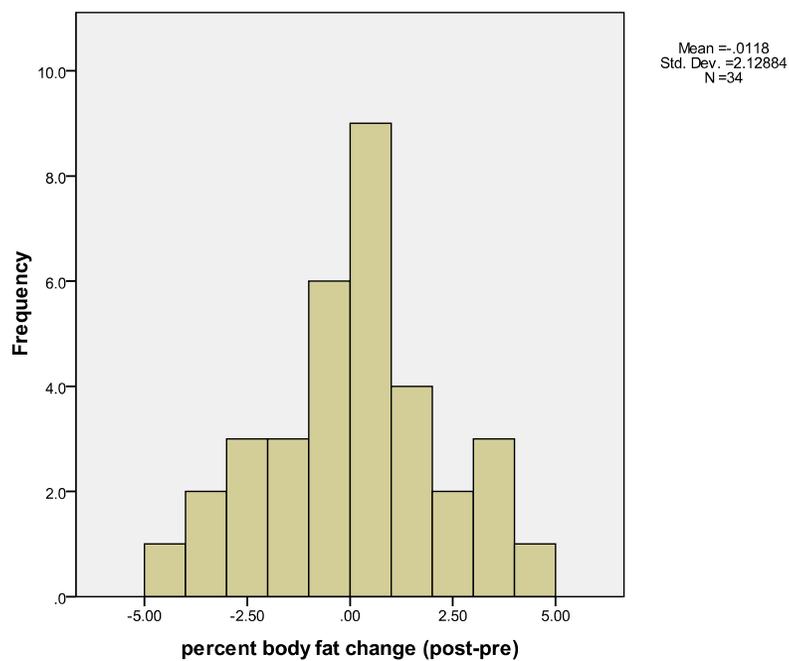


Figure 3. Histogram of % BF change.

*Research Question Two: Did people's eating and drinking habits change over the holidays?*

There were significant changes in several eating habits over the 6-week holidays. Significant changes to the nutrition questionnaire are presented in Table 3.

Table 3

*Changes in Eating Habits over the Holidays*

Category	Pre-holidays	Post-holidays	<i>p</i> -values
Vegetable Intake (cups/week)	8.6 ± 8.3	6.2 ± 4.0	0.034*
Splurging (days/week)	1.6 ± 1.9	2.5 ± 2.1	0.019*
Regular Soda (cans/week)	1.5 ± 2.2	2.2 ± 2.6	0.028*
Social Gatherings (days/week)	1.6 ± 1.5	2.2 ± 1.7	0.044*

\* Significant at the  $p < 0.05$  level

*Research Question Three: Did the exercise regimens change during the weeks of Thanksgiving to New Year's Day?*

The expectation of the third research hypothesis was that participants would exercise less over the 6-week holiday season. There was a reduction ( $p < 0.001$ ) in the self-reported number of days per week that participants exercised from  $3.7 \pm 2.0$  days/week at baseline to  $2.6 \pm 2.3$  days/week at the end of the holiday period.

*Research Question Four: Was holiday weight gain related to a person's body mass index (BMI)?*

The researcher expected to find that participants with a BMI  $\geq 25$  kg/m<sup>2</sup> would gain more weight than those who started the study with a normal BMI. However, there were no significant differences between normal and overweight participants for weight change ( $p = 0.25$ ), BMI change ( $p = 0.22$ ), waist circumference change ( $p = 0.67$ ), and %BF change ( $p = .75$ ). The change in BMI over the 6-week holiday season is shown in Figure 3.

*Research Question Five: Was there a difference in weight change and %BF change between men and women during the holiday period?*

The expectation for the final research question was that men would experience a greater weight change and %BF change compared to women during the 6-week holiday period. The independent  $t$ -tests revealed no significant differences between men and women for weight change ( $p = 0.95$ ), BMI change ( $p = 0.98$ ), waist circumference change ( $p = 0.51$ ), and %BF change ( $p = 0.38$ ).

