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Title of Dissertation: "The Effect of Eating Style and Portion Size on the Accuracy of Dietary Self-Monitoring Among Normal Weight and Overweight Women"

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Doctor of Philosophy Degree
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ABSTRACT

Title of Thesis: The Effects of Eating Style and Portion Size on the Accuracy of Dietary Self-Monitoring Among Normal Weight and Overweight Women

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Given the dramatic rise in obesity and related disorders, it is imperative to improve the accuracy of dietary self-monitoring, a cornerstone of treatment. An ambulatory self-monitoring study and a laboratory food estimation study were used to examine (1) the role of eating style (gorging) and weight status (obesity) in dietary underreporting and (2) portion size as mechanism underlying dietary underreporting. Gorging was defined as two or fewer meals per day with at least seven hours between waking and the first meal. Obese was defined as a BMI between 25 and 34.9 kg/m^2.

Seventy-six women, ages 19-50 participated. A 2 x 2 (weight by eating style) between groups one-week ambulatory study design was used to examine the accuracy of dietary self-monitoring. Reported energy intake (EI), from a self-monitoring eating diary, was compared to measured energy needs assessed by an ambulatory activity monitor. Accuracy was determined by the Goldberg equation and the ratio of energy intake to energy expenditure (EI:EE). Overweight and gorgers were expected to underestimate EI as compared to normal weight and non-gorgers, respectively. Overweight gorgers were expected to underestimate EI compared to all other groups.

The effect of portion size on meal size estimation was examined using a laboratory based 2 x 2 x 2 x 2 (weight by eating style by meal size by time) mixed design. Both a regular and large meal size were presented during 2 laboratory visits, scheduled one week apart. Overweight gorgers were expected to underestimate large meals to a greater extent than all other groups. Groups were expected to underestimate large compared to regular meals.

Overall, energy needs were greater for obese and gorgers compared to normal weight and non-gorgers. However, there were no differences in report EI among overweight compared to normal weight women, and gorgers reported less EI than non-gorgers. This lack of difference in reported EI, a possible indication of dietary underreporting by overweight women, was not confirmed using the Goldberg equation or EI:EE. The Goldberg equation categorized 93.4% of all participants as underreporters, with no differences between groups. Comparing the EI:EE ratio between groups indicated that gorgers underreported compared to non-gorgers. For meal estimation, regular meals were less accurately estimated than large meals. Unexpectedly, all groups overestimated both small and large meals.

Few studies to date have examined factors explaining the association between weight and accuracy in reported intake. The role of large portion sizes as a mechanism underlying dietary underreporting was not supported. Future research should continue to focus on understanding mechanisms associated with accuracy of dietary self-monitoring. Knowing why people underreport can lead to improvements in accuracy, increasing our understanding of the relationship between eating behaviors and health, and also improve efforts for weight loss and weight maintenance.

The Effects of Eating Style and Portion Size on the Accuracy of Dietary Self-Monitoring Among Normal Weight and Overweight Women

by

Kristy L. Morris

Dissertation submitted to the faculty of the

Department of Medical and Clinical Psychology

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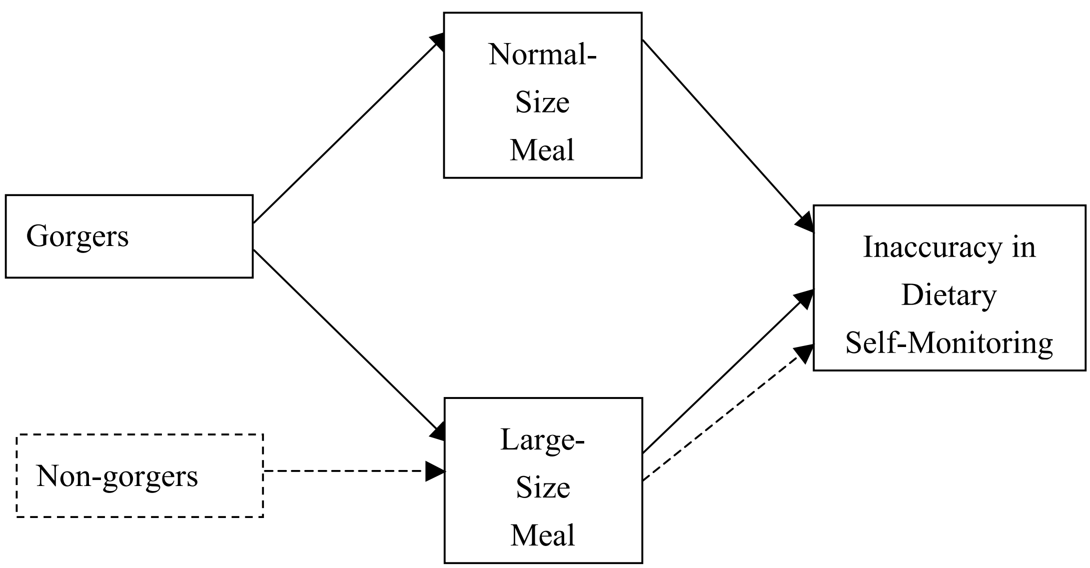
Introduction

Self-monitoring of eating behavior is the cornerstone of behavioral treatment approaches for weight management (Wadden & Sarwer, 1993). Dietary self-monitoring is used to understand the relationships between eating behaviors, a range of diseases (e.g., hypertension and diabetes), and the development and treatment of obesity. Accurate dietary self-monitoring is important for correctly identifying the relationship between nutrition and health (Macdiarmid & Blundell, 1998). In spite of its importance, the accuracy of self-monitored food intake is suboptimal (Bingham, 1987; Blundell, 2000; Burke et al., 2005; Lissner, Heitman, & Lindroos, 1998; Livingstone, 1995; Schoeller, 1990; Yon, Johnson, Harvey-Berino, Gold, & Howard, 2007). Inaccurate reporting, particularly underreporting, is the fundamental problem (Bingham, 1987; Lissner et al., 1989; Livingstone, 1995; Schoeller, 1990) and continues to be implicated as a serious challenge in studies of nutrition and health (Black, 2000).

Over the last decade, the identification and understanding of inaccurate dietary self-monitoring has been increasingly emphasized. To date, much of the research on dietary underreporting has focused on population characteristics, including weight status, sex, food types, and psychological factors such as dietary restraint. One of the most salient findings from these studies is the consistent association between dietary underreporting and overweight (Black, Jebb, & Bingham, 1991; Goris, Westerterp-Plantenga, & Westerterp, 2000; Heitmann, 1993; Livingston & Black, 2003; Livingston & Robson, 2000; Schoeller, 1990; Tooze et al., 2004). Overweight and obesity, however, are end points of sustained eating patterns and in themselves do not fully explain why differences in accuracy exist between normal weight and overweight people. The mechanisms that underlie dietary underreporting among overweight and obese individuals are still unknown. A detailed investigation of these differences is necessary to further the understanding of nuances in dietary self-monitoring. This study examines one proposed mechanism, eating style, as an explanatory factor underlying dietary underreporting among overweight as well as normal weight women.

Gorging is an eating style characterized by eating the majority of daily calories in one or two sittings. Difficulty in accurately estimating large portion sizes is expected to underlie the association between weight and eating style and dietary underreporting. Figure 1 provides a conceptual model of the proposed study.

Figure 1. The role of gorging in dietary underreporting.



In the present study, gorging was defined based on criteria used by Kim and colleagues (2007) as individuals with (a) an average of one or two eating episodes per day; (b) 7 or more hours between waking and the first eating episode, with less than 100 calories eaten from waking to the first episode; and (c) skipped breakfast and lunch on 3 out of 7 days for the past month. Individuals with regular eating patterns are defined as having (a) an average of three or more eating episodes per day (including labeling three of these episodes as breakfast, lunch, and dinner), with no less than 100 calories eaten per episode; (b) less than 3 hours between waking and the first eating episode; and (c) skipped meals less than 3 times per week for the past month, with breakfast and lunch not skipped successively in a day.

The introduction to this dissertation will first address the relationship between portion size and gorging, the nature of dietary assessment, methods of dietary assessment, and methods to determine the accuracy of dietary assessment are presented. Additionally, research to date on dietary underreporting is presented along with the methodologies to assess dietary underreporting, including changes in body weight, biomarkers, and estimated energy requirements and the Goldberg equation for metabolic rate. Next, the prevalence of dietary underreporting, selective underreporting, and the characteristics of dietary underreporting, including sex, obesity, dietary restraint are addressed. Then, ways in which human perception might influence dietary reporting, including the role of portion size on dietary underreporting are reviewed. The final sections of this dissertation address the methods and research design of this investigation, followed by a detailed description of results and discussion of the study findings.

Dietary Assessment

Nature of Dietary Underreporting

An individual's reported food intake may increase or decrease over an assessment period because of either natural variations in food intake or error in reporting. If the increase or decrease in food intake is related to natural variation, then the effects should balance across the study sample and therefore should not present a problem in the interpretation of research results. Variations in reported food intake are problematic for study interpretation when the source of the increase or decrease of food intake is not related to actual food intake, but rather reflects a recording error. Dietary underreporting, that is, reporting energy intake lower than what is consumed, is a more common error than over-reporting (Black, 2000; Macdiarmid & Blundell, 1998). Recording errors may be a result of intentional underreporting and/or unintentional underreporting (Macdiarmid & Blundell, 1998). Unfortunately—further complicating work in this field—the role of each behavioral process involved in reporting errors appears to vary based on the method of dietary assessment (Bingham, 1991).

Methods of Dietary Assessment

Several methods are available for collecting data on dietary intake, and they fall into two categories: retrospective and prospective dietary assessment. Retrospective assessment methods are those in which respondents are asked to retrieve and report memories of dietary intake (i.e., diet history interviews, dietary recall, and food frequency questionnaires (FFQ); Block, 1982; Marr, 1971; Young & Nestle, 1995). Prospective methods are methods in which food intake is recorded as it occurs (i.e., paper-and-pencil and computerized food diaries; Krause & Mahan, 1984; Stone et al., 2000).

Retrospective self-monitoring. Retrospective methods range from interviews, to self-report food frequency questionnaires, to in-person or telephone interviews about dietary intake over a specified period of time (e.g., 1 month, 1 year). The information obtained from retrospective methods may include a general description of an individual's typical diet, as in a diet history, and more detailed information about what an individual specifically eats, as assessed in a dietary interview (Smith, 1991).

Retrospective methods, particularly FFQ, are often used in epidemiologic research because of their efficiency and low cost. In FFQs, individuals are asked to count the frequency of consumption of each of a set of food and drink items (e.g., frequency of consumption of sugary cereals, fruits, vegetables) during a specified period (e.g., 1 month, 1 year). FFQs are often developed for a population of interest or modified for use in specific populations under study (e.g., urban, rural, Hispanic). This flexibility is particularly useful in epidemiologic studies that include diverse populations or any population in which an existing food frequency has not been adequately validated (Borrud, McPherson, Nichaman, Pillow, & Newell, 1989). However, it may be problematic when comparing across studies. Cognitive demands placed on the respondent (e.g., it requires memory, estimation, and judgment skills; Baranowski & Domel, 1994; Fries, Green, & Bowen, 1996) and potential social desirability biases are blamed for problems with retrospective dietary self-report.

Prospective self-monitoring. Prospective self-monitoring diaries are typically used for 3–7 days (Johnson, 2002) and are recorded by paper and pencil or computer. Accuracy of prospective monitoring has been found to improve with time, up to 7–10 days, after which precision no longer increases significantly (Forester, Jeffery, Van Natta, & Pirie, 1990; Hartman et al., 1990; Kushi, Kaye, Folsom, Soler, & Prineas, 1988; Mertz et al., 1991). Prospective monitoring is considered to be the so-called gold standard of dietary self-monitoring as it is the most accurate method of measuring dietary intake because it does not rely on memory and is relatively unaffected by problems of retrospective self-monitoring biases (Cook, Pryer, & Shetty, 2000).

Dietary Underreporting: Assessing the Validity of Dietary Intake Methods

Comparing Assessment Methodologies

The value of the data collected through dietary self-report or self-monitoring depends on the validity of the assessment methods. Dietary underreporting can occur using any method of dietary assessment, and many of the factors that contribute to underreporting are common across all methods (Macdiarmid & Blundell, 1998). To judge the accuracy of dietary self-monitoring techniques, self-reported food intake must be compared to another method of energy intake or requirements. This is complicated by the factors involved in self-monitoring and reporting of food intake.

The gold standard for validation of the accuracy of dietary assessment methods has changed over the years. Early methods of examining the accuracy of self-report assessment methods used comparisons of self-report measures as the gold standard. Later, multiple-day food records (e.g., 7 days) were used as the so-called reference instrument. They assumed that self-reported information was correct, errors in the reference instrument were independent of the measure being validated, and errors were independent of true intake (Kipins et al., 2001). Recent evidence suggests that these assumptions about dietary report reference instruments are not correct, that reports using food records or recalls are biased toward underreporting, and that individuals systematically differ in their reporting accuracy (Bandini, Schoeller, Cyr, & Dietz, 1990; Black, Bingham, Johansson, & Coward, 1997; Heitmann, 1993; Heitmann & Lissner, 1995; Martin et al., 1996; Sawaya et al., 1996). In spite of these shortcomings, 7-day records were at one time considered the gold standard for validating other assessment methods (Willett, 1990), until physiological measures became available (Block, 1982; Willett, 1990).

The self-monitoring procedure may change behaviors themselves (i.e., food intake; Stein & Corte, 2003), which is called *reactivity*. Although not all studies have found reactivity effects (Hufford, Shields, Shiffman, Paty, & Balabanis, 2002; Sobell, Bogardis, Schuller, Leo, & Sobell, 1989), evidence suggests that prospective dietary self-monitoring temporarily increases positive behaviors and decreases negative or socially undesirable behaviors (Kazdin, 1974; Willis & Nelson, 1982). In studies examining reactivity of eating behavior, results show that many participants admitted to intentionally altering their food intake (Macdiarmid & Blundell, 1997). One reason for intentional underreporting was identified as the hassle or inconvenience of recording. Because completing food records can be time consuming, participants described using alternative meal and snacking patterns, substituting foods that were easier to weigh, or not eating certain foods because they were too burdensome to record. Additionally, dietary monitoring might improve memory and awareness, therefore increasing the accuracy of dietary self-reporting. Prospective diaries are the current gold standard for self-reported food intake and will be used in this study. However, based on the above reasons, generalizability to individuals who do not keep records may be limited for the above reasons.

Changes in Body Weight

Several studies have used changes in body weight as a method of assessing dietary misreporting by comparing energy requirements for maintenance of body weight to self-reported energy intake (de Vries, Zock, Mesink, & Katan, 1994; Lissner et al., 1989; Mertz et al., 1991; Stockley, 1985). If, for example, reported energy intake is lower than expected energy expenditure with no notable weight change, dietary underreporting is assumed to cause the discrepancy. However, this method can be problematic as decreases in body weight may indicate reduced food intake, rather than underreporting. Using this method, up to 81% of participants underestimate their dietary intake (Mertz et al., 1991). Additionally, this method is not sensitive to metabolic rate or activity level. It also requires significant differences between energy intake and energy expenditure in order for weight change to be large enough to indicate accurate reporting of decreased food intake (de Vries, Zock, Mesink, & Katan, 1994).

Biomarkers to Validate Dietary Assessment

Biomarkers are measures in body fluids or tissues that reflect dietary intake independent of self-report (Katan, 1998). Such validation methods use energy requirements to validate energy intake and specific nutrients in dietary monitoring (Macdiarmid & Blundell, 1998). Examples of biomarkers include adipose tissue fatty acids, urinary potassium, serum vitamin C, and serum carotenoids (Arab & Akbar, 2002; Olsen, 1994; Tangney, Bienias, Evans, & Morris, 2004). These methods have not been used frequently, nor have they been validated systematically (Bingham et al., 1995; Bingham et al., 1997; Johannson, Callmer, & Gustafsson, 1992; Porrini, Gentile, &

Fidanza, 1995; Tjonneland, Overad, Thorling, & Ewertz, 1993).

Two biomarkers with good reliability and validity include urinary nitrogen and doubly labeled water. Urinary nitrogen measures dietary nitrogen intake (Bingham & Cummings, 1985; Isaksson, 1980) and is used to assess protein intake. Urinary nitrogen is compared with self-reported protein intake to assess accuracy of dietary self-monitoring. Urinary nitrogen depend on the assumption that research participants are in nitrogen balance and that there is no nitrogen accumulation due to growth or repair of lost muscle tissue or nitrogen loss because of starvation or injury (Bingham, 2003).

Doubly labeled water (DLW) can also be used for measuring total energy intake. The DLW technique is a physiological measure of energy metabolism developed approximately 50 years ago (Lifson & MacLintock, 1966). This methodology has been used in human research over the last 20 years (Schoeller, 1999) and is now considered the gold standard for assessing the validity of dietary intake. Energy requirements can be assessed directly from total energy expenditure using DLW ($^{2}H_2{}^{18}O$; Lifson & MacLintock, 1966). Naturally occurring, nonradioactive stable isotopes of hydrogen (^{2}H) and oxygen (^{18}O) are used to label the total body water pool. After consumption of the labeled water, ^{18}O is eliminated from the water pool as water and carbon dioxide, while ^{2}H is eliminated only as water. The difference in the elimination rates of ^{18}O and ^{2}H is related to the carbon dioxide production rate (rCO_2), which is used to determine energy expenditure (Weir, 1949).

When energy intake estimated from food diaries is compared with the use of DLW, dietary records are found to underestimate energy requirements consistently (Goran & Poehlman, 1992; Prentice et al., 1986; Schulz, Westerterp, & Bruck, 1989;

Seale, Rumpler, Conway, & Miles, 1990; Westerterp, Saris, van Es, & ten Hoor, 1986). The first DLW studies to indicate the problem of dietary underreporting found that energy intake reported by obese women was 64% of measured energy expenditure, compared to 98% in normal weight women (Prentice et al., 1986). Subsequent studies revealed that the agreement between energy intake and energy expenditure was generally good in normal weight volunteers (Goldberg et al., 1991; Prentice et al., 1986; Schulz, Westerterp, Bruck, 1989; Seale, Rumpler, Conway, & Miles, 1990), whereas underreporting was consistently found in obese adults and children (Bandini, Schoeller, Cry, & Deitz, 1990; Black, Jebb, & Bingham, 1991; Prentice et al., 1986).

Estimated Energy Requirements

Total energy expenditure measured using biomarkers is considered ideal for estimating energy requirements in a weight-stable adult population (Seale, 2002). It is particularly advantageous as it is independent of a participant's ability to accurately provide dietary information. The use of biomarkers becomes problematic, however, if individuals alter their typical eating behaviors because such alterations may not indicate habitual intake (Bingham, 1991). There are additional limitations of the use of biochemical markers, including expense (costing $500 or more for one dose of DLW for an average-weight adult), limiting its use in large population studies. Additionally, the availability of stable isotopes and the complex methodology for use and analysis limit its use for research. An alternative to the use of biomarkers is estimating energy requirements based on energy intake and energy expenditure.

The use of estimated energy requirements to assess dietary intake requires knowledge of energy needs. Energy needs can be derived from measurements of energy expenditure (Food and Agriculture Organization [FAO], 1985). The use of energy expenditure to examine energy intake and accuracy of dietary self-monitoring depends on the fact that during energy balance, energy intake equals energy expenditure (EI = EE). Energy expenditure is mainly determined by the basal metabolic rate (BMR) and physical activity (International Dietary Energy Consultant Group, 1990).

Values for energy requirements were published in reports addressing recommended intakes (Black, Coward, Cole, & Prentice, 1996; FAO, 1985; U.S. Department of Health, 1996). Physical activity level (PAL) values are correlated with energy expenditure levels. The extreme limits of energy expenditure requirements were established using specific participant characteristics (Black, 2000). For example, the lower limits were defined in studies using totally sedentary participants, including nonambulatory elders and wheelchair-bound adolescents (PAL = 1.21 units). Participants used to define upper limits were athletes in training and soldiers, with a mean PAL of 2.4 units. Cyclists of the Tour de France and polar explorers had a mean PAL of 4.0 units and 5.0 units, respectively. The mean weight and height for groups were used to estimate a mean BMR for each group, and the mean ratio of reported energy intake to estimated BMR (EI:BMR) was calculated as an index of energy expenditure. The mean EI:BMR score determined to indicate underreporting was 1.43 (Black, 1996).

Black and colleagues (1991) examined the use of estimated energy requirements to detect dietary underreporting. They reviewed energy intake compared with energy requirements (EI:BMR) in 37 adult dietary surveys from 10 European countries and the United States, with a total of 68 groups. Mean reported energy intake in each study was compared with the FAO (1985) recommended energy intake for light activity (PAL of

1.55), multiplied by BMR. As a result of reviewing these early studies, from which data commonly revealed underreporting of dietary intake, Black and colleagues (1991) concluded that dietary underreporting was a widespread and serious problem. Reported energy intake was compared with energy requirements, leading Black and colleagues to suspect that results could have been influenced by variations in daily food intake, the number of participants studied, the number of days of dietary assessment, and the use of equations to estimate BMR.

Goldberg and colleagues (1991) derived a formula to take into account the differences in energy intake and energy expenditure that might result from variations in daily food intake, the number of participants studied, the number of days of dietary assessment, and the use of equations to estimate BMR. This formula, formally called the Goldberg formula, calculates an appropriate cutoff value for EI:BMR (defined in detail subsequently), below which it would be statistically improbable that the reported energy intake could represent the intake necessary to sustain long-term weight maintenance or a genuinely low intake obtained by chance.

Goldberg Equation and Cut-off Scores

EI:BMR, used with cutoff scores calculated by the Goldberg equation (Black et al., 1991; Goldberg et al., 1991), has been used as a method of determining the accuracy of dietary reporting. The principle of the Goldberg cutoff score is based on the assumption that EI is equal to EE ± changes in body stores. It is assumed that group changes in body stores can be ignored (Braam, Ocke, Buenode de Mesquita, & Seidell, 1998), and therefore EI = EE. Because an individual's energy requirements vary with age, sex, and body size, as does BMR, energy requirements can be defined as multiples of BMR (World Health Organization [WHO], 1985). EI:BMR, as an expression of energy requirement, has also been used interchangeably with PAL, including both scheduled and daily exercise (Black, 2000). The mean reported EI can be expressed as EI:BMR and compared with PALs of that population to determine reported accuracy; however, absolute agreement is not expected because of errors in the measurement of each part of the equation. Confidence limits are therefore used to reflect the agreement between EI:BMR and PAL based on the Goldberg equation. The Goldberg equation calculates the upper and lower confidence limits to reflect the accuracy of dietary intake, as follows:

$$\text{EI:BMR} > \text{PAL} \times \exp\left[SD_{\min} \times \frac{\left(\frac{S}{100}\right)}{\sqrt{n}} \right]$$

$$\text{EI:BMR} < \text{PAL} \times \exp\left[SD_{\max} \times \frac{\left(\frac{S}{100}\right)}{\sqrt{n}} \right],$$

where PAL is the mean physical activity level for the population group under study, $SD_{\min}$ is –2 for the 95% lower confidence limit, $SD_{\max}$ is +2 for the 95% upper confidence limit, and n is the number of participants in the study. S is the factor that takes into account the variation in dietary intake, BMR, and energy requirements and is calculated as follows:

$$S = \sqrt{\frac{CV_{wEI}^2}{d + CV_{wB}^2 + CV_{tP}^2}},$$

where CV_{wEI}^2 is the within-participant coefficient of variation in energy intake, d is the number of days of the dietary assessment, CV_{wB}^2 is the coefficient of variation of repeated BMR measurements (or the precision of estimated compared with measured BMR), and CV_{tP}^2 is the total variation in PAL. CV_{tP}^2 is the coefficient of variation derived from the mean and standard deviation of a study. It is made up of true between-participant variation, an element of within-participant variation, and methodological errors.

Black (2000) suggested factors for substitution into the Goldberg equation based on previous research. Substitution factors to be used in the Goldberg equation are 23% for within-participant daily variation in energy intake (CV_{wEI}^2), 15% for between-participant variation in physical activity (CV_{wB}^2), and 8.5% for variation in basal metabolic rate (CV_{tP}^2).

