Food Portion Size Perceptions of Various Athletes at the University of Wisconsin - Stout

by

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ABSTRACT

Americans' waistlines are expanding at a rapid rate. Large portion sizes may be to blame as they supply more calories and entice individuals to eat more (Young and Nestle, 2002). Registered dietitians obtain dietary intake information from patients and clients, but usually with impaired accuracy. Portion estimation is a major source of error since most people cannot identify a standard portion size. Collegiate athletes are typically leaner than the general population, but are also at risk for portion distortion and obesity in the future if they lead more sedentary lives after completing their athletic career. The goal of this study was to determine the typical portion sizes that various athletes consume, what they perceive to be a standard portion size, and to determine if specific factors play a significant role in their portion size choices. This study used life-size color photographs of six common foods as a portion estimation aid. There were 86 participants, all of whom were athletes at UW-Stout. Football players tended to have a higher body mass index

(BMI) than cross country runners. This study found that males typically consume larger portions than females. Most subjects typically consumed larger portions than the standard portion size, and many were unable to correctly identify the photo that represented a standard portion. Registered dietitians should provide nutrition education that emphasizes portion sizes and calorie differences between portions to help fight the obesity epidemic.

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Chapter I: Introduction

In order to obtain the most accurate dietary intake records from a patient or client, it is necessary to have an estimate of the amount of food consumed (Foster et al., 2006). Food portions can be approximated using several different methods. The most common techniques used for estimating portion size include the following: obtaining the weight of food, observation of eating, food records, food frequency questionnaires, and dietary recalls. Each method has its strengths and limitations in terms of time, cost, effectiveness, and ease of use (Williamson et al., 2003). Responses from subjects on food frequency questionnaires, food diaries, or 24-hour recalls depend on the individual's ability to accurately estimate portion sizes. Individuals have a tendency to underestimate large portions in dietary assessments. Food photographs have frequently been used as an aid to subjects recalling their portion size on dietary surveys (Nelson, Atkinson & Darbyshire, 1996). There are few resources that represent portion sizes in photographic form. The book that is most inclusive to date, representing over 100 foods in the United States (US), is the Portion Photos of Popular Foods (Hess, 1997).

Most of the population is unable to identify standard portion sizes that have been established by the US Department of Agriculture (USDA), as seen on MyPyramid, or on the Nutrition Facts label printed on food packages (Seligson, 2003; Young & Nestle, 2002). Not only do consumers have difficulty identifying standard portions, but advertisements and portions served at establishments outside the home further skew their view of portion sizes. Larger portion sizes supply more calories and also entice individuals to eat more (Young & Nestle).

Obesity in the United States has been on the rise at a rapid rate since the 1970s (Hedley et al., 2004). The Center for Disease Control (CDC) reports that adult obesity has more than doubled from 15% in the 1970s to 32.9% in 2003. The CDC defined overweight individuals as those who had a BMI between 25 and 29.9. Obese individuals

were classified as those who had a BMI greater than or equal to 30. In 1991, there were no states with obesity rates at 20% or higher. By 2006, only four states with obesity rates under 20% remained. Approximately 34% of adults over age 20 are obese (Center for Disease Control and Prevention, 2007).

The general cause of the rapid increase in prevalence of obesity is more calories consumed than the amount of energy an individual burns (Nestle, 2003). Portion sizes have certainly increased, indicating that consumers are taking in excess calories, thus leading to weight gain. The food produced in the US now provides 500 calories per day per capita more than in the 1970s, indicative of an increase in energy intake. Common foods were researched by Young and Nestle (2002) to see how portion sizes contribute to the rise in prevalence of obesity. Their findings showed that since the 1970s, cookies are now up to seven times larger, cooked pasta is usually five times the standard portion size, and muffins are more than three times the standard portion size. Fast foods like hamburgers, French fries, and soda are two to five times the size at which they were first introduced. Consumers believe these larger portions are typical as car manufacturers make bigger cup holders to hold the Seven Eleven 64-ounce "Double Gulp" soft drink and other soft drinks that have increased in size. Restaurants are using larger plates and bakers use bigger muffin tins. Consumers get sucked into the greater value of buying the larger portions because they get more food for their money. Large food portions have been shown to increase energy intake by up to 56%. Limiting portion sizes can help lower caloric intake (Ledikwe, Ello-Martin, & Rolls, 2005). Due to the dramatic increase in portion sizes, public health education should focus on the need to return to smaller portions (Young & Nestle).

Statement of the Problem

Portion distortion is one of the major contributing factors to the obesity epidemic. Larger food portion sizes contain more calories and also encourage people to eat more.

When individuals consume more calories than they typically burn, it leads to weight gain. This is a topic of interest with athletes because one day they will become former athletes, and will possibly lead more sedentary lives. Collegiate athletes typically are not overweight or obese; however, if they experience portion distortion now, there is a high probability it will continue, putting them at risk to be overweight or obese like the general population. This study investigated the perceptions of portion sizes of six common foods by various athletes at the University of Wisconsin-Stout to see if specific factors played a role in the athletes' perceptions of portion size. Dissemination of the outcomes of this study provided a basis for identifying to what extent athletes may experience portion distortion. It also presented the opportunity for dietitian intervention to educate athletes about standard food portion sizes, and the importance of maintaining an active lifestyle to manage weight (Schwartz, & Byrd-Bredbenner, 2006).

Purpose of the Study

The goal of this study was to determine the typical portion sizes that various athletes consume, what they perceive to be a standard portion size, and to find out if specific factors play a significant role in their portion size choices.

The specific objectives of this research were as follows:

1. Identify factors that significantly affect subjects' typical portion size and subjects' view of a standard portion size.
2. Analyze the subjects' portion size perceptions to determine if they are able to identify a standard portion size of six commonly consumed foods using life-size color food photographs.
3. Determine if it is necessary for dietitians to educate athletes about standard portion sizes and energy intake as a basis for weight management.

Assumptions of the Study

It was assumed in this study that the subjects were honest in their responses on the survey, and chose the letter that best corresponded to their typical portion size as well as their perception of a standard portion size. Another assumption is that subjects know English and were able to clearly see the food photographs.

Definition of Terms

Body Mass Index (BMI) is an assessment of weight compared to height. To calculate BMI, weight in kilograms is divided by height in meters squared (kg/m^2). The resulting number is the BMI (National Institute of Health, Medline Plus, 2006).

In the data presented in Chapter four, BMI categories are as follows: anorexic is <17.5, underweight is 17.5-20.7, normal range is 20.7-26.3, marginally overweight is 26.3-27.7, overweight is 27.7-31.1, obese is 31.1-35, severely obese is 35-40, and morbidly obese is >40.

Disinhibition is the tendency to eat in excess when food is appealing and readily available, such as at a buffet (Ard, Desmond, Allison, & Conway, 2006).

Portion distortion is defined as perceiving "large portion sizes as appropriate amounts to eat at a single eating occasion" (Schwartz & Byrd-Bredbenner, 2006, p.1412).

Standard portion size is the portion size of a food as recommended by the USDA's MyPyramid. For example, a standard portion size, or a standard serving size, of cooked rice is 1/3 cup.

Typical portion size is defined as the amount of food individuals deem appropriate to serve themselves for consumption at a single eating occasion.

Limitations of the Study

One of the limitations of the study was the number of participants from each sport. There were fewer total athletes on all teams participating in the study compared to number of athletes on the football team. The sample size for the study was relatively small at a Wisconsin university that draws students mostly from Wisconsin and Minnesota. Therefore, the sample size may not be generalizable to collegiate athletes outside of the University of Wisconsin-Stout. Another limitation was that the athletes may have known each other and possibly discussed the study amongst themselves. Subjects may also have responded to survey questions according to what they thought were the researcher's expectations instead of choosing the answers that best represented their perspective.

Methodology

This thesis is prepared in five chapters. Chapter two will examine previous research related to this study. The methods of the research are explained in chapter three. Presentations of the results of the research are included in chapter four. Chapter five includes the discussion, conclusions, and applications of the research.

Chapter II: Literature Review

Introduction to reported dietary intake

Existing methods for describing dietary intake and assessing an individual's intake ranges from quantitative approaches, which require the actual weighing of food consumed, to qualitative approaches, such as diet histories (Howat et al., 1994). There is no ideal method for evaluating dietary intake. It is important for nutrition professionals to work with clients on dietary intake and to be as accurate as possible because obesity rates are higher than ever and are continuing to rise in parallel to increasing portion sizes. Most people do not realize how much they are eating or the calories contained in the foods they eat, so nutrients and calories are figured based on the individual's reported food consumption. There is some inaccuracy in reporting dietary intake due to an individual's variation in food consumed from day to day, poor memory recall, inability to estimate portions resulting in over or underestimation, and inadequate knowledge of portion sizes.

Portion Size Estimation

"In adults, the ability to estimate portion size of food eaten appears to be affected by the food type, the quantification aid used, and consistency of subject's perceptions and estimation skills" (Robson & Livingstone, 2000, p. 281). Portion size measurement aids (PSMAs) may be beneficial for subjects trying to accurately describe portion sizes (McGuire, Chambers, Godwin, & Brenner, 2001). According to Godwin, Chambers, and Cleveland (2004), numerous factors play a role in reliability of aids used for estimation including the way the aids are presented to the subjects, the type of aid used for recall, the food type and shape, characteristics of the subject, and the extent to which the aid resembles the size and shape of the food.

Williamson et al. (2003) conducted a study comparing portion size estimates using digital photography versus weighed and visual estimation methods. Foods in the

study were made to represent typical meals in a university cafeteria. There were 60 meals of 10 varying portion sizes prepared for test meals. The meals included an entrée, starches, vegetables, fruits, desserts, condiments, and beverages. Reference foods were prepared and weighed in usual portion sizes to compare with test meals for when researchers did the direct visual estimation. Food items of each meal were weighed beforehand. Meal portions were 0% to 235% of reference portions. Researchers were trained to use the visual estimation method and another group of researchers was trained to estimate food using digital photography. Estimates were recorded as a percentage of the reference portion size such as 10%, 90%, 100%, etc. The reference portions, portions selected by participants, and leftovers on the plate for all meals were used in the digital photography method. Food was photographed using a digital video camera and put into a computer program specifically made for estimating food portions in digital photographs.

The results of the study showed that digital photography is a valid way to measure food selections, plate waste, and food intake. Digital photography and visual estimation provided similar estimates. For both digital photography and visual estimation, there was a small tendency towards portion overestimation. Direct visual estimation was the more accurate method for portion estimation. This study showed that digital photography and direct visualization by trained observers are both accurate methods for portion estimation (Williamson et al., 2003).

Trends in food consumption

Marion Nestle has done extensive research on the increase in portion sizes and the obesity epidemic. The cause of obesity is essentially consuming more calories than an individual expends. Over time, the weight gain leads to obesity. Nestle (2003) found that people tend to see a food as a single portion size, no matter what size it is. Most individuals do not realize that larger portions provide more calories.

Young and Nestle (2002) studied the change in portion sizes from the 1970s to date. In 1970, only about 34% of food was consumed outside the home. By the late 1990s, food consumed outside the home had increased to 47%. Restaurants and fast food outlets serve larger portions because it provides the customer with more value for their money. Young and Nestle sampled foods such as steak, soda, cake, white bread products, and alcoholic beverages from many types of restaurants. Foods were weighed and the weight was compared to standard portions that have been established by the USDA and the Food and Drug Administration (FDA) for food labels. Information was also collected about the portion sizes of the foods from manufacturers, professional journals, advertising, menus, cookbooks, and old food composition tables. All of the foods and beverages, except the white bread, surpassed the USDA and FDA standard portions. Cookies had the largest increase at 700%, pasta was 480%, muffins were 333%, steak was 224%, and bagels were 195% larger. Hamburgers and French fries are offered at two to five times the size they were when they were first introduced. Large portions are seen as a bargain by the consumer, and most people are choosing restaurants based on the size of their portions. Young and Nestle concluded that more attention should be paid to the fact that portion size plays a major role in weight management and total caloric intake.

Smiciklas-Wright, Mitchell, Mickle, Goldman, and Cook (2003) investigated the change in reported portion size estimates from 1989-1991 and 1994-1996. The purpose of their study was also to determine if portion sizes changed and if so, of which foods. Portion estimates were completed by subjects two years and older on three consecutive days. A 24-hour recall was taken on the first day and food records were kept for days 2 and 3. Subjects used rulers, measuring cups, spoons, and their own household cups and bowls to help them estimate portions. The findings showed that there were significant differences in the amount of food eaten at each eating occasion in 1989-1991 and 1994-1996 for 33 of the 107 foods the study reviewed. Most foods in 1994-1996 were reported

in larger portions than in 1989-1991, without a significant effect for age or gender. The researchers concluded that portion sizes of many commonly consumed foods became larger for both males and females of all ages after 1991. The researchers recommended that data consumption should be looked at again in the future to observe any changes in portion sizes from the 1994-1996 study.