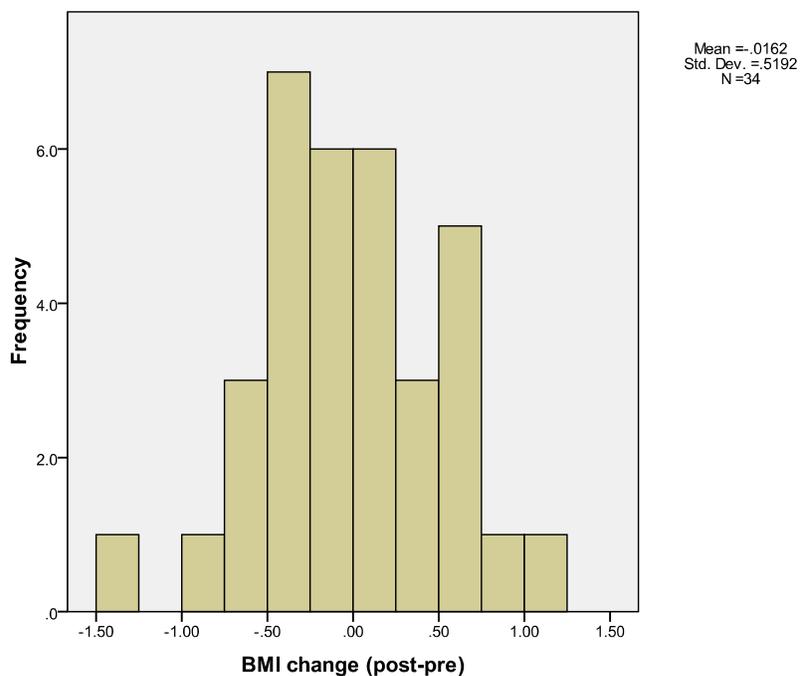


Figure 3. Histogram of BMI change.

Weight changes were correlated with changes in BMI ( $r = 0.99, p < 0.001$ ), changes in %BF ( $r = 0.58, p < 0.001$ ), and changes in waist circumference ( $r = 0.43, p = 0.012$ ). Pearson product-moment correlations showed a positive correlation between the number of days that the participants self-reported overeating and weight change ( $r = 0.48, p = 0.004$ ) and BMI change ( $r = 0.50, p = 0.003$ ).

### Summary

Chapter IV discussed the statistical results that were found for each of the five research hypotheses. Overall, despite a few changes in eating and exercise habits, there were no significant changes in body mass nor body composition over the 6-week holiday

period. Furthermore, participants' weight and body composition changes were not influenced by BMI or gender.

## CHAPTER V

### DISCUSSION

#### Chapter Overview

This chapter discusses the findings of the current study along with how they relate to previous research performed on weight gain over the holidays. This chapter also discusses the reasons for weight change and %BF change over the holidays. The limitations to this study along with recommendations for further research are also discussed in this chapter.

#### Summary of Findings

Different researchers have studied weight change over the holiday season prior to this current study, and there are also many articles written in popular magazines on this subject. The significance of this current study was to determine the amount of weight and body composition changes over the holiday season and if the changes were significant. The results of prior research are varied regarding the amount of weight gained over the holidays. Many popular magazines such as *Shape* as well as newspaper articles report that the average person can gain up to seven pounds over the holidays (Somer, 1997; Vantreese, 2007). Research studies however, report that the average holiday weight gain is 1-2 lbs (Hull, Hester, et al., 2006; Yanovski et al., 2000). The significance of this current study was to determine if people gained weight and fat mass over the 6-week holiday season.

Table 4

*Research Questions, Study Results, and Supporting Research*

Research Question	Study Results	Supporting Research
1. Did people gain fat mass and weight during the 6-week holiday season?	There was a risk of people gaining weight and fat mass over the holidays but not every participant gained weight and fat mass. Some subjects lost weight over the 6-week period. The amount that participants gained was not found to be significant.	Hull, Hester, et al. (2006); Phelan et al. (2008)
2. Did people's eating habits change over the holidays?	Eating habits did change over the holidays but the results were not statistically significant. More social gatherings were attended as well as more alcohol consumed, on average, over the 6-weeks.	D'Arrigo (2007); Gorin et al. (2004); Phelan et al. (2008)