Prevalence of Underreporting

The prevalence of dietary underreporting has been examined in several large national dietary surveys. A summary of these studies is given in Table 1. The EI:BMR and cutoff limits developed using the Goldberg equation (Goldberg, 1991) are the typical measure of accuracy because these cutoff values are (a) more valid than weight change, (b) more valid for comparisons of retrospective dietary report methods, and (c) much less costly than biomarkers. Calculated values for each study varied because chosen cutoff values depended on specific study factors (e.g., number of participants, weight, etc.). Cutoff values in these studies ranged from <0.9 to <1.4 and indicated that prevalence of underreporting in these studies ranged from 18% to 45% (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Heywood, Harvey, & Marks, 1993; Klesges, Eck, & Ray, 1995; Lafay et al., 1997; Price, Paul, Cole, & Wadsworth, 1997; Smith, Webb, & Heywood, 1994).

In addition to the Goldberg cutoff value, multiplying BMR by EI:BMR values for dietary underreporting relative to a sedentary physical activity score (1.27) is another method of calculating underreporting. According to WHO (1985), the minimum intake required for long-term survival is 1.27 × BMR. Studies using the WHO cutoff value for underreporting found that these values ranged from 1.20 to 1.28 and that 33% to 54% of participants reported values below dietary intake needed for long-term survival (Fogelholm, Mannisto, Vartiamen, & Pretinen, 1996; Gregory, Foster, Tyler, & Wiseman, 1990; Hirvonen, Mannisto, Roos, & Pietinen, 1997; Klesges, Eck, & Ray, 1995).

Few studies have been conducted to examine population trends in dietary underreporting. In one study comparing the National Health and Nutrition Examination Survey II (NHANES–II; Klesges, Eck, & Ray, 1995), developed in 1987, with NHANES–III (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997), developed from 1988 to 1991, findings indicated that the level of underreporting decreased from 31% to 23%. However, one considerable difference between the two studies was that NHANES–III included reports of dietary intake during Saturdays and Sundays, whereas NHANES–II only included reports from Monday through Friday. Because energy intake is typically higher during weekends compared to weekdays (de Castro, 1991; Tarasuk & Beaton, 1992), it is probable that differences in intake indicating a decrease in dietary underreporting were an artifact of this methodological difference.

The WHO Monitoring Cardiovascular Disease study conducted in a Finnish sample (Fogelholm, Mannisto, Vartiaimen, & Pretinen, 1996) found an increase in underreporting over time. Dietary surveys collected in 1982 and 1992 were included in this large study on cardiovascular risk factors. Each survey included a random sample of men and women aged 25–54. Results showed that dietary underreporting by women increased from 34% in 1982 to 47% in 1992, and by men from 26% in 1982 to 42% in 1992. It was suggested that this increase was a result of society becoming more diet conscious, leading people to minimize actual food intake (Macdiarmid & Blundlell, 1998). The increase in underreporting of dietary intake could also be related to both the rise in obesity and the trend toward consumption of larger portions.

Characteristics Associated With Dietary Underreporting

Following the development of techniques to measure energy expenditure more accurately, there has been a growing interest in examining individual factors related to misreporting of dietary intake. A number of studies examined population characteristics associated with underreporting (Ballard-Barbash, Graubard, Krebs-Smith, Schatzkin, & Thompson, 1996; Bingham et al., 1995; de Vries, Zock, Mesink, & Katan, 1994; Fogelholm, Mannisot, Vartiainen, & Pietinen, 1996; Heitmann, 1993; Heywood, Harvey, & Marks, 1993; Klesges et al., 1995; Lafay et al., 1997; Lissner & Lindross, 1994; Price, Paul, Cole, & Wadsworth, 1997; Pryer, Vrijheid, Nichols, Kiggins, & Elliot, 1997; Smith, Web, & Heywood, 1994). Table 2 provides a summary of studies that examined population characteristics associated with dietary underreporting. In these studies, dietary underreporting was found to be related to gender, weight status, dietary restraint, and selective underreporting by specific subgroups.

Sex

Women are significantly more likely than men to underreport their dietary intake (Ballard-Barbash, Graubard, Krebs-Smith, & Thompson, 1996; Bingham et al., 1995; Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; de Vries, Zock, Mesink, & Katan, 1994; Fogelholm, Mannisto, Vartiaimen, & Pretinen, 1996; Heitmann, 1993; Heywood, Harvey, & Marks, 1993; Hirvonen, Mannisto, Roos & Pietinen, 1997; Klesges, Eck, & Ray, 1995; Lafay et al., 1997; Price, Paul, Cole, & Wadsworth, 1997; Pryer, Vrijheid, Nichols, Kiggins, & Elliot, 1997). It is possible that cultural demands for thinness and beauty contribute to this pattern of results as women are more likely than men to be concerned with weight, food, and eating. Considering the social demands placed on thinness, it is probable that women report what is perceived as socially acceptable (Schoeller, 1990). This, however, does not explain the notable differences in the underreporting observed between obese versus normal weight individuals.

Obesity

Obesity is a critical factor involved in dietary underreporting that complicates the understanding of the relationship between nutrient intake and health. Early studies on dietary intake of obese compared to normal weight participants indicated that obese individuals consumed less than their normal weight counterparts (Fricker, Fumeron, Clair, & Apfelbaum, 1989). On the basis of these studies, it was concluded that obesity might result from lower energy expenditures because of slowed metabolic functioning, rather than from overeating. After the development of physiological techniques that more accurately measured energy expenditure (e.g., DLW), it became evident that the amount of food consumption reported by obese participants was not correlated with their energy expenditure measurements (Apfelbaum, Bostsarron, & Lacatis, 1971; Lichtman et al., 1992; Prentice et al., 1986; Ravussin, Burnand, Schuts, & Jequier, 1982). Findings from these studies showed that obese individuals consumed more food than normal weight participants. Thus it was concluded that obese research participants were likely to underestimate their dietary intake.

Weight per se does not fully explain why differences in accuracy exist between normal weight and overweight groups. Increased weight is commonly associated with inaccuracies of dietary report (Black, Jebb, Bingham, Runswick, & Poppitt, 1995; Lichtman, et al., 1992; Schoeller, Bandini, & Dietz, 1990), but not all studies found this. For example, Lissner and colleagues (1989) found no differences in underreporting between overweight and normal weight participants. Johnson, Goran, and Poehlman (1994) documented underreporting among overweight women, but not men. Dietary underreporting is therefore not directly a function of weight status. This study examines weight status (overweight and normal weight) as a moderating factor in the accuracy of self-reported dietary intake.

Several hypotheses have been put forth to test for differences in weight status and accuracy in dietary self-monitoring. Selective reporting and dietary restraint are two variables that were examined with the hope of explaining these differences. However, results remain inconsistent, and the mechanisms underlying errors in dietary self-monitoring remain largely unknown.

Dietary Restraint

Dietary restraint, or the conscious effort to reduce food intake, is thought to be one factor that impacts the accuracy of dietary reporting. It partially accounts for the observed sex- and weight-related differences in reporting accuracy (Macdiarmid & Blundell, 1997). Studies show that restrained eaters report lower energy intake than unrestrained eaters (Bingham et al., 1995; Black, Jebb, Bingham, Runswick, & Poppitt, 1995; Lafay et al., 1997; Macdiarmid & Blundell, 1997; Mela & Aaron, 1997). Whether this finding is a result of lower energy intake or underreporting has not been determined. Results from studies that examined the differences in energy intake of restrained versus unrestrained eaters were mixed, partially because of differences in assessment methods. For example, an investigation using the DLW technique (Bathalon et al., 2000) found no effect of dietary restraint on accuracy of dietary self-monitoring. In another study using urinary nitrogen excretion, dietary restraint was associated with underreporting among overweight women (Bingham, 2003). Unfortunately, these studies did not consistently account for weight status, further clouding the interpretation of results. Knowledge of why these differences exist is not only a necessary precursor to understanding more fully errors in dietary self-monitoring, but it will also inform our understanding of eating behaviors that contribute to and maintain obesity.

Selective Underreporting

A number of studies found that underreporting occurs for certain food types, particularly fats (Fricker, Baelde, Igoin-Apfelbaum, Huet, & Apfelbaum, 1992; Heitmann & Lissner, 1995), and most often in overweight samples (Goris, Westerterp-Plantenga, & Westerterp, 2000; Johnson, Goran, & Poehlman, 1994). In addition to macronutrient composition, inaccuracies in meal types (i.e., breakfast, lunch, dinner, snacks) have also been investigated. Results indicated that underreporting occurred for specific meals, particularly snacks, rather than for all meals, in both overweight and normal weight participants (Poppitt, Swann, Black, & Prentice, 1998).

In summary, despite a large body of literature examining the process and nuances of underreporting, findings continue to be mixed. Most studies show that women and overweight individuals tend to underreport dietary intake. Few biological markers of dietary intake are available, and none of these validly captures total fat or carbohydrate intake (Heitmann & Lissner, 1995). Therefore, even in studies indicating that obese people over-report relative energy from protein, there is no evidence of the degree or the proportion at which misreporting occurs for other macronutrients. Assessment methods may also account for differences in findings of food intake and accuracy of food intake (i.e., 24-hour food recall vs. food frequency questionnaire vs. 7-day self-report vs. DLW, or weight vs. resting metabolic rate vs. DLW). Weight status, gender, and restrained versus unrestrained eating patterns also impact dietary monitoring, but more research is needed to understand these individual characteristics.

Examining the Effects of Eating Style and Weight Status on Variables Related to Accuracy of Dietary Self-Monitoring

Dietary habits and physical activity are linked to the development of obesity. Weight is determined by the relationship between energy intake and energy expenditure and is maintained by energy balance. Results of several studies have found that eating patterns, including eating frequency, temporal distribution of eating events across the day, skipping breakfast, and eating away from home, influence body weight (Bellisle, Rolland-Cachera, Deheeger, & Guilloud-Bataille, 1988; Fabry, 1964; Jenkins et al., 1989; Keim, Van Loan, Horn, Barbieri, & Mayclin, 1997; Ma, et al., 2003; Stanton & Keast, 1989). More specifically, consuming most of one's daily caloric intake in one or two sittings (i.e., gorging) may increase body fat percentage and suppress metabolic rate (Fabry et al., 1966; Metzner, Lamphiear, Wheeler, & Larkin, 1977), whereas eating smaller meals more frequently throughout the day (i.e., nibbling) may suppress hunger and raise metabolic rate (Jenkins et al., 1989).

Metabolic suppression among obese gorgers may explain why obese individuals commonly report an energy intake that is smaller than their expected energy expenditure. This line of research began as early as four decades ago, documenting a negative relationship between meal frequency and body fat percentage. These findings suggest that those who eat more frequently and have a greater total energy intake actually weigh less and have lower body fat percentages than individuals who eat less frequently (Fabry, 1964; Huenemann, 1972; Metzner, Lamphiear, Wheeler, & Larkin, 1977). Subsequent studies investigating the metabolic effect of meal frequency have been inconsistent. This area of research gained scientific interest in the early 1990s, when the terms *gorging* and *nibbling* were operationally defined (Verboeket–van de Venne & Westerterp, 1991) and advances in technology allowed for more sophisticated examination of the impact of eating patterns, specifically as related to metabolic rate.

In a study by Ma and colleagues (2003), three 24-hour recalls and body weight measurements were collected five times over a 1-year period from approximately 500 participants. The purpose of this investigation was to evaluate the relationship between eating patterns and obesity, while controlling for physical activity and total energy intake.

Results indicated that the number of eating episodes was inversely associated with the risk for obesity. Participants who reported four or more eating episodes per day were at 45% lower risk of obesity than participants who reported three or fewer eating episodes per day. Additionally, results showed that participants who regularly skipped breakfast (75% or more days) were at 4.5 times greater risk of obesity compared to those who regularly consumed breakfast. Although total energy intake by meal was not examined, the eating patterns in this study associated with obesity are similar to the gorging eating style, such that gorgers consumed less than 100 calories within 7 hours of waking (skipping breakfast), and most energy intake was consumed in one or two sittings (number of eating episodes).

Verboeket–van de Venne and Westerterp (1991) defined *gorging* as eating two meals per day, with the first meal after 12:00 P.M. Nibbling was defined as eating seven small meals per day, with the first meal at 7:00 A.M. and the last meal at 8:30 P.M. In this study, participants followed either a gorging or nibbling meal pattern for two days, after which energy expenditure was assessed using indirect calorimetry, carbohydrate oxidation, and fat oxidation. Although no differences were found between gorgers' and nibblers' resting metabolic rates (RMR), the effect of meal pattern on other physiological processes of weight regulation, including increases in carbohydrate oxidation between the first and second meals and induced diurnal lipogenesis, was demonstrated in a relatively short period of time.

Although some studies have not found an association between gorging and metabolic suppression, the link could be explained by the method of assessing eating style and metabolic rate. Most studies experimentally manipulated eating style by a shortterm modification of meal patterns, which may not have been sufficient to induce a measurable change in metabolic rate. The studies that found an association between eating style, body weight, and body composition used an observational method to measure eating behaviors (e.g., Fabry et al., 1966). Daily physical activity patterns and degrees of eating pathology were not assessed in these studies.

Another explanation for why some studies found differences in reported intake is that certain eating patterns, characteristically similar to gorging, may be associated with underreporting and not metabolic suppression. Kim and colleagues (2007) recently tested this hypothesis by examining the relationship between eating style (gorging and non-gorging) and weight on metabolic suppression and accuracy of dietary self-monitoring. They sought to identify clearly the effect of specific variables, including total energy expenditure, body composition, eating pathology, and eating style. Kim and colleagues (2007) did not find support for the metabolic suppression hypothesis among overweight women or gorgers. Results indicated, however, that gorgers underreported dietary intake to a greater extent than non-gorgers, independent of weight. No differences were found between gorgers and non-gorgers in total energy expenditure, body composition, or eating pathology.

The reason why gorging contributes to dietary underreporting is unclear. This study examines the role of gorging in dietary underreporting in the context of portion size. It is possible that gorging is associated with obesity and thus that gorging plays a role in the dietary underreporting observed in obese individuals. In addition, consistent consumption of larger meals may alter an individual's reference standard for what is a so-called regular meal size, therefore making it more difficult for obese individuals to accurately gauge meal sizes. This difficulty, in turn, could affect the accuracy of recording a particular meal. Additionally, it is unclear whether larger portion sizes alone can affect accuracy of portion size estimation or if a common factor related to a habitual eating style might contribute to systematic errors in dietary monitoring. This study seeks to inform this line of research by examining the role of gorging status and portion size on the accuracy of dietary self-monitoring.

Role of Perception and Portion Size on Food Size Estimation

Perception and Related Principles

Perception is a process where individuals interpret and organize sensations to produce a meaningful experience of the world (Foley, 1997). A common problem found in the biology of sensory perception is the trade-off between two desirable goals: the ability to detect even single-signal events (high sensitivity) and not becoming saturated over various orders of magnitude of input sensitivity (large dynamic range; Osame & Copelli, 2007). One of the most relevant principles of perception is the Weber-Fechner law, which attempts to describe the relationship between the physical magnitudes of stimuli and the perceived intensities of those stimuli (Stevens, 1975). Ernst Heinrich Weber (1795–1878) was one of the first to study the human response to physical stimuli by using a mathematical approach. His idea was that perception of change did not correspond directly with change. Weber conducted a series of experiments to study this. In his most classic, he blindfolded a man, placed one end of a scale in his hand, and then removed weight from the other end to increase the perceived weight in the man's hand. He asked the blindfolded participant to announce when he could feel the weight change. He discovered that perception was, in fact, relative. In this case, if he doubled the initial weight in the man's hand, he would have to double the weight change to get a reaction from him. Formulaically, change in perception was equal to the change in the stimuli divided by the stimulus itself times a value determined by the stimuli itself. This proved to be true for many forms of stimuli, including touch, sight, sound, and other nonphysical stimuli, including market forces and war strategies (Foley, 1997; Stevens, 1975).

Gustav Theodor Fechner (1801–1887) believed that Weber discovered a fundamental mathematical principle of the mind–body interaction. Fechner elaborated on Weber's findings through his theoretical interpretations in what he coined *Weber's law*, which stated that a person's perception of change in stimuli is logarithmic with respect to the actual change being produced. Fechner also improved on Weber's findings by theorizing that sensations could be predicted if stimuli were known. He also suggested that if a stimulus could be measured, so could a sensation.

Stevens (1986) improved the Weber-Fechner law, by proposing a relationship between the magnitude of a physical stimulus and its perceived intensity or strength. A percentage change in objective magnitude leads to the same percentage change in subjective magnitude. Together, these laws of perception can have important implications in the area of eating behaviors. For example, two cookies are not as satisfying as one. The emotional and behavioral drive to keep increasing our eating pleasure, in spite of no equal physical reaction, is not well understood. Although there was a great deal of work on perception in the early 19th century, few studies have translated the effects of perception on consumption. Those that have translated perception effects are addressed in more detail subsequently.

Perception in Food Size Estimation

The effects of shape on perception have been investigated over time. It has been found that triangles are perceived to be larger than squares (Anastasi, 1936; Fisher & Foster, 1968), squares larger than circles (Pfeiffer, 1932), and tall, thin objects larger than short, wide objects (Anderson & Cuneo, 1978; Holmberg, 1975). There is little research, however, on how these shapes affect consumption. Of the few studies that have related shape to consumption volume, it has been demonstrated that elongation (a tall, thin glass compared to a short, wide glass) increases the perceived capacity of that glass in prepoured volumes (Raghubir & Krishna, 1999) and in natural settings when individuals pour their own beverages (Wansink & Van Ittersum, 2003). Additionally, consumption is less with in single-serving contexts (Wansink & Van Ittersum, 2003).

Early efforts to improve accuracy in self-reporting of food intake examined the use of portion size aids. These studies found that between 14% and 67% of foods were in error by more than 50% when no aid was used, compared to the use of photographs in dietary surveys (Chu, Kolonel, Hankin, & Lee, 1984; Edington et al., 1989; Guthrie, 1984; Pietinen et al., 1988; Tjonneland, Overad, Thorling, & Ewertz, 1993). In spite of these benefits, errors in estimation of food size remained, leading to dietary underreporting or underreporting of nutrient intake. Overall, visual aids (e.g., photographs) improved accuracy of estimation, yet were not sufficient to eliminate inaccuracies altogether.

On the basis of these findings, Nelson and colleagues (1994) further examined estimation errors using photographs as visual aids. They were the first to examine the role of perception associated with errors in food estimation. More specifically, they examined portion size estimation errors in relation to factors potentially influencing perception. In this work, Nelson and colleagues described the estimation of food size as a complex process involving perception, conceptualization, and memory. Perception was an individual's ability to relate an estimation variable to a food that is present in reality. Conceptualization concerned an individual's ability to make a mental construct of the amount of the estimation variable to a typical meal, and memory was related to the individual's accuracy of the conceptualization. Results demonstrated a bias in the perception of food portion size from photographs such that the use of a single visual aid (photograph) was associated with larger errors in estimation of portion size than the use of a series of visual aids (eight photographs). Additionally, they found that large portions were likely to be underestimated.

This study failed to elaborate on the potential mechanisms related to perception associated with inaccurate reporting. Notwithstanding this limitation, this study was the first to acknowledge the role of portion size in portion size estimation errors. Considering the significant increases in portion sizes over the last two decades, increased portion sizes associated with greater errors in food estimation have profound implications for the increased rates of obesity in the United States.

Increase in Portion Size

There has been a substantial increase in portion sizes of meals over the last 20 years, which has been part of the so-called supersizing phenomenon (Nielsen & Popkin, 2003). This increase has been substantial and has broad-reaching effects. For example, one study comparing standard serving sizes established by the U.S. Department of Agriculture (USDA) for dietary guidance and by the U.S. Food and Drug Administration (FDA) for food labels found that most foods exceeded USDA and FDA standard portions by 200% to 480% (Heini & Weinsier, 1997). Furthermore, it has been found that most commonly available food portions exceed USDA and FDA standard sizes, and most foods are available in larger portion sizes than in the 1970s (Young & Nestle, 2002). A more recent study by Nielsen and Popkin (2003) examined nationally representative dietary intake data across time (1977–1996) to determine patterns and trends in portion sizes by type of food and eating location and compared them to portion sizes eaten outside the home. Findings revealed that between 1977 and 1996, portion sizes and energy intake increased for all key foods at all locations examined for the total U.S. population. Additionally, the quantity and portion sizes of certain foods (e.g., salty snacks, soft drinks, and French fries) increased. Not surprisingly, the largest portion sizes for most foods were found at fast food establishments.

There is a general consensus that this increase in portion sizes is an important factor contributing to the obesity epidemic. Although no empirical studies show a causal relationship between increased portion sizes and obesity, there are studies showing that controlling portion sizes helps limit calorie intake, particularly when eating high-calorie foods (U.S. Department of Health and Human Services, 2005). It is possible that larger portion sizes are more difficult to estimate accurately. Therefore it may be that this increase in portion size contributes to the inaccuracies in dietary underreporting.

Relationship Between Portion Size and Energy Intake

Population-based research indicates that the average reported energy intake has decreased over the past decade (Fogelholm, Mannisto, Vartiainen, & Pietinen, 1996). This observation is inconsistent with the increasing rates of obesity (Kuczmarski, Flegal, Campbell, & Johnson, 1994). One explanation for this discrepancy is the overall decrease in energy expenditure (Macdiarmid & Blundell, 1998). Dietary trends suggest that a decrease in total physical activity is related to a decrease in energy expenditure (Fogelholm, Mannisto, Vartiaimen, & Pretinen, 1996; Heini & Weinsier, 1997; Prentice & Jebb, 1995), as there is a decline in overall physical activity. In addition, evidence suggests that the prevalence of underreporting dietary intake is increasing (Fogelholm, Mannisto, Vartiaimen, & Pretinen, 1996; Hirvonen, Mannisto, & Roos, 1997). On the basis of these data, researchers speculate that there may be a relationship between accuracy of dietary self-monitoring and the quantities of foods consumed or the ability to estimate meal sizes accurately (Lissner et al., 1989; Macdiarmid & Blundell, 1998; Scagliusi, Polacow, Artioli, Benatti, & Lancha, 2003).

A handful of studies examined the relationship between portion size and excess energy intake. Although results are not consistent in terms of a specific portion size increase needed to lead to increased energy intake (e.g., Edelman, Engell, Bronstein, & Hirsch, 1986; Engell, Kramer, Zaring, Birch, & Rolls, 1995), most studies found a positive relationship between portion size and the amount of food consumed (Krassner, Brownell, & Stunkard, 1979; LeBow, Chipperfield, & Magnusson, 1985; Rolls, 2004; Rolls, Morris, & Roe, 2002; Rolls, Roe, Kral, Meengs, & Wall, 2004). Research has shown that most people do not know what constitutes a standard serving size (Young & Nestle, 1995, 1998), nor do they reliably notice variations in portion size (Rolls, Morris, & Roe, 2002). With difficulty in judging large portion sizes, accurate recording of food intake is problematic. It is possible that large portion sizes may contribute to dietary underreporting.

Few studies have fully examined the role of eating style (gorgers vs. non-gorgers) on the accuracy of dietary self-monitoring of variously sized meals. Of those that have, none has systematically examined the impact of serving size and weight status on underreporting. It is possible that eating large amounts of calories in one sitting, as observed in gorgers, interferes with accurate assessments of portion size and energy intake, thus leading to an increased likelihood of errors in reporting of dietary intake. This study examines whether errors in self-monitoring of large meals are related to patterns of food intake (i.e., gorging), and whether these errors are a result of difficulties in estimation of large portion size.

Current Investigation

Eating patterns characterized by gorging purportedly involve routine consumption of large meal sizes. Portion sizes have increased substantially in the United States over the last decade, and the effect of portion size on accuracy of dietary self-monitoring is an important component requiring further investigation. Errors in estimating meal sizes potentially explain underreporting in dietary monitoring and may explain the rise in overweight and obesity. To date, no study has dismantled the relationship between weight status and eating patterns on accuracy of dietary self-monitoring. Furthermore, no study has examined the role of portion size on the accuracy of dietary self-monitoring between normal weight, overweight, gorgers and non-gorging individuals.