Portion size affects amount consumed

When subjects are given a predetermined amount of food on a plate, there has been an effect of portion size. When subjects serve themselves, the amount of food eaten was relatively consistent. Researchers Rolls, Morris, and Roe (2002) hypothesized that when subjects were able to serve themselves, the amount of food presented in a serving dish would not have an effect on their intake, but when the researcher dished out the portion on their plate, then portion size would affect their intake.

The study included fifty-one male and female subjects, who were 21-40 years old, in good health, not trying to gain or lose weight, not taking medication that would affect appetite, were not athletes in training, were not pregnant or lactating, regularly ate three meals per day, and had no food restrictions that would affect their intake participated in the study. Subjects completed a questionnaire that evaluated dietary restraint, perceived hunger, disinhibition, and an eating attitudes test that tested for eating disorders. Height and weight were also measured and recorded. Testing was completed on four different days, with test dates one week apart. Subjects arrived at the laboratory for lunch to obtain macaroni and cheese served in one of four portion sizes: 500, 625, 750, or 1000g. One group of subjects got the macaroni and cheese on a plate, and the other group received it in a serving dish to serve themselves the portion they wanted. Subjects were assigned to a group based on matching age, sex, BMI, and scores for dietary restraint and disinhibition. The food was weighed before and after the meal to figure out how much each subject ate. For the individuals who served themselves, the macaroni and cheese taken from the dish

was weighed as well as leftovers from the plate. Subjects completed a discharge questionnaire asking if they knew the purpose of the study, factors that affected responses, and whether they noticed any differences in the test days (Rolls et al., 2002).

There were 27 subjects in the pre-portioned group and 24 subjects in the group that served themselves. There was no difference between men and women in age or disinhibition, but men had higher body mass indexes (BMIs), and women had more dietary restraint and depression. The subjects in both groups ate more macaroni and cheese as portion size increased, so there was no significant difference between serving method. Participants ate 30% more food and calories when they were given the largest portion of macaroni and cheese than when they had the smallest portion. Subjects in both groups ate 67% of the smallest portion, but 43% of the largest portion. Ratings of hunger and satiety were not significant. Age, gender, BMI, dietary restraint, and disinhibition did not have a significant effect, meaning that men and women, overweight and normal weight, restrained and unrestrained, were affected by portion size. Only 45% of subjects reported that they noticed a difference in portion size from each test day. The portions used in this study were relatively large, but were similar to the portions served in restaurants. More people are dining out than ever, and the portions served in restaurants provide more energy than most Americans need (Rolls et al., 2002).

Trends in food consumption among college students

The purpose of Guthrie's (1984) research study was to determine young adults' perceptions of portion size, and to see how accurately they could describe a portion size without additional aids such as food models or hints from the interviewer. College students make up a large portion of the population that tend to enjoy convenience foods. These students have busy lives with classes, jobs, and other activities, that can lead to poor food choices. College students usually choose foods that have a long shelf life, are easily portable, or can be found in vending machines. Convenience products are

increasing in portion size, and they often target this age group. As long as consumers are unable to identify standard portion sizes of the foods they eat, they will continue to consume larger portions. Guthrie's study included 147 adults, ages 18-30. Guthrie found that serving size perceptions were widely varied. Men tended to choose larger portions than women. A range of 8 to 68% of subjects could estimate some food items within about 25% of the actual amount. Zero to two thirds of subjects overestimated portion sizes by at least 51%. Guthrie concluded that subjects need assistance with estimating portion sizes in order to obtain more accurate dietary intake data.

Research has shown that larger portions and an unlimited supply of food, such as cafeteria-style dining, prompt individuals to eat more (Bryant & Dundes, 2005). College students, especially those in the dorms, usually eat at a cafeteria, which increases their risk of gaining weight. Bryant and Dundes studied portion sizes of college age adults.

The subjects included 42 undergraduates recruited from a sociology course at a private university who represented various races, majors, and both sexes. Subjects were asked to measure out their serving size of cereal if they were to just eat cereal for breakfast without any other foods (no eggs, bacon, etc). Subjects were also instructed to look at the cereal box to see the suggested serving size (one cup). They were to pour their perception of a one cup serving into a second bowl. Subjects were given a 14-ounce bag of M&Ms® and asked to pour into a bowl the amount they usually consume if they were having M&Ms® for a snack by itself. The third item was Hawaiian Punch®. Subjects poured the amount of punch they would normally consume for dinner into a glass, and were asked to estimate how many cups they would typically drink. To evaluate whether larger bowls affect portion size, subjects were given two bowls, of varying sizes, and were asked to pour another bowl of cereal as before, only this time, twice; once for both the larger and the smaller bowl. Finally, participants filled out a questionnaire about how much attention they pay to food labels, and whether they think their portion size is

affected by eating in a college cafeteria. The researchers weighed the cereal and M&Ms® the students had poured (Bryant & Dundes, 2005).

The researchers found that about 33% of subjects typically ate twice as much, or more, than the standard serving size. Only one third of respondents' estimates of the actual serving size were within 90-110% of the serving size category. Slightly over one third of respondents underestimated the actual serving size. They also found that 37% of participants typically ate 200% of the standard serving size of M&Ms®, and 60% of participants regularly drank 200% of the serving size for punch. Most males (86%) drank larger portions of punch, and only 34% of females drank large portions. The difference in intake between males and females was found to be significant. Most students felt that cafeteria-style dining contributed to their selection of larger portion sizes. Bryant and Dundes also found that the actual serving size of cereal and punch was less than half of what the students typically consume. Only one third of subjects were able to estimate the standard serving size of cereal within 10% of the actual amount. The researchers expected to find that a bigger bowl in the second pouring of cereal would lead to pouring a larger portion size; however, that was not the case in this study (Bryant & Dundes, 2005).

Portion selection of young adults

In a study conducted by Schwartz and Byrd-Bredbenner (2006), the participants were 16-26 years of age, and enrolled in an introductory psychology course at a university. The purpose of the study was to determine typical portion sizes of young adults, how their portions compare to standard portion sizes, and whether the sizes of typical portions have changed over time. There were 63, 62, and 52 participants at breakfast, lunch, and dinner. Most (64%) of subjects were freshman, and 75% of subjects were female. The food for each meal was arranged on a buffet table in household serving dishes. Dinner plates came in sizes of 7.5, 9, and 10.25 inches in diameter. Bowls were 6,

12, and 28 ounces in volume, and glasses were 12, 20, and 32 ounces. Subjects could choose the size they wanted to hold their typical portion size, to avoid limiting their choices. Subjects were told to complete a questionnaire that obtained their demographic information such as age, gender, and college major. The researchers also assessed their hunger status and preference for the foods served to evaluate whether those factors affected the selection of portion size. Each subject went individually to the buffet table to self-serve the amount of food he or she would typically eat of each menu item. The beginning weight of the food was recorded, and any leftovers on the plate were also weighed and recorded to determine the weight of each individual's typical portion.

The researchers found that there was no significant effect on portion size from factors like hunger status or preference for the foods. They also found that time of day did not influence portion size selections. For some foods, males chose larger portions than females. This was expected because males tend to have higher energy needs as they are usually bigger than females. Typical portion sizes of cornflakes, milk on cereal, and jelly tended to exceed standard portion sizes by more than 25%. Typical portion sizes of butter, tuna salad, tossed salad, and salad dressing tended to be less than standard portion sizes by 25% or more. "Individuals who are unaware of how the portion sizes they typically select compare with reference portion sizes will likely face challenges in their attempts to control their body weight..." (Schwartz & Byrd-Bredbenner, 2006, p. 1416).

Burger, Kern, and Coleman (2007) also studied the portion choices of college students. There were 51 university students who participated in this study. The average BMI of participants was 23.5. Each subject arrived at the lab to have height and weight measured. Subjects also served themselves each food as if they were going to eat it as either a snack or as part of a meal after instruction from the researcher. Provided for participants was silverware of two sizes, an 11" inch dinner plate, and a 6" bowl, which were placed on a scale to weigh the amount of food selected. Peanut butter, jelly, and

margarine were spread on bread to be more realistic, and the bread with the spread on it was put on the scale. Corn chips were measured twice, once with a smaller 85 gram bag of chips, and the second time with a large 368.5 gram bag of chips. Rice was measured as a side dish and also as if it was part of a main dish. Liquids were presented with the subject choosing the typical size cup they would use. Cups were available in sizes that students usually find on campus from the 591 mL small to the 1.9 L extra large. Participants poured the amount typically consumed at one time into the cup.

Results of the study showed that in general, subjects selected portion sizes significantly larger than standard amounts for most of the food items. Packaging of food had a significant effect on portion size. Subjects chose larger portions from the larger bag of chips compared to the smaller bag. Males selected significantly larger portions of solid foods than the reference portion size. Males also chose significantly larger portions of high-energy density, high-fat, and high-carbohydrate foods than females. On the other hand, there was no effect of gender on portion size selection of low-energy dense, low-fat, or low-carbohydrate foods. The researchers found that a higher BMI predicted a larger portion selection of five foods: peanuts, M&Ms®, cereal, jam, and soda. Those with a higher BMI may see larger portions as more typical, leading to the consumption of much larger portion sizes of energy-dense foods, and increasing their risk of obesity (Burger et al., 2007).

Validity of portion size measurement aids

In a study by Howat et al. (1994), 44 women, ages 18 to 50 years participated. Participant BMIs ranged from 16.9 to 64.5. Subjects were divided into two groups, 26 of which were in the control group, trained with 24 different food models. The experimental group had 18 subjects, trained with 13 different food models and 11 life-size photographs. A 24-hour recall was conducted before training began and the other was done after training. Calories were calculated using a computer-based program. The color

food photos were 16 x 16.5 inches and were depicted on a white plate in front of a one inch grid background. Three portion tests were given to subjects to assess their ability to estimate food portions using the knowledge they obtained in training. The tests were completed before training, and 3 and 11 days after the training session. Participants estimated portion sizes for 11 common foods in two separate sets. Subjects used food models for portion estimation in the first set, and food photos for the second set of portion estimations. Training provided participants with two photos, one with the actual size given for comparison. The testing procedure gave only one photograph, and did not identify the portion size. Subjects reported estimated quantities of the food portions, which were compared to the actual amount of the food. The error was calculated from the difference in the two values.

Most participants overestimated portion size using the food models and food photos. The control group had more significant errors using the food photos. Greater error using food models and photos was found for amorphous and liquid foods compared to solid food, showing that form of the food can affect accuracy of portion estimation. Both training techniques did improve subjects' ability to recall and estimate food portions more efficiently; however, estimates were better using food photos. There was no correlation found among subjects' estimates of portion size and their BMI (Howat et al., 1994).

Role of age, sex, and BMI in portion estimation

The gender, age, and body size of an individual can play a role in perception of portion size. Researchers Nelson, Atkinson, and Darbyshire (1994) examined the use of photographs for portion estimation in relation to factors that may influence perception of portion size, such as the size of the photo, the number of photos, and color versus black and white photos. The researchers chose six common foods that were passed through a small window to the subjects to view along with the photographs. Subjects were given a

visual analogue scale (VAS) labeled one to eight and were asked to mark the spot that best represented the portion size of the food presented. Participants also wrote down a number that described the amount of food on the plate as a fraction or percentage of the amount shown in the photograph. The weight of the food was subtracted from the amount the subject estimated on the VAS for each of the eight photos. The results from the study showed that portions tended to be underestimated; however, they were underestimated less often when using the eight photographs.

This study found highly significant data in relation to gender, age, and BMI. Males underestimated portion sizes more than females. The 65 and older age group tended to overestimate portion sizes for the eight photographs and underestimate portions less than the other age groups. Subjects with a BMI greater than or equal to 30 tended to underestimate portion size. Color photographs led to a slight overestimation when using a single photograph versus eight photos. The researchers found that a single photo leads to a higher percentage of error than using a series of eight photographs. They also noted that large portions tended to be underestimated using a single photo instead of a series of eight photos (Nelson et al., 1994).

A study by Lillegaard, Overby, and Andersen (2005) investigated whether children and adolescents could estimate portion sizes accurately using food photographs, and whether their age played a role in their ability to estimate portion sizes. A photographic book of foods that contained 13 color photos was used for this study. Photos were labeled A, B, C, or D with the letter A representing small portion sizes and D representing large portion sizes. Subjects ranged in age from 9 to 19 with 41 females and 22 males participating. Subjects were shown real plates of food and asked to estimate the portion size of the food by comparing it to the portions in the photographs. They wrote down the letter of the photo that they felt best represented the portion on the plate. Subjects were presented with 17 food items in two different portion sizes to estimate.