Research Question	Study Results	Supporting Research
3. Did a person's exercise regimen change between the weeks of Thanksgiving to New Year's Day?	Participants exercised less over the 6-week holiday period. There was a significant difference in the number of days people exercised before and during the holidays.	Craig et al. (2006); Van Staveren et al. (1986)
4. Was holiday weight gain related to a person's body mass index (BMI)?	People with a BMI $\geq 25$ kg/m <sup>2</sup> were not more likely to gain weight over the holidays than those of normal BMI.	Field et al. (2001); Hull, Radley, et al. (2006); Yanovski et al. (2000)
5. Was there a difference in weight change and fat mass change between men and women during the holiday period?	There was no significant difference in weight change or fat change between men and women over the holidays.	Hull, Radley, et al. (2006); Ziebland et al. (2002)

## Discussion

### *Research Question One*

The first research question asked if participants gained weight and %BF over the 6-week holiday season. This was determined by using the ADP method (Bod Pod<sup>®</sup>) to measure body mass and %BF. On average, the weight and %BF changes from the beginning of the holiday period to the end were not statistically significant; weight (-0.04 kg change) and %BF (0.0% BF change) remained stable. However, nine participants (26% of sample) gained more than 1 kg during this 6-week period with 12% of the sample gaining more than 2 kg. Similarly, Hull, Hester, et al. (2006) reported that 15% of their college-aged sample gained 2 kg or more over the Thanksgiving to New Year's Day period despite no change for the entire sample. Of the participants who gained weight in the current study ( $n = 16$ ), the average amount gained was 1.22 kg with a corresponding increase of 1.3% BF.

Although the weight for most participants in the current study remained stable, any amount of weight gained during the holidays could alter a person's health over time. Phelan et al. (2008) found that people have a hard time losing weight that they may have gained over the holidays even if the amount was minimal. The weight often stays on and can lead to health related problems such as high blood pressure and type 2 diabetes. Prior research concluded that the weight gained over the holidays was retained and the time period between Thanksgiving and New Year's Day was a critical period for weight gain and obesity (Yankovski et al., 2000).

Similar to the present study, the average weight of college students enrolled at the University of Oklahoma remained stable over the holidays. However, despite no change in weight, they reported an increase in trunk fat mass (Hull, Hester, et al., 2006). Those who gained weight in the present study also had an increase in waist circumference ( $84.0 \pm 13.0$  cm to  $85.9 \pm 13.2$  cm,  $p < 0.001$ ).

Participants in a study done by Yanovski et al. (2000) thought they had gained as much as four times the amount of weight than they had actually gained. There were a variety of reasons people stated for assuming they had gained weight. Many participants thought they had increased their weight due to lack of exercise and eating unhealthy holiday foods. Others stated that emotional stress caused them to believe they had gained weight. Two people reported that they felt their clothing fit tighter and felt more uncomfortable. Like the Yanovski study, participants in the current study assumed they had gained much more weight than they actually had. Most of the participants (71%) assumed they had gained weight over the holidays. The average perceived weight gain for the sample was 1.42 kg even though the actual weight change was -0.04 kg.

Although participants did not gain a significant amount of weight over the 6-week period, 71% of the individuals in this current study perceived they had gained between 2-15 lbs. This may be a reason why popular magazines and newspaper often speculate that the average person gains between 7-10 lb over the holidays.

### *Research Question Two*

The second research question asked if people's eating habits changed during the holiday season. The answers on the questionnaires were evaluated using a paired *t*-test

for each question and there were a few significant changes. Although nutrition choices changed for most of the subjects over the 6-week holiday period, the weight of the participants was not affected.

Phelan et al. (2008) found that the holidays can cause people to increase their consumption of alcohol. Those who drank regular soda consumed more cans than usual and participants tended to splurge more often on foods they would not normally eat over the holidays.

Social gatherings were also attended more often between Thanksgiving and New Year's Day than normal. Longer eating durations and eating around others at social gatherings may influence a person's weight over the holidays (Hull, Radley, et al., 2006). More time is spent around food and eating over the holidays. This can decrease people's will power to keep to a diet or choose healthy food choices (Verplanken & Faes, 1999). Many of the food choices at social gatherings are not healthy and are high in fat and high in calories. It is quite common to eat and drink more than usual at social gatherings around the holidays (Ziebland et al., 2002). Participants in this current study stated in the questionnaire that they ate too much over the holidays and that they ate more unhealthy food than usual.