Dietary self-monitoring is considered the gold standard for self-reported food intake and is relied on in both empirical research and clinical settings involving body weight and food consumption. There are no practical alternative methods for obtaining detailed prospective reports of eating patterns. The purpose of this study is to examine the effects of both eating style and portion size on the accuracy of dietary self-monitoring.

Knowledge of the role of gorging status and portion size on the ability to accurately estimate meal sizes and record dietary intake may improve dietary self-monitoring and ultimately increase our understanding of the role of diet as related to health.

The current study focuses on behavioral factors that may be responsible for dietary underreporting, while controlling for key physiological variables, including weight, RMR, and PAL. In addition, this study extends the research of Kim and colleagues (2007), which suggested that eating style alone accounted for differences in self-reported food intake, rather than the effects of metabolic suppression. The current investigation used both an ambulatory and laboratory study. As summarized in Figure 2, the impact of meal size on the accuracy of portion size estimation was examined in a laboratory based study by assessing estimations of both regular and large pre-measured meals. The effects of weight status and eating style on the accuracy of dietary self-monitoring were examined in an ambulatory study by measuring the ratio of estimated energy intake to energy needs. Intake was estimated from 7-day prospective eating diaries. RMR was measured by indirect calorimetry. The value obtained was subsequently categorized as accurate reporting or underreporting, by using cutoff scores calculated from the Goldberg equation (Goldberg, 1991).

Aim 1: Examine the Effects of Weight Status and Eating Style on the Accuracy of Dietary Self-Monitoring

Few of the studies examining the role of weight status on accuracy of dietary intake have considered underlying factors associated with weight status itself. The first aim of the current study was to determine whether eating style influenced the accuracy of dietary self-monitoring, independent of weight status. This aim was addressed in a 2 x 2 (weight by eating style) between groups one-week ambulatory study design. Participants then estimated energy intake for one week using prospective computerized self-monitoring diaries. During this week, estimated energy expenditure was assessed using the Actigraph, an ambulatory physical activity monitor. Resting metabolic rate was measured using indirect calorimetry. Accuracy of dietary self-monitoring was measured by comparing reported energy intake with measured energy needs, and determined by calculating cutoff scores using the Goldberg equation (Goldberg, 1991). Additionally, the extent of dietary underreporting was measured using the ration of energy intake to energy expenditure (EI:EE).

Based on existing literature, it was expected that overweight women would underreport energy intake compared to normal weight women. It also was anticipated that a gorging eating style, independent of weight status, would be associated with dietary underreporting. Because it is likely that gorgers and overweight women eat larger amounts of food per sitting compared to individuals with regular eating patterns and normal weight women, it is believed that their reference standard for meal size is purportedly larger. If it is the difference in reference standard that contributes to dietary underreporting, then it is likely that gorgers will underreport to a greater extent than non-gorgers, regardless of weight status.

Hypothesis 1

A) Overweight women will underreport dietary intake as compared to normal weight women.

B) Gorgers will underreport dietary intake as compared to non-gorgers.

C) Overweight gorgers will underreport dietary intake as compared to all other groups.

Aim 2: Examine the Effect of Meal Size on Dietary Underreporting

Studies to date have examined the role of meal size on dietary intake, but not on the accuracy of dietary self-monitoring. The second aim of this study was to examine whether underreporting of meal size is more likely to occur with larger meals. This aim was addressed using a 2 x 2 x 2 x 2 (weight by eating style by meal size by time) mixed design. Weight and eating style were between group measures. Meal size and time were both two-level within subjects variables. The study was conducted in a laboratory setting at two visits, one-week apart. Accuracy of meal size estimation was determined by calculating the differences between the actual and estimated amount of food (in cups). Estimation of additional units of measurement (e.g., grams, pounds, ounces) were compared and results can be seen in Appendix A. It was hypothesized that all individuals would be more likely to underestimate the size of large meals, independent of eating style or weight status. It was also expected that overweight gorgers would underestimate large meals to a greater extent than all other groups.

Hypothesis 2

A) Large meal size is expected to be underestimated as compared to regular meal size for all groups.

Hypothesis 3

A) Overweight women are expected to underestimate large meal size as compared to normal weight women, reflected by a main effect of weight.

B) Gorgers are expected to underestimate large meal size compared as to non-gorgers, as reflected by a main effect of eating style.

C) Overweight gorgers will underestimate large meal size as compared to all other groups.

Research Design and Methods

General Overview

This study was designed to examine (1) the effects of weight and eating style on the accuracy of dietary self-monitoring and (2) the effects of portion size on the accuracy of meal size estimation. These aims were addressed in two study components, an ambulatory self-monitoring study and a laboratory food estimation study. Participants were recruited to participate in both the ambulatory and laboratory components. The ambulatory component examined the accuracy of dietary self-monitoring by weight and eating style groups (Aim 1) through the ambulatory assessment of energy intake and energy expenditure. The effect of portion size on meal size estimation (Aim 2) was tested in a laboratory based study where participants estimated both a regular and large meal size at two visits, scheduled 1 week apart, at the Uniformed Services University of the Health Sciences (USUHS). Figure 2 depicts the study overview.

Participants were randomly assigned, within weight and eating style categories, to two meal size orders (Meal Size Condition A; RL-LR and Meal Size Condition B; LR-RL) to counterbalance for order effects. Participants assigned to Group A estimated a regular meal first and a large meal second. Participants in Group B estimated a large meal first and a regular meal second. For each participant, meals were identical; however, the order was reversed on Visit 2. These meals were not consumed.

Accuracy of meal size estimation was measured by comparing actual and estimated meal size. Accuracy of dietary reporting was measured by comparing energy intake with energy needs. To assess the accuracy of self-reported food intake, ambulatory intake was compared to measured energy needs based on RMR and activity monitoring. RMR was measured through indirect calorimetry during Visit 1. Ambulatory assessment of food intake and energy expenditure occurred between Visit 1 and Visit 2. Participants completed a computerized food diary and wore an ambulatory activity monitor for 7 days.

Participants

Seventy-six premenopausal, nonsmoking, otherwise healthy women between the ages of 19 and 49 were recruited through newspaper advertisements and flyers from the Washington, D.C., metropolitan area. (see Appendix B for advertisements). Participants were recruited based on both weight status and eating style to participate in a study examining dietary self-monitoring. Thirty-eight participants were categorized as normal weight, defined as a body mass index (BMI) between 18.5 and 24.9 kg/m^2. Thirty-eight participants were categorized as overweight, which included both overweight and Class I obesity, defined as a BMI between 25 and 29.9 kg/m^2 and between 30 and 34.9 kg/m^2, respectively. Participants were matched on age and ethnicity.

To be eligible to participate, individuals were required to be free from major medical or mental health conditions that interfered with metabolic rate or eating behavior. These conditions included diabetes, heart disease, cancers, and thyroid disease. Participants with other conditions known to impact eating behaviors and energy metabolism were also excluded, including smoking, perimenopausal or postmenopausal symptoms, and pregnancy. Additionally, because both mood and eating disorders might impact an individual's eating behaviors (Baucom & Aiken, 1981; Forster & Jeffery, 1986), individuals diagnosed with a current eating or mood disorder or taking antidepressant or antipsychotic medication at the time of the study were excluded from participation. Basic behavioral, medical, and mental health information pertaining to exclusion was elicited during the initial phone screen to determine participant eligibility (see Appendix C for the phone screen). Self-reported medical conditions were confirmed using the medical information form, as described in previous studies (Kim et al., 2007; Sbrocco, Nedegaard, Stone, & Lewis, 1999).

Participation in this study was limited to females. The purpose of this study was to examine dietary underreporting more thoroughly. Studies reported that underreporting was consistently associated with women to a greater extent than men (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Heywood, Harvey, & Marks, 1993; Klesges, Eck, & Ray, 1995). These gender differences may be a reflection of the sociocultural demands of thinness and body concerns placed on women, but not on men (Schoeller, 1990). Because of the differences associated with both dietary underreporting and cultural demands of thinness, this study included females only.

Eating Style Definitions

Eating style (gorgers and non-gorgers) was defined based on criteria used by Kim and colleagues (2007). Gorgers were defined as individuals who (a) have an average of one or two eating episodes per day; (b) wait 7 or more hours between waking and the first eating episode, with less than 100 calories eaten from waking to the first episode; and (c) skipped breakfast and lunch on 3 out of 7 days for the past month. Thirty-eight participants were characterized as gorgers. Non-gorgers were defined as individuals who (a) have an average of three of more eating episodes per day (including labeling three of these episodes as breakfast, lunch, and dinner), with more than 100 calories eaten per episode; (b) wait less than 3 hours between waking and the first eating episode; and (c) skipped meals less than 3 out of 7 days for the past month, with breakfast and lunch not skipped successively on the same day. Thirty-eight participants were characterized as non-gorgers.

Procedures

An overview of the study procedure is provided in Table 3.

Recruitment

Participants were recruited by placing advertisements in local newspapers in the Washington, D.C., metropolitan area and by posting flyers on local university campuses (see Appendix B for advertisements). It was expected that normal weight gorgers would be more difficult to recruit compared to the other groups. Therefore, recruitment was evaluated when one of the four experimental conditions (overweight gorgers, overweight non-gorgers, normal weight gorgers, or normal weight non-gorgers) was 50% filled. It was established that if one or more of the other groups had less than 10% of participants recruited at that point in time, those populations were to be specifically targeted through additional advertisements (e.g., normal weight, overweight, gorgers, or non-gorgers). In this study, normal weight and overweight non-gorgers were recruited at a greater rate than normal weight and overweight gorgers. Therefore both normal weight gorgers and overweight gorgers were specifically targeted for recruitment.

Telephone Screen

Interested individuals were instructed to call the USUHS Weight Management Program. Potential participants were screened by telephone to determine age, weight status, eating style, and eligibility according to exclusion criteria (See Appendix C for the telephone screen.). For characteristics such as age, weight, gender, and medical information, participants were asked directly to report such characteristics (e.g., *How much do you weigh? Are you currently taking antidepressant medication?*) during the telephone screen.

To determine eligibility based on menstrual cycle status, participants were asked a series of questions about their menstrual cycles during the telephone screen, including the date of their last period, menstrual cycle regularity, and current use of birth control. Participants were also asked to report whether they had been diagnosed as being menopausal by a physician or had experienced perimenopausal symptoms, including hot flashes or missed periods. Positive responses for perimenopause or menopause led to exclusion from participation as significant changes in body composition and metabolic rate related to menopause have been demonstrated (Heymsfield et al., 1994; Poehlman, Toth, & Gardner, 1995; Schofield, Schofield, & James, 1985). Additionally, to ensure that participants were not pregnant, participants were required to schedule their first appointment 3–9 days after the start of their period.

Eating Style Categorization

To preliminarily categorize eating style (gorger and non-gorger), potential participants were asked a series of open-ended questions regarding eating behavior. Frequency of eating episodes was assessed by asking potential participants to report the average number of meals eaten per day. Late day eating and breakfast skipping were assessed by asking participants how frequently they ate breakfast and how many hours passed between waking and their first eating episode. Additionally, participants were asked to consider the last month and to report, on average per week, how frequently they ate a midmorning snack, lunch, midafternoon snack, dinner, evening snack, or nocturnal meal.

Individuals were classified as gorgers if, on average, the consumption of two or fewer meals per day (or 14 meals per week or less when thinking of the last month) was endorsed and breakfast was regularly skipped. Those who consumed two or fewer meals per day, yet ate breakfast regularly, did not fit the criteria for gorging. Individuals who reported eating two or fewer meals per day and waited less than 7 hours between waking and their first eating episode were not included as criteria for gorging were not met. Individuals who reported eating, on average, two or fewer meals per day with at least 7 hours or more between waking and their first eating episode were given a preliminary allocation to the gorging group.

Individuals were classified as non-gorgers if, on average, the consumption of three or more meals per day was endorsed and breakfasts were eaten regularly. Individuals who endorsed eating two or fewer breakfasts were not classified as non-gorgers and therefore were not eligible to participate. Individuals who reported eating three or more meals per day with more than 3 hours but less than 7 hours between waking and their first eating episode were not classified as non-gorgers and therefore were not eligible to participate. Participants who reported eating, on average, three or more meals per day with 3 hours or less between waking and their first eating episode were given a preliminary allocation to the non-gorgers group.

Self-report eating style assessed by the telephone screen was confirmed using times of meals assessed during 7-day dietary self-monitoring. If self-reported eating style was not consistent with prospective eating diaries in terms of time of first meals and meal skipping, participants were not included in the statistical analysis. Four participants were excluded from the statistical analysis based on these criteria (see Appendix D for a copy of the decision tree for classification of eating style).

Study Requirements and Instructions

Participants were recruited to participate in a study on the effects of eating style and metabolism. Participants were told that previous research indicated that meal skipping, particularly skipping breakfast, was associated with increased weight and lower metabolic rate. Participants were told that the purpose of this study was to further investigate these findings by examining the effects of weight and eating behaviors on metabolism. Less than full disclosure regarding the purpose of the study was used to avoid confounds that result from participant reactivity. Research showed that accuracy of dietary recording improved when participants were aware that the accuracy of their monitoring is being evaluated. Such reactivity effects could possibly confound the results such that the true relationship of eating style and weight on the accuracy of dietary self-monitoring would be obscured.

Interested and eligible individuals were informed that participation required two visits to the Human Performance Laboratory (HDL) at USUHS, with the first visit (Visit 1) scheduled 3–9 days after the start of menstruation. They were required to be available at, or before, 7:00 A.M. for a 90 minute visit. Visit 1 included the assessment of height, weight, body composition, and RMR. Participants were told that they would estimate the size of two pre-measured meals, fill out questionnaires, and be instructed on the use of both a computerized eating diary and an activity monitor. They were told they would weigh and record all foods and drinks consumed in the computerized eating diary and wear the physical activity monitor for 7 days after Visit 1. They and return to USUHS in 1 week for a 45 minute visit (Visit 2). During Visit 2, they would return all the equipment provided and have the opportunity to ask questions related to the self-monitoring. Additionally, they would estimate the size of two pre-measured meals and complete two questionnaires.

Interested and eligible individuals who agreed to participate were scheduled for their first appointment. This study included a laboratory and ambulatory component. See Figure 2 for the Study Protocol Overview.

Ambulatory Design Overview. The ambulatory component consisted of 1 week of ambulatory dietary self-monitoring and assessment of energy expenditure. The ambulatory component is relevant to Aim 1 of this study, the purpose of which is to examine the effects of weight and eating style on the accuracy of dietary self-monitoring. Participants reported their energy intake using a computerized self-monitoring eating diary, in which all foods and drinks were recorded. Energy expenditure was measured using an Acti-heart activity monitor.

Laboratory Design Overview. The laboratory based component consisted of two visits to the Uniformed Services University Human Performance Laboratory (USUHS HPL). The laboratory based component is relevant to Aim 2 of this study, the purpose of which is to examine the effects of portion size on the accuracy of meal size estimation. During both visits (time 1 and time 2), participants are asked to estimate the size of 2 pre-measured meals, one regular size meal and one large size meal. In addition, physiological measurement of resting metabolic rate also is measured during visit 1. This laboratory measure of energy requirements is an important variable in Aim 1 of this study, which is to examine the accuracy of dietary reporting. In addition to the laboratory component of Aim 1, there is an ambulatory component, which consists of 1 week of prospective dietary food monitoring using a handheld computerized eating diary. Additionally, energy expenditure is assessed by an ambulatory physical activity monitor.

Detailed Study Procedures: Visit 1. Participants arrived at the USUHS HPL no later than 7:00 A.M. When participants arrived at the HPL, the informed consent document was reviewed with the participant. Information on the procedures of the study was provided and possible risks and benefits were discussed Participants who agreed to participate were asked to sign the informed consent document (see Appendix E for a copy of the consent form).

After consent was given, height in centimeters and weight in kilograms were measured using a balance beam scale. Body composition was measured using bioelectric impedance (BEI; RJL Systems, Inc, Clinton Twp., MI). Participants were asked to remove their right sock and lie on their backs on a floor mat. Electrodes were placed on the participants' bare hands and feet, and resistance and reactance of electric current was measured. Resistance and reactance scores were noted and entered into the BEI computer program to calculate the percentage of body fat. To determine adherence to requirements to refrain from exercising, eating, or drinking caffeine for 12 hours prior to testing, participants were asked to respond to the questions on the Metabolic Procedures Checklist prior to testing (see Appendix F for a copy of the Metabolic Procedures Checklist).

After anthropomorphic variables were measured, participants were randomly assigned, within weight and eating style categories, to Meal Size Condition A (RL-LR) or

Meal Size Condition B (LR-RL) to counterbalance for order effects. Participants assigned to Group A estimated a regular meal first and a large meal second. Participants in Group B estimated a large meal first and a regular meal second. For each participant, meals were identical; however, the order was reversed on Visit 2. The meals were not consumed.

After assignment to meal size conditions, participants were asked to complete the first of two meal size estimations for Visit 1 (Visit 1, Time 1). Participants were presented with a pre-measured pasta bake (see Appendix G for the pasta bake recipe), which was either a regular or large meal size, depending on meal size condition. Participants were then asked to estimate the size of the food, including serving size, number of cups, grams, ounces, and pounds of the presented food. Participants were also asked to estimate the macronutrient composition of the food, including calories, percentage fat, percentage protein, and percentage carbohydrates (see Appendix H for meal size estimation form).

After the first meal size estimation condition, RMR was measured using indirect calorimetry with the FitMate Pro Metabolic Monitor (2004; Rome, Italy) Participants were asked to lie back in a reclining chair with the lights dimmed. A disposable face mask was placed over the participant's nose and mouth, and it was tightened to ensure that no air leaked. The participant remained still and relaxed for 20 min, while rates of O^2 inspiration and CO^2 expiration were measured. Specific details of this procedure are described in the RMR section of the Methods found below.

After the metabolic testing, participants completed the second meal size estimation (Visit 1, Time 2). Participants were presented with a second pre-measured pasta bake, identical to the first, only smaller or larger, depending on meal size condition.

Participants were asked to estimate the size of the food, including serving size, number of cups, grams, ounces, and pounds of the presented food. Participants were also asked to estimate the macronutrient composition of the food, including calories, percentage fat, percentage protein, and percentage carbohydrates.

Following the second meal size estimation, participants were asked to complete an information packet, including a demographics questionnaire, the Beck Depression Inventory–II (BDI–II; Beck, Steer, Ball, & Ranieri, 1996), and a Palm and activity monitor borrowing contract (see Appendix I for the BDI–II; see Appendix J for the demographic information form and the Palm and activity monitor borrowing contract).

After completion of the information packet, participants were instructed on how to properly record dietary intake using the Palm m100 as a computerized eating diary. The participants were given a Healthometer brand (1998; Boca Raton, FL) 16-ounce capacity (model 3222) portable scale to measure all foods. As described previously (Sbrocco, Nedegaard, Stone, & Lewis, 1999), participants were asked to weigh and record all meals consumed for 7 days between Visit 1 and Visit 2. Along with dietary intake, participants were instructed to record times at which they woke and times at which meals were consumed. Participants were also instructed on the use of the ActiHeart physical activity monitor. The ActiHeart activity monitor, attached to the chest using electrodes, measured movement and heart rate to assess daily energy expenditure. Participants were asked to wear this monitor for 7 days between Visit 1 and Visit 2. Participants recorded all scheduled activity, including the type of activity, time of day, number of minutes, and distance (if applicable) (see Appendix K for activity log).

Participants were asked not to alter their usual behaviors. They were asked to continue to eat and exercise as they normally do. Participants had the opportunity to ask any questions about this or the coming week and were then scheduled for Visit 2. This visit took approximately 90 min to complete.

Detailed Study Procedures: Visit 2. Participants were scheduled to return to the HPL one week after Visit 1. When participants arrived, they returned their ambulatory monitoring equipment, including the Palm m100 and the ActiHeart activity monitor. Participants were asked to complete the first of two meal size estimations for Visit 2 (Visit 2, Time 1).

Participants were presented with pre-measured pasta bakes (see Appendix G for the pasta bake recipe), identical to the meals presented at Visit 1. The meals included a regular and large meal, presented in reverse order from Visit 1, depending on meal size condition. Participants were then asked to estimate the size of the food, including serving size, number of cups, grams, ounces, and pounds of the presented food. Participants were also asked to estimate the macronutrient composition of the food, including calories, percentage fat, percentage protein, and percentage carbohydrates (see Appendix H for the meal size estimation form).

Following the first meal size estimation, participants were asked to complete a questionnaire packet. This questionnaire packet included a payment information form, a medical information form, and the Eating Inventory (Stunkard & Messick, 1985; see Appendix I for the Eating Inventory and medical information form and Appendix J for the payment information form).

After the questionnaire packet, participants completed the second meal size estimation (Visit 2, Time 2). Participants were presented with a second pre-measured pasta bake, identical to the first, only smaller or larger, depending on meal size condition. Participants were asked to estimate the size of the food, including serving size, number of cups, grams, ounces, and pounds of the presented food. Participants were also asked to estimate the macronutrient composition of the food, including calories, percentage fat, percentage protein, and percentage carbohydrates.

Initial feedback based on participant questions was given regarding food intake, eating behaviors, and activity. Participants were debriefed (see Appendix L for the debriefing form). Participants were told that the true purpose of the study was to examine the effect of eating patterns and portion size on the accuracy of dietary self-monitoring. It was explained that amount of food consumed in one sitting was expected to be associated with greater dietary underreporting and that larger meal sizes were expected to be more difficult for everyone to accurately estimate. Any additional questions were answered. This visit took approximately 45 minutes.

Measures

Anthropomorphic Measures

Weight and height. Body weight and height were measured, without shoes, using a standard balance beam scale to the nearest 0.1 kg and 0.05 cm. Height was measured at the beginning of Visit 1. Weight measurements were taken at the beginning of both Visit 1 and Visit 2. Height and weight were converted to BMI (kg/m^2).

Body composition. Body fat percentage and fat-free mass percentage are often required for use in the calculations for RMR. Body fat percentage and fat-free mass were measured by BEI using the portable RJL body composition analyzer. BEI calculates body composition by measuring tissue conductivity (Heymsfield et al., 1994). Resistance and reactance were entered into accompanying software that calculated the body fat percentage. Assessing body composition using BEI equipment is safe, noninvasive, portable, and accessible (Foster & Lukaski, 1996; Houtkooper, Lohman, Going, & Howell, 1996). Studies on the measurement properties of this device indicated that if proper procedures were followed, BEI was both reliable and valid (r^2 between 0.85 and 0.98 and errors between 1% and 20%) when compared to DLW and hydrostatic weighing (Heymsfield et al., 1994; Houtkooper, Lohman, Going, & Howell, 1996).

To increase the reliability of BEI, the participants were instructed to report to the HPL after at least 12 hours of restricted physical activity, in a fasted state, well hydrated (32 oz of water 24 hours before the appointment and 64 oz of water 48 hours before the appointment), and having removed all items containing metal (such as jewelry and underwire bras; Houtkooper, Lohman, Going, & Howell, 1996).

Demographics

Each participant completed a demographics form, which included questions on age, gender, date of birth, ethnicity or race, level of education, marital status, annual household income, and employment information (see Appendix J for a copy of the demographics form).

Psychosocial Measures

Eating Inventory. The Eating Inventory (Stunkard & Messick, 1985) was used as a measure of eating pathology among participants. The Eating Inventory is a 51-item instrument that contains three subscales (Dietary Restraint, Disinhibition, and Perceived Hunger) and that is used to measure eating behavior (see Appendix I for a copy of the

Eating Inventory). The Eating Inventory is a valid and reliable self-report measure of eating behaviors and cognitions (Westenhoefer, Stunkard, & Pudel, 1999) and was developed using both lean and obese people. Allison and colleagues (1992) reported .91 test–retest reliability over a 2-week period. The Dietary Restraint subscale of the Eating Inventory was negatively correlated ($r = -.46$) with actual food intake (Lasessle, Tuschle, Kotthaus, & Pirke, 1989). In other words, highly restrained eaters ate fewer kilocalories than individuals who were less restrained.