The results showed that in general, 60% of portion estimations were correct, and 95% of estimations were made within an error of one photograph. When foods were served exactly the same way it was depicted in the photograph, subjects were correct on portion estimations 82% of the time. On the other hand, when the food differed from the photo, such as in shape or portion size, only 48% of estimations were correct. There were no significant differences between age and accuracy of portion estimation. The research findings suggest that it may be easier to estimate food portions if the food closely resembles the food in the photograph (Lillegaard et al., 2005).

Estimation of large portion sizes

One problem with estimating larger portions could be due to the size of portion estimation aids used in relation to the size of the portion consumed. One study by Harnack, Steffen, Arnett, Gao, and Luepker (2004) evaluated the accuracy of estimating large portions that were eaten in a restaurant. The size of the portion estimation aid used was assessed for accuracy in reporting. Subjects were 25 to 84 years old, and were served a meal at a hotel restaurant in Minneapolis, MN. The meal consisted of hamburger on a bun, French fries, ice cream, and the participant's choice of beverage. Demographic information and subjects' height and weight were obtained. There were 49 subjects who participated in the study. When participants finished eating, the researchers collected the leftover food to be weighed, and amount eaten was calculated based on the weight of the food they were served. After eating, subjects also estimated the amount of food they ate using two different sizes of 3-dimensional (3D) food models. The smaller size of food models depicted a two ounce hamburger patty, 2.14 ounce French fries, and 2.36 ounce ice cream. The larger size food models displayed a 4 ounce hamburger patty, 3.21 ounce French fries, and 4.71 ounce ice cream. When participants used the smaller size food models to estimate how much they ate, they underestimated the amount they ate for all three foods. When they used the larger food models to estimate their intake, participants

were closer to the actual portion consumed for ice cream, but still underestimated intake of hamburger patty and French fries. Based on nutrient assessment of the foods, the amount of calories in the food served to subjects was about 998 calories. The average amount that subjects estimated they ate based on the portions they chose from the food models was 599 calories from the smaller models and 728 calories from the larger food models. The study concluded that larger portion sizes tend to be underestimated (Harnack et al., 2004).

Effect of portion size on energy intake

The energy density of foods has an effect on total caloric intake for both genders. A study done by Kral, Roe, and Rolls (2004) included 39 female subjects, ages 20 to 45. Subjects completed demographic and health questionnaires, as well as an assessment of dietary restraint, disinhibition, hunger, attitude towards eating, depression, and degree of emotional eating. Participants arrived at the lab on the same day each week for six weeks for breakfast, lunch, and dinner. For lunch, subjects were given Italian pasta bake, made in two separate energy densities, and served in three different portion sizes. To determine how much the subject ate, the food was weighed before and after the meal. Before and after each meal, subjects completed visual analogue scales (VAS) to rate their degree of hunger, fullness, thirst, and prospective consumption. The results of the study showed that there was a significant effect of portion size as well as a significant effect of energy density on the weight of the food eaten at lunch. There was no significant interaction between portion size and energy density, which means those factors act alone to affect total food intake.

The researchers found that subjects ate 20% more food when they were given the largest portion of pasta compared to when they had the smallest portion. Subjects also ate 10% less food when they were served the pasta with a higher energy density compared to the pasta with lower energy density. Even though less food was consumed with the

higher energy density pasta, the overall caloric intake was 26% higher at lunch. When served the biggest portion size of pasta, the combined effect of portion size and energy density led to a 56% increase in caloric intake. Breakfast and dinner energy intakes did not differ; only lunch was found to have an effect on total calorie intake. Taste ratings of the pasta for both high and low energy density servings showed that the pasta was equally well liked (Kral et al., 2004).

The subjects noticed that the portion size increased, and they also admitted to being able to eat more when they were served a larger portion. Even though energy density of the food varied, the participants did not rate hunger or fullness differently after lunch. The researchers also noted that although subjects felt the portions were larger than their usual portion sizes, they still responded to the larger portions by consuming more of what they were served. Subject characteristics were not found to have any effect on the portion of food or the energy density of the food. The conclusion of the study was that large portions of energy dense foods contributed to increased caloric intake (Kral et al., 2004).

Eating out often at fast food establishments is an indicator of high BMI in women. For men, eating at restaurants and fast food establishments is associated with higher BMI (Diliberti, Bordi, Conklin, Roe, & Rolls, 2004). In 2000, Americans put forth 47% of their money for food on food eaten away from home, and it continues to increase. When eating outside the home, consumers are served low-cost, energy-dense foods in large portions. The study by Diliberti et al. investigated whether a larger portion size of an entrée had an effect on energy intake for a restaurant meal. A restaurant that served cafeteria-style on a university campus was the location of choice, and participants were served the entrée at 100% of the standard portion size on five days, and 150% of the standard portion size on the other five days. Participants were observed by the researchers and amount of entrée served was pre-weighed, then the amount leftover was weighed in

the research kitchen. The amount consumed was calculated and recorded. Those who bought the entrée completed a short survey about the appropriateness of the serving size, how much they ate compared to what they typically consume, value for what they paid, and taste of the entrée. They also reported their sex and age, while researchers recorded an estimate of the participant's body size in terms of underweight, normal weight, overweight, or obese.

There were 89 participants who bought the 100% portion size and 91 participants who bought the 150% portion size. The difference between the groups was not gender or body size, but age and university status. More of the customers who bought the 150% portion size were 25 to 34 years old and were graduate students. The researchers in this study found that portion size had a significant effect on energy intake. For the 150% portion size of the entrée, participants obtained 43% more calories than those who bought the 100% serving size. It was also noted that participants who bought the larger entrée also ate much more of the side items, such as tomato and a roll with butter, than those who bought the smaller portion of the entrée. Subject characteristics did not have an effect on portion size and energy intake, meaning that there was a significant increase in energy intake among both genders, all age groups, and in normal and overweight participants (Diliberti et al., 2004).

On the survey rating for appropriateness of portion size, there was an effect of body size. Underweight and normal weight individuals felt that the 150% portion was closer to being too large than those who bought the 100% portion. Overweight and obese participants felt that both portions were appropriate sizes. When participants rated their perception of what they ate at the meal, ratings did not differ significantly between individuals who had the larger portion and those who had the standard portion size. Even though there were major differences in intake, the two groups did not differ in their perception of how much food they ate. The female participants felt that they ate more at

the meal than they typically eat, whereas the men did not. The results of the study showed that large portion sizes served in restaurants contributes to increased caloric intake. Participants in this study ate significantly more when they were served a larger portion, and they reported on the survey that they were not aware that they had eaten more food due to the larger portion size (Diliberti et al., 2004).

A review by Ello-Martin, Ledikwe, and Rolls (2005), discussed research that shows the effect of portion size on caloric intake and the influence of energy density and portion size on intake. It seems that very young children tend to eat similar amounts of food, no matter what size portion they are given. Children more or less under age three respond to physiological hunger and satiety cues. As children get a little older, they tend to use external cues more, such as the portion they are served. Rolls, Engel, and Berch (as cited in Ello-Martin et al.) conducted a study that found some five year old children ate significantly more calories when they were given a bigger portion size. In a later study, investigators Fisher, Rolls, and Birch (as cited in Ello-Martin et al.) found that four-year-olds ate 25% more food when they were served an entrée twice the size of what would have been appropriate for them. They also ate 25% less food when they put the food on the plate themselves versus an adult serving them a large portion of food. Ello-Martin et al. concluded that since children over the age of three respond to environmental cues to eat more food, it is no surprise that adults follow similar patterns.

In a study by Rolls, Roe, Meengs, and Wall (2004), when individuals were offered 6, 8, 10, or 12 inch sandwiches on different days, both genders significantly raised their caloric intake in parallel to the increase in size of the sandwich. When served the 12 inch sandwich, women ate 31% more calories, and men consumed 56% more calories than when they were served the 6 inch sandwich. The participants rated their hunger and fullness the same at the end of the meal even though food intake tended to increase.

It could be argued that a large intake at one meal may lead to eating less at the next meal. A study by Rolls, Roe, Kral, Meengs, and Wall (2004), researched how snack portions affect energy intake. Subjects in this study were given different sized packages of potato chips for a snack, and then received dinner later. When they were given the largest size package of potato chips, the men ate 37% more chips and women consumed 18% more chips than when they were served the medium sized package. Subjects did not change their intake at dinner after eating more calories during the snack.

From the previous study, Rolls, Roe, and Meengs (2006) proceeded to determine whether portion size affects energy intake on more than just one eating occasion. Subjects in the study ranged in age from 19 to 37 years, and had BMIs of 20 to 29. On two consecutive days for three weeks in a row, participants ate breakfast, lunch, and dinner at the lab. After each meal, they were given a snack to eat mid-morning, mid-afternoon, and after dinner. The menus were the same each week, but the portions varied from 100%, 150%, and 200%. Female subjects were served greater than 3,000 calories each day and men were served greater than 3,900 calories each day in order to ensure energy intake was not restricted. Subjects used a visual analogue scale (VAS) to rate hunger, fullness, and prospective consumption before and after each meal. A discharge questionnaire was given to find out if subjects knew the purpose of the study and if they noticed any changes between test days.

The results showed that overall caloric intake for the two days increased when the portion size increased for both genders. When portions were increased to 50% above the baseline amounts, men and women ate 16% more calories and obtained 120% of daily calorie needs. When portions were increased to 100% above baseline amounts, subjects obtained 26% more calories, or about 130% of daily energy needs. Subjects' intake did not change between the first and second day, so they did not adjust to overeating on the first day. Portion size and energy intake was not affected by age or BMI. Men did have a

higher energy intake than women. Almost all of the subjects noticed a change in portion size, but only four subjects reported that it affected their intake. Overall, larger portions led to an increased intake for all foods including sides, entrée, desserts, and snacks. Subject characteristics had little effect on portion size consumed. The study supports previous conclusions that larger portions lead to excess caloric intake that may be contributing to an increase in body weight (Rolls et al., 2006).

In the review by Ello-Martin et al. (2005), the researchers mentioned that recent survey data from the American Institute of Cancer Research in 2004 showed that of 1,000 adults surveyed, 42% report that they decided how much food to eat based on how much they typically eat. The results also showed that 69% report that when they eat out, they consume all of their entrées all or most of the time, but 30% would be satisfied with a smaller portion.

Levitsky and Youn (2004) conducted a study with nine males and four females who were undergraduate students. Height and weight was measured, and BMI ranged from 20 to 26. For the first week, subjects chose foods from the buffet table and were allowed as little or as much food as they wanted. Each food was placed on a separate plate or bowl. Each plate or bowl was weighed before and after eating to calculate how much each subject ate. For the second week, subjects were assigned to a group: A, B, or C. Each group sat at a table separate from the other groups. One group received 100% of the portion size, another group received 125% of the portion size, and the other group received 150% of the portion size. On three different days, each group received each of the three varying portion sizes. Increasing the portion size influenced subjects to eat more. There was no difference between genders. The results of this study corroborate with similar findings that larger portions result in greater intake of food.

Prevalence of obesity in former athletes

O'Kane, Teitz, Fontana, and Lind (2002) studied the prevalence of obesity in adults, 20 to 60 years old, to compare national data on adult obesity with that of former college rowers. Their hypothesis was that former rowers would have lower rates of obesity throughout adulthood. The researchers sent questionnaires to 4,680 former intercollegiate rowing athletes. They had a 46% response rate, with 2,165 questionnaires returned. Subjects were asked how long their rowing career lasted, and their training methods, current height and weight, as well as college height and weight. BMI was calculated for both college and current reports. Data from the Centers for Disease Control (CDC) and Prevention Third National Health and Nutrition Examination Survey (NHANES III) provided the BMI data for the comparison group in their study.

The researchers found that for both sexes, current BMI was higher than their college BMI. For women, current average BMI was within normal range; on the other hand, current average BMI for men was just under 30. There was also a trend for both sexes towards a higher BMI at each higher age group. Only 10% or less of the former rowers were classified as obese. Comparison of current BMI for men who continued rowing during adulthood with men who stopped rowing showed that there was less obesity in those who were still rowing. It should be noted that only 8% of men and only 5% of women were still rowing. Current BMI of former rowers compared to the general population shows a lower rate of obesity and a higher percentage of normal weight among male and female former rowers. Percentage of obese individuals increased with age in the general population and former rowers. The data suggests that participation in sports or regular physical activity in early adulthood may be beneficial for preventing obesity later in life (O'Kane et al., 2002).