A study on the effects of holiday eating behavior and weight gain tested 65 college students who were recruited from introductory psychology classes. The subjects were instructed to record everything they ate and drank over the holidays in a food journal. The results showed that the mean intake of caloric consumption over Thanksgiving weekend increase (2,440 kcal) when compared to the caloric consumption two days prior to Thanksgiving (2,159 kcal) (Klesges et al., 1989).

A prior study tested 140 young adult Dutch women on their diet and exercise by holding interviews done by dietitians throughout the testing period (Van Staveren et al., 1986). Their results showed that there was a seasonal effect on the amount of fat consumed. The participants consumed less fat during the summer months (37.2 % of energy) than they did during the winter months (39.4 % of energy). Brown, Black, and Backer (1982) found that seasonal change is one of the most important reasons for various food intake and changes in body weight. Van Staveren et al. (1986) also found that there was a higher intake of vegetables in the summer (25 g) than in the winter (12 g). This study also showed that total energy intake was not affected by seasonal variation.

### *Research Question Three*

The third research question asked if individuals' exercise regimen changed during the weeks of Thanksgiving to New Year's Day. The results of the current study were found by comparing subjects' answers on the questionnaire using a paired *t*-test. The findings were significant at the alpha level 0.01.

Overall, participants exercised less throughout the 6-week holidays. Getting ready for the holidays can take up a lot of time and can alter a person's exercise regimen. The holidays are also a time to relax and enjoy oneself for many people. Exercise often gets pushed to the back of the priority list. The holidays can cause a change in activity level due to cold weather and stressful schedules (Craig et al., 2006). Another study conducted by Yankovski et al. (2000) found that people decreased exercise activity throughout the holidays. Van Staveren et al. (1986) suggested that there were small

seasonal differences in the amount of physical activity in a study conducted on Dutch women. Individuals seemed to participate in physical activity less during the winter months and more in the summer months of the year. Ma et al. (2006) also reported that seasonal variation impacts recreational physical activity with less exercise in the winter than in the spring and summer.

The questionnaire in this study showed that the subjects exercised less over the 6-week period and they reported feeling like they had gained weight because of a lack of exercise. Many participants stated that they thought they had gained between 2-5 lb because of a lack of exercise between Thanksgiving and New Year's Day.

#### *Research Question Four*

The fourth research question asked if weight change was related to BMI. An independent *t*-test was conducted to determine if participants with a BMI  $\geq 25$  kg/m<sup>2</sup> gained more weight than those participants with a BMI  $< 25$  kg/m<sup>2</sup>. The results were not significant at the alpha level 0.05.

The classification for underweight, normal weight, overweight, and obese has been set by US dietary guidelines. These are shown in Table 1 in Chapter 2. A few studies have found that overweight and obese people tend to gain more weight than normal weight people over the holidays. Prior research suggests that individuals who are overweight or obese are likely to gain up to 5 lb while normal weight people will likely gain only 1 lb over the holidays (Yanovski et al., 2000). Hull, Radley, et al. (2006) found that people in the normal weight range did not gain weight over the Thanksgiving holiday, but those who were classified as overweight and obese gained weight over

Thanksgiving. Despite a tendency for participants with BMIs  $< 25 \text{ kg/m}^2$  to lose weight (-0.27 kg) and overweight participants to gain weight (0.34 kg), there was not a significant difference in weight change between these two groups in the present study.

Andersson and Rossner (1992) tested both obese and normal weight individuals during the holidays. Their study found that body weight increased among obese participants ( $0.6 \pm 2.4 \text{ kg}$ ), but it was not considered to be significant. The normal weight group had less of a weight increase, but the increase was statistically significant ( $0.4 \pm 0.8 \text{ kg}$ ,  $p < 0.001$ ).

Phelan et al. (2008) showed that the risk of gaining weight over the holidays was lowest in normal weight individuals, moderate in overweight individuals and greatest in obese individuals. Their study found that those individuals who had been successful at losing weight prior to the study had made more controlled behaviors to manage their weight over the holidays. They had made pre-holiday plans to control their eating and they had planned on exercising throughout the holidays as well. It was important to the successful weight loss group to work hard and manage their weight during the holiday season (Phelan et al.).