Although findings were mixed, dietary restraint (i.e., the cognitive control of food intake) was associated with dietary underreporting in a number of studies (Asbeck et al., 2002; Bathalon et al., 2000; Bingham et al., 1995; Lafay et al., 1997; Macdiarmid & Blundell, 1997; Mela & Aaron, 1997). The Eating Inventory was used in the current investigation in order to identify differences between groups, and, if present, control for confounds related to eating behaviors and cognitions, including dietary restraint.

Beck Depression Inventory–II. The BDI–II was used as a measure of depressive symptomatology (Cronbach's $\alpha = 0.92$–0.93; 21 items; Beck, Steer, & Brown, 1996; see Appendix I for a copy of the BDI–II). The BDI–II took approximately 10 min to complete. Although persons who reported having been diagnosed with Major Depressive Disorder or current use of antidepressant medication were excluded from this study, subsyndromal symptoms related to mood disorders might still exist among participants. Because negative mood without clinical levels of depression can still impact eating behavior, differences between groups were assessed.

The BDI–II was demonstrated to be a valid and reliable self-report measure of the somatic–affective and cognitive–affective dimensions of depression (Steer, Ball, Ranieri,

& Beck, 1997; Steer, Ball, Ranieri, & Beck, 1999; Steer, Clark, Beck, & Ranieri, 1999). The BDI–II has been used in eating behavior research (e.g., Ricca et al., 2001; Sbrocco, Nedegaard, Stone, & Lewis, 1999; Troop, Serpell, & Treasure, 2001) and in screening for some eating disorders (Ricca et al., 2000). It was found to be useful in distinguishing symptomatic from asymptomatic eating disorder groups (Petersen, 2001).

Accuracy of Dietary Self-Reporting

Goldberg Equation. The Goldberg equation (Black, Coward, Cole, & Prentice, 1996; Black et al., 1991; Goldberg et al., 1991) was used to determine the accuracy of dietary reporting. EI:BMR is an expression of energy requirement, calculating the difference between energy intake and energy needs based on RMR and EE. The Goldberg equation (Goldberg et al., 1991) is used to calculates upper and lower confidence limits, which serve as cutoff scores to identify levels of dietary intake that are below what is required to maintain weight. Calculations require the following input variables; EI, BMR, PAL, number of participants (n), upper and lower confidence limits (SD_{min} and SD_{max}), and S, a factor that takes account of the variation in intake, BMR, and energy requirements . The rationale and use of the Goldberg cutoff score are discussed, in detail, in the Introduction, pages 24-26. Indirect calorimetry was used to measure RMR. PAL was measured using the International Physical Activity Questionnaire (IPAQ). EE was measured using the ActiHeart activity monitor. Reported EI was measured using prospective computerized dietary self-report diaries. A more detailed description of methods of assessing RMR, EE, PAL, and EI follow.

Resting Metabolic Rate: Indirect Calorimetry

A FitMate Pro v. 1 metabolic monitor (2004; Rome, Italy) was used to assess metabolic rate using indirect calorimetry. RMR was calculated using air samples (carbon dioxide [CO_2] and oxygen [O_2]) continuously collected while the participant was wearing a face mask to cover the nose and mouth and resting in the supine position (Lichtman et al., 1992; Weststrate, 1993). Indirect calorimetry was conducted in the HPL located at USUHS. For optimum accuracy, measurement requires a minimum of 4 hours of sedentary activity, fasting, and the absence of stimulatory substances prior to assessment (Roffey, Byrne, & Hills, 2006). Therefore participants were asked to refrain from exercising, eating, or drinking caffeine for 12 hours prior to testing. To determine adherence with these requirements, participants were asked to respond to the questions on the Metabolic Procedures Checklist prior to testing (see Appendix F for a copy of the Metabolic Procedures Checklist).

Because metabolic rate is influenced by monthly menstrual cycles, all participants were scheduled for assessment during the midphase of their menstrual cycles (Armellini, et al., 1990). Midfollicular phase is estimated, conservatively, as the seventh day after the start of menstruation, with an error of ± 2 days (Armellini, et al., 1990). For this study, the protocol used in the Human Performance Lab (HPL) at USUHS was used. Participants are tested between the 3rd and 9th day following the first day of menstruation.

Participants arrived at the HPL no later than 7:00 A.M. to control for potential time-of-day effects on metabolism. With a mask covering the nose and mouth, participants reclined in a reclining chair. They were instructed to lie still with no voluntary movements, not to sleep, and to avoid engaging in any activities (e.g., reading) for the duration of the RMR assessment. Participants were instructed to signal the investigator to stop the assessment at any time should they become nervous or anxious.

The total duration of the resting metabolic assessment was approximately 20 min, including time to allow for adjustment to the face mask. The actual measurement period was 15 min in a relaxed state. The valid time of measurement was determined by the stabilization of five data points (2004; Rome, Italy). This would likely occur after about 5–10 min for most participants. Therefore, the last 10 min of the measurement were used to obtain standardized data points where carbon dioxide production to oxygen uptake measured.

Energy Intake: Computerized Self-Monitoring Records

EI was recorded for 7 days using a computerized self-monitoring diary running on a Palm m100. Participants were trained to use the diary by the principal investigator. They were instructed on weighing foods and recording items in the computerized self-monitoring diary. Dietary intake was recorded using the Balance Log (2004; Golden, CO) software program, which contained almost 4,300 foods from brand names and dietary information from over 24 chain restaurants. Caloric data from these logs calculated mean caloric intake and percentages of kilocalories from fat, carbohydrates, and protein. The completed dietary records were evaluated for energy and nutrient content.

Physical Activity

Ambulatory physical activity monitoring: ActiHeart physical activity monitor. Ambulatory physical activity was monitored using an ActiHeart activity monitor. The ActiHeart has been found to be reliable and valid for estimating physical activity and calculating energy expenditure (Brage et al., 2004). This device utilizes a combined heart rate (HR) and multidirectional accelerometer movement sensor. The Actiheart digitizes the ECG signal and calculates the heart rate from the true R-to-R interval. Additionally, it provides digital interpretation reports of both movement intensity and duration of movement. The data related to level of activity and heart rate are combined with information on the participant, including height, weight, gender and age, into a proprietary algorithm that calculates an estimate of energy expenditure expressed in kcals. This formula does not account for basal metabolic rate.

This devise was worn at the chest, attached by electrodes placed at the level of the third intercostal space. Data were uploaded and downloaded using an ActiReader. Data included daily active energy expenditure and total daily energy expenditure. ActiHeart's activity count data were converted into a minute-by-minute energy expenditure. Both activity and heart rate are used in a validated algorithm to calculate hourly and daily energy expenditure.

Systematic validation and reliability has been established for ambulatory electronic accelerometer-based physical activity device (Actigraph), which have also been established as improvement over other activity measurement techniques in terms of utility and accuracy (Patterson, et. al, 1993). The Actiheart is a further improvement in actigraph devices, as it adds a heart rate monitor in order to decrease errors related to intensity of activity. The Actiheart has been found to be reliable and valid for estimating physical activity and calculating energy expenditure (Brage, Brage, Franks, Ekelune, Wareham, 2005). Technical reliability (coefficients of variation, CV) and validity for movement were assessed with sinusoid accelerations (0.1-20 m/s(2)) and for HR by simulated R-wave impulses (25-250 bpm). Agreement between Actiheart and ECG was determined during rest and treadmill locomotion (3.2-12.1 km/h). Median intrainstrument CV was 0.5 and 0.03% for movement and HR respectively. Corresponding interinstrument CV values were 5.7 and 0.03% with some evidence of heteroscedasticity for movement. The linear relationship between movement and acceleration was strong (R^2=0.99, P<0.001). Correlations with intensity were generally high (R^2>0.84, P<0.001) but highest when combining HR and movement.

Retrospective self-report physical activity monitoring. The International Physical Activity Level Questionnaire. Self-report PAL was determined using the IPAQ (Sjostrom, Bull, & Craig, 2002; see Appendix K for a copy of the IPAQ). This semi-structured interview assessed daily lifestyle, recreation, and planned exercise activities. Additionally, the IPAQ was found to have good reliability and validity in several studies (Craig et al., 2003; Bergman, Hagstromer, & Sjostrom, 1006; Sjostrom, Bull, & Craig, 2002).

Prospective self-report physical activity monitoring. Exercise log. Physical exercise was measured using a daily exercise log entered into the Palm m100. Participants were asked to record the type of physical activity, the intensity of the exercise (e.g., minutes per mile walked/run, intensity level on the cardiovascular equipment), the number of minutes exercised, and distance (if applicable).

Meal Size Estimation Tasks

Meal size. Participants estimated the size of large and regular size meals. The difference in estimated and actual meal size was used to measure the accuracy of meal size estimation. A pasta bake entrée, which had been used in a well-established research protocol on laboratory eating studies by Rolls and colleagues (2004), was utilized. Participants were on randomized to one of two meal size orders. They were given one of two pasta bake entrées that differed only in size and Entrées were either 500 g or 900 g.

Caloric composition consisted of 875 kcal for the 500 g entrée and 1,575 kcal for the 900 g entrée. The meal was formulated to contain ~25% of energy from fat, ~60% of energy from carbohydrates, and ~15% of energy from protein. The ingredients for the entrée consisted of commercially available national brands, and the entrée was made by weighing ingredients on a scale to the nearest 0.1 g (see Appendix G for the pasta bake recipe).

One meal type, rather than multiple meal types, was chosen based on research findings indicating that type of foods consumed did not effect the amount of foods consumed (Bell, Castellanos, Pelkman, Thorwart, & Rolls, 1998; Rolls, Morris, & Roe, 2002). In this study, participants estimated the size of two pre-measured meals, a regular size and a large size, at two time points (Visit 1, Visit 2).

Order effects. Order of meal size was counterbalanced across participant groups to control for order effects. On Visit 1, participants were randomly assigned, within weight and eating style categories, to Meal Order A or Meal Order B. Participants assigned to Order A estimated a regular meal first and a large meal second. Participants in Order B estimated a large meal first and a regular meal second. For each participant, meals were identical; however, the order was reversed on Visit 2. No meals were consumed. Order effects were examined statistically by comparing differences accuracy of meal size estimation for both regular and large meals by meal size estimation condition (Meal Order A and Meal Order B).

Meal size estimation variables. The typical procedure for reporting food intake using a prospective food diary is to report weight or serving size of a particular food. Although weighing foods and recording food weights improves accuracy of dietary self-monitoring (Wing & Tate, 2003), many computerized or paper-and-pencil prospective diaries ask individuals to estimate amount of foods, meaning either weight or serving size of foods. With that information, individuals can estimate caloric and macronutrient content by comparing food size with a so-called calorie counter resource booklet, or they are automatically calculated by dietary software. The amount of general knowledge of dietary information, such as serving size of foods and weight of foods, may be a factor in accurately reporting food intake. In the present study, participants were asked to estimate caloric content and macronutrient composition, including percentages of fat, carbohydrates, and protein, in addition to weight (in grams, cups, pounds, and ounces) and serving size for the pre-measured meal. This information was converted into a change score, representing the difference between actual and estimated size of foods. The change score was used to examine the accuracy of food size estimation (see Appendix H for a copy of the meal size estimation form).

Practice effects. It is possible that 7 days of self-monitoring could improve meal size estimation at time 2. In order to determine whether improvements in meal size estimation occurred, practice effects were examined statistically by comparing the accuracy of meal size estimation at time 1 to the accuracy of meal size estimation at time 2.

Data Analytic Strategy

Aim 1: Examine the effect of weight status and eating style on the accuracy of dietary self-monitoring

For Aim 1, a 2 (eating style) x 2 (weight status) ANOVA was used to examine the differences in accuracy of ambulatory food intake over 1-week. For these analyses, the two primary dependent variables were (1) reported energy intake and (2) the ratio of reported energy intake to measured energy needs (EI:EE). A chi square was performed to examine the differences in accuracy of dietary reporting between eating style and weight groups for categorical data. For this analysis, the primary dependent variable was the Goldberg Equation.

Aim 2: Examine the effect of meal size on dietary underreporting

For Aim 2, a 2 (eating style) x 2 (weight) x 2 (meal size) x 2 (time) mixed model Repeated Measures Analysis of Variance was performed to examine the effect of meal size on dietary underreporting. The two between-subjects factors were eating style (gorging and non-gorging) and weight status (normal weight and overweight). The repeated measures factors were meal size (regular, large) and time (Visit 1, Visit 2). The primary dependent variable for Aim 2 was the difference in estimated compared to actual amount (in cups) of pre-measured meals. Simple effects testing was used to follow up significant interactions.

Power Analysis

Effect size calculations were based on both the expected differences in the accuracy of dietary self-monitoring and in differences in portion size estimation between gorgers and non-gorgers. Because no studies to date have examined the affect of eating style or portion size on accuracy, calculations were based on the outcome data of the NHANES-III survey (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997) and Kim (2007). Briefel and colleagues (1997) presented survey data on the ratio of EI:BMR among female underreporters (n = 1189; 0.69 $\pm$ 0.01 SEM) and adequate reporters (n = 2624; 1.48 $\pm$ 0.01). Additionally, they provide data on the prevalence of overweight underreporters (n = 1189; 51% ± 2.5% SD) and adequate reporters (n = 2624; 29.4% ± 1.20 SD). The means for both tests were significantly different with large effect sizes for both tests (Cohen's f = 0.36; Cohen's f = 0.40, respectively).

The data of Kim et. al (2007) were used to calculate an effect size for accuracy. They found differences in energy intake between gorgers (n = 26; 1305.6 ± 349.95) and non-gorgers (n = 25; 1805 ± 574.6), which suggested gorgers underreported to a greater extent than non-gorgers [$F(1,47) = 10.44$, $p < 0.01$]. The means for this test were significantly different, with a large effect size (Cohen's f = 0.53)

Based on prior research, we expected the effect size to be large (Cohen's f = 0.4) (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Kim, 2007). This effect size will require 72 participants (18 in each group) to detect between group differences with p=0.05 and a power of 0.80. Furthermore, to account for an estimated 20% attrition rate an additional 4 participants per cell were recruited. Therefore, a total 88 participants were to be recruited for this proposed study.

Results

Information on Participants Excluded From Analyses

Eighty-five women were recruited and consented to participate in the current study. Of these 85 women, nine participants were excluded from data analysis. Two participants dropped from the study after reporting that daily food entry was too time consuming. One participant did not complete the required questionnaires, including the food estimation forms. One overweight participant and 3 normal weight participants did not meet the required time criteria for gorging (i.e., 7 hours between waking and first meal at least 3 days per week over the past month). Lastly, two participants did not meet the BMI cut-off criteria. In both cases, participants were greater than the 34.9 kg/m^2 BMI cut-off for overweight participants.

Data indicated that excluded participants were, on average, 28.8 years old (SD = 7.8), had 16.9 years of education (SD = 1.7), and had a mean BMI of 26.7 kg/m^2 (SD = 5.5). Additionally, 44% (n=4) of excluded participants were Caucasian, 44% (n=4) were Black or African America, and 11% (n=1) was Hispanic. Excluded participants (n=9) did not differ from participants who completed the study protocol (n=76) on demographic variables or BMI (p's > 0.10).

Demographic Data for Participants Included in the Current Study

The analyses reported in this study are based on the remaining 76 participants who fulfilled eligibility criteria and completed study requirements. Means and standard deviations for demographic variables by weight group and eating style are shown in Table 4. Results were calculated using Analyses of Variance for continuous variables and Chi-Square for categorical data. All groups were comparable on demographic variables including age, years of education, ethnicity, marital status, employment, and income (p's > 0.10).

Comparison of Psychosocial Variables by Weight and Eating Style Groups

Eating Inventory

Table 5 shows Eating Inventory scores by weight and eating style groups. A 2 by 2 Multivariate Analysis of Variance was used to compare Eating Inventory subscale scores by weight and eating style conditions. Subscales include Dietary Restraint, Disinhibition, and Perceived Hunger. One overweight gorger did not complete the Eating Inventory questionnaire, and was therefore not included in these analyses. There was an overall multivariate weight by eating style interaction [$F(3,69) = 2.65$, $p = 0.05$] for the Eating Inventory. Also, there were overall main effects of weight [$F(3,69) = 2.89$, $p = 0.04$] and eating style [$F(3,69) = 2.78$, $p = 0.04$]. However, these results must be interpreted in the context of the interaction. The main effect of gorging is accounted for by the lower overall scores of the normal weight gorgers, as is the difference between in normal weight vs. overweight groups. Simple effects testing indicate the normal weight gorgers had marginally significant lower scores [$t(74) = 2.20$, $p = 0.06$] than overweight gorgers.

To better understand the differences in the Eating Inventory between groups, the individual subscales were examined. There were no weight by eating style interactions for Dietary Restraint [$F(1,71) = 1.65$, $p = 0.20$], Disinhibition [$F(1,71) = 1.11$, $p = 0.29$], or Perceived Hunger [$F(1,71) = 1.16$, $p = 0.08$]. For Disinhibition, there was a main effect of weight [$F(1,71) = 6.38$, $p = 0.01$], with the normal weight group scoring lower than the overweight group. This was primarily accounted for by the low disinhibition of the normal weight, non-gorgers. There were no main effects of weight for Dietary Restraint [$F(1,71) = 0.55$, $p = 0.45$] or Perceived Hunger [$F(1,71) = 0.002$ $p = 0.96$]. No main effects of eating style were found for Dietary Restraint [$F(1,71) = 0.22$, $p = 0.63$], Disinhibition [$F(1,71) = 0.65$, $p = 0.42$], or Perceived Hunger [$F(1,71) = 3.06$, $p = 0.08$].

Norms for the Eating Inventory subscales have been developed on normal weight (Westenhoefer, Stunkard, & Pudel, 1999) and overweight female samples (Garner, 1990). Normal weight females score 8.8 (SD=5.0) on the Dietary Restraint subscale while overweight women score 12.0 (SD=4.5). Normal weight women score 5.5 (SD=3.6) on the Disinhibition subscale and overweight women score 8.4 (SD=3.6). Lastly, normal weight women score 5.0 (SD=3.5) on perceived hunger. Norms for perceived hunger are not available for an overweight sample. Both overweight and normal weight participants in this study were within their respective norms. Because of this, Eating Inventory scores were not covaried in further analyses.

BDI-II

Table 5 contains mean BDI-II scores by weight and eating style groups. Analysis of Variance revealed a weight by eating style interaction [F(1,72) = 3.68, p = 0.05]. Simple effects testing revealed overweight gorgers had higher BDI-II scores compared to normal weight gorgers [t(75) = 1.31, p = 0.02] and overweight non-gorgers [t(75) = 1.31, p = 0.05]. There were no main effects of weight [F(1,72) = 1.87, p = 0.17] or eating style [F(1,72) = 0.69, p = 0.40]. Mean BDI-II scores fell well below the cutoff of sixteen for all groups, indicating minimal depressive symptomatology. Therefore, BDI scores were not covaried in further analyses.

Comparison of Physiological Variables by Weight and Eating Style Groups

Data for physiological variables by weight and eating style groups are shown Table 6. Differences in measured physiological variables (BMI, body fat, weight change, energy needs, heart rate) and self-reported physiological variables (activity level, energy intake) were compared using Univariate Analysis of Variance by weight and eating style groups. A chi square was used to compare the distribution of high, medium, and low physical activity level (PAL) between eating style and weight groups.

Measured Physiological Variables

BMI. Height in meters and weight in kilograms were converted to body mass index (BMI; kg/m^2). No weight by eating style interaction for BMI [F(1,72) = 0.31, p =

0.57] was observed. The main effect of weight was not examined statistically because groups were selected based on this variable, thus precluding statistical analysis. Contrary to expectations, there was a significant main effect of eating style [$F(1,72) = 4.25$, $p = 0.04$], such that gorgers had a greater BMI than non-gorgers. Overweight gorgers met NHLBI classification criteria for obesity (BMI = 30.0 ± 3.4 kg/m^2) and overweight non-gorgers met criteria for overweight (BMI = 28.4 ± 2.8 kg/m^2) (NHLBI, 1998).

Body Fat Percentage. Body composition was measured using bioelectric impedance. No weight by eating style interaction [$F(1,72) = 0.13$, $p = 0.71$] for body fat percentage was found. There were main effects of weight [$F(1,72) = 64.97$, $p < 0.01$] and eating style [$F(1,72) = 4.66$, $p = 0.03$]. Overweight women had higher body fat percentages than normal weight women. Gorgers had higher body fat percentage than non-gorgers.

Both normal weight and overweight groups had higher body fat than expected. According to the American Council on Exercise (2007), body fat measurements equal to and greater than 32% are above indicate above an “acceptable” range. The highest measurement of body fat was the overweight gorgers, who had 42% body fat. Next highest were overweight non-gorgers, who had 40% body fat, followed by normal weight gorgers with 33% body fat. Surprisingly, only the normal weight non-gorgers had a body fat of 30%, which is just slightly below the “obese” range.

Weight Change during 1-week ambulatory monitoring. Weight was measured using a balance beam scale to the nearest 0.1 kg. Weight change was determined by the difference in weight between time 1 and time 2. No weight by eating style interaction [$F(1,72) = 0.39$, $p = 0.53$], main effect of weight [$F(1,72) = 0.24$, $p = 0.61$], or main effect of eating style [F(1,72) = 0.01, p = 0.90] was found. The overall change in weight over time was statistically significant [t(1,75) = 2.58, p = 0.01], with participants gaining an average of 0.24 (0.1) kg.

Energy Expenditure (EE). Energy expenditure (kcal/day) was measured using the ActiHeart Activity Monitor. No weight by eating style interaction [F(1,72) = 0.24, p = 0.62] or main effect of weight [F(1,72) = 2.61, p = 0.11] was found. There was a main effect of eating style [F(1,72) = 6.50, p = 0.01], such that the energy expenditure of gorgers was greater than non-gorgers. Because there was a significant difference in BMI between gorgers and non-gorgers, a follow up analysis was performed, covarying for BMI. When BMI was covaried, the main effect of eating style groups remained [F(1,71) = 4.05, p = 0.04].

Heart rate was measured using the ActiHeart activity monitor as a variable in calculating energy expenditure. Average weekly beats per minute (bpm) were compared between weight and eating style groups to determine if differences in heart rate accounted for group differences in the comparison of measured energy expenditure between groups. No weight by eating style interaction [F(1,72) = 0.15, p = 0.68], main effect of weight [F(1,72) = 0.01, p = 0.89], or main effect of eating style [F(1,72) = 0.16, p = 0.68] was found.

Resting Metabolic Rate (RMR). Resting metabolic rate was measured using the COSMED metabolic monitor. No weight by eating style interaction [F(1,72) = 1.04, p = 0.30] was found. As expected, there was a main effect of weight [F(1,72) = 17.75, $p <$ 0.01] with the overweight group having a greater RMR than the normal weight group. There was also a main effect of eating style [F(1,72) = 4.04, p = 0.04] with gorgers having a greater RMR than non-gorgers. When BMI was covaried, there was no longer main effect of eating style [$F(1,71) = 1.78$, $p = 0.18$].

Measured Energy Needs (Resting Metabolic Rate and Energy Expenditure). Energy needs were measured by summing resting metabolic rate (RMR) and energy expenditure (EE). Energy expenditure (kcal/day) was measured using the ActiHeart Activity Monitor. There was no weight by eating style interaction [$F(1,72) = 0.93$, $p = 0.33$]. There were main effects of weight [$F(1,72) = 13.55$, $p < 0.01$] and eating style [$F(1,72) = 9.55$, $p < 0.01$]. Energy needs were greater for the overweight group compared to normal weight group. Energy needs were also greater for gorgers compared to non-gorgers. The main effect of weight was expected, as energy needs are dependent on weight. The main effect of eating style, however, was not expected. A follow-up analysis was performed, covarying for BMI, in order to determine if the main effect of eating style was accounted for by difference in BMI between eating style groups. When BMI was covaried, there was a marginally significant main effect of eating style for measured energy needs [$F(2,70) = 2.83$, $p = 0.06$], suggesting differences were accounted for, in part, by BMI.

Self-reported Physiological Variables

Physical Activity Level. Self-reported physical activity was measured by self-reported number of minutes of exercise and physical activity level (PAL) scores measured using the International Physical Activity Questionnaire (IPAQ). Univariate Analysis of Variance was used to examine differences in self-reported energy expenditure, using self-reported minutes of exercise logged in an activity monitor. Chi-square was used to examine difference in PAL.