Pihl and Jurimae (2001) researched the cardiovascular risk factors in former male athletes based on their changes in weight during the post-competitive period. The study

included 150 former athletes who previously participated in endurance sports and sports games nationally or internationally at least 15 years prior to the study. Weight was self-reported and recorded for each subject at age 20. Current height and weight was also measured, recorded, and BMI was calculated. Of the subjects, 63.3% were regularly physically active. The data showed that weight gain was significantly related to a lack of physical activity. Weight gain was also significantly higher in former athletes whose physical activity was lacking after retiring from a career in their sport compared to individuals who kept up with physical activity. In order to prevent weight gain, physical activity plays a major role. Body fat is higher for middle-age and older athletes than in younger athletes. The data from the study suggests that most former athletes are likely to gain weight within 15 to 30 years after retiring from their sport.

Three dimensional portion size aids

Three-dimensional (3D) resources used to estimate food portion sizes can include plastic food models, objects, such as a tennis ball, or common household measures such as cups, measuring spoons, glasses, plates, and bowls. These tools can be used as an aid for estimating food portion sizes. Three-dimensional models tend to be common shapes used to represent a given portion size. A common example is that a deck of cards represents about three ounces of meat. In Weber, Tinsley, Houtkooper, and Lohman's (1997) study, they found that learning to recognize standard portion sizes using food models had an effect on progression towards accurately estimating portion sizes of amorphous and solid foods in cups. According to Chambers, Godwin, and Vecchio (2000), it may be that the more a food model resembles the actual food, subjects find it more appealing and easier to use for recall of portion size of that food.

Schwartz and Byrd-Bredbenner (2006) investigated the accuracy of two different types of practical portion size measurement aids (PSMAs): 2D and 3D. Accuracy of portion size estimates for amorphous forms of fruits, vegetables, and grains were

compared when subjects used practical PSMAs to when they did not use practical PSMAs. The 2D aid was a life-size photograph of a golf ball and a tennis ball with labels that described the cup volume of both balls. The 3D aid was an actual golf ball and tennis ball, both with tags attached labeling their cup volume. Food was presented to subjects on plates, in predetermined measures, using 36 foods divided into three sets of 12. Each set of foods included the same food, but in varying portion sizes, shapes, and heights or widths. This was done to assess whether practical PSMAs help create more accurate estimates of the foods in various forms. Demographic data was collected from a questionnaire. Subjects were randomly assigned to one of two groups and estimated the portion size of the foods in each of the three sets of food. All subjects estimated, in cup measurements, the portion sizes of the foods in set one. Subjects were asked to estimate the amount of each food in set two using the 2D or 3D PSMA assigned to their group and record it on the form provided for them. The subjects were then asked to estimate the amount of each food in set three without a PSMA and record them.

Subjects included 113 young adults, ranging in age from 17 to 24. Subject characteristics did not significantly affect portion estimations. The use of both types of practical PSMAs significantly affected portion estimation. Even when a PSMA was used, it only facilitated up to 60% accuracy, which shows that there was still quite a bit of error in portion estimation (Schwartz & Byrd-Bredbenner, 2006).

Two dimensional portion size aids

The purpose of the study by Godwin et al. (2004) was to compare subject accuracy in reporting food intake when they used two-dimensional (2D) versus three-dimensional (3D) portion size estimation aids (PSEAs). Factors such as interview methods, in person or via telephone, and guidance to certain PSEAs versus subject choice of any aid were investigated. Subjects included 120 individuals of both genders, ranging in age from 18 to 65. Subjects chose food from a buffet table that were pre-weighed.

After subjects finished eating, their leftovers were weighed and the total amount of food consumed was calculated. The next day, the subject estimated how much they ate via telephone or in-person interviews, using 2D or 3D PSEAs, and guidance or no guidance towards using specific aids.

The data collected showed that none of the participants were able to estimate their intake within 20%. The average accuracy of estimating using 2D versus 3D aids were fairly similar, but there were three foods for which mean inaccurate estimations for 2D aids were more than 20% and were less than 20% for 3D aids. This indicates that when 2D aids were only flat drawings without shading, the 3D aids were more effective for estimating portion size. Use of 2D aids was more of a challenge over the telephone compared to in person; however no significant differences were found in reported intake. Guiding participants to a certain aid did not affect accuracy of reported intake. Misestimations in this study for 2D aids could be because the 2D aids were not made to look 3D. Representation of a 3D food using a more accurate 2D PSEA would probably be more beneficial (Godwin et al., 2004).

McGuire et al. (2001) compared the accuracy of a 2D muffin diagram to other portion size measurement aids (PSMAs). A total of 120 subjects, 58 of which were men and 62 were women, participated in the study. There were seven muffins of different sizes and shapes that were numbered for the study. Subjects estimated the size of four muffins after taking thirty seconds to look at and touch each one. The muffin was taken and placed out of sight, and subjects estimated the size of the muffin according to size categories of mini, small, medium, large, extra large, and jumbo. They also estimated the amount by using any PSMAs such as a ruler, bean bag, or 2D muffin diagrams, or no PSMA at all. Finally they described their confidence of the accuracy of their estimation using a five point scale. The 2D muffin diagram was in a muffin shape, but was depicted using a tapered cylinder for the base of the muffin and the top of the muffin was

spherical. The diagrams were meant to look like muffins and represent them in size, but were definitely not the same as using an actual photograph of a muffin.

The researchers found that more than 90% of the subjects decided to use a PSMA for estimation. Among those who used a PSMA, 70% used the 2D muffin diagram, which also led to the greatest overestimation. "This finding is important because it indicates that developing PSMAs is difficult and that validation of new aids is essential before their use" (McGuire et al., 2001, p. 471). The beanbags and ruler also produced overestimation by at least 30%. Subjects' confidence in their estimation did not correlate with their percentage of error, suggesting that individuals do not realize the extent of their errors (McGuire et al., 2001).

Food Photographs

Robson and Livingstone (2000) evaluated the use of food photographs as an aid for quantifying food intake. Their goals were to evaluate subject error in using photographs to quantify the amount of food consumed at six meals over a period of two separate days, and to assess the affect of the errors on estimating nutrient intakes. There were 15 male and 15 female subjects ages 18 to 36. Height and weight measurements were taken for each participant. Subjects were informed of the purpose and approved all foods prior to the study.

Food photographs used in the study were single color prints, with the food pictured on plates, in bowls, or glasses on top of a wooden table. Subjects were invited to breakfast, lunch, and dinner on two non-consecutive days. Each participant was given a pre-weighed amount of food, a portion large enough so the subject was not limited by the amount of food provided. Serving dishes and leftover food were weighed. The amount of each food consumed by every individual was calculated. The day after eating, subjects returned to estimate how much they ate by using fractions or multiples of portion shown in the single food photograph. The same procedure took place on the second eating day

for each subject to provide data over two days versus just one day (Robson & Livingstone, 2000).

The researchers found that there were no significant gender differences in using food photos to estimate portion size. As a group for the first day, ten foods were overestimated and six were underestimated. On the second day, seven foods were overestimated and ten were underestimated. There was no evidence that a certain shape of food or other characteristic had an effect on subject over- or underestimation of portion size. For most foods, there was no significant relationship between the extent of the error and the amount of food consumed in relation to the photograph quantity. This study did not find that age, gender, or BMI had an effect on portion size estimation. The errors made in quantifying the food consumed using a photograph could be due to factors that cannot be quantified or controlled including the subject's motivation, cooperation, mood, restraint, memory, perception, etc. Single photographs may not be as beneficial for portion estimation as using multiple photographs. Robson and Livingstone also suggested that if subjects had been given the opportunity to estimate portion size immediately after each meal instead of waiting a day, the single food photographs might have been more helpful (Robson & Livingstone, 2000).

Again Nelson et al. (1996), studied the use of food photographs as an aid to estimating portion size and the nutrient content of meals. Subjects were between 18 and 90 years old, and from various backgrounds. Participants arrived for one meal, either breakfast, lunch, or dinner, where they served themselves any of the foods being offered. After the subject chose the amount of food, the weight was taken and recorded. Subjects sat down to eat their meal, and any leftovers were weighed and recorded. The amount of food participants ate was calculated. Twenty-two commonly consumed foods were used in the study. Foods that were easy to describe in common household measurements, such as a slice of bread, were not used in the study. The point was to incorporate foods for

which a portion estimation aid would be needed. "Within five minutes of the completion of the meal, subjects were given a VAS and a set of eight color photographs for each food they had eaten" (1996, p. 33). Using the VAS, subjects were asked to relate the size of the portion they just ate to the eight photos. Based on the results of the study, men and women were both prone to overestimating small portion sizes and underestimating large portion sizes. This study corroborates the conclusion from Nelson et al.'s previous research (1994) that food photographs are beneficial for estimating portion sizes.

In an earlier study in 1992 by Faggiano as mentioned in Cypel, Guenther, and Petot's (1997) article on the validity of PSMAs, 103 men and women, ages 35 to 64, chose their own portion sizes. The weight of the food subjects selected was measured and foods eaten were recorded. The next day, subjects recalled the amount of food consumed the day before using a set of seven food photos that varied in portion size. Results showed that some foods tended to be overestimated, while others were underestimated. The researchers in the study did not find a significant effect of age or gender on the accuracy of portion estimation.

Photographic atlases for assessing portion size

"A photographic atlas is a set of photograph series, usually bound together in a single volume" (Nelson & Haraldsdottir, 1998, p. 231). Nelson and Haraldsdottir researched how to create a photograph series of food portion sizes to formulate some practical guidelines. They recommend using an even number of photographs such as four or six, but three is typical, and using only one photo to represent a portion is not recommended. It is most common to place the photograph series in order of smallest to largest, and images should be labeled with numbers or letters. Whether the picture is in color or black and white should have no effect on an individual's ability to estimate portion size. It is best to have one food item on a plate rather than foods in combinations on a plate.

Foods that should be included in the atlas are ones which are amorphous, can vary greatly in size, and are not easily described in household measurements such as one slice of bread. The number of foods to include in the atlas depends on the following factors: the purpose of the atlas, resources available for creating the atlas, desired cost for professionals to pay for the atlas, and the extent to which the foods represent other foods that have similar characteristics and appearances, or equivalent foods. Subjects can identify portions using a photograph series in numerous different ways. One way is to ask the subject which photograph best displays their typical portion size. The subject can choose one of the labeled photographs or a portion in between two photos. Subjects could select a portion size greater than the largest portion shown or smaller than the smallest portion shown. The last option is to use a visual analogue scale to allow subjects to choose a portion size at any point on a continuum (Nelson & Haraldsdottir, 1998).

Turconi et al. (2005) researched the validity of using a color food photo atlas to estimate portion sizes. A color food photo atlas was assimilated by taking photos of three different portion sizes (small, medium and large, respectively) of 434 actual foods that had been prepared and weighed. There were 448 male and female subjects, who ranged in age from 16 to 60. Demographic data was collected from participants. Subjects arrived at a cafeteria to get their food that was weighed by the researchers. Subjects ate their meal, then about five minutes after completing the meal, they estimated how much food they ate using the photographs in the food atlas. The findings suggest that using a photographic food atlas to estimate portion sizes is a valid method. The study also did not find a correlation between age, gender, and BMI.

Portion Photos of Popular Foods

Portion Photos of Popular Foods (Hess, 1997) is a color food portion size estimation aid (PSEA). The book includes at least 109 foods commonly consumed in the US. It contains life-size photographs of each food with three separate portion sizes on

each page. There are 128 total pages included in the book. Foods are photographed on appropriate plates or in bowls, and some photos include accessories of common household silverware such as a fork or spoon. The book was created to be used by nutrition professionals in various settings for portion size education and dietary recall of portions. The book features portion sizes that vary according to the Nutrition Facts label, diabetic exchanges, and the USDA Food Guide Pyramid for ease of use by the client and nutrition professional. A color code is located on each page to identify which photo represents the Nutrition Facts label, USDA Pyramid, and diabetic exchange portion. Forms of the food pictured may vary in order to provide the best means of estimation; for example, a glass of milk displayed in a tall, narrow glass as well as in a shorter, wider glass. Portion Photos of Popular Foods is available for purchase for $169 through the American Dietetic Association (ISBN: 978-0-88091-162-7). It is a spiral-bound book that measures 12" x 15", small enough to transport easily.

Chapter III: Methodology

Larger portion sizes have emerged along with increases in the availability of food in the US food supply, caloric intake from food, and higher rates of obesity. Individuals tend to overlook monitoring their portion sizes in an effort to manage their weight, which suggests the importance of stressing the impact of portion sizes on caloric intake and weight management (Young & Nestle, 2002).