Another study tested body composition and body weight in 100 college students at the University of Oklahoma during the holiday season (Hull, Hester, et al., 2006). They divided the subjects into two groups, one being normal weight individuals ( $\text{BMI} \leq 24.9 \text{ kg/m}^2$ ) and the other being overweight/obese individuals ( $\text{BMI} \geq 25 \text{ kg/m}^2$ ). Their results found that the normal weight group had 9 individuals who lost a significant amount of body weight over the holidays ( $P < 0.05$ ) and the overweight group had 8 subjects who gained more than 2.0 kg of body weight but this was not significant ( $P =$

0.14). Both the overweight/obese and the normal weight group gained a significant amount of body fat between Thanksgiving and New Year's Day ( $p < 0.05$ ).

#### *Research Question Five*

The fifth research question examined the difference in weight change and %BF change between men and women during the holiday period. There were a total of 13 males and 21 females that completed the study. The sexes were compared using an independent  $t$ -test. The differences between men and women were not significant at the alpha level of 0.05.

Other research has shown that men had a tendency to eat more ( $M = 2634.61$  kcal,  $SD = 713.89$ ) than women ( $M = 1923.10$  kcal,  $SD = 568.87$ ) over the holidays (Klesges et al., 1989). A prior study also found an increase in body weight between pre and post Thanksgiving holiday in males (0.6 kg) and females (0.4 kg) to be different (Hull, Radley, et al., 2006).

Men gained more weight than women in their study, but they did not report the difference to be statistically significant. Similarly, another study by this research team concluded that there was no statistically significant difference in weight change and body composition change between men and women over the holidays (Hull, Hester, et al., 2006).

Andersson and Rossner (1992) conducted a study on obese patients at an obesity unit. They were weighed before and after Christmas. The results were compared to a normal weight group. They reported that the increase in body weight was more

pronounced for men than for women ( $p < 0.001$ ) in both the obese patients and the control group.

### Study Limitations

Some limitations should be noted in the current study that should be addressed to assist in further research. First, the participants knew the purpose of the study and that they were going to have their body composition evaluated before and after the holidays. This could have altered the participants' eating and exercise behavior during the duration of the study.

Another limitation of the study was relying on the honest and non-biased answers from the participants on the nutrition and exercise questionnaires. One exercise question asked how many days per week a subject exercised, but intensity and duration were not taken into account.

The third limitation could include the sample of participants that were included in the current study. Thirteen subjects were well education university professors or university employees. The other 24 participants were members of the community. Sixty-six percent of Americans are overweight (Ogden et al., 2006); however, only 12 participants (35% of this study sample) had a BMI  $\geq 25$  kg/m<sup>2</sup>, the criterion for overweight. There was also a limited amount of subjects who consumed alcohol over the holidays. Our study contained only 19% of individuals who drank alcohol. The national average of people who drink alcohol is 71% (Hamrick, 2006).

### Recommendations and Changes for Future Research

Although the current study was conducted with few limitations, some recommendations for further research on weight change and fat mass change over the holidays should be considered. The first recommendation would be to blind the subjects in some manner so that they are not aware that their weight and fat mass are being measured. Another recommendation is to draw a sample from a larger geographical area that includes people from a broad variety of occupations and lifestyles. Finally, a more in depth questionnaire on exercise with questions about the duration and intensity of exercise is recommended. Additional research that includes these recommendations would provide more conclusive data to answer the questions posed in this study.

### Prevention

While few variables proved to be significant in the present study, past research has found that weight increases and/or fat mass increases between Thanksgiving and New Year's Day (Hull, Hester, et al., 2006; Hull, Radley, et al., 2006; Phelan et al., 2008; Yanovski et al., 2000; Reid & Hackett, 1999). Therefore, prevention is important to assist those that may be at risk of weight gain and fat mass gain over the holidays. Those that have been found to be most at risk for weight gain over the holidays are individuals with a BMI  $\geq 25$  kg/m<sup>2</sup>. Many different diseases are associated with rapid weight gain such as high blood pressure, coronary heart disease, type 2 diabetes, hypertension, obesity, and osteoporosis (Mokdad et al., 2003).

There are things that individuals can do to help try and keep the pounds off during the holidays. D'Arrigo (2007) suggested eating food in smaller portions and eating at a slow pace. Making wise food choices is also important during the holiday because high caloric, high fat foods are easily accessible. Incorporating exercise into your daily routine is also important in keeping excess pounds off (D'Arrigo).