Thirty four participants (2 normal weight non-gorgers, 8 normal weight gorgers, 14 overweight non-gorgers, and 10 overweight gorgers) did not complete self-report physical activity logs, therefore, were not included in the analysis comparing minutes of exercise. There was no weight by eating style interaction [$F(1,41) = 1.34$, $p = 0.25$] for reported minutes of exercise. Main effects of weight [$F(1,41) = 6.94$, $p = 0.01$] and eating style [$F(1,41) = 7.25$, $p = 0.01$] were found. Overweight women reported exercising more than normal weight women, and non-gorging participants reported exercising more than participants in the gorging group.

Looking at PAL measured by the IPAQ, there were no differences between groups [$\chi2$ (2, N=76) = 7.64, $p = 0.26$]. Overall, 53% of participants had low PAL scores, 15.8% had medium, and 30.3% had high PAL scores. The low scores are consistent with normative data from the Behavioral Risk Factor Surveillance System (BRFSS, 2007) data, which indicate 26.9% do not engage in physical activity, 52.3% of women engage in low levels of physical activity, and 18.9% engage in moderate physical activity. Unlike participants in this study, however, only 13.5% of the BRFSS sample engaged in high levels of physical activity. Data are not available by weight or eating style groups.

The association between measured and self-report physical activity level was examined using Pearson correlation. Measured physical activity was determined using the ActiHeart Activity monitor. Self-reported physical activity was determined by the average minutes of exercise reported by participants. There was a positive correlation between measured physical activity and self-report physical activity ($r(42) = 0.29$, $p = 0.05$), suggesting that the measured and self-reported indices of physical activity are associated. Thirty four participants did not complete self-report physical activity records.

Self-reported Energy Intake (EI). Self-reported EI was measured using ambulatory food monitoring diaries. No weight by eating style interaction [F(1,72) = 0.56, p = 0.45] or main effect of weight [F(1,72) = 0.24, p = 0.11] was observed. There was a main effect of eating style [F(1,72) = 6.82, p = 0.01], such that gorgers reported less EI than non-gorgers. To ensure these differences were not accounted for by BMI, a follow-up analysis was performed, covarying for BMI. When BMI was covaried, the main effect of eating style remained significant [F(1,71) = 6.98, p = 0.01].

Summary of Physiological Variables by Weight and Eating Style Groups. Overall, results indicated greater resting metabolic rate and energy needs (resting metabolic rate + measured energy expenditure) for overweight compared to normal weight groups. Additionally, the overweight group reported exercising for a greater number of minutes compared to the normal weight group. At the same time, there were no differences in reported energy intake between overweight and normal weight groups. These data suggest the overweight group underreported dietary intake.

Results also show that gorgers had higher measured energy expenditure, resting metabolic rate, and energy needs compared to non-gorgers. In spite of these greater energy needs, gorgers reported less energy intake compared to non-gorgers, indicating dietary underreporting by gorgers.

Aim 1: Do *Weight and Eating Style Affect the Accuracy of Dietary Self-Monitoring*

Accuracy Estimates from the Goldberg Equation

Table 7 contains the distribution of "accurate reporters," "underreporters," and "over-reporters" by groups based on the Goldberg Equation. The Goldberg formula was used calculate the differences in energy intake and estimated energy needs, and used previously published values to estimates the differences that might result from variations in daily food intake, the number of participants studied, the number of days of dietary assessment, and the use of equations to estimate BMR.

Upper- and lower-limits were calculated from the current sample. The lower cut-off limit for the self-reported energy intake to energy needs, used to identify underreporters, yielded a value of 1.49. This lower limit cut-off was slightly higher than the normative lower limit cut-off value of 1.47 calculated by Black (1991). The upper cutoff limit calculated from the current sample, used to identify over-reporters, was 1.64. A chi-square analyses revealed no statistically significant differences between weight and eating style groups in accuracy of self-reported food intake [$\chi2$ (2, N=76) = 7.64 (2), p = 0.26].

Results indicated 93.40% of all participants underreport food intake. The single accurate reporter (1.30%) was an overweight non-gorger. Four participants (5.20%) were categorized as over-reporters. Of these, all were non-gorgers, half normal weight and half overweight.

Accuracy Estimates: Assessing Underreporting from the EI:EE

As another method of estimating underreporting, the ratio of energy intake to energy expenditure (EI:EE) was calculated. Energy intake was estimated from food diary data. Energy expenditure was calculated by summing resting metabolic rate (RMR) and energy expenditure. RMR was calculated from indirect calorimetry using the FitMate Pro. Energy expenditure was measured using the ActiHeart Activity monitor. Reported EI and measured EE by weight and eating style groups are displayed in Figure 3.

The ratio of energy intake to energy expenditure was compared by eating style and weight groups. Differences in EI and EE are shown in Figure 4. A ratio of 1 indicates an individual's energy intake is equal to energy expenditure. A ratio below 1 indicates energy intake is less than energy expenditure, and a ratio above 1 indicates energy intake is above energy expenditure. A Univariate Analysis of Variance was used to compare EI:EE by weight and eating style groups. Additionally, post-hoc one-sample t-tests were used to compare the extent of underreporting by comparing the difference between EI:EE and 1, where 1 is an indicator of accurate reporting.

Results of the ANOVA indicated no weight by eating style interaction [$F(1,72) = 0.48$, $p = 0.49$] or main effect of weight [$F(1,72) = 0.66$, $p = 0.41$] for EI:EE. There was a main effect of eating style [$F(1,72) = 21.74$, $p < 0.01$]. Gorgers had a lower EI:EE score, indicating a larger disparity between reported energy intake and energy expenditure measured from RMR and physical activity.

There was an average weight gain of 0.24 (0.1) kg from time 1 to time 2. Because EI:EE is a valid measure of accuracy of reported energy intake during weight stability, an analysis of covariance, covarying for weight change, was used to determine whether results for EI:EE could be accounted for by weight gain over time. When weight change was covaried, the results did not change.

For the normal weight non-gorging group, a one-sample t-test indicated that EI:EE did not significantly differ from 1 [$t(19) = -1.39$, $p = 0.17$], suggesting that underreporting among the normal weight, non-gorging participants was not substantial. Because EI=EE (Black, 2000; Braam, Ocke, Buenode de Mesquita, & Seidell, 1998), normal weight non-gorging participants can be classified as accurate reporters. For the overweight non-gorging group, a statistically significant difference between EI:EE and 1 was observed [t(17) = -2.10, $p = 0.05$], suggesting the underreporting was meaningful. Meaningful underreporting was also found for normal weight gorgers [t(17) = -6.64, $p < 0.01$] and overweight gorgers [t(19) = -8.35, $p < 0.01$].

To examine convergent validity of the two indices of under reporting, the association between the Goldberg related equation and the EI:EE ratio was examined using Pearsons correlations. This was examined using the Goldberg Equation cut-off score of 1.49 classification of underreporters, accurate reporters, and overreporters across weight and eating style groups. Table 8 presents the associations between the Goldberg Equation and EI:EE as assessments accuracy of dietary reporting across weight and eating style groups using Pearson correlations. There was a positive correlation between EI:EE and the Goldberg Equation scores for underreporters ($r(72) = 0.86$, $p < 0.01$), suggesting that these measures of accuracy are associated for underreporters. Because of the small number of accurate and overreporters identified using the Goldberg Equation, these groups were collapsed. There was no significant correlation between EI:EE and the Goldberg Equation scores for accurate and overreporters ($r(4) = -0.70$, $p = 0.14$), suggesting that these measures of accuracy are not associated for accurate and overreporters. Results must be interpreted cautiously given the small n.

When using more conservative cut-offs, associations were found among underreporters and both accurate and overreporters. Using the cut-off score of 1.47, there was a positive correlation between EI:EE and the Goldberg Equation scores for underreporters ($r(64) = 0.82$, $p < 0.01$) and both accurate and overreporters ($r(12) = 0.70$, $p = 0.01$). Using a more conservative cut-off score of 1.35, there was a positive correlation between EI:EE and the Goldberg Equation scores for underreporters ($r(51) = 0.76$, $p < 0.01$) and both accurate and overreporters ($r(12) = 0.76$, $p = 0.01$). These data suggest that the Goldberg related equation and EI:EE as measures of accuracy are associated for all groups.

Summary of Aim 1: Accuracy of Dietary Self-Monitoring

Overall, results examining the accuracy of dietary self-monitoring were mixed. Examining the dietary underreporting using the Goldberg equation indicated that 93.4% of participants were categorized as dietary underreporters, with no differences between weight or eating style groups. This is contrary to the expectations that overweight women and gorgers would underreport as compared to normal weight women and non-gorgers, respectively.

The ratio of EI:EE was used to examine the extent of dietary underreporting. When EI:EE was compared between groups, there were no differences between overweight and normal weight groups, therefore, the expectation that overweight would underreport compared to normal weight groups was not supported. However, results showed that gorgers had a lower EI:EE compared to non-gorgers, indicating a greater discrepancy between reported energy intake and measured energy expenditure, suggesting greater underreporting by gorgers compared to non-gorgers.

The extent of dietary underreporting was further examined by comparing EI:EE to 1, as 1 is an indication of perfect agreement between energy intake and energy expenditure. Results indicated that there was no significant difference between EI:EE and 1 for normal weight non-gorgers, suggesting that the underreporting, identified using the Goldberg Equation, was no meaningful. Findings revealed significant differences between EI:EE and 1 for all other groups, suggesting the overreporting was substantial for overweight and gorgers. Although there was no weight by eating style interaction for accuracy of dietary reporting, these data suggest there is a meaningful difference between normal weight non-gorgers and both overweight and gorgers, related to dietary underreporting.

Aim 2: Examine the Effect of Meal Size on Accuracy.

Participants were asked to estimate meal size by rating five units of measurement (serving size, ounces, pounds, cups, and grams). The present analyses focus on estimated cups as the unit of measurement because this unit of measurement is more commonly used in measuring amounts food compared to serving size, ounces, pounds, and grams. Alternative units of measurements (serving size, ounces, pounds, and grams) can be found in Appendix A. The two meal sizes were regular (500g) and large (900g), which correspond to 2.0 cups and 3.75 cups, respectively.

Univariate Analyses of Variance were used to determine whether there was an order effect on the accuracy of meal size estimation. Furthermore, 2 x 2 (weight x eating style) Multivariate Analyses of Variance were used to examine differences in hunger and meal size perception prior to meal size estimation. For each meal size, 2 x 2 x 2 Repeated Measures Analysis of Variance were used to examine accuracy of meal size estimation by weight and eating style groups over time. Additionally, one-sample t-tests were used to compare estimated meal size to actual meal size in order to determine the extent of accuracy estimations.

Order effect

Order of meal presentation was counterbalanced. In Order Group A, at time 1, participants estimated a regular meal first and a large meal second (NR). At time 2, they received the reverse order (LR). In Order Group B, at time 1, participants estimated a large meal first and a regular meal second (LR). At time 2, meal presentation was reversed (RL). For each participant, meals were identical and the order was reversed on Visit 2.

Univariate Analyses of Variance were used to determine whether there was an order effect of meal size. That is, did participants estimate meal size differently after the presentation of a regular size meal compared to a large size meal? These analyses were conducted to examine both large and regular meals at both time 1 and time 2.

Order of presentation affected meal size estimations for large meals at time 1 [$F(1,72) = 5.58$, $p = 0.02$] and at time 2 [$F(1,72) = 3.79$, $p = 0.05$]. In both cases, large meals were estimated as larger after the presentation of a regular meal first compared to a large meal first. Order did not affect meal size estimation for regular meals at time 1 [$F(1,72) = 1.91$, $p = 0.16$] or time 2 [$F(1,72) = 1.16$, $p = 0.28$].

Hunger Ratings by Weight and Eating Style Groups

A 2 x 2 (weight x eating style) Multivariate Analysis of Variance was used to examine differences in hunger prior to meal size estimation. Means by groups, meal, and time are shown in Table 9. Separate MANOVA's were calculated for time 1 and time 2. Two 10 cm visual analogue scales were used to measure hunger. Participants were asked: (1) "How hungry are you?" which was anchored by "not at all" and extremely; and (2) "How much food could you eat right now?" which was anchored by "nothing at all" and "a large amount."

Hunger at Time 1. For large meals at time 1, there was no multivariate weight by eating style interaction [$F(2,71) = 0.29$, $p = 0.74$], main effect of weight [$F(2,71) = 1.30$, $p = 0.27$], or main effect of eating style [$F(2,71) = 2.34$, $p = 0.10$]. For regular meals, there was no multivariate weight by eating style interaction [$F(2, 70) = 0.49$, $p = 0.61$] and no main effect of weight [$F(2,70) = 1.11$, $p = 0.33$]. For regular meals, there was a multivariate main effect of eating style [$F(2,70) = 6.69$, $p < 0.01$]. Gorgers reported less hunger than non-gorgers when estimating the size of regular meals. Both questions "How Hungry are you" [$F(1,71) = 6.00$, $p = 0.01$] and "How much are you able to eat" [$F(1,71) = 13.44$, $p < 0.01$] contributed to the significant difference.

Hunger at Time 2. For large meals at time 2, there was no multivariate weight by eating style interaction [$F(2, 71) = 1.32$, $p = 0.27$], main effect of weight [$F(2,71) = 0.10$, $p = 0.90$], or main effect of eating style [$F(2,71) = 0.56$, $p = 0.57$]. Additionally, for regular size meals, there was no multivariate weight by eating style interaction [$F(2,71) = 0.36$, $p = 0.69$], main effect of weight [$F(2,71) = 0.20$, $p = 0.81$] or main effect of eating style [$F(2,71) = 1.05$, $p = 0.35$].

Perception of Meal Size by Weight and Eating Style Groups

A 2 x 2 (weight x eating style) Multivariate Analysis of Variance was used to examine differences in perception of meal size prior to meal size estimation. Separate MANOVA's were calculated for time 1 and time 2. Means by groups, meal, and time are shown in Table 10. Two 10 cm visual analogue scales were used to measure perception of meal size. Participants were asked: (1) "How large is this meal?" and (2) Compare this meal size to your usual dinner. Both questions were anchored by "not at all" and "extremely."

Meal Size Perception at Time 1. At time 1, no multivariate weight by eating style interaction [F(2,71) = 1.96, p = 0.14], main effect of weight [F(2,71) = 0.23, p = 0.79], or main effect of eating style [F(2,71) = 1.73, p = 0.18] for perceived size of large meals was found.

Additionally, there was no multivariate weight by eating style interaction [F(2,70) = 0.51, p = 0.60] and no main effect of weight [F(2,70) = 0.38, p = 0.68] for perceived size of regular meals. A multivariate main effect of eating style [F(2,70) = 4.45, p = 0.01] indicated gorgers perceived regular meals as smaller than non-gorgers when estimating regular meals. Both questions “How Large is This Meal” [F(1,71) = 4.48, p = 0.03] and “Compare this to your usual dinner” [F(1,71) = 8.67, p < 0.01] contributed to the significant differences.

Meal Size Perception at Time 2. At time 2, there was no multivariate weight by eating style interaction [F(2,70) = 0.20, p = 0.81], no main effects of weight [F(2,70) = 1.34, p = 0.26], and no eating style [F(2,70) = 0.78, p = 0.46] for perceived size of large meals. Additionally, there was no multivariate weight by eating style interaction [F(2,71) = 2.70, p = 0.69], no main effects of weight [F(2,71) = 0.19, p = 0.82], and no main effects of eating style [F(2,71) = 0.04, p = 0.95].

Practice Effects

Differences in accuracy of estimation of meal size for regular and large meals, over time, are displayed in Figure 5. Repeated Measures Analysis of Variance examined differences in accuracy of estimation of meal size over time. There was no weight by eating style interaction [F(1,72) = 0.26, *p* = 0.77], main effect of weight [F(1,72) = 0.69, *p* = 0.50], or main effect of eating style [F(1,72) = 1.07, *p* = 0.34] within groups for accuracy of meal size estimation from time 1 to time 2. This indicates no improvement in accuracy over time, and suggests there were no significant practice effects to confound meal size estimation findings. This is also true for large and regular meal sizes.

When examining practice effect differences over time for large meal size estimation, no weight by eating style interaction [$F(1,72) = 0.33$, $p = 0.56$], main effect of weight [$F(1,72) = 0.87$, $p = 0.76$] or main effect of eating style [$F(1,72) = 1.97$, $p = 0.16$] within groups from time 1 to time 2 was found. Examining regular size meals over time, there was also no weight by eating style interaction [$F(1,72) = 0.37$, $p = 0.84$], main effect of weight [$F(1,72) = 0.92$, $p = 0.34$] or eating style [$F(1,72) = 0.89$, $p = 0.34$] found within groups.

Accuracy of Meal Size Estimation

Differences in accuracy of meal size estimation between regular and large meal size were compared between groups. Overall, regular meals were less accurately estimated compared to large meals [$F(1,72) = 263.89$, $p < 0.01$]. Comparisons across groups and meal size revealed no weight by eating style interaction [$F(2,72) = 0.21$, $p = 0.88$], main effect of weight [$F(2,72) = 0.96$, $p = 0.32$], or main effect of eating style [$F(2,72) = 0.82$, $p = 0.36$] for accuracy of estimation of meal size.

Accuracy of estimation of meal size by weight and eating style groups for regular and large meals, over time, are shown in Figure 6. Large meals were not associated with a weight by eating style by time interaction [$F(2,72) = 0.34$, $p = 0.55$], weight by time interactions [$F(2,72) = 0.12$, $p = 0.72$], or eating style by time interactions [$F(2,72) = 1.99$, $p = 0.16$]. For regular size meals, there were no weight by eating style by time interaction [$F(2,72) = 0.85$, $p = 0.35$], weight by time interaction [$F(2,72) = 2.93$, $p = 0.91$], or eating style by time interaction [$F(2,72) = 1.40$, $p = 0.24$] .

Data on hunger indicated that gorgers reported less hunger compared to non-gorgers when estimating regular size meals at time 1 (see page 76). Because of this, hunger was controlled for in the analysis examining the accuracy of meal size estimation for regular meals at time 1. When hunger was covaried, there was no difference between gorgers and non-gorgers [$F(1,71) = 0.51$, $p = 0.47$].

Actual Compared to Estimated Meal Size Within Weight and Eating Style Groups

Estimated meal size was greater than actual meal size for large meals at time 1 [$t(72) = 21.54$, $p < 0.01$] and time 2 [$t(72) = 18.70$, $p < 0.01$] and for regular meals at time 1 [$t(72) = 15.85$, $p < 0.01$] and time 2 [$t(72) = 9.10$, $p < 0.01$].

In order to determine extent of accuracy for meal size estimation, one-sample t-tests were used to compare estimated meal size to actual meal size among groups. The test values were 3.75 cups for the large meal size and 2 cups for the regular meal size, which represented the actual amount of cups for each meal size. Table 11 presents the estimated meal size for both regular and large meals groups at time 1 and time 2.

Normal weight non-gorgers. Estimated meal size was greater than actual meal size for large meals at time 1 [$t(19) = 13.26$, $p < 0.01$] and time 2 [$t(19) = 8.15$, $p < 0.01$], and for regular meals at time 1 [$t(19) = 10.64$, $p < 0.01$] and time 2 [$t(19) = 6.80$, $p < 0.01$] among normal weight non-gorgers.

Normal weight gorgers. Estimated meal size was greater than actual meal size for large meals at time 1 [$t(17) = 9.66$, $p < 0.01$] and time 2 [$t(17) = 7.58$, $p < 0.01$], and for regular meals at time 1 [$t(17) = 7.31$, $p < 0.01$] and time 2 [$t(17) = 7.20$, $p < 0.01$] among normal weight gorgers.

Overweight non-gorgers. Estimated meal size was greater than actual meal size for large meals at time 1 [t(17) = 10.59, $p < 0.01$] and time 2 [t(17) = 13.89, $p < 0.01$], and for regular meals at time 1 [t(17) = 7.65, $p < 0.01$] and time 2 [t(17) = 8.99, $p < 0.01$] among overweight non-gorgers.

Overweight gorgers. Estimated meal size was greater than actual meal size for large meals at time 1 [t(19) = 9.86, $p < 0.01$] and time 2 [t(19) = 9.81, $p < 0.01$], and for regular meals at time 1 [t(19) = 6.81, $p < 0.01$] and time 2 [t(19) = 8.42, $p < 0.01$] among overweight gorgers.

Actual Association of Meal Size Estimations at Time 1 and Time 2

Overall, there were significant overall correlations for estimations of large meal size ($r(76) = 0.56$, $p < 0.01$) and regular meal size ($r(76) = 0.53$, $p < 0.01$) between time 1 and time 2. These data provide support for the reliability of meal size estimation over time.

The association of meal size estimations between time 1 and time 2 was also examined for eating style and weight groups. There were significant correlations for estimations of large meal size ($r(38) = 0.54$, $p < 0.01$) between time 1 and time 2 and for regular meal size ($r(38) = 0.71$, $p < 0.01$) between time 1 and time 2 for normal weight women. There were significant correlations for estimations of large meal size ($r(38) = 0.61$, $p < 0.01$) between time 1 and time 2 and for regular meal size ($r(38) = 0.39$, $p = 0.01$) among overweight women. Also, there were significant correlations for estimations of large meal size ($r(38) = 0.48$, $p < 0.01$) and regular meal size ($r(38) = 0.53$, $p < 0.01$) for non-gorgers. Finally, there were significant correlations for estimations of large meal size ($r(38) = 0.63$, $p = 0.01$) between time 1 and time 2 and for regular meal size ($r(38) = 0.54$, $p < 0.01$) for gorgers. These data provide support for the reliability of meal size estimation over time among eating style and weight groups.

Association between Ambulatory Versus Laboratory-based Assessments of Accuracy for Dietary Reporting

Table 12 presents the associations between ambulatory-based versus laboratory based assessments for accuracy of dietary reporting across all groups using Pearson correlations. There were no significant correlations between ambulatory dietary self-monitoring and laboratory based meal size estimations of large meals at time 1 ($r(76) = -0.11$, $p = 0.32$), large meals at time 2 ($r(76) = 0.02$, $p = 0.86$), regular meals at time 1 ($r(76) = -0.14$, $p = 0.21$), and regular meals at time 2 ($r(76) = -0.12$, $p = 0.29$). These data suggest that the ambulatory measure of dietary intake and laboratory based estimations of meal size estimation are not associated.

Summary of Aim 2: Accuracy of Meal Size Estimation

Overall, regular meal size was overestimated compared to large meals, with no difference between weight or eating style groups. In spite of the differences between regular and large meals, all groups overestimated regular and large size meals. There was no improvement in accuracy of meal size estimation from time 1 to time 2.

Discussion

Dietary underreporting is a fundamental problem in self-monitoring of food intake. Research has consistently demonstrated an association between underreporting and increased weight. However, few studies have examined factors that explain this relationship. Recently, gorging was found to play a role in dietary underreporting, independent of weight (Kim et al., 2007). The purpose of this study was to attempt to replicate these findings and examine probable mechanisms to explain dietary underreporting. Specifically, by examining the role of portion size as a possible mechanism underlying dietary underreporting. The consumption of large portion sizes, as observed in gorgers and found in overweight compared to normal weight individuals, may interfere with accurate assessments of portion size and, consequently, lead to increased errors in reporting of dietary intake.

Aim 1: Accuracy of Dietary Reporting

Comparing Reported Energy Intake by Weight and Eating Style Groups

There were no differences in reported energy intake between overweight and normal weight groups, despite greater energy needs and greater EE for the overweight group. Additionally, gorgers, independent of weight status, reported less EI than non-gorgers, in spite of greater BMI and EE compared to non-gorgers. The weight increase between time 1 and time 2 was equivalent to one-half of a pound, which could be accounted for by natural fluctuations in weight, water retention related to phase of the menstrual cycle, or consumption food prior to visit 2 but not visit 1. It is most likely that the latter, consumption of food prior to visit 2, accounts for the weight gain. For visit 1, participants were asked to arrive at the Human Performance Lab in a fasted state, not having eaten or had anything to drink other than water for 12 hours, in order to accurately measure resting metabolic rate. This restriction was not indicated for visit 2 and the consumption of foods prior to visit 2 was not assessed. These differences in reported EI between groups suggest that both overweight and gorging are associated with dietary underreporting.