A major obstacle for individuals to control dietary intake is the inability to estimate portion size (Byrd-Bredbenner & Schwartz, 2004). Portion size estimation aids (PSEAs) may be beneficial for individuals who are describing their portion size (McGuire et al., 2001). Aids most commonly used are portion size models of neutral shapes, models that replicate actual foods, and food photographs. Using photographs has many benefits including the ability to copy them for questionnaires, opportunity to make them specific and include a variety of individual foods (Nelson et al., 1996). Portion size measurement aids (PSMAs) are lightweight, inexpensive, compact, easily transported, and easy to obtain (Byrd-Bredbenner & Schwartz, 2004). According to Lillegaard, Overby, and Andersen (2005), visual aids, such as food photographs, may help to improve subjects' ability to accurately describe portion sizes. As a result of their study, they also concluded that a book containing food photographs can be helpful for children and adolescents to estimate portion size.

Usually food photographs are taken of small, medium, and large portions. Subjects pick the photo that best represents their typical portion size (Nelson et al., 1994). Nelson et al. also describe a complex mental process that occurs when portion sizes are identified using food photographs. The process involves perception, conceptualization, and memory. Perception is when a subject relates a food amount that is physically present to an amount shown in a photograph. Conceptualization is a subject's ability to mentally visualize an amount of food that is not currently present, and relate it to an amount in a

food photograph. Memory has an effect on the accuracy of the conceptualization. Previous research has shown the benefits of using photographs to aid subjects in estimating portion size (Nelson et al., 1996).

The *Portion Photos of Popular Foods* book (Hess, 1997) is a photographic aid that can be used for portion size estimation. The book has 109 life size photos of foods commonly consumed in the US. Each food is shown in three different portion sizes: small, medium, and large, respectively. The book was created noting the varying portions described by the Nutrition Facts label, Food Guide Pyramid, and the food exchanges of each food (Edens, 2003).

It is important to research the typical portion sizes of young adults, as well as how typical portion sizes compare to standard portion sizes (Schwartz & Byrd-Bredbenner, 2006). This research paper investigated the aforementioned using life-size color food photographs. Sections addressed in this chapter include subject selection and description, instrumentation, data collection procedures, data analysis, and limitations of the study.

Subject Selection and Description

The sample population for this study was college athletes, ages 18-22. The athletes were participating in their sport's pre-season at the University of Wisconsin – Stout during the month of August, 2006. The subjects who participated in this study were involved in football, women's soccer, women's volleyball, and men's cross country. The Institutional Review Board (IRB) for the Protection of Human Subjects at the University of Wisconsin-Stout approved this research study. An informed consent form (Appendix A) was used for the study. Participation was strictly voluntary as described on the participant consent form and could be terminated at any time without discrimination. The consent form also explained that confidentiality would be sustained during the study.

Instrumentation

The survey used in this study was a 26 question survey (Appendix B). Subjects were asked to report their age, sport, and height and weight. Subjects were also asked about their level of interest in nutrition, previous college courses taken in nutrition, who taught them the most about nutrition, and the subject's desire to gain, lose, or maintain weight. The survey was developed by the researcher solely for use in this research study. The researchers had a handout for their own reference that contained the page number of each food item, the name of the food, and the standard portion size of each of the six foods used in this research study to refer to during the data collection procedure.

Data Collection Procedures

The researcher first prepared for the research study by choosing six foods representing various food groups to be researched in this study. Cornbread, pancakes, rice, mixed vegetables, watermelon, and beef patty were the six foods designated for the study. These foods were elected to be in the study because they represented various food groups as well as different shapes for portion estimation. The researcher labeled the photographs in the *Portion Photos of Popular Foods* book (Hess, 1997) with letters on post-it notes so they would stick to the page and clearly label the photo it correlated to. The letter A was assigned to the smallest portion photo, B to the medium sized portion photo, letter C to the largest portion photo, and the letter D was placed on the side of the page as it described a portion larger than any of those pictured. A manila folder was also prepared before data collection for completed surveys to be placed into once each subject completed the survey to ensure confidentiality.

The researcher sent an email to the coaches of the women's volleyball team, the football team, the men's cross country team, and the women's soccer team. The email gave background information about the researcher and the research project to be completed. It stated the requirements of the athletes who chose to participate as well as

the day the research was to be conducted. The athletes' participation in the study occurred during pre-season. The time of day was after the athletes finished practice in their particular sport, but before the athletes ate supper to assume that hunger was a constant for all athletes who participated. The athletes were asked to participate as they were on their way to eat dinner at the UW-Stout Merle M. Price Commons. Two tables were set up in the Commons with two researchers present.

As the athletes arrived to participate in the study, they were given an informed consent form to read over and a paper 26 question survey was administered to each subject. Subjects were standing during the study and used the table as a hard surface to place their surveys on to record responses. Pens were provided, and small groups ranging from two to eight were randomly formed around each researcher to conduct the study. The study was done with free flow of subjects, which is why there was a range of group sizes. Once subjects agreed to terms of the study, they were given time to fill out the top portion of the survey which included sport, age, height, and weight. Subjects were also asked multiple choice questions about their level of interest in nutrition, previous college courses taken in nutrition, who taught them the most about nutrition, and the subject's desire to gain, lose, or maintain weight. Once subjects were ready to continue, the investigator opened the *Portion Photos of Popular Foods* book (Hess, 1997) to display the first food item. Subjects were instructed to look at the photos and refer to the first set of questions for the first food item. Once subjects arrived at the third question for each set of three questions, they were instructed to stop and wait for the researcher to say the standard portion size of the food. This process was repeated for each of the six different food items. Subjects then turned in their completed surveys to the manila envelope.

Data Analysis

A number of statistical analyses were used in this study. The Statistical Program for Social Sciences, version 14.0, (SPSS, 2005) was used to analyze the data.

Demographic information was analyzed using descriptive statistics such as percentages and frequencies. Crosstabulation (frequencies and percentages) with a Pearson Chi-Square analysis between BMI category and gender, and between sport and gender were analyzed. Independent group t-tests were used to analyze characteristics within gender. Chi square analyses were used to assess the correlation between BMI and typical portion size. Pearson's correlation coefficient was used to assess the association between factors such as BMI and gender, and their effect on portion sizes.

Limitations

A weakness of this study was the limited number of subjects who participated, which makes the results less generalizable. There was also a large group size during the data collection. Subjects may have felt that other participants nearby might see their reported weight or other survey responses. Height and weight were self-reported. It was assumed that the athletes were very familiar with their height and weight. Another limitation is that both genders were not represented for each sport; for example, female soccer players participated in the study, but male soccer players did not. The study also focused on only six foods without obtaining subjects' food preferences prior to the study. Subject likes and dislikes may have influenced the reported typical portion size.

Chapter IV: Results

Obesity is more prevalent than ever, with a 74% increase in the number of people who are obese since 1991 (Burger, Kern, & Coleman, 2007). The increase in portion sizes is one of the contributing factors to the drastic rise in obesity. When individuals consume more food, their energy intake increases (Kral et al., 2004). Caloric intake becomes even higher with added effects of larger portion size and energy-dense foods. "Many Americans believe that the kind of food they eat is more important than its quantity" (Young & Nestle, 2003, 234). Individuals have a tendency to eat more food when they are served a large amount of food at one time (Nestle, 2003).

To help nutrition professionals combat the rise in obesity and obtain accurate calorie and nutrient records, it is important to assess the diets of patients and clients (Byrd-Bredbenner & Schwartz, 2004). Portion size estimation is difficult; thus there is a relatively high percentage of error when individuals estimate portions of foods consumed (Godwin et al., 2004). There are numerous ways to collect information about an individual's dietary intake including obtaining the weight of the foods, directly observing the person while eating, 24 hour recalls, food records, and food frequency questionnaires (Williamson et al., 2003).

Dietary intake data relies on the individual's ability to recall food portions and keep good records of what they ate. The most accurate way to determine a person's actual food intake is weighing the food before and after eating. Weighing food can be problematic, however, because it is expensive, time-consuming, and disruptive. Portion estimation of foods that are solid, liquid, and amorphous may improve with the use of PSMAs (Byrd-Bredbenner & Schwartz, 2004). Examples of PSMAs used may be replica food models, food photographs, or rulers, bean bags, measuring cups, and numerous other resources.

For this research study, food photographs from the *Portion Photos of Popular Foods* (Hess, 1997) were used to accompany a survey. The survey was given to subjects to complete, asking them to report demographic information, as well as answer a set of three questions about six specific food items. Participants were asked to mark the letter on their survey that corresponded with the food photograph that best represented each of the following: their typical portion size, their perception of which photo best represented what they felt was a standard portion size according to the USDA's MyPyramid guidelines, and which photo represented their perception of the standard portion size according to MyPyramid. The purpose was to determine the typical portion sizes that various athletes consume, what their perception of a standard portion size of six common foods were, and to determine whether subject characteristics played a significant role in their portion size perceptions.

Item Analysis

Based on the objectives of the study, the data were analyzed and broken down into the following sections: description of subjects and portion size analysis.

Description of subjects

There were 86 total participants in the study, who were ages 18-22, from the football, soccer, volleyball, and cross country teams at UW-Stout. Age was similar among males and females in this study. Males tended to be taller and weigh more than females (Table 1). Table 1 shows that on average, males were .15m taller than females in the study, and average weight was 29.51kg more than the females. An ANOVA analysis showed significance for both at $p<.001$. There were 49 males and 37 females.

Table 1

Mean and Standard Deviation for Demographics By Gender

	Total Group		Males		Females	
Variable	M	SD	M	SD	M	SD
Age (years)	19.34	1.21	19.08	1.19	19.68	1.18
Height (m)	1.77***	0.10	1.84	0.06	1.69	0.08
Weight (kg)	82.28***	22.20	94.98	21.21	65.47	7.33
BMI (kg/m2)	25.83	5.01	27.98	5.52	22.98	2.04

***p<.001.

There were a total of 41 males in football, 8 males in cross country, 22 females in soccer, and 15 females in volleyball who participated in the study. Table 2 provides subject demographics by sport.

Table 2

Mean and Standard Deviation for Demographics By Sport

	Males				Females			
	Football		Cross Country		Soccer		Volleyball	
Variable	M	SD	M	SD	M	SD	M	SD
Age (years)	18.90	1.09	20.00	1.31	19.45	1.18	20.00	1.13
Height (m)	1.84	0.06	1.80	0.05	1.65***	0.06	1.74***	0.07
Weight (kg)	100.20***	18.96	68.03***	6.29	61.54***	5.14	71.21***	6.25
BMI (kg/m2)	29.38***	4.90	20.84***	1.56	22.58***	1.81	23.57***	2.26

***p<.001.

The average weight of participants on the football team was significantly (p<.001) greater than the weights of participants in the other three sports. BMI for football players was significantly greater than the BMI of cross country, soccer, and volleyball players (p<.001). Football players had the highest BMI (29.38), and the cross country runners had the lowest BMI (20.84), even though sports were of similar heights (1.80m and 1.84m). These data were not statistically significant. Female participants from the volleyball team (1.74m) were significantly taller (p<.001) than the soccer players (1.65m).

Table 3 categorizes the BMI of males and females. The majority (58.1%) of both males and females were of normal weight, and only one [female] participant fell into the anorexic category. More males than females were in the overweight or obese categories, and no females had a BMI that placed them in any of the categories beyond marginally overweight. These data were not statistically significant.

Table 3

BMI Category by Gender

	Total		Male		Female	
Variable	Frequency	%	Frequency	%	Frequency	%
Anorexic	1	1.2	0	0.0	1	2.7
Underweight	3	3.5	3	6.1	0	0.0
Normal range	50	58.1	17	34.7	33	89.2
Marginally overweight	11	12.8	8	16.3	3	8.1
Overweight	9	10.5	9	18.4	0	0.0
Obese	7	8.1	7	14.3	0	0.0
Severely obese	3	3.5	3	6.1	0	0.0
Morbidly obese	2	2.3	2	4.1	0	0.0

Note. BMI is weight in kilograms divided by height in meters squared (kg/m^2). BMI categories are as follows: anorexic is <17.5, underweight is 17.5-20.7, normal range is 20.7-26.3, marginally overweight is 26.3-27.7, overweight is 27.7-31.1, obese is 31.1-35, severely obese is 35-40, and morbidly obese is >40.

Table 4 breaks down BMI category by sport. For males, the cross country runners had BMIs that placed them in underweight and normal weight categories, and only football players made up the overweight and obese categories. It is notable that 75.0% of the total underweight participants were in cross country, whereas 72.7% of the marginally overweight participants were in football. No statistical significance was found. For females, almost all (95.5%) of the soccer players and 80.0% of volleyball players had BMIs in the normal range.