Self monitoring one's behavior can help fight off unwanted pounds. A study conducted on 57 participants tested a cognitive-behavioral treatment program over Christmas and New Year's Day. The self-monitoring intervention group was given phone calls and daily mailings that focused on self monitoring (Boutelle et al., 1999). This group was more consistent with self-monitoring and managed their weight better than the control group.

Other recommendations for keeping weight off over the holidays include getting involved in web chats, weekly newspaper columns, and e-mail newsletters for moral support and ideas for maintaining weight (Squires, 2007).

### Conclusion

This study hypothesized that participants would have an increase in weight and an increase in fat mass over the 6-week holiday period. The results of the study did not support this research hypothesis. Some eating habits changed over the holidays but the changes did not significantly affect the weight or body composition of the individuals. The amount of exercise self-reported by the participants decreased between the weeks of Thanksgiving to New Year's Day, but this also did not have a significant effect on weight change and fat mass change. Also, BMI did not affect weight change, and there was no

significant difference found in weight change and fat mass change between men and women in our study.

It appears that the commonly held belief that a lot of weight is gained over the holidays is an exaggeration. However, sample-selection bias may have been a factor; thus, the results are specific to this sample and should not be generalized.

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APPENDICES

## Appendix A. Advertisement of the Study

# BODY COMPOSITION TESTING



**Free Bod Pod  
Testing in the  
HPER!**

**Get your body fat  
percentage tested using the  
Bod Pod. Offer available to**

- \* Must be between the ages of 25-65 years to participate.**
- \* Must be able to attend two test dates over the holiday season.**
  - **November 24<sup>th</sup> or 25<sup>th</sup>**
  - **January 5<sup>th</sup> or 6<sup>th</sup>**
- \* Must be willing to be tested in the Bod Pod.**
- \* Must be willing to fill out a nutrition and exercise assessment survey.**
- \* For more information please contact:**

**Jessyka Larson**  
e-mail: [jess.larson@aggiemail.usu.edu](mailto:jess.larson@aggiemail.usu.edu)

## Appendix B. E-mail Describing the Study

Dear USU Faculty and Staff members;

My name is Jessyka Larson and I am a graduate student at USU. I am conducting a study to evaluate body composition and weight change over the holidays for my thesis. I am currently looking for faculty and staff members who are interested in participating in this study.

Body composition will be evaluated using the Bod Pod in the HPER Department.

The Bod Pod is an egg shaped chamber that uses air displacement plethysmography to estimate fat mass and fat-free mass. This easy, pain-free testing takes about 8 minutes and you will be required to wear a swimsuit or compression shorts during the test.

Your participation involves coming into the lab in the HPER building on two separate occasions. The first test will be November 24 or 25. The last test will be taken on January 5 or 6. Each participant will be able to choose a Monday or a Tuesday to attend for each session.

Participants will also be asked to fill out a nutrition and exercise assessment at each test session, and height, weight, and waist circumference will be taken at each test session as well.

This is a great opportunity to get state-of-the-art body composition testing for free. All faculty and staff are welcome to participate excluding members who are pregnant. The study is limited to 34 participants so don't delay.

If you are interested in participating or have any questions please contact:

Jessyka Larson

[jess.larson@aggiemail.usu.edu](mailto:jess.larson@aggiemail.usu.edu)

Appendix C. Written Consent Form



Department of Health, Physical Education and Recreation  
7000 Old Main Hill  
Logan UT 84322-7000  
Telephone: (435) 797-1495

## **INFORMED CONSENT**

### **Effects of the Holidays on Body Composition and Weight Change Using Air Displacement Plethysmography**

**Introduction/ Purpose** Assistant Professor Dale R. Wagner, Ph.D. in the Department of Health, Physical Education and Recreation at Utah State University and master's student Jessyka Larson are conducting a research study to find out if weight and body composition change over the holidays. There will be approximately 34 participants in this study.