Using the comparison of reported EI between groups, in this case, weight and eating style groups, is a useful method to examine initially the accuracy of dietary reporting. Simply comparing groups on energy intake rather than considering energy needs, however, is not sufficient to understand fully who is underreporting and, furthermore, to what extent. Therefore, for a more thorough examination of the accuracy of dietary reporting, the Goldberg equation and the ratio of reported energy intake to measured energy needs (EI:EE) were two additional methods used in this study.

Accuracy of Self-Reported Energy Intake Using the Goldberg Equation

The Goldberg equation was used to calculate cutoff scores based on reported energy intake and measured energy needs. These cutoff scores were used to identify dietary underreporting by categorizing individuals into accurate reporters or underreporters.

Dietary underreporting was found in 93.4% of the study sample, with no statistically significant differences between weight and eating style groups. This rate of underreporting is higher than in most previous studies to date using the Goldberg equation. These studies have found that 24% to 46% of overweight and obese women underreport their dietary intakes (Hirvonen, Mannisto, Roos, & Pietinen, 1997; Johnson, 2002; Johnson, Goran, & Poehlman, 1994). Black (2000) suggested values to use in the equation based on sample size, days of sampling, and physical activity levels. It could be that the 1.49 cutoff score calculated with this sample is larger due to the small sample size, consequently providing a more liberal cutoff score than other studies. Using a more conservative approach, overweight non-gorgers underreported 61%, which is more in line with previous research. Furthermore, overweight gorgers and normal weight gorgers underreported 90% and 78%, respectively. While not statistically significant [$\chi2$ (2, N=76) = 10.29, p = 0.11], there is still a notable difference between overweight and normal weight gorgers compared to overweight and normal weight non-gorging participants, who underreported 61% and 40%, respectively. To date, there are no other studies that use the Goldberg equation to examine the presence of underreporting of dietary intake among gorgers.

Extent of Underreporting Using EI:EE

The comparison of reported EI to EE between weight and eating style groups was used to further examine the extent of dietary underreporting. The ratio of EI to EE between weight and eating style groups was compared against 1, where 1 is an indicator of accurate reporting. Findings reveal that gorgers have a larger disparity between reported energy intake and measured energy expenditure compared to non-gorgers. Although this difference is not found between weight groups, more detailed analyses revealed no significant difference between EI:EE from 1 for the normal weight non-gorger group, indicating that the underreporting of energy intake is not meaningful when compared with measured energy needs. In other words, normal weight non-gorgers are not considered dietary underreporters. There was a significant difference between EI:EE and 1 for overweight non-gorgers, indicating dietary underreporting. This underreporting was also found for overweight and normal weight gorgers. These findings are consistent with previous literature, which found an association between dietary underreporting and increased weight. These results, therefore, are consistent with previous studies that found a difference in accuracy of reporting between normal weight and overweight groups.

Overall, these data suggest that there is a meaningful difference between overweight and normal weight, and between gorgers and non-gorgers, which affects the accuracy of dietary reporting. Because both overweight persons and gorgers consume a greater amount of calories in one sitting than normal weight and non-gorgers, respectively, it was hypothesized that it is more difficult to accurately estimate large meal sizes, thus contributing to the dietary underreporting associated with overweight and gorging. The ambulatory monitoring techniques were largely in support of these hypotheses, whereas the laboratory studies indicated an unanticipated tendency towards over-reporting of meal sizes for among all groups.

Eating Style and the Accuracy of Dietary Underreporting

One of the most salient findings from this study is the consistent differences between gorgers and non-gorgers. Gorgers had greater weight, body fat, and energy needs, including resting metabolic rate and energy expenditure. In spite of these greater differences, gorgers reported lower energy intake than non-gorgers, suggesting underreporting by gorgers. Additionally, gorgers had a lower ratio of EI:EE, indicating a greater discrepancy between reported energy intake and energy needs, again, suggesting dietary underreporting.

Currently, we do not fully understand to construct of gorging. For example, we do not know the prevalence of gorging, and if this occurs to a greater extent among overweight compared to normal weight populations. Furthermore, we do not know whether, and how, overweight gorgers differ from normal weight gorgers. Related to the current study, our lack of a comprehensive understanding of gorging may cloud our interpretation of these results. More specifically, we do not know how recruiting for gorgers effected this study’s findings. If gorging is more prevalent in overweight compared to normal weight populations, recruiting for gorging reduce naturally occurring differences in the accuracy of dietary self-monitoring and may have contributed to the lack of differences between overweight and normal weight groups in the measurement of meal size estimation using EI:EE. A better understanding of gorging is needed to make sense of the findings related to accuracy of dietary self-monitoring among weight status and eating style groups.

Metabolic Suppression Hypothesis

Although the current study did not directly examine the metabolic suppression hypothesis, data on physiological measurement of energy needs indicated greater energy needs for overweight participants compared to normal weight participants and for gorgers compared to individuals with a regular eating pattern. These data provide no evidence to support the metabolic suppression hypothesis, given reported energy intake was lower for gorgers compared to non-gorgers, and overweight compared to normal weight groups. These data are consistent with previous literature that examined the metabolic suppression hypothesis among overweight participants and gorgers.

Early research found that obese groups reported eating less than normal weight groups (Fricker, Fumeron, Clair, & Apfelbaum, 1989; Fricker, Baelde, Igoin-Apfelbaum, Huet, & Apfelbaum, 1992). It was hypothesized that EI smaller than expected EE among these obese individuals due to metabolic suppression, not overeating (Fabry, 1964; Huenemann, 1972; Metzner, Lamphiear, Wheeler, & Larkin, 1977). Findings from research that examined the relationship between weight and metabolic suppression were inconsistent. Additionally, few studies examined the role of eating patterns on metabolic suppression, and no conclusive support was found (Kinabo & Durin, 1990; Verboeket–van de Venne & Westerterp, 1991).

Most recently, Kim and colleagues (2007) used detailed metabolic assessment to examine the metabolic suppression hypothesis among both weight and eating style groups. Findings of that study failed to confirm the metabolic hypothesis. Failure to support the metabolic suppression hypothesis suggests that energy intake lower than energy needs is associated with dietary underreporting, rather than a reduced energy intake, as once thought (Apfelbaum, Bostsarron, & Lacatis, 1971; Lichtman et al., 1992; Prentice et al., 1986; Ravussin, Burnand, Schuts, & Jequier, 1982). As research has consistently found an association between overweight and dietary underreporting (Black, Jebb, Bingham, Runswick, & Poppitt, 1995; Lichtman, et al., 1992; Schoeller, Bandini, & Dietz, 1990), it is important to also consider the role of eating patterns, particularly gorging, in the accuracy of dietary reporting.

Aim 2: Accuracy of Meal Size Estimation

Meal Size as a Mechanism Underlying Dietary Underreporting

Results of this study show that regular meal sizes are less accurately estimated than large meals. Contrary to expectations, however, data revealed that all groups overestimated, rather then underestimated, regular and large meal sizes. Furthermore, there were no overall differences in the estimation meal sizes between eating style and weight groups. It was expected that, because of the larger references standard of meals expected for overweight women and gorgers, they would underestimate regular and large size meals compared to normal weight and non-gorgers. It was also expected that overweight gorgers would underestimate the size of regular meals to a greater extent than normal weight gorgers and non-gorgers, and that normal weight non-gorgers would underestimate the size of large meals less than overweight non-gorgers and gorgers. However, no group differences were found in the magnitude of reporting inaccuracy of laboratory-based meal sizes.

One of the most salient findings from this study is the degree to which participants overestimated food size. Participants estimated large meal size as 2 times greater than actual meal size, and estimated regular meal size as 3 times greater than actual meal size. Participants' overall deficits in accurately estimating food size, regardless of group, punctuates the challenges related weight loss and weight management. This is a critical issue given the astonishing, and growing, rates of overweight and obesity coupled with the large portion sizes served in the United States. With weight increasing at alarming rates, and with the "super sizing" of portion sizes as commonplace, having a better understanding of food sizes and their corresponding nutritional values is more important than ever. Knowledge of portion sizes and dietary intake is key to successful management of weight and health related to overweight and obesity. These results suggest further work is needed to both educate individuals on portion size and to examine the utility of existing portion size definitions.

It is important to address the difference in hunger and perceived meal size related to the accuracy of meal size estimation. Gorgers reported less hunger and perceived meals to be smaller than non-gorgers when estimating regular meals at time 1. These differences were not present when estimating regular meals at time 2 or large meals. Given the adage "my eyes are bigger than my stomach" when experiencing hunger, decreased hunger by the gorgers is consistent with the perception of smaller meal size. Along these lines, decreased hunger and meal size perception would have likely decreased meal size estimation. Because all groups overestimated meal size, it is highly unlikely that hunger ratings accounted for group differences in comparing the accuracy of meal size estimation between groups.

There are a number of explanations that could account for these contrary findings. It could be that portion size is not a factor in dietary underreporting, and the mechanism that underlies the association between accuracy of dietary reporting with weight and eating style remains unclear. It could also be that factors related to methodological issues prevent the effect of portion size on dietary underreporting from being adequately captured, including the estimation of food sizes prior to consumption or the size of meals presented.

This study used a design modified from that developed by Rolls and colleagues (Kral, Meengs, Wall, Roe, & Rolls, 2003; Kral, Roe, & Rolls, 2004; Rolls, Morris, & Roe, 2002; Rolls, Roe, Kral, Meengs, & Wall, 2004). Results from those studies found that participants' ratings of perceived portion size increased as the portion size of the entrée increased (Kral, Roe, & Rolls, 2002; 2004), indicating that being aware of portion size differences did not prevent participants from consuming larger amounts of food when larger portions were served. Therefore, individuals are unaware that being served larger portions increases their energy intake even though individuals in certain situations can correctly discern different portion sizes of foods. Other studies also found that larger portion sizes were associated with greater energy intake following consumption of those foods (Diliberti, Bordi, Concklin, Toe, & Rolls, 2004; Hill & Peters, 1998; McConahy, Smiciklas-Wright, Birch, Mitchell, Picciano, 2002; Young & Nestle, 1995).

There are several key differences between Rolls' paradigm and the methodology of this study which may have contributed to the differences in study findings. First, Rolls focused on the effect of portion size on energy intake. This study, on the other hand, examined the effect of meal size on the accuracy of estimation of food size. Participants were asked to estimate the size of foods, and they were not asked to consume the foods presented to them. Given the consistency of data in support of the association between portion size and energy intake, there may be differences in estimating energy intake compared to estimating size of foods prior to consumption. It could be that there is a difference in cognitive appraisal of food size prior to consumption compared to following consumption. Anecdotally, an individual may look at a large portion of food and think, “That is so big, I could never eat all of that,” or even simply, “That is a lot of food.” In the same eating episode, if the individual did not attend to the size of the food prior to consumption, energy intake might be underestimated. There might be a disconnect between prior estimation and energy intake, where the participant believes that the portion “wasn’t *that* big.” This underestimation may be due to a number of factors, including recall error, portion distortions, subconscious behavior motivated by societal pressures to be thin and healthy, a need for social acceptance, or lack of knowledge about portion sizes. Such mechanisms remain unclear.

Also, participants were asked to rate the portion size of consumed meals; however this was measured differently in Rolls’ studies compared to the current study. First, participants in Rolls’ studies were asked to rate the portion size of the meals they consumed using a 10cm visual analogue scale (VAS) with 2-point descriptive anchors (e.g., not at all larger and extremely large). Furthermore, ratings of portion size were measured using a subjective rating relative to their “usual” food intake. In the current study, participants were asked to estimate the size of foods using a 10cm VAS with 5-point numerical anchors (e.g., 100 g, 300 g, 500 g, 700 g, and 900 g). The anchors in the current study were objective measures of food size. When measuring subjective relativity of food size, the accuracy of ratings cannot be determined, therefore, the outcome variables between Rolls' studies and the current one cannot be compared.

Alternatively, results of this study may be best explained by considering the role of psychophysics, particularly perception, on meal size estimation errors. This is particularly relevant to the portion sizes used in the current study. It may be that the portion sizes used in this study did not represent either a realistic amount of food or a meaningful change in portion size. The Weber-Fechner law and Stevens' power law would suggest that the subjective effect of adding 100 calories to a meal depends on the size of the meal. For example, the difference between 100 and 200 calories is subjectively different from that between 500 and 600 calories. In the current study each participant was asked to estimate a 500 g and 900 g pasta bake. The increase from 500 g to 900 g is perceptibly large. Perhaps more progressive increases in food sizes (e.g., 550 g, 600 g, 650 g, etc.) would provide a more sophisticated comparison.

Finally, the 900 g serving translates to 2 lbs of pasta bake. This is an unusually large amount of food for one sitting. To put it in perspective, one serving of pasta at the Olive Garden is approximately 320 grams. Perhaps a more subtle differentiation (e.g., 500 g to 600 g), would provide a more realistic comparison. More subtle and more realistic comparisons may have yielded results more consistent with findings of previous studies that examined the relationship between portion size and energy intake and consistent with the expectations of this study.

Limitations

Although this study was well designed, there were a number of methodological limitations that might affect the generalizability of these results. In addition, there were methodological limitations, mentioned previously, that leave questions about the relationship between accuracy of dietary self-monitoring and both weight and eating style unanswered. These limitations included issues related to sample characteristics, the methodology for measuring the accuracy of dietary intake, the meal related to meal size estimation, and the estimation of foods prior to consumption, rather than following consumption.

Study sample limitations include issues related to gender, exclusion of nonhealthy adults, and eating style. First, the current study sample consisted of premenopausal women only. This sample was chosen based on findings in previous literature that consistently found an association between underreporting and increased weight among women. By excluding men, children, adolescents, and perimenopausal women, these findings are limited in their generalizability. Second, although half the study sample was overweight, they were otherwise healthy. Participants with hypertension, diabetes, heart disease, kidney disease, thyroid problems, eating disorders, or depression were excluded from participation. These factors limit the generalizability of the current findings given the high comorbidity of increased weight and health problems.

Also, as suggested by Kim and colleagues (2007), the history of gorging behaviors may, in itself, be a factor worth studying. There are no data available on the prevalence of gorging. Given the difficulty in recruiting normal weight gorgers, it begs the question, What is the relationship between gorging and increased weight, and are normal weight gorgers similar to or different from overweight gorgers? It may be that normal weight gorgers are characteristically different from overweight gorgers such that factors driving eating behaviors are fundamentally different. Moreover, in this study, criteria for gorging were met if a participant's gorging behavior was present over a 4-week time period prior to the study. The history of gorging, in terms of actual length of time participants had eating behaviors characteristic of gorging, was not collected; therefore its impact on accuracy of dietary self-monitoring and portion size estimation is unknown. It may be that a long history of gorging is more likely to be associated with dietary underreporting compared to a shorter history of gorging.

In addition to sample limitations, there were also limitations in the methodology for measuring accuracy of dietary intake—specifically, the Goldberg equation and RMR. In this study, 93% of all participants were categorized as underreporting using the Goldberg equation. While this is one of the most salient findings from these data, it may be that the 1.49 cutoff score calculated for this sample population overestimated dietary underreporting. While the Goldberg equation was found to be a valid and reliable method to measure energy needs, the gold standard for measuring energy needs is the DLW technique. Owing to financial limitations, using this method was not possible in this study.

The most notable limitations were related to the meal size conditions. First, as addressed previously, the 400 g difference between the regular and large meals was considerable and most likely did not represent a meaningful increase in portion size. Also, the 900 g large meal was most likely quite a bit larger than most large meals, therefore failing to capture an accurate representation of large meal size. If this study was designed to include more subtle differentiation between regular and large food sizes (e.g., 500 g vs. 600 g) as well as more progressive increases in food sizes (e.g., 550 g, 600 g, 650 g, etc.), findings might have picked up differences in food size estimation that were missed with this design. These smaller differences might have provided more realistic comparisons, and differences between groups might have been found.

Last, the pasta bake itself might have been off-putting, particularly at 7:00 A.M. The objection to this food, and this food in large quantities, may have negatively impacted perception of pleasantness and/or food cravings and therefore led to overestimation of food size. It may be that if more appropriate breakfast foods had been chosen, such as bagels or oatmeal, participants would have perceived the food choices as more realistic, and results in line with the study hypotheses would have been found.

Future Directions

The mechanisms underlying the association between overweight and dietary underreporting remain unclear, as does the role of gorging in the accuracy of dietary self-monitoring. To better understand dietary underreporting, future research should focus beyond the first steps of identifying characteristics of underreporters and move to examining what interferes with accurate reporting. Future research should focus on more fully understanding the mechanisms of dietary underreporting, as well as the role of portion size in meal size estimation.

Accuracy of Dietary Self-Monitoring

The focus of this study provides important direction for furthering the understanding of the effects of eating style and portion size on the accuracy of dietary self-monitoring. Given the dramatic rise in obesity in the United States, it is imperative that we better understand the role of diet and eating behaviors on weight. To do this, much more work is needed for improving the accuracy of dietary self-monitoring. The first step, identifying population characteristics associated with dietary underreporting, has been accomplished in the literature. The next step is to identify the mechanisms involved in dietary underreporting. More information is needed about the reasons for underreporting of food intake to improve dietary self-monitoring and, ultimately, to understand the relationship between diet and health and eating behaviors and weight.

As mentioned previously, we do not fully understand the construct of gorging or, more specifically, how gorging is related to the accuracy of dietary self-monitoring. This is one of few studies using a comprehensive operational definition of gorging. Findings from this study revealed several differences between gorgers and non-gorgers including weight, body composition, energy needs, and the accuracy of dietary underreporting. By focusing future research on better understanding the gorging as an eating style, as well as the differences between gorgers and non-gorgers, we may better understand the phenomena of dietary underreporting. In line with this, research should begin by examining the validity of gorging as an eating style, with the definition used in the current study as a starting point. Valid and consistent definitions are critical in order to move forward in understanding this pattern of eating. This line of research should also include identifying the prevalence of gorging, and also how gorgers are different than non-gorgers, and how overweight gorgers differ from normal weight gorgers. More fully understanding the characteristics of eating style will is needed to identify and understand the mechanisms underlying dietary underreporting.

Another important area of further research that was highlighted in this study is measurement methods of accurate reporting. Results of this study indicated 93.4% of the participants underestimated dietary intake. It is likely that these results are related to errors in measurement, not true underreporting by the study sample. It may be that the liberal cut-off scores calculated by the Goldberg Equation increased the number of identified underreporters, and therefore decreased the differences weight and eating style groups. This study emphasizes the need for a valid, reliable, and affordable measure of the accuracy of dietary self-monitoring. Future research should continue efforts to develop such a method. This has important implications for health related to weight, as improving the detection of dietary underreporting will aid in our understanding of dietary reporting and ultimately the relationship between eating behaviors and health, as well as the development and treatment of overweight and obesity.

Accuracy of Meal Size Estimation

Results of this study did not support the hypothesis that increased portion size is associated with underreporting, however, increased portion size as a mechanism cannot be ruled out based on these results. It may be that difficulty in accurately estimating large portion sizes is, indeed, a mechanism underlying dietary underreporting. However, a more sensitive study design be needed. Future research should continue to focus on identifying the mechanisms involved in dietary underreporting.

Based on the limitations of this study design, a study more sensitive to the nuances of meal size estimation and accuracy of dietary reporting may be important for clarifying the role of portion size in dietary underreporting. Such a study would include more realistic food size estimation conditions, including a large portion size, closer in size to what individuals eat. It should also include the consumption of meals, rather than estimation of meals prior to consumption. The comparison of more progressive increases in portions may be helpful to better replicate so-called real-life differences in food sizes.

Additionally, alternative foods, or even a range of foods, should be considered in future research in order to partial out the differences, and lack thereof, between accuracy of meal size estimation between weight and eating style groups.

Finally, alternative mechanisms underlying dietary underreporting should be considered. These data revealed certain differences between eating style and weight groups that may have contributed to dietary underreporting. The difference in body composition is one such difference. Overweight and gorgers had higher body fat compared to normal weight and non-gorgers, respectively. Perhaps food choices more likely to lead to increased fat, such as high in refined sugar and high fat foods, are foods more often consumed by overweight and gorgers. It may also be that differences in types of foods result in differences in accuracy of meal size estimation. A close examination of body fat and related food types is another important next step in our understanding of the mechanisms underlying dietary underreporting.

Conclusions

Research has consistently demonstrated an association between underreporting and increased weight; however, few studies have examined factors that explain this relationship. The purpose of this investigation was to expand previous research by examining the effects of eating style on the accuracy of dietary self-monitoring. Additionally, the purpose of this study was to examine the role of portion size as a possible mechanism underlying dietary underreporting.

Results demonstrate that gorgers underreport dietary intake to a greater extent than individuals with regular eating patterns during daily life assessments, independent of weight. Although the association between increased portion size and dietary underreporting was not supported in the laboratory phase of this study, the relationship cannot be ruled out. Future research should expand study design related to the food size estimation condition as well as the construct of gorging.

Tables

Table 1.

The Prevalence of Dietary Underreporting Based on EI:BMR Values in National Dietary Surveys

Study	Authors	Dietary Assessment	EI:BMR cut-off values	Prevalence of underreporting (%)		
				All	*Men*	*Women*
NHANES II	Klesges et al.	24 h recall	<0.92[1]	31	-	-
(1976-80)	(1995)		<1.2[2]	54	-	-
NHANES III	Briefel et al.	24 h recall	<0.9[1]	23	18	28
(1988-1991)	(1997)					
ANDS	Heywood et al.	24 h recall	<0.9[1]	18	12	24
(1983)	(1993)					
CSDII	Ballard-Barbash	4x24 h recall	<1.06[1]	-	-	52
(1985-6)	et al. (1996)	(women only)				
DNSBA	Gregory et al.	7 d WFR	<1.1[1]	35	30	29
(1986-7)	(1990)		<1.2[2]	38	29	47
NSHD	Price et al.	7 d est FR	<1.1[1]	21	19	23
(1989)	(1997)					
MONICA	Fogelholm et al.	3 day est FR	<1.28[2]	-	26	34
(1982)	(1996)		<1.28[2]	-	42	47
FLVS	Lafay et al.	3 d est FR	<1.05[1]	-	16	16
(1993)	(1997)					
WSDS	Smith et al.	FFQ	<1.14[1]	28	-	-
(1989-90)	(1994)					
NORKOST	Johansson et al.	FFQ	<1.35[1]	18	12	24
(1993-4)	(1997)					

1 Cut-off criterion based on Goldberg et al. (1991); 2. Cut-off criterion based on WHO (1991) values "-" not reported or measured ; ANS, Australian Nation Survey; CSFII, Continuing Surveys of Food Intake by Individuals; DNSBA, Dietary and Nutritional Survey of British Adults; est FR, estimated food record; FFQ, food frequency questionnaire; FLVS, Fleurbai Laventie Ville Sante study; NHANES, National Health and Nutritional Examination Survey; NSHD, National Survey of Health and Development; WFR, weighed food record; WSDS, Western Sydney Dietary Survey.

Table 2.

*Characteristics Associated With Dietary Underreporting**

Authors	Dietary assessment	Underreporting	Weight status	Sex	Smoking	Age	Education	Physical Activity
Klesges et al. (1995)	24 h recall	EI:BMR <0.92	OW	Women	-	NS	Less educated	-
Briefel et al. (1997)	24 h recall	EI:BMR <0.92	OW	Women	Non-smokers	Older	Less educated	Less active (men only)
Ballard-Barbash et al. (1996) (BMI)	4 x 24 h recall women only	EI:BMR <0.92	OW	-	NS	NS	Less educated	NS
Heywood et al. (1993)	24 h recall	EI:BMR <0.92	-	Women	-	Older (men only)	-	-
Lafay et al. (1997)	FFQ	EI:BMR <0.92	OW	NS	-	Older	-	NS
Smith et al. (1994)	FFQ	EI:BMR <0.92	OW	Women	-	NS	NS	NS
Fogelholm et al. (1996)	3 d est FR	EI:BMR <0.92	OW	Women	-	-	-	-
Hirvonen et al. (1997)		EI:BMR <0.92	OW	Women	-	Older	More educated	-
Price et al. (1997)	7 d est FR	EI:BMR	OW	Women	Smokers	-	Less	NS

		<0.92			(women only)		educated (women only)	
Pryer et al. (1997)	7 d WFR	EI:BMR <0.92	OW	Women	Smokers	NS	-	-
de Vries et al (1994)	3 d WFR	Energy needs	OW (men only)	Women	-	NS	-	-
Heitmann (1993) (Fatness)	Diet history	UN:DN	OW	NS	NS	NS	NS	NS
Bingham et al. (1995)	16 d WFR (women only)	UN:DN	OW	-	-	-	-	-

"-" variable is not reported or measured; est FR, estimated food record; FFQ, food frequency questionnaire; NS, not statistically significant; OW, overweight; UN/DN, ratio of urinary nitrogen to dietary nitrogen; WFR, weighed food record; * General demographic characteristics measured unless otherwise specified

Table 3.