Table 4

BMI Category By Sport

	Football		Cross Country		Soccer		Volleyball	
Variable	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Anorexic	0	0.0	0	0.0	0	0.0	1	6.7
Underweight	0	0.0	3	37.5	0	0.0	0	0.0
Normal range	12	29.3	5	62.5	21	95.5	12	80.0
Marginally overweight	8	19.5	0	0.0	1	4.5	2	13.3
Overweight	9	22.0	0	0.0	0	0.0	0	0.0
Obese	7	17.1	0	0.0	0	0.0	0	0.0
Severely obese	3	7.3	0	0.0	0	0.0	0	0.0
Morbidly obese	2	4.9	0	0.0	0	0.0	0	0.0

Note. BMI categories are as follows: anorexic is <17.5, underweight is 17.5-20.7, normal range is 20.7-26.3, marginally overweight is 26.3-27.7, overweight is 27.7-31.1, obese is 31.1-35, severely obese is 35-40, and morbidly obese is >40.

As shown in Table 5, more males (51.0%) desired to gain weight than females (2.7%). Females were more interested in losing weight (54.0%) than males (12.2%). A Pearson Chi-Square analysis showed a significant difference ($p<.001$) between males and females in their attempt to change their weight.

Most female athletes (51.4%) derived most of their nutrition information from family, while 30.6% of males obtained nutrition information from health professionals and 28.6% from coaches. Due to small cell sizes, chi-square results could not be used to indicate statistical significance for these data.

Level of interest in nutrition was similar for both males and females as 44.9% of males and 43.2% of females had a high level of interest in nutrition. Most males (46.9%)

had a medium interest in nutrition, and 51.4% of females had a medium interest. Only 8.2% of males and 5.4% of females had a low interest in nutrition.

Most participants had not taken a nutrition course prior to the study, but in general, more females (27.0%) than males (12.2%) had taken a nutrition course. This was not statistically significant.

Table 5

Survey Responses by Gender

	Total n=86		Male		Female	
Variable	Frequency	%	Frequency	%	Frequency	%
Currently attempting to						
Gain Weight	26***	30.2	25	51.0	1	2.7
Lose Weight	26***	30.2	6	12.2	20	54.1
Maintain Weight	34	39.5	18	36.7	16	43.2
Source of nutrition information						
Teachers	9	10.5	6	12.2	3	8.1
Family	22	25.6	3	6.1	19	51.4
Coaches	18	20.9	14	28.6	4	10.8
Health professionals	21	24.4	15	30.6	6	16.2
Media	3	3.5	1	2.0	2	5.4
Multiple responses	13	15.1	10	20.4	3	8.1
Level in interest in nutrition						
High	38	44.2	22	44.9	16	43.2
Medium	42	48.8	23	46.9	19	51.4
Low	6	7.0	4	8.2	2	5.4
Nutrition courses taken						
Yes	16	18.6	6	12.2	10	27.0
No	70	81.4	43	87.8	27	73.0

***$p<.001$.

Table 6 displays the survey responses by sport. As mentioned previously, males were more interested in gaining weight. Over half of the males who wanted to gain weight were football players (53.7%); however, the cross country team was more likely

to want to maintain current weight. Both of the women's teams were more interested in losing or maintaining current weight.

Sources of nutrition information for males in both football and cross country were predominantly coaches and health professionals. The female volleyball players reported that family (80.0%) was the primary source of their nutrition information, whereas 31.8% of the soccer players reported they obtained their information from family. Participants from soccer also reported getting their nutrition information from coaches and health professionals (18.2% for both). These data were not found to be statistically significant.

Each sport reported a high level of interest in nutrition at 40.0% or higher. Most of the participants in the study had a medium level of interest in nutrition, with the lowest percentage being 46.3% of football players. No cross country runners had a low level of interest in nutrition, while only 9.8% of football players, and 4.5% of soccer and 6.7% of volleyball players had a low level of interest. Most of the athletes had not previously taken a course in nutrition. Only 9.8% of football players, 25.0% of cross country runners, 31.8% of soccer players, and 20.0% of volleyball players reported having taken a course in nutrition.

Table 6

Survey Responses by Sport

	Football		Cross Country		Soccer		Volleyball	
Variable	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Currently attempting to								
Gain Weight	22	53.7	3	37.5	0	0.0	1	6.7
Lose Weight	5	12.2	1	12.5	12	54.5	8	53.3
Maintain Weight	14	34.1	4	50.0	10	45.5	6	40
Source of nutrition information								
Teachers	5	12.2	1	12.5	3	13.6	0	0
Family	3	7.3	0	0.0	7	31.8	12	80
Coaches	10	24.4	4	50.0	4	18.2	0	0
Health professionals	13	31.7	2	25.0	4	18.2	2	13.3
Media	1	2.4	0	0.0	2	9.1	0	0
Multiple responses	9	22.0	1	12.5	2	9.1	1	6.7
Level of interest in nutrition								
High	18	43.9	4	50.0	10	45.5	6	40
Medium	19	46.3	4	50.0	11	50.0	8	53.3
Low	4	9.8	0	0.0	1	4.5	1	6.7
Nutrition classes taken								
Yes	4	9.8	2	25.0	7	31.8	3	20
No	37	90.2	6	75.0	15	68.2	12	80

Portion size analysis

Eight graphs were created to depict the differences between the subjects' typical portion size, their estimate of what a standard portion size was, and what their perception

was of the actual USDA standard portion size. After comparing the data using crosstabs and the Pearson Chi-Square tests for the six food items, there were only two significant differences found for the typical portion size, estimates of a standard portion size, and the actual USDA standard portion size between genders. The estimate of which photograph represented a standard portion size of cornbread was significant ($p<.001$), and the estimate of which photograph represented a standard portion size of watermelon was significant at $p<.05$. Only gender is compared for each of the six food items because no correlation between portion size and sport or age was found. For each of the following graphs of the subjects' portion size estimates for the six food items, the small was the actual standard portion size according to USDA's MyPyramid.

Figure 1, on the following page, shows the total for both genders' estimates of the portion size of cornbread. Most (91.9%) of the estimates for the amount of cornbread typically consumed were medium or large. More than one third (38.4%) of respondents identified the correct standard portion size for cornbread. Close to 28.0% of respondents chose the large portion as their perception of a standard portion size.

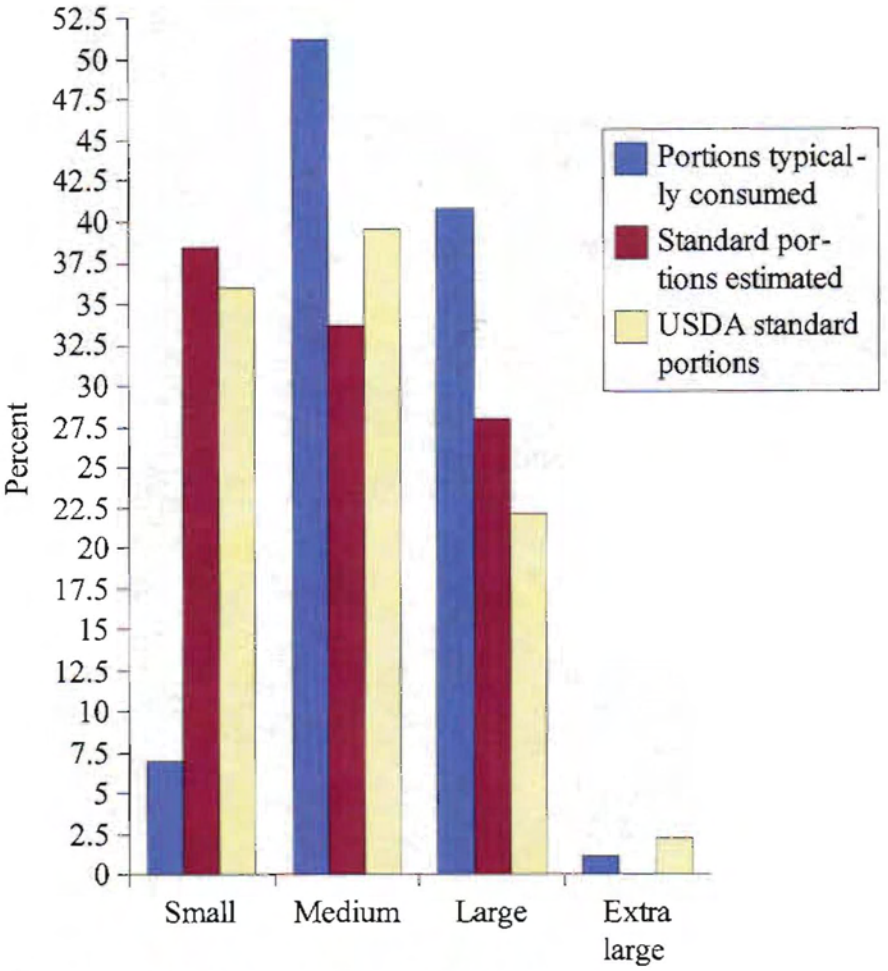

Figure 1. Estimates of portion size for cornbread.

There was a significant difference ($p<.001$) between genders for the estimation of a standard portion size of cornbread. Figure 2 shows the difference between males and females in what their perception of a standard portion size was. More females (64.9%) than males (18.4%) chose the correct standard portion size, the small, whereas 8.1% of females and 42.9% of males chose the large portion.

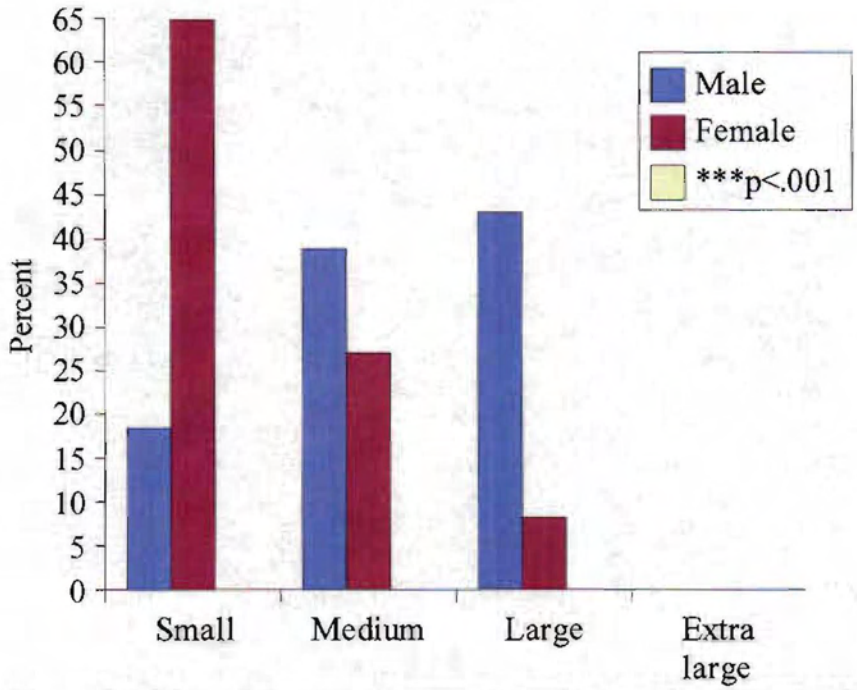

Figure 2. Male and female estimates of standard portion size of cornbread.

Figure 3 shows that 54.7% of respondents typically eat a medium sized portion of pancakes and less than 15.0% eat the actual standard portion size, the small. When subjects estimated what a standard portion size of pancakes was, 54.7% felt that it was the medium size portion while 34.9% chose the correct response. Once subjects were told the standard portion size according to the USDA, 64.0% chose the small portion size. Only 1.2% chose the extra large portion, 19.8% chose the medium portion, and 15.1% chose the large portion size.

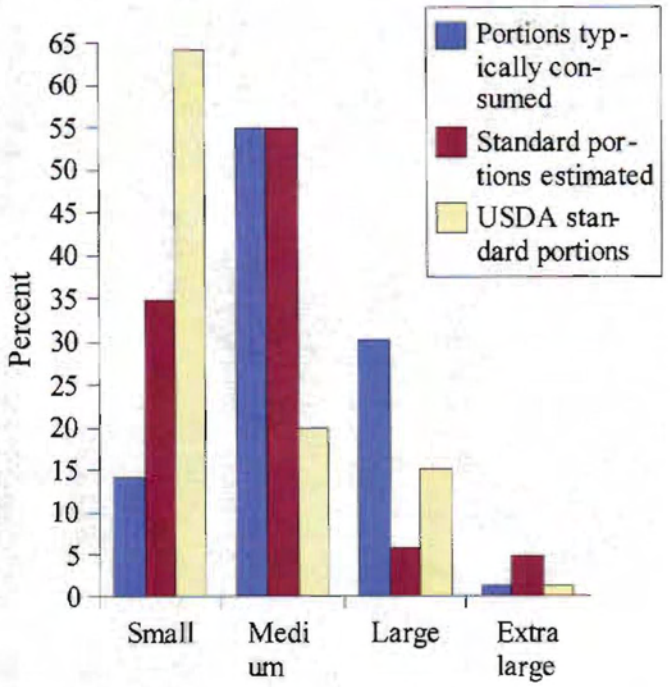

Figure 3. Estimates of portion size for pancakes.