**Procedures** If you agree to be in this research study, you will be asked to come to the Exercise Physiology Laboratory in the HPER building on the USU-Logan campus two separate times. Each time the following procedures will take place:

1. You will be asked to follow some pre-testing guidelines that include no exercise or strenuous activity for 2 hours prior to the testing session, avoid gas-producing foods for 12 hours prior to the session, and bring a tight-fitting, lightweight swimsuit (e.g., Speedo) or non-padded lycra-spandex compression shorts and a jog bra with you.
2. You will be asked to urinate and eliminate as much gas and feces as possible before changing into your swimsuit.
3. While wearing your swimsuit, your height and weight will be measured.
4. While wearing your swimsuit, a measurement will be taken with a tape measure of your waist circumference.
5. Your body volume will be measured by the Bod Pod. You will sit in a large egg-shaped chamber with a large window with the door closed for two 20-second trials. During this time you will be required to sit motionless and breathe normally. This measurement will be used for the estimation of your body fat.
6. You will answer questions about your nutrition and exercise habits on a one-page questionnaire.



Department of Health, Physical Education and Recreation  
7000 Old Main Hill  
Logan UT 84322-7000  
Telephone: (435) 797-1495

Each session will last approximately 20 minutes. Your total participation time for this study should be about 40 minutes.

## **INFORMED CONSENT**

### **Effects of the Holidays on Body Composition and Weight Change Using Air Displacement Plethysmography**

#### **Risks**

There is minimal risk in participating in this study. Some people may feel claustrophobic inside the Bod Pod. However, the chamber door is closed for only about 30 seconds per trial. Also there is a very large window that allows you to see everything outside the chamber. Furthermore, there is an emergency button inside the chamber that will allow you to open the chamber door from the inside. There have been no reported incidences of injury associated with the Bod Pod since its inception in 1994. A technician will be available to assist you if needed. An office adjacent to the lab contains a phone for "911" emergencies.

**Benefits** You will be given an estimate of your body fat percentage and an interpretation of this value at the end of the study. Knowledge of your body fat percentage can help you assess your health and fitness status. Furthermore, the information gained from this study may help the investigators learn more about weight gain over the holidays.

**Explanation & offer to answer questions** Jessyka Larson has explained this research study to you and answered your questions. If you have other questions or research-related problems, you may reach Dr. Dale R. Wagner at 797-8253 or by email at [dale.wagner@usu.edu](mailto:dale.wagner@usu.edu).

**Withdrawal due to Pregnancy:** Should you become pregnant during the course of the study, it is your responsibility to inform the researchers. You will be withdrawn from the study without consequence or loss of benefits, as pregnancy will create obvious changes in body composition that will confound the study.



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**Voluntary nature of participation and right to withdraw without consequence**

Participation in research is entirely voluntary. You may refuse to participate or withdraw at any time without consequence or loss of benefits. You may be withdrawn from this study without your consent by the investigator

**INFORMED CONSENT**

**Effects of the Holidays on Body Composition and Weight Change Using Air Displacement Plethysmography**

**Confidentiality** Research records will be kept confidential, consistent with federal and state regulations. Only the investigators will have access to the data, which will be kept in a locked file cabinet in a locked room. Personal, identifiable information will be kept for the duration of the study only.

**IRB Approval Statement** The Institutional Review Board for the protection of human participants at USU has approved this research study. If you have any pertinent questions or concerns about your rights or a research-related injury, you may contact the IRB Administrator at (435) 797-1821 or email [irb@usu.edu](mailto:irb@usu.edu).

**Copy of consent** You have been given two copies of this Informed Consent. Please sign both copies and retain one copy for your files.

**Investigator Statement** "I certify that the research study has been explained to the individual, by me or my research staff, and that the individual understands the nature and purpose, the possible risks, and benefits associated with taking part in this research study. Any questions that have been raised have been answered."



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**Signature of PI & student or Co-PI**

---

Dale R. Wagner, Ph.D.  
Principal Investigator  
*435-797-1495*

---

Jessyka N. Larson  
Student Researcher  
*435-760-0619*

**Signature of Participant** By signing below, I agree to participate.

---

Participant's signature

---

Date

Appendix D. Pre-test Nutrition and Exercise Questionnaire

NAME \_\_\_\_\_

1. How would you rank your level of health conscious eating? (Put a single mark on the line)

\_\_\_\_\_

Not at all conscious

Extremely Conscious

2. How would you rank your health in general compared to others your age? (Put a single mark on the line)

\_\_\_\_\_

Not at all healthy

Extremely Healthy

3. What is the most you have ever weighed in your adult life? (Other than when you were pregnant)

4. Has your weight changed in the last year?

1=lost weight

2=gained weight

3=no weight change

5. If so, how many pounds?

6. Are you currently following any specific diet for any reason?

7. How strict do you plan to be in maintaining your usual dietary routine over the holidays (Thanksgiving through New Year's Day)? (Put a single mark on the line)

Not at all strict

Extremely Strict

8. How many days do you anticipate eating more calories compared to your normal intake (Thanksgiving through New Year's Day)?