Study Procedures

Step	Description	Time
	1. Phone Screen	
Phone Screen	a. Inclusion/Exclusion determination	30 min.
	b. Categorization based on eating style and weight	
	c. Study requirements and instructions	
	1. Study description and Informed Consent Form (20 min)	
Visit 1	2. Height, weight, and body composition (5 – 10min)	1hr 30 min
	3. Meal size estimation #1 (10 min)	to
	4. Resting metabolic rate (20 min)	1hr 50 min
	5. Meal size estimation #2 (10 min)	
	6. Demographics Information, Beck's Depression Inventory,	
	Palm borrowing contract (5-10 min)	
	7. Palm Pilot and Activity Monitor Instruction (20 - 30 min)	
	8. Schedule for Visit 2	

Visit 2	1. Return Palm Pilot and Activity Monitor 2. Meal size estimation #1 (10 min) 3. Completion of the Three Factor Eating Questionnaire, Medical Information Form, and Physical Activity Level Assessment (20 min) 4. Meal size estimation #2 (10 min) 5. Participant Debriefing (5 - 10 min) 6. Payment	45 - 50 min
		Total Time: 2 hrs 45 min - 3 hrs 10 min.

Table 4.

Demographic Variables for Eating by Weight and Eating Style Groups

	Gorger		Non-gorger	
	Normal Weight n=18 Mean +/- SD	**Overweight n=20 Mean +/- SD**	**Normal Weight n=20 Mean +/- SD**	**Overweight n=18 Mean +/- SD**
Age (years)	30.22 (8.6)	27.55 (8.2)	32.45 (9.8)	31.22 (8.9)
Years of Education	17.11 (2.1)	16.15 (2.3)	17.05 (1.7)	17.06 (2.5)
	% (n)	**% (n)**	**% (n)**	**% (n)**
Ethnicity				
Caucasian	83.3 (15)	70.0 (14)	80.0 (16)	72.2 (13)
Black or African American	11.1 (2)	30.0 (6)	15.0 (3)	22.2 (4)
Other	5.5 (1)	0 (1)	5.0 (1)	5.5 (1)
Marital Status				
Single	61.1 (11)	75.0 (15)	45.0 (9)	72.2 (13)
Married	22.2 (4)	15.0 (3)	45.0 (9)	16.6 (3)
Other	16.6 (3)	10.0 (2)	10.0 (2)	11.1 (2)
Employment Status				
Full-time	77.7 (14)	65.0 (13)	70.0 (14)	72.2 (13)
Part-time	11.1 (2)	25.0 (5)	20.0 (4)	16.6 (3)
Other	11.1 (2)	10.0 (2)	10.0 (2)	11.1 (2)
Income				
Below $40,000	33.3 (6)	40.0 (8)	30.0 (6)	44.4 (8)
$40,000-$70,000	33.3 (6)	35.0 (7)	40.0 (8)	27.7 (5)
Above $70,000	33.3 (6)	20.0 (4)	30.0 (6)	27.7 (5)

Note. No significant differences between groups.

Table 5.

Psychosocial Variables by Weight and Eating Style Groups

Subscale	Gorger		Non-gorger	
	Normal Weight	**Overweight**	**Normal Weight**	**Overweight**
	n=18	**n=19***	**n=20**	**n=18**
Eating Inventory				
Total Score[a, b, c]	18.04 (13.4)	22.25 (8.8)	20.70 (10.7)	21.99 (10.6)
Dietary Restraint	8.94 (6.8)	11.26 (3.2)	10.95 (4.7)	10.33 (4.2)
Disinhibition[d]	5.27 (3.3)	6.36 (3.0)	3.90 (2.7)	6.55 (3.6)
Perceived Hunger	3.83 (3.3)	4.63 (2.6)	5.85 (3.3)	5.11 (2.8)
BDI-II[e]	2.89 (4.0)	5.95 (4.7)	3.90 (3.4)	3.39 (3.8)

Note. *One overweight gorger was excluded from analysis comparing Eating Inventory for incomplete Questionnaire data; [a]Weight by eating style interaction [$F(3,69) = 2.65$, $p = 0.05$] for Eating Inventory total score; [b]Main effect of weight [$F(3,69) = 2.89$, $p = 0.04$] for Eating Inventory total score; [c]Main effect of eating style [$F(3,69) = 2.78$, $p = 0.04$] for Eating Inventory total score; [d]Main effect of weight [$F(1,71) = 6.38$, $p = 0.01$] for Disinhibition; [e]Weight by eating style interaction [$F(1,72) = 3.68$, $p = 0.05$].

Table 6.

Measured and Self-reported Physiological Variables by Weight and Eating Style Groups

	Gorger		Non-gorger	
	Normal Weight	**Overweight**	**Normal Weight**	**Overweight**
	n=18	**n=20**	**n=20**	**n=18**
	M (SD)	**M (SD)**	**M (SD)**	**M (SD)**
Measured Variables				
BMI (kg/m^2) [a]	22.73 (1.8)	30.02 (3.4)	21.48 (1.8)	28.48 (2.8)
Body Fat % [b, c]	33.11 (4.7)	42.81 (5.5)	29.94 (5.2)	40.55 (6.3)
Body Weight (kg)	63.30 (9.4)	83.36 (14.4)	57.83 (6.2)	78.77 (9.4)
Weight Change (kg)	0.35 (0.8)	0.14 (0.9)	0.21 (0.7)	0.23 (0.7)
Energy Expenditure (kcal/day) [d]	680 (315)	834 (448)	529 (234)	612 (204)
Resting Metabolic Rate (RMR; kcal/day) [e, f]	1474 (271)	1773 (244)	1418 (210)	1600 (267)
Energy Needs (kcal/day) [g,h]	2155 (320)	2607 (589)	1948 (358)	2212 (353)
Heart Rate (bpm)	58 (11)	60 (9)	61 (11)	60 (7)
Self-Report Variables				
Activity (min/wk) [*i,j]	44.70 (18.6)	57.02 (24.8)	57.51 (23.1)	89.14 (32.2)
Energy Intake (kcal/day) [k]	1503 (428)	1720 (366)	1814 (382)	1892 (435)
PAL Score	**% (n)**	**% (n)**	**% (n)**	**% (n)**
High	27.7 (5)	20.0 (4)	40.0 (8)	33.3 (6)
Medium	16.6 (3)	20.0 (4)	10.0 (2)	16.6 (3)
Low	55.5 (10)	60.0 (12)	50.0 (10)	50.0 (9)

Note. [*]34 participants were excluded from analysis comparing average minutes of exercise because activity logs were not completed; [a]Main effect of eating style [F(1,72) = 4.25, p = 0.04] for BMI; [b]Main effect of weight [F(1,72) = 64.97, p < 0.01] for body fat %; [c]Main effect of eating style [F(1,72) = 4.65, p = 0.03] for body fat %; [d]Main effect of eating style for energy expenditure [F(1,72) = 6.50, p = 0.01]; [e]Main effect of weight [F(1,72) = 17.75, p < 0.01] for RMR; [f]Main effect of eating style [F(1,72) = 4.04, p = 0.04] for RMR. When BMI was covaried, there was no longer a significant differences between eating style groups [F(2,70) = 2.83 p = 0.06]; [g]Main effect of weight [F(1,72) = 13.55, p < 0.01] for energy needs; [h]Main effect of eating style [F(1,72) = 9.55, p < 0.01] for energy needs; [i]Main effect of weight [F(1,41) = 6.94, p = 0.01] for energy intake; [j]Main effect of eating style [F(1,72) = 4.04, p = 0.04] for energy intake; [k]Main effect of eating style [F(1,72) = 4.04, p = 0.04] for energy intake.

Table 7.

Accuracy of Self-reported Energy Intake by Weight and Eating Style Groups

	Gorger		**Non-gorger**	
	Normal Weight n=18 % (n)	**Overweight n=20 % (n)**	**Normal Weight n=20 % (n)**	**Overweight n=18 % (n)**
Level of Accuracy				
Underreporting	100.0 (18)	100.0 (20)	90.0 (18)	83.3 (15)
Accurate Reporting	0	0	0	5.5 (1)
Over-reporting	0	0	10.0 (2)	11.1 (2)

Note. Accuracy determined by Goldberg Equation.

Table 8.

Associations between the Goldberg Equation and EI:EE as assessments accuracy of dietary reporting across weight and eating style groups

	Underreporters	**Collapsed accurate and overreporters**
Goldberg cut-off of 1.49	**0.86**	-0.70
Goldberg cut-off of 1.47	**0.82**	**0.70**
Goldberg cut-off of 1.35	**0.76**	**0.76**

Bold signifies $\rho < 0.05$

Table 9.

Hunger Ratings by Group, Meal Size, and Time

Meal Size, Time	Gorger		Non-gorger	
	Normal Weight n=18* M (SD)	**Overweight n=20 M (SD)**	**Normal Weight n=20 M (SD)**	**Overweight n=18 M (SD)**
Large Meal, Time 1				
Hungry (cm)	3.07 (2.3)	3.83 (3.2)	4.75 (3.1)	4.80 (2.9)
Able to eat (cm)	2.90 (1.9)	3.74 (2.6)	4.13 (2.5)	4.94 (2.7)
Regular Meal, Time 1				
Hungry (cm) [a]	3.08 (2.8)	3.34 (2.9)	5.08 (3.2)	4.78 (3.0)
Able to eat (cm) [a]	2.75 (1.7)	3.08 (2.1)	4.39 (1.9)	5.04 (2.6)
Large Meal, Time2				
Hungry (cm)	1.96 (1.8)	2.98 (3.5)	3.24 (3.3)	2.72 (3.1)
Able to eat (cm)	3.06 (2.0)	3.09 (2.6)	3.06 (1.8)	3.09 (2.8)
Regular Meal, Time 2				
Hungry (cm)	1.89 (2.0)	3.06 (3.3)	2.81 (2.9)	2.49 (3.0)
Able to eat (cm)	3.28 (2.3)	3.18 (2.4)	2.96 (2.2)	3.58 (2.7)

Note. Estimation of food size was measured on a 0-10cm Visual Analogue Scale, where 0 was low and 10 was high; [*]One normal weight gorger was excluded from analysis comparing hunger and perceived meal size for regular meals at time 1 for incomplete data; [a]Main effect of eating style [$F(2,70) = 6.69$, $p < 0.01$] for regular meals at time 1. Both "How Hungry are you" [$F(1,70) = 6.00$, $p = 0.01$] and "How much are you able to eat" [$F(1,70) = 13.44$, $p < 0.01$] contributed to the significant differences.

Table 10.

Perceived Meal Size Ratings by Group, Meal Size, and Time

	Gorger		Non-gorger	
Meal Size, Time	**Normal Weight n=18* M (SD)**	**Overweight n=20 M (SD)**	**Normal Weight n=20 M (SD)**	**Overweight n=18 M (SD)**
Large Meal, Time 1				
Large (cm)	8.27 (1.4)	8.76 (1.5)	8.84 (1.2)	8.89 (2.4)
Meal size (cm)	7.73 (2.2)	6.98 (2.9)	7.85 (2.6)	8.91 (1.5)
Regular Meal, Time 1				
Large (cm) [a]	6.28 (2.2)	6.32 (2.2)	7.40 (1.3)	7.07 (1.6)
Meal size (cm) [a]	6.46 (2.0)	5.85 (1.9)	7.51 (1.8)	7.37 (1.6)
Large Meal, Time2				
Large (cm)	8.20 (1.4)	8.79 (1.2)	8.70 (1.6)	9.03 (1.4)
Meal size (cm)	7.63 (2.0)	7.36 (3.0)	8.07 (2.3)	8.15 (2.7)
Regular Meal, Time 2				
Large (cm)	5.37 (2.0)	6.05 (2.0)	6.35 (2.3)	6.27 (1.8)
Meal size (cm)	5.43 (1.8)	5.97 (2.3)	6.40 (2.2)	6.26 (2.5)

Note. Estimation of food size was measured on a 0-10cm Visual Analogue Scale, where 0 was low and 10 was high; [*]One normal weight gorger was excluded from analysis comparing hunger and perceived meal size for regular meals at time 1 for incomplete data; [a]Main effect of eating style [$F(2,70) = 4.45$, $p = 0.01$] for regular meals at time 1. Both "How Large is This Meal" [$F(1,71) = 4.48$, $p = 0.03$] and "Compare this to your usual dinner" [$F(1,71) = 8.67$, $p < 0.01$] contributed to the significant differences.

Table 11.

Estimated size of regular and large meals for groups at time 1 and time 2

	Large Meal Time 1 Actual Cup Size: 3.75	Large Meal Time 2 Actual Cup Size: 3.75	Regular Meal Time 1 Actual Cup Size: 2	Regular Meal Time 2 Actual Cup Size: 2
Normal Weight Gorger	8.1	7.9	6	5.6
Overweight Gorger	8.2	8.8	5.6	6.3
Normal Weight Non-gorger	8.9	8.4	6	5.6
Overweight Non-gorger	9	9.1	6.5	6.1

Table 12.

Association between accuracy of ambulatory assessment of dietary intake and laboratory based estimation of meal size across weight and eating style groups

	Large Meal at Time 1	Large Meal at Time 2	Regular Meal at Time 1	Regular Meal at Time 2
Association between ambulatory and laboratory based measures	0.11	0.86	0.21	0.29

Bold signifies ρ < 0.05

Figures

Figure 2.

Laboratory and Ambulatory Design Overview

Laboratory Visit 1 2 hours	**Ambulatory Monitoring** 7-days	**Laboratory** Visit 2 1 hour
Portion Size Estimation 2 cups 32/3 cups		Portion Size Estimation 2 cups 32/3 cups
Resting Metabolic Rate	Energy Intake Energy Expenditure	
Questionnaires		Questionnaires

Figure 3.

Reported Energy Intake Compared to Measured Energy Needs by Weight and Eating Style Groups

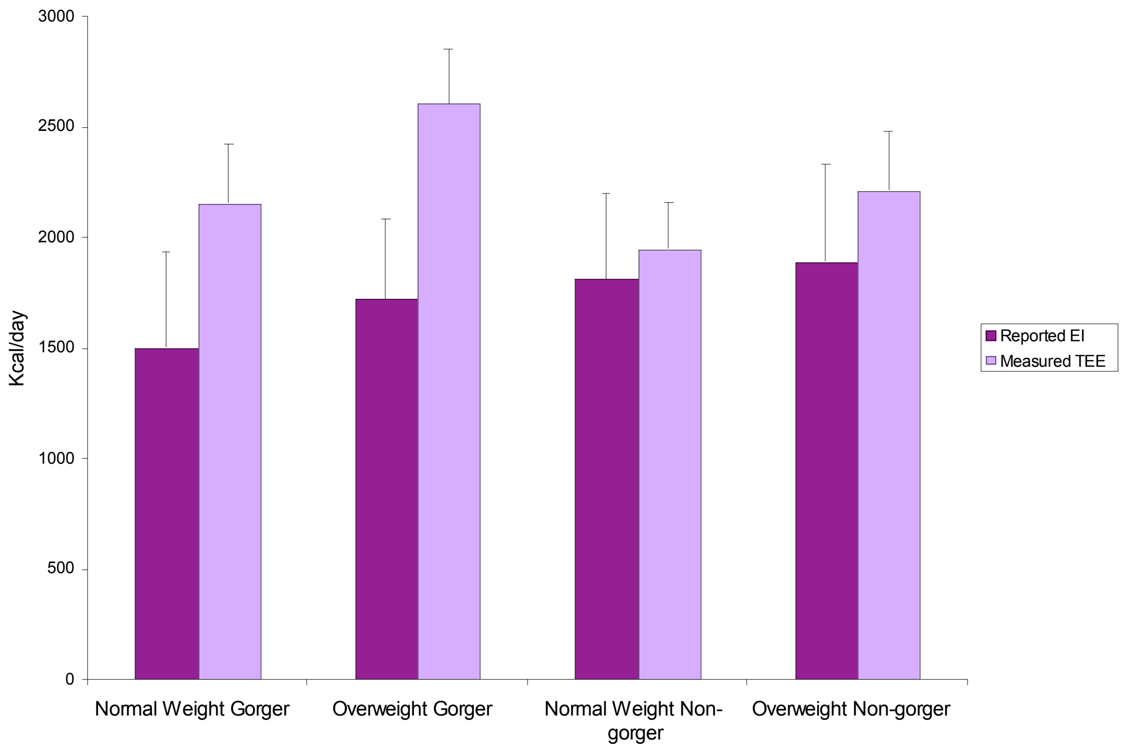


Figure 4.

EI:EE Scores by Weight and Eating Style Groups

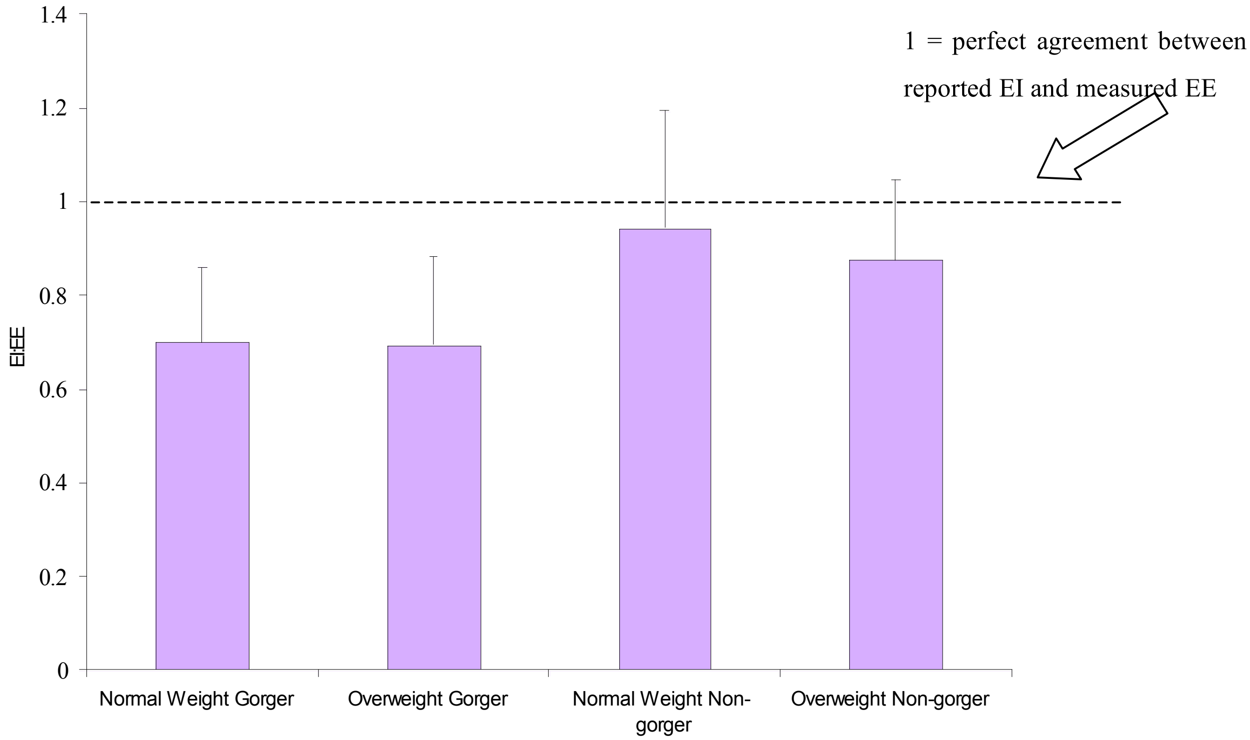


Figure 5.

Accuracy of Meal Size Estimation Over Time for Cups

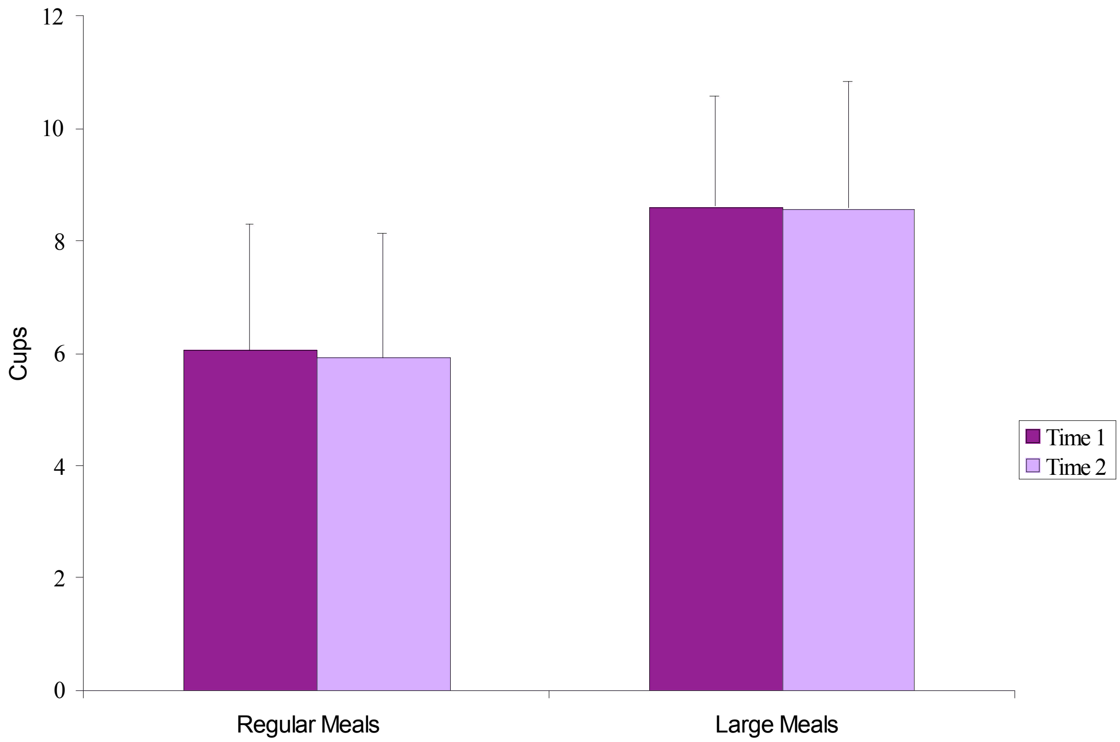
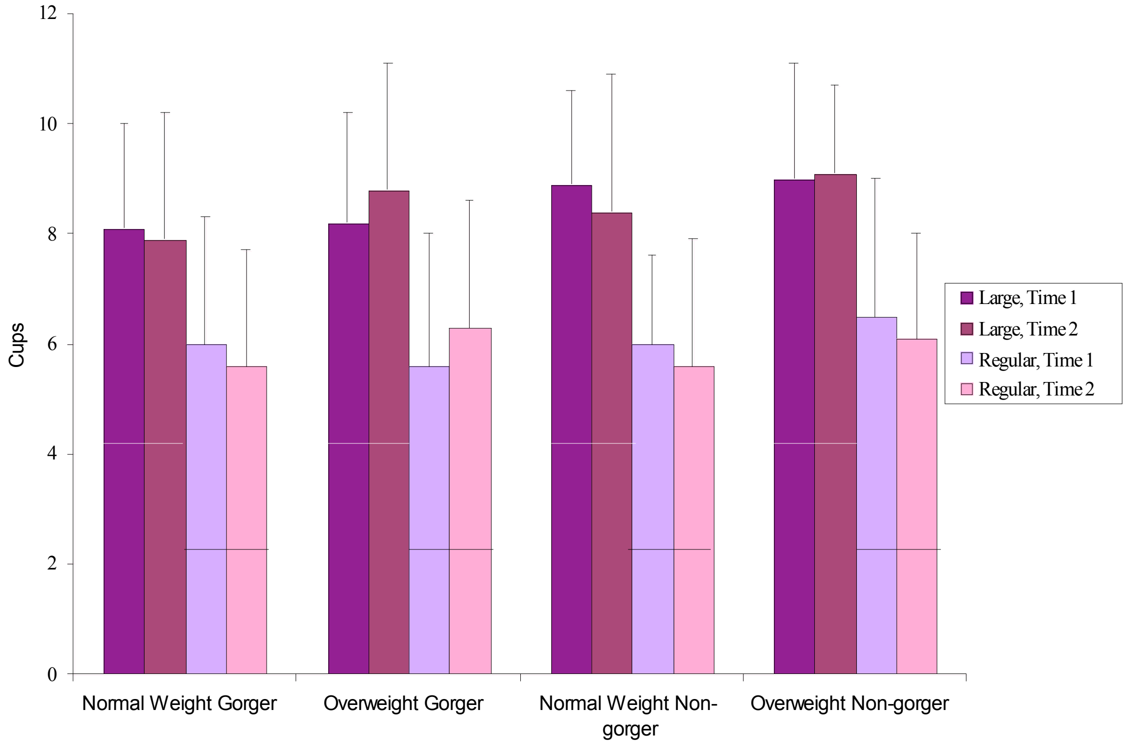


Figure 6.