Figure 4 depicts portion estimates of rice. Less than 20.0% of subjects typically eat a small portion of rice. More subjects (10.5%) chose an extra large portion of rice as their typical portion size than the other five foods in this study. Combined, 70.8% of subjects typically eat a medium or large portion of rice. Almost half (45.3%) of subjects were able to correctly estimate a standard portion of rice, which is one third cup cooked. Another 41.9% chose the medium portion as their estimate of a standard portion size. Once subjects were informed of the actual standard portion size measurement, 62.8% chose the correct portion size, while still 2.8% chose the large portion size.

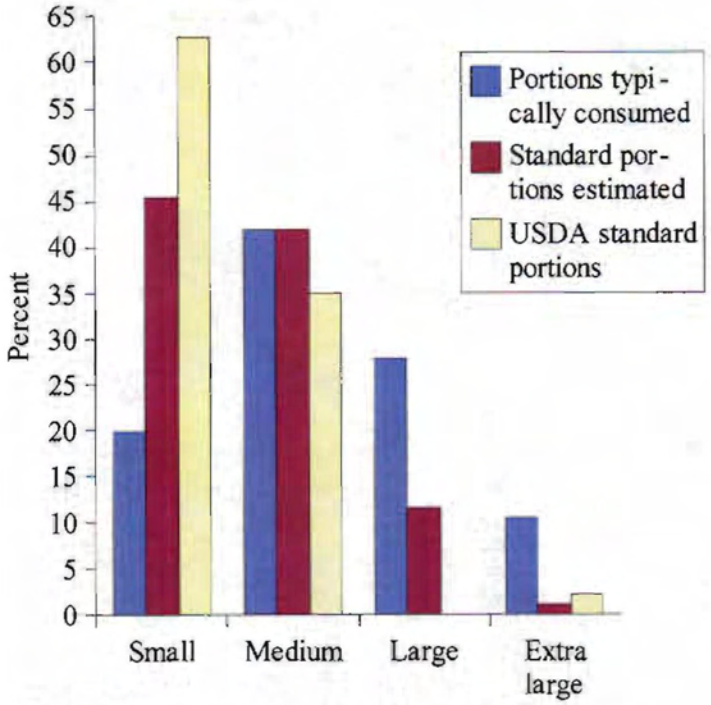

Figure 4. Estimates of portion size for rice.

Figure 5 depicts portion estimates of mixed vegetables. One third (33.7%) chose the small, 38.4% chose the medium, 26.7% chose the large, and 1.20% chose the extra large as their typical portion size. Subjects' estimates of a standard portion size of mixed vegetables was mostly small or medium, with one third estimating the small, and 44.2% estimating that medium was the correct standard portion size. About one third (34.9%) chose the small for their estimate of the USDA standard portion size, and 45.3% chose the medium; however 17.4% and 2.3% chose the large and extra large portions.

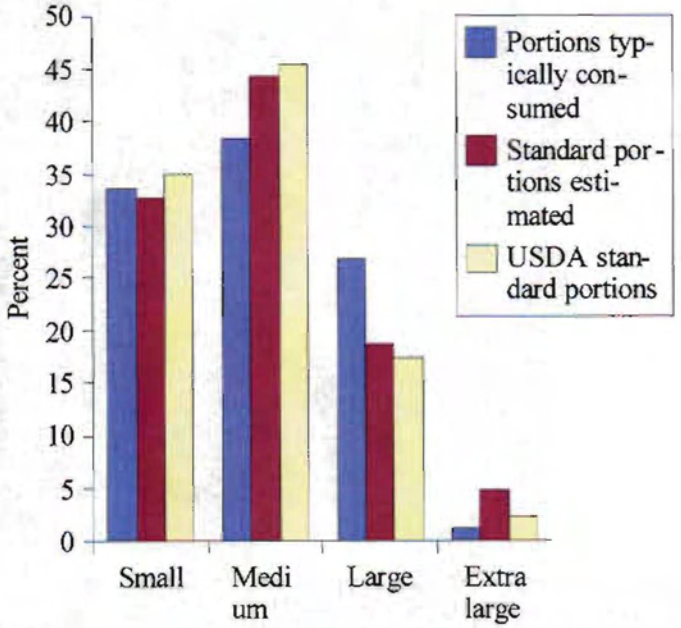

Figure 5. Estimates of portion size for mixed vegetables.

Figure 6 displays portion size estimates for watermelon. Typical portion size for watermelon was consumed mostly in the medium portion size (55.8%), 19.8% of subjects ate large portions, only 18.6% typically ate small portions, and 5.8% ate extra large portions. When subjects estimated the standard portion size of watermelon, 37.2% selected the small, 52.3% chose the medium, and 10.5% felt that it was the large portion. A significant difference ($p<.05$) between genders was found here. Figure 7 shows the difference between males and females' estimates of standard portion size for watermelon. The highest percentage of subjects (68.6%) were correct in estimating the USDA standard portion size for watermelon than any of the other five foods in this study, and 24.4% chose the medium size portion.

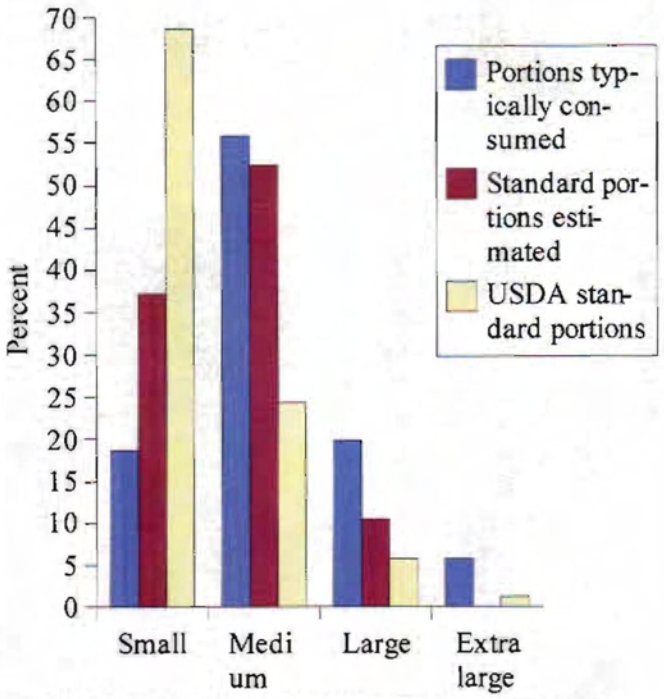

Figure 6. Estimates of portion size for watermelon.

In Figure 7, more males (14.3%) than females (5.4%) chose the large portion of watermelon for their estimate of a standard portion size, 40.8% of males and 67.6% of females chose the medium portion, and 44.9% of males and 27.0% of females chose the small portion. Neither gender estimated the extra large portion to be the standard portion size. A significant difference ($p<.05$) was found between genders for estimation of portion size for watermelon.

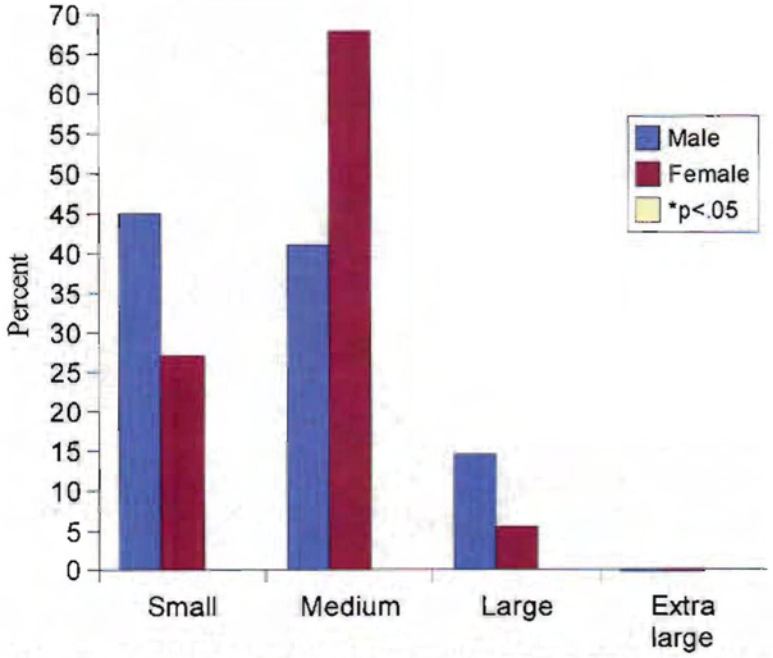

Figure 7. Male and female estimates of standard portion size of watermelon.

Figure 8 represents subjects' estimates of portion size for a beef patty. Subjects' typical portion sizes included 15.1% who chose the small, 44.2% who chose medium, 31.4% selected large, and 9.3% selected extra large portions. For estimating standard portion size, most (53.5%) subjects chose the small portion, and 41.9% chose the medium portion. In comparison to that, when subjects were told the USDA standard portion size, 72.1% chose the small portion, 24.4% chose the medium, and 3.5% chose the large portion.

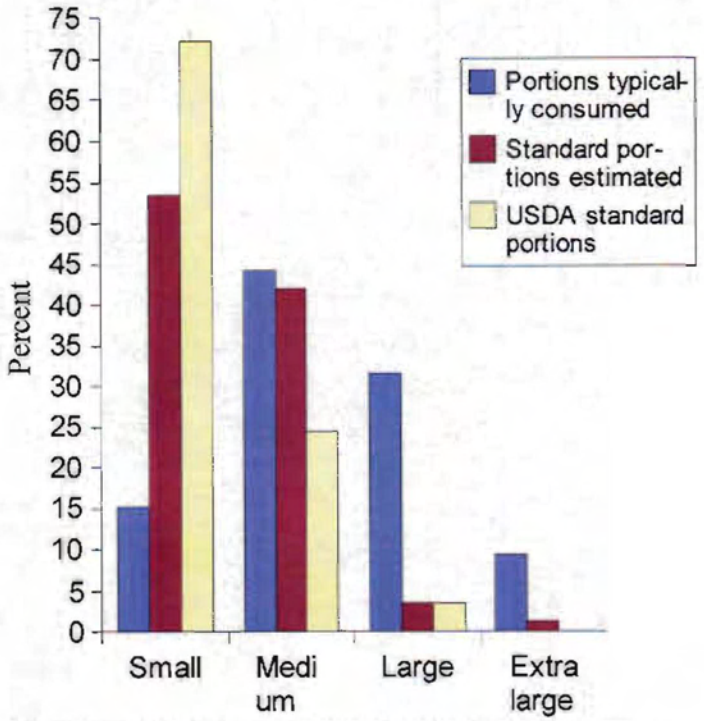

Figure 8. Estimates of portion size for beef patty.

It is notable that due to small cell sizes, it was difficult to obtain significance or generalize the results of the data collected from this portion of the study.

Chapter V: Discussion

Obesity is increasing at a rapid rate in the United States and has become a major public health problem (Nestle, 2003). The increase in caloric intake from large portion sizes contributes to the obesity epidemic as individuals take in more calories than they burn (Young & Nestle, 2002). Dietitians collect dietary intake data to assess the calorie and nutrient intakes of clients, and they should ask questions to obtain more accurate information about the actual amount of food eaten (Young & Nestle, 1998). Estimating portion size for dietary intake data has many possible inaccuracies that can accompany it (Godwin et al., 2004). Portion size aids, such as portion models, food photos, and food replicas, can be used to help estimate portion sizes (Nelson et al., 1996). Visual aids can help with portion estimation, though the extent of their benefits is not known (Robson & Livingstone, 2000). This study investigated the typical portion sizes of various collegiate athletes compared to their perception of what a standard portion is, and if they can identify from a photo what best represents a standard portion size of six different foods. A survey instrument was developed to obtain subject demographic information and record subject responses to questions about typical portion size and perceived portion size. The 86 subjects participating in the study were athletes on the University of Wisconsin – Stout's women's volleyball, women's soccer, men's football, and men's cross country teams. Data were collected and results were analyzed to determine if subject characteristics impacted typical portion size and portion estimation, and to compare subjects' portion size perceptions to determine if they are able to identify a standard portion size of six commonly consumed foods using food photographs. Other purposes of the study were to compare reported typical portion sizes to what subjects perceive to be a standard portion size, and to determine whether dietitians should educate athletes about standard portion sizes and how large portion sizes affect energy intake and weight management.