9. How many days do you anticipate consuming more alcohol than your usual intake (Thanksgiving through New Year's Day)?
10. Over the past 7 days, how many cups of fruit have you eaten excluding fruit juices? (One small piece of whole fruit is equal to one cup)
11. Over the past 7 days, how many cups of vegetables have you eaten excluding vegetable juices?
12. Over the past 7 days, how often did you eat breakfast?
13. Over the past 7 days, how often did you eat lunch?
14. Over the past 7 days, how often did you snack after eating dinner?
15. Over the past 7 days, how often did you drink alcohol?
16. Over the past 7 days, how often did you splurge and eat something you would not normally eat?
17. Over the past 7 days, how often did you drink diet soda?
18. Over the past 7 days, how often did you drink regular soda?
19. Over the past 7 days, how often did you overeat – continued eating until after you felt full?
20. Over the past 7 days, how often did you eat at a social gathering?
21. How many days per week do you exercise?

22. Do you plan on exercising throughout the holidays?

1= yes      2= no

23. If yes, how many days per week?

24. Do you think you will gain weight over the six-week holidays?

1= yes      2= no

25. If yes, how much weight do you expect to gain?

26. How has your weight changed in the past 6-weeks?

1=lost weight      2=gained weight      3=no weight change

27. If so, how many pounds?

Appendix E. Post-test Nutrition and Exercise Questionnaire

NAME \_\_\_\_\_

1. How strict were you in maintaining your usual dietary routine over the holidays?

Not at all strict

Extremely strict

2. How many days do you think you ate/drank more of the following compared to your normal intake? (Please fill out the table below)

	Nov 27 – Dec 1	Dec 2 – Dec 15	Dec 16 – Dec 25	Dec 26 – Jan 4
Total calories				
Fruits				
Vegetables				
Breakfast				
Alcohol				

3. Over the past 7 days, how many cups of fruit have you eaten excluding fruit juices?

(One small piece of whole fruit is equal to one cup)

4. Over the past 7 days, how many cups of vegetables have you eaten excluding vegetable juices?

5. Over the past 7 days, how often did you eat breakfast?

6. Over the past 7 days, how often did you eat lunch?
7. Over the past 7 days, how often did you snack after eating dinner?
8. Over the past 7 days, how often did you drink alcohol?
9. Over the past 7 days, how often did you splurge and eat something you would not normally eat?
10. Over the past 7 days, how often did you drink diet soda?
11. Over the past 7 days, how often did you drink regular soda?
12. Over the past 7 days, how often did you overeat – continued eating until after you felt full?
13. Over the past 7 days, how often did you eat at a social gathering?
14. Did you exercise throughout the holiday season?  
1= yes      2= no
15. If yes, how many days per week?
16. Do you think you have gained weight in the past 6-weeks?  
1= yes      2= no
17. If so, how much do you think you have gained?
18. Why do you think you've gained weight?

Appendix F. Data Collection Form

\_\_\_\_\_ Subject number

Gender\_\_\_\_\_ Age\_\_\_\_\_ Ethnicity\_\_\_\_\_ Marital Status\_\_\_\_\_

---

**Data Collection #1** Date\_\_\_\_\_

Height\_\_\_\_\_ cm Weight\_\_\_\_\_ kg BMI\_\_\_\_\_ kg/m<sup>2</sup> Waist\_\_\_\_\_ cm

Body volume\_\_\_\_\_ L Body density\_\_\_\_\_ g/cc %Body Fat\_\_\_\_\_

---

**Data Collection #2** Date\_\_\_\_\_

Height\_\_\_\_\_ cm Weight\_\_\_\_\_ kg BMI\_\_\_\_\_ kg/m<sup>2</sup> Waist\_\_\_\_\_ cm

Body volume\_\_\_\_\_ L Body density\_\_\_\_\_ g/cc %Body Fat