Limitations

There were several limitations in this study. One of the limitations was the small sample size from a Wisconsin University that draws students mainly from Wisconsin and Minnesota. The results may not represent collegiate athletes of these sports as a whole. Subjects may also have responded to survey questions according to what they thought were the researcher's expectations instead of choosing the answers that best represented their perspective. There was also a large group size during the data collection. Subjects may have felt that other participants nearby might see their reported weight or other survey responses. Height and weight were self-reported by subjects. Another limitation is that the researcher could not compare data between both genders of the same sport. The number of foods examined were limited in this study due to practical use of time. Lastly, subject likes and dislikes of the six foods chosen for the study may have influenced the reported typical portion size.

Conclusions

The first objective of this study was to identify any factors that significantly affected subjects' typical portion size and subjects' view of a standard portion size. Finding that males choose larger portions of some foods than females was expected (Schwartz & Byrd-Bredbenner, 2006). Males tend to be larger than females, causing their bodies to require more calories. Schwartz and Byrd-Bredbenner suggest that individuals who are not familiar with standard portion sizes and have large typical portion sizes will probably have more difficulty managing their weight and other health-related conditions.

In this study, there was no significant effect of subject characteristics such as age and BMI in perceptions of portion size, and only in two instances there was an effect of gender on portion size. Opposing the general findings of this study was a study by Nelson et al. (1996) that found that age, sex, and BMI were factors that affected estimates of subjects who used eight portion photos to estimate food portions. Burger et al. (2007),

also found that males chose significantly larger portion sizes than the standard portion in some foods. They also found that a higher BMI led to larger typical portion sizes of some foods compared to the standard portion size.

On the other hand, there have been other studies that found no effect of subject characteristics on portion size. Studies by Kral et al. (2004), Diliberti et al. (2004), and Byrd-Bredbenner and Schwartz (2004) found no effect of subject characteristics on portion size selections. A study by Rolls et al. (2002) found no effect of gender, age, or BMI on portion size and concluded that overall, subject characteristics had no significant effect of portion size on intake.

Subjects in this study were placed in BMI categories. Those placed in a BMI category called anorexic does not signify a medical diagnosis of anorexia, but simply describes the low weight compared to the height of the individual. The same is true for those placed in the categories up to morbidly obese, except that they have a higher mass compared to their height. O'Kane et al. (2002) mentioned that power-sport athletes tend to have higher BMIs than endurance athletes and the general population. Many athletes are lean individuals, but may have a falsely high BMI due to increased muscle mass. For example, in this study, cross country runners tended to have a much lower BMI than the football players, probably due to the large amount of muscle mass the football players carry.

The second objective was to analyze subjects' perceptions of a standard portion size to determine if they were able to identify a standard portion size using food photographs. It can be concluded from this study that most athletes experience portion distortion. A majority of subjects typically consumed larger portions than the standard portion size, and many were unable to correctly identify the photo that represented a standard portion. A study by Schwartz and Byrd-Bredbenner (2006) concurs with this conclusion as they also found that young adults experience portion distortion with some

foods. Rolls et al. (2002) also found that the more food subjects were served, the more they ate. Subjects did not realize they were eating larger portions, thus they too experienced portion distortion. Rolls et al. (2006) later found similar results. Increased portion size led to increased intake in subjects, thus causing a higher energy intake, basically unnoticed by participants. Levitsky and Youn (2004) also found results similar to the aforementioned studies. Bryant and Dundes (2005) found that there was about an equal amount of subjects who overestimated or underestimated standard portion sizes. In the study, reported typical consumption of cereal and punch tended to be 50% or less of what the subjects were actually consuming. Chambers et al. (2000) found that most subjects in their study experienced portion distortion.

Based on the findings in this study, it can be concluded that dietitians and nutrition professionals should develop portion size education materials to present to collegiate athletes and the general population alike. Levitsky and Youn (2004, 2549) summarize the aforementioned perspective: "...it should be possible to stop and possibly reverse this trend toward increased body weight by controlling the size of portions served to the American people." A suggestion by Ello-Martin et al. (2005, 238S) was to "...train adults to recognize and respond to their physiologic cues related to satiety." Furthermore, Ello-Martin et al. suggested that it would be beneficial for the population if restaurants and other food vendors would offer smaller portion sizes at a cheaper cost than buying the larger portion. Education is a necessity for people to obtain the knowledge and skills they need to make lifestyle changes. Nutrition education should involve using aids that are helpful in teaching individuals about standard portion sizes. According to Rolls et al. (2002), nutrition education should also involve teaching individuals how to read food labels. Food Nutrition Facts labels list a serving size that tends to be much smaller than the typical portion size of most consumers. It is also vital to teach people how to limit the amount of food available as Rolls et al. found in their study that larger portions led to

increased energy intake. Schwartz and Byrd-Bredbenner (2006) suggest teaching individuals how to measure portion sizes accurately as well.

Recommendations

Further research is needed on the topic of using PSMAs such as food photographs. A study that would be beneficial is one that examines the accuracy of portion estimation using a set of three, four, or five varying portions of color, life-size food photographs for comparing portion estimations while subjects have the food right in front of them, immediately after they have eaten, and after some time has elapsed between when subjects eat the food and when they estimate the portions of food eaten at that meal.

It is also important for researchers to continue to evaluate which PSMAs work best for clients and subjects to most accurately estimate their portion sizes, especially for foods that are more difficult to estimate (Howat et al., 1994). In order to research accurate estimations of portion size, it is essential to measure what subjects actually consume as part of the study. This is important for comparing what was actually consumed to the participant's estimation of the amount consumed. Another possibility is to measure subjects' accuracy in estimating pre-measured or pre-weighed amounts of food using PSMAs.

Future studies should obtain data about subject likes and dislikes of the foods used for the study to ensure that individual preferences do not affect the portion size a subject chooses for each food. This will help prevent subjects from choosing less of a food they do not like or possibly consuming more of a food they like to compensate.

It would also be beneficial for Registered Dietitians to learn where collegiate athletes obtain most of their nutrition information. Registered Dietitians are already aware that there is much misinformation out there. The media plays a role in the lives of most Americans, so it is important for nutrition professionals to be involved with the

mass media to help educate the general population about various nutrition topics. In a future study, it might be beneficial to include peers as a response option to the question of where subjects obtain nutrition information on the survey used in this study because many athletes ask each other questions about nutrition.

The last objective of the study was to determine if dietitians should educate athletes about portion sizes and energy intake. After reviewing results from this study, it can be concluded that athletes experience portion distortion. Schwartz and Byrd-Bredbenner (2006) suggested that Registered dietitians should keep in mind when conducting dietary recalls with clients that their typical portion sizes are probably not the same as standard portion sizes. Portion sizes at restaurants will most likely not get smaller, but are following a trend toward portion sizes that are even larger than current portions. Registered dietitians need to express to clients how many calories they actually need, and the portion sizes that best suit their calorie limit compared to their typical portion sizes. "Bringing portion distortion under control could help confront and combat the growing diet-related problems in this country" (1417). Smiciklas-Wright et al. (2003) suggested that Registered dietitians should counsel clients about the need to decrease portion sizes and be able to recognize the difference between typical and standard portion sizes. Registered dietitians should emphasize the importance of physical activity and healthy eating for their dual role in weight loss. Nutrition education and counseling with young adults should cover the topics of controlling portion sizes of all foods as well as instilling in the client that they should pay attention to any change in eating habits based on food packaging and what the media conveys (Burger et al., 2007).

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Appendix A: IRB Protection of Human Subjects Consent Form

Consent to Participate In UW-Stout Approved Research

Title: Food Portion Size Perceptions of Various Athletes at UW-Stout

Investigator:
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Research Sponsor:
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Description: The study includes collegiate athletes identifying portion sizes, from a portion size photo book, that they would consume on an ordinary day of six different food items. Subjects will also come up with what they think a portion size of each of the six foods items would be according to the Food Guide Pyramid, and identify the picture that best represents that measurement. Finally, the investigator will share what the standard portion size is, and the subjects will identify the picture that they think best represents that measurement.

Risks and Benefits: The risk involved in participation of this study includes other athletes knowing you are participating in the study, a small time requirement, and emotional reflection on your eating habits. Your participation in this study could provide useful data that will help formulate nutrition education guidelines designed to teach athletes what standard size portions look like to learn the basis for a healthy lifestyle, and can develop lifelong nutrition habits beginning as a collegiate athlete.

Time Commitment and Payment:
The estimated amount of time requested of you in order to complete the study is 15-25 minutes.

Confidentiality:
Your name will not be included on any documents. We do not believe that you can be identified from any of this information. This informed consent will not be kept with any of the other documents completed with this project.

Right to Withdraw:
Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. Should you choose to participate and later wish to withdraw from the study, you may discontinue your participation at this time without incurring adverse consequences.

IRB Approval:
This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

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Statement of Consent:

By completing the following survey, you agree to participate in the project entitled Food Portion Size Perceptions of Athletes at UW-Stout.

Appendix B: Survey

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Food Portion Size Perceptions of Athletes at UW-Stout

Age_____ Sport_____ Height_____'_____" Weight_____lbs.

Circle one. Are you currently trying to gain, lose, or maintain your weight?
☐ gain
☐ lose
☐ maintain

Who taught you the most about nutrition? (Check one)
☐ teachers
☐ family/relatives
☐ friends
☐ coaches
☐ health professionals
☐ the media

What is your level of interest in nutrition?
☐ high
☐ medium
☐ low

Have you ever previously taken a college level nutrition class?
☐ yes
☐ no

If yes, please name the class(es) _____

_____

Food Item #1

1. Identify and check below the letter of the food item that best depicts the portion size you would consume of this food item on an average day.
☐ A
☐ B
☐ C
☐ D

2. Based on what you think a portion size of this food would be according to the Food Guide Pyramid, identify the picture that best represents that measurement and check the corresponding letter below.
☐ A
☐ B
☐ C
☐ D
Once you get to this question, stop. Wait for the researcher to state what a standard portion size is for this food item.

3. Now that you know the standard portion of the food item, choose the letter that you think best represents that standard measurement.

☐ A
☐ B
☐ C
☐ D

Food Item #2

1. Identify and check below the letter of the food item that best depicts the portion size you would consume of this food item on an average day.

☐ A
☐ B
☐ C
☐ D

2. Identify and check below the letter of the food item that you think best depicts an actual portion size of the food.

☐ A
☐ B
☐ C
☐ D

Once you get to this question, stop. Wait for the researcher to state what a standard portion size is for this food item.

3. Now that you know the standard portion of the food item, choose the letter that you think best represents that standard measurement.

☐ A
☐ B
☐ C
☐ D

Food Item #3

1. Identify and check below the letter of the food item that best depicts the portion size you would consume of this food item on an average day.

☐ A
☐ B
☐ C
☐ D

2. Identify and check below the letter of the food item that you think best depicts an actual portion size of the food.

☐ A
☐ B
☐ C
☐ D

Once you get to this question, stop. Wait for the researcher to state what a standard portion size is for this food item.

3. Now that you know the standard portion of the food item, choose the letter that you think best represents that standard measurement.

☐ A
☐ B
☐ C
☐ D

Food Item #4

1. Identify and check below the letter of the food item that best depicts the portion size you would consume of this food item on an average day.
☐ A
☐ B
☐ C
☐ D

2. Identify and check below the letter of the food item that you think best depicts an actual portion size of the food.
☐ A
☐ B
☐ C
☐ D

Once you get to this question, stop. Wait for the researcher to state what a standard portion size is for this food item.
3. Now that you know the standard portion of the food item, choose the letter that you think best represents that standard measurement.
☐ A
☐ B
☐ C
☐ D

Food Item #5

1. Identify and check below the letter of the food item that best depicts the portion size you would consume of this food item on an average day.
☐ A
☐ B
☐ C
☐ D

2. Identify and check below the letter of the food item that you think best depicts an actual portion size of the food.
☐ A
☐ B
☐ C
☐ D

Once you get to this question, stop. Wait for the researcher to state what a standard portion size is for this food item.
3. Now that you know the standard portion of the food item, choose the letter that you think best represents that standard measurement.
☐ A
☐ B

☐ C
☐ D

Food Item #6

1. Identify and circle below the letter of the food item that best depicts the portion size you would consume of this food item on an average day.
☐ A
☐ B
☐ C
☐ D

2. Identify and circle below the letter of the food item that you think best depicts an actual portion size of the food.
☐ A
☐ B
☐ C
☐ D

Once you get to this question, stop. Wait for the researcher to state what a standard portion size is for this food item.
3. Now that you know the standard portion of the food item, choose the letter that you think best represents that standard measurement.
☐ A
☐ B
☐ C
☐ D