Accuracy of Meal Size Estimation by Weight and Eating Style Groups for Cups



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APPENDIX A: Accuracy of Meal Size Estimation Using Alternative Units of Measurement (Serving Size, Ounces, Pounds, and Grams)

Additional Analyses
Tables
Figures

Examination of Order Effects

Large Meal at Time 1. Order of presentation affected meal size estimations for large meals at time 1 for serving size [$F(1,72) = 5.42$, $p = 0.02$], ounces [$F(1,72) = 7.44$, $p < 0.01$], pounds [$F(1,72) = 5.50$, $p = 0.02$], and grams [$F(1,72) = 6.11$, $p = 0.01$]. In all cases, meal size estimation of large meals was greater after presentation of a regular meal versus a large meal first during time 1.

Regular Meal at Time 1. Order did not affect meal size estimation for regular meals at time 1 for serving size [$F(1,72) = 2.24$, $p = 0.13$], ounces [$F(1,72) = 2.43$, $p = 0.13$], pounds [$F(1,72) = 2.39$, $p = 0.12$], or grams [$F(1,72) = 2.67$, $p = 0.10$].

Large Meal at Time 2. Order did not affect meal size estimation for large meals at time 2 for serving size [$F(1,72) = 0.31$, $p = 0.37$], ounces [$F(1,72) = 0.63$, $p = 0.42$], pounds [$F(1,72) = 0.59$, $p = 0.44$], and grams [$F(1,72) = 2.28$, $p = 0.13$].

Regular Meal at Time 2. Order did not affect meal size estimation for regular meals at time 2 for serving size [$F(1,72) = 1.11$, $p = 0.29$], ounces [$F(1,72) = 0.22$, $p = 0.63$], pounds [$F(1,72) = 0.52$, $p = 0.47$], or grams [$F(1,72) = 1.61$, $p = 0.20$].

Aim 2: Examine the Effect of Meal Size on Accuracy of Meal Size Estimation.

Accuracy of meal size estimation was measured by calculating the difference between actual and estimated size of meals, including serving size, ounces, pounds, and grams. These scores measured both the large and regular meals, which were estimated at two time points. Accuracy of meal size estimation by weight and eating style groups can be seen in Figures 7-10. Results were calculated using a 2 x 2 x 2 Repeated Measures Multivariate Analysis of Variance in order to examine the accuracy of meal size estimation by weight and eating style groups over time. Additionally, one-sample t-tests were used to compare estimated size of meals (in serving size, ounces, pounds, and grams) to actual size of meals in order to determine extent of accuracy for each meal size estimation.

Accuracy of Meal Size Estimation by Weight and Eating Style Groups

Serving Size. Accuracy of estimation of serving size by weight and eating style groups for regular and large meals, over time, can be seen in Figure 7. The test values were 3.75 for the large meal size and 2 for the regular meal size, which represented the actual amount of serving size for each meal size. Repeated Measures Analysis of Variance found no weight by eating style by time interaction [$F(2,72) = 1.90$, $p = 0.17$] for large meals. No weight by time interaction [$F(2,72) = 2.40$, $p = 0.12$] or eating style by time interaction [$F(2,72) = 0.54$, $p = 0.46$] for accuracy of estimation of large meals was found. For regular meals, there was no weight by eating style by time interaction [$F(2,72) = 0.14$, $p = 0.70$], weight by time interaction [$F(2,72) = 0.16$, $p = 0.96$], or eating style by time interaction [$F(2,72) = 2.01$, $p = 0.16$] for accuracy of estimation of regular meals.

Overall, there was no weight by eating style interaction [$F(2,71) = 2.23$, $p = 0.11$] for accuracy for serving size estimation. There was a main effect of weight [$F(2,71) = 3.71$, $p = 0.02$]. Overweight participants estimated serving size to be larger than regular weight participants. Further analyses revealed that the main effect of weight was accounted for by difference in large meals [$F(1,72) = 6.79$, $p = 0.01$] but not regular meals [$F(1,72) = 2.66$, $p = 0.10$]. Normal weight participants more accurately estimate serving size of large meals compared to overweight participants. Contrary to expectations, however, overweight participants overestimate, rather than underestimate, serving size for large meals. There was no main effect of eating style [$F(2,71) = 1.33$, $p = 0.27$].

Ounces. Accuracy of estimation of ounces by weight and eating style groups for regular and large meals, over time, can be seen in Figure 8. The test values were 30 for the large meal size and 16 for the regular meal size, which represented the actual amount of ounces for each meal size. Repeated Measures Analysis of Variance found no weight by eating style by time interaction [$F(2,72) = 0.16$, $p = 0.68$] for large meals. A weight by time interaction [$F(2,72) = 4.96$, $p = 0.02$] was found, such that overweight women estimated large meal size as larger than normal weight women at time 1, but not time 2. There was no eating style by time interaction [$F(2,72) = 1.99$, $p = 0.16$] for accuracy of estimation of large meals were found. For regular meals, no weight by eating style by time interaction [$F(2,72) = 0.06$, $p = 0.80$], no weight by time interaction [$F(2,72) = 1.06$, $p = 0.30$], and eating style by time interaction [$F(2,72) = 0.002$, $p = 0.97$] for accuracy of estimation of regular meals was found.

Overall, there was no weight by eating style interaction [$F(2,71) = 0.08$, $p = 0.92$] for accuracy of estimation of ounces. There was a main effect of weight that approached statistical significance [$F(2,71) = 2.80$, $p = 0.06$] such that overweight participants overestimated ounces to a greater extent than normal weight participants. Further analyses revealed no main effect of weight for large meals [$F(1,72) = 2.61$, $p = 0.11$] or for regular meals [$F(1,72) = 0.29$, $p = 0.58$]. No main effect of eating style [$F(2,71) = 0.08$, $p = 0.92$] for accuracy of estimation of ounces was found.

Pounds. Accuracy of estimation of pounds by weight and eating style groups for regular and large meals, over time, can be seen in Figure 9. The test values were 2 for the large meal size and 1.11 for the regular meal size, which represented the actual amount of pounds for each meal size. Repeated Measures Analysis of Variance found no weight by eating style by time interaction [$F(2,72) = 0.001$, $p = 0.99$], weight by time interaction [$F(2,72) = 0.74$, $p = 0.39$] and no eating style by time interaction [$F(2,72) = 0.36$, $p = 0.55$] for accuracy of estimation of large meals. For regular meals, no weight by eating style by time interaction [F(2,72) = 0.45, p = 0.50], no weight by time interaction [F(2,72) = 2.27, p = 0.13], and no eating style by time interaction [F(2,72) = 0.45, p = 0.50] for accuracy of estimation of regular meals was found.

Overall, there was no weight by eating style interaction [F(2,71) = 0.04, p = 0.95], main effect of weight [F(2,71) = 0.36, p = 0.69], or main effect of eating style [F(2,71) = 0.20, p = 0.81] for accuracy of estimation of pounds.

Grams. Accuracy of estimation of grams by weight and eating style groups for regular and large meals, over time, can be seen in Figure 10. The test values were 900 for the large meal size and 500 for the regular meal size, which represented the actual amount of grams for each meal size. Repeated Measures Analysis of Variance found no weight by eating style by time interaction [F(2,72) = 0.22, p = 0.64], no weight by time interaction [F(2,72) = 0.12, p = 0.72] and no eating style by time interaction [F(2,72) = 2.87, p = 0.09] for accuracy of estimation of large meals. For regular meals, no weight by eating style by time interaction [F(2,72) = 1.19, p = 0.27], no weight by time interaction [F(2,72) = 0.23, p = 0.62], and no eating style by time interaction [F(2,72) = 2.12, p = 0.14] for accuracy of estimation of regular meals was found. Overall, there was no weight by eating style interaction [F(2,71) = 0.12, p = 0.88], main effect of weight [F(2,71) = 0.47, p = 0.62], or no main effect of eating style [F(2,71) = 1.67, p = 0.19] for accuracy of estimation of grams.

Actual Compared to Estimated Meal Size within Weight and Eating Style Groups

Serving Size. Mean estimation of serving size compared to actual serving size by weight and eating style groups for both large meals and regular meals are shown in Tables 13 and 14, respectively. Overall, estimated serving size was greater than actual serving size for large meals at time 1 [t(72) = 14.52, $p < 0.01$] and time 2 [t(72) = 16.63, $p < 0.01$], as well as for regular meals at time 1 [t(72) = 12.83, $p < 0.01$] and time 2 [t(72) = 13.60, $p < 0.01$].

Normal weight non-gorgers. Estimated serving size was greater than actual serving size for large meals at time 1 [t(19) = 8.16, $p < 0.01$] and time 2 [t(19) = 8.95, $p < 0.01$], as well as for regular meals at time 1 [t(19) = 7.98, $p < 0.01$] and time 2 [t(19) = 7.15, $p < 0.01$] among normal weight non-gorgers.

Normal weight gorgers. Estimated serving size was greater than actual serving size for large meals at time 1 [t(17) = 4.38, $p < 0.01$] and time 2 [t(17) = 5.73, $p < 0.01$], as well as for regular meals at time 1 [t(17) = 4.38, $p < 0.01$] and time 2 [t(17) = 4.74, $p < 0.01$] among normal weight gorgers.

Overweight non-gorgers. Estimated serving size was greater than actual serving size for large meals at time 1 [t(17) = 8.87, $p < 0.01$] and time 2 [t(17) = 9.93, $p < 0.01$], as well as for regular meals at time 1 [t(17) = 6.99, $p < 0.01$] and time 2 [t(17) = 7.25, $p < 0.01$] among overweight non-gorgers.

Overweight gorgers. Estimated serving size was greater than actual serving size for large meals at time 1 [t(19) = 9.69, $p < 0.01$] and time 2 [t(19) = 10.25, $p < 0.01$], as well as for regular meals at time 1 [t(19) = 6.60, $p < 0.01$] and time 2 [t(19) = 8.49, $p < 0.01$] among overweight gorgers.

Ounces. Mean estimation of ounces compared to actual ounces by weight and eating style groups for both large meals and regular meals are shown in Tables 13 and 14, respectively. Overall, estimated ounces were greater than actual ounces for large meals at time 1 [t(72) = 2.97, $p < 0.01$] and time 2 [t(72) = 3.99, $p < 0.01$], as well as for regular meals at time 1 [t(72) = 8.37, $p < 0.01$] and time 2 [t(72) = 9.10, $p < 0.01$].

Normal weight non-gorgers. Estimated ounces were greater than actual ounces for regular meals at time 1 [t(19) = 3.71, $p < 0.01$] and time 2 [t(19) = 3.60, $p < 0.01$] among normal weight non-gorgers. There were no significant differences between estimated and actual ounces for large meals at time 1 [t(19) = 0.59, $p = 0.55$] or time 2 [t(19) = 1.53, $p = 0.14$].

Normal weight gorgers. Estimated ounces were greater than actual ounces for regular meals at time 1 [t(19) = 3.59, $p < 0.01$] and time 2 [t(19) = 4.93, $p < 0.01$] among normal weight gorgers. No significant differences between estimated and actual ounces for large meals at time 1 [t(17) = 0.24, $p = 0.81$] or time 2 [t(19) = 1.86, $p = 0.14$] were found.

Overweight non-gorgers. Estimated ounces were greater than actual ounces for large meals at time 1 [t(17) = 2.08, $p = 0.01$] and time 2 [t(17) = 2.52, $p = 0.02$], and for regular meals at time 1 [t(17) = 4.92, $p < 0.01$] and time 2 [t(17) = 4.36, $p < 0.01$] among overweight non-gorgers.

Overweight gorgers. Estimated ounces were greater than actual ounces for large meals at time 1 [t(19) = 2.57, $p = 0.01$] and time 2 [t(19) = 2.07, $p = 0.05$], and for regular meals at time 1 [t(19) = 4.40, $p < 0.01$] and time 2 [t(19) = 5.54, $p < 0.01$] among overweight gorgers.

Pounds. Mean estimation of pounds compared to actual pounds by weight and eating style groups for both large meals and regular meals are shown in Tables 13 and 14, respectively. Overall, estimated pounds were greater than actual pounds for regular meals at time 1 [t(72) = 4.62, $p < 0.01$] and time 2 [t(72) = 5.63, $p < 0.01$]. No differences between actual and estimated pounds for large meals at time 1 [t(72) = -0.92, $p = 0.36$] or time 2 [t(72) = 0.77, $p = 0.43$] were found.

Normal weight non-gorgers. Estimated pounds were greater than actual pounds for regular meals at time 1 [t(19) = 2.32, $p = 0.03$] and time 2 [t(19) = 2.56, $p = 0.01$] among normal weight non-gorgers. There were no differences between actual and estimated pounds for large meals at time 1 [t(19) = -0.85, $p = 0.40$] or time 2 [t(19) = 1.04, $p = 0.30$].

Normal weight gorgers. Estimated pounds were greater than actual pounds for regular meals at time 2 [t(17) = 3.74, $p < 0.01$] among normal weight gorgers. This approached significance for regular meals at time 1 [t(17) = 1.91, $p = 0.07$]. There were no differences between actual and estimated pounds for large meals at time 1 [t(17) = -1.40, $p = 0.17$], large meals at time 2 [t(17) = 0.03, $p = 0.97$].

Overweight non-gorgers. Estimated pounds were greater than actual pounds for regular meals at time 1 [t(17) = 2.55, $p = 0.02$] and time 2 [t(17) = 2.26, $p = 0.03$] among overweight non-gorgers. No differences between actual and estimated pounds for large meals at time 1 [t(17) = 0.16, $p = 0.86$] or time 2 [t(17) = -0.16, $p = 0.86$] were found.

Overweight gorgers. Estimated pounds were greater than actual pounds for regular meals at time 1 [t(19) = 2.29, $p = 0.03$] and time 2 [t(19) = 2.86, $p = 0.01$] among overweight gorgers. There were no differences between actual and estimated pounds for large meals at time 1 [t(19) = -0.30, $p = 0.76$] or time 2 [t(19) = 0.39, $p = 0.70$].

Grams. Mean estimation of grams compared to actual grams by weight and eating style groups for both large meals and regular meals are shown in Tables 13 and 14, respectively. Overall, estimated grams were greater than actual grams for large meals at time 1 [t(72) = 3.76, $p < 0.01$] and time 2 [t(72) = 3.41, $p < 0.01$], as well as for regular meals at time 1 [t(72) = 10.66, $p < 0.01$] and time 2 [t(72) = 10.32, $p < 0.01$].

Normal weight non-gorgers. Estimated grams were greater than actual grams for regular meals at time 1 [t(19) = 4.80, $p < 0.01$] and time 2 [t(19) = 3.57, $p < 0.01$] among normal weight non-gorgers. No differences between estimated and actual grams for large meals at time 1 [t(19) = 1.22, $p = 0.23$] and time 2 [t(19) = 1.04, $p = 0.31$] observed.

Normal weight gorgers. Estimated grams were significantly greater than actual grams for regular meals at time 1 [t(17) = 5.38, $p < 0.01$] and time 2 [t(17) = 6.26, $p < 0.01$] among normal weight gorgers. There were no differences between estimated and actual grams for large meals at time 1 [t(17) = 1.38, $p = 0.18$] and time 2 [t(17) = 1.47, $p = 0.15$].

Overweight non-gorgers. Estimated grams were greater than actual grams for large meals at time 1 [t(17) = 2.83, $p = 0.01$], and for regular meals at time 1 [t(17) = 5.88, $p < 0.01$] and time 2 [t(17) = 4.63, $p < 0.01$] among overweight non-gorgers. There was no difference between estimated and actual grams for large meals at time 2 [t(17) = 1.56, $p = 0.13$].

Overweight gorgers. Estimated grams were greater than actual grams for large meals at time 1 [t(19) = 2.19, $p = 0.04$] and time 2 [t(19) = 3.16, $p < 0.01$], and for regular meals at time 1 [t(19) = 5.10, $p < 0.01$] and time 2 [t(19) = 7.11, $p < 0.01$] among overweight gorgers.

Accuracy of Meal Size Estimation Over Time

Serving Size. Differences in accuracy of serving size estimation for both regular and large meal sizes, over time, are shown in Figure 11. Overall, there was a difference in accuracy of serving size estimation over time [F(2,71) = 0.35, $p = 0.03$], independent of weight or eating style groups, whereby all groups combined estimated serving size as smaller at time 1 compared to time 2. These differences were accounted for by large [F(1,72) = 4.97, $p = 0.02$], but not regular [F(1,72) = 0.28, $p = 0.59$] meal sizes. Further analysis of differences over time, however, showed no weight by eating style interaction [F(2,71) = 0.26, $p = 0.77$] for accuracy of serving size estimation within groups. Additionally, there were no main effects of weight [F(2,71) = 0.69, $p = 0.50$], or eating style [F(2,71) = 1.07, $p = 0.34$].

Ounces. Differences in accuracy of estimation of ounces for regular and large meals sizes, over time, are shown in Figure 12. Overall, there was no difference in accuracy of estimation of ounces over time [F(2,71) = 1.43, $p = 0.24$], independent of weight or eating style. Looking at differences over time, there was no weight by eating style interaction [F(2,71) = 0.25, $p = 0.77$], main effect of weight [F(2,71) = 1.33, $p = 0.26$], or main effect of eating style [F(2,71) = 0.18, $p = 0.83$].

Pounds. Differences in accuracy of estimation of pounds for regular and large meals sizes, over time, are shown in Figure 13. Overall, there was no difference in accuracy of estimation of pounds over time [F(2,71) = 2.29, $p = 0.10$], independent of weight or eating style. Looking at differences over time, no weight by eating style interaction [F(2,71) = 1.46, $p = 0.23$], main effect of weight [F(2,71) = 1.55, $p = 0.21$], or main effect of eating style [F(2,71) = 0.48, $p = 0.61$] was observed.

Grams. Differences in accuracy of estimation of grams for regular and large meals sizes, over time, are shown in Figure 14. Overall, there was no difference in accuracy of estimation of grams over time [F(2,71) = 0.08, $p = 0.91$], independent of weight or eating style. Looking at differences over time, there was no weight by eating style interaction [F(2,71) = 0.76, $p = 0.47$]. There was no main effect of weight [F(2,71) = 0.11, $p = 0.88$] or eating style [F(2,71) = 1.18, $p = 0.31$].

List of Tables For Additional Analyses

Table 13.

Accuracy of Meal Size Estimation by Weight and Eating Style Groups for Regular Size Meals

	Gorger				**Non-gorger**			
	Normal Weight		**Overweight**		**Normal Weight**		**Overweight**	
	Time 1	**Time2**	**Time 1**	**Time 2**	**Time 2**	**Time 2**	**Time 1**	**Time 2**
Serving Size	OE	OE	OE	OE	OE	OE	OE	OE
Ounces	OE	OE	OE	OE	OE	OE	OE	OE
Pounds	ns	OE	OE	OE	OE	OE	OE	OE
Cups	OE	OE	OE	OE	OE	OE	OE	OE
Grams	OE	OE	OE	OE	OE	OE	OE	OE

Note. OE: overestimation of meal size; ns: non significant differences

Table 14.

Accuracy of Meal Size Estimation by Weight and Eating Style Groups for Large Size Meals

	Gorger				**Non-gorger**			
	Normal Weight		**Overweight**		**Normal Weight**		**Overweight**	
	Time 1	**Time2**	**Time 1**	**Time 2**	**Time 2**	**Time 2**	**Time 1**	**Time 2**
Serving Size	OE	OE	OE	OE	OE	OE	OE	OE
Ounces	OE	OE	t	OE	OE	OE	ns	OE
Pounds	t	OE	ns	ns	ns	ns	ns	ns
Cups	OE	OE	OE	OE	OE	OE	OE	OE
Grams	ns	ns	OE	OE	ns	ns	OE	ns

Note. OE: overestimation of meal size; ns: non significant differences; t: trend for significant differences

List of Figures for Additional Analyses

Figure 7.

Accuracy of Meal Size Estimation by Weight and Eating Style Groups for Serving Size

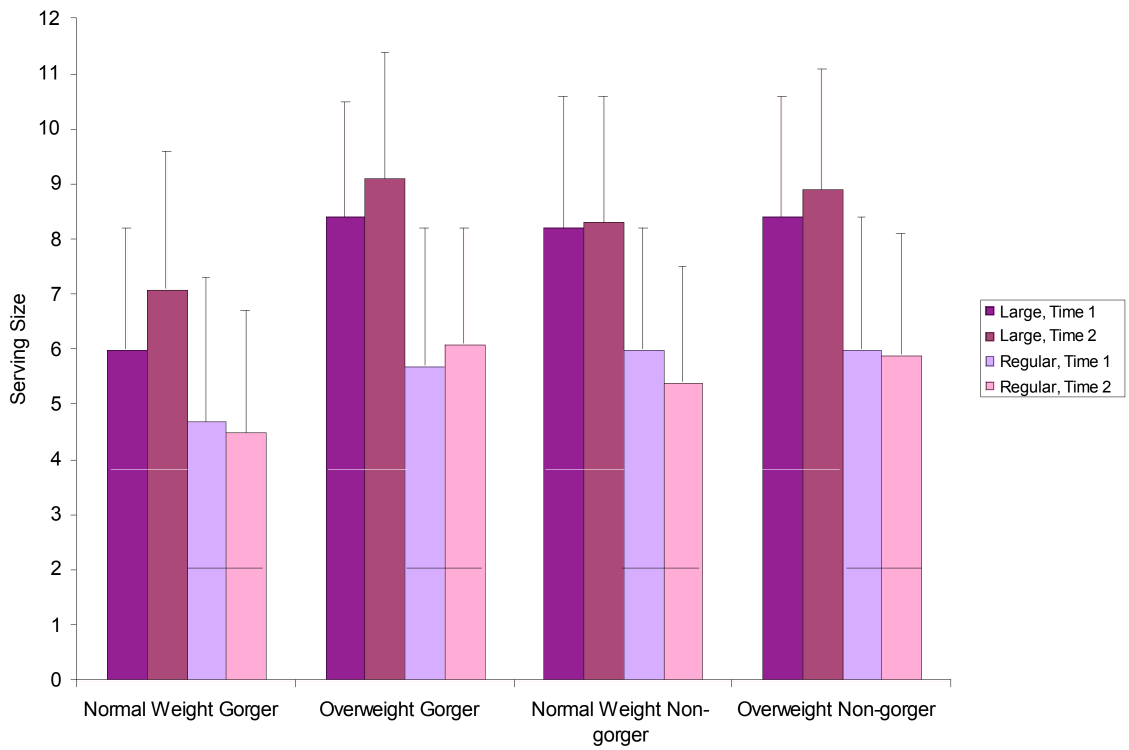


Figure 8.

Accuracy of Meal Size Estimation by Weight and Eating Style Groups for Ounces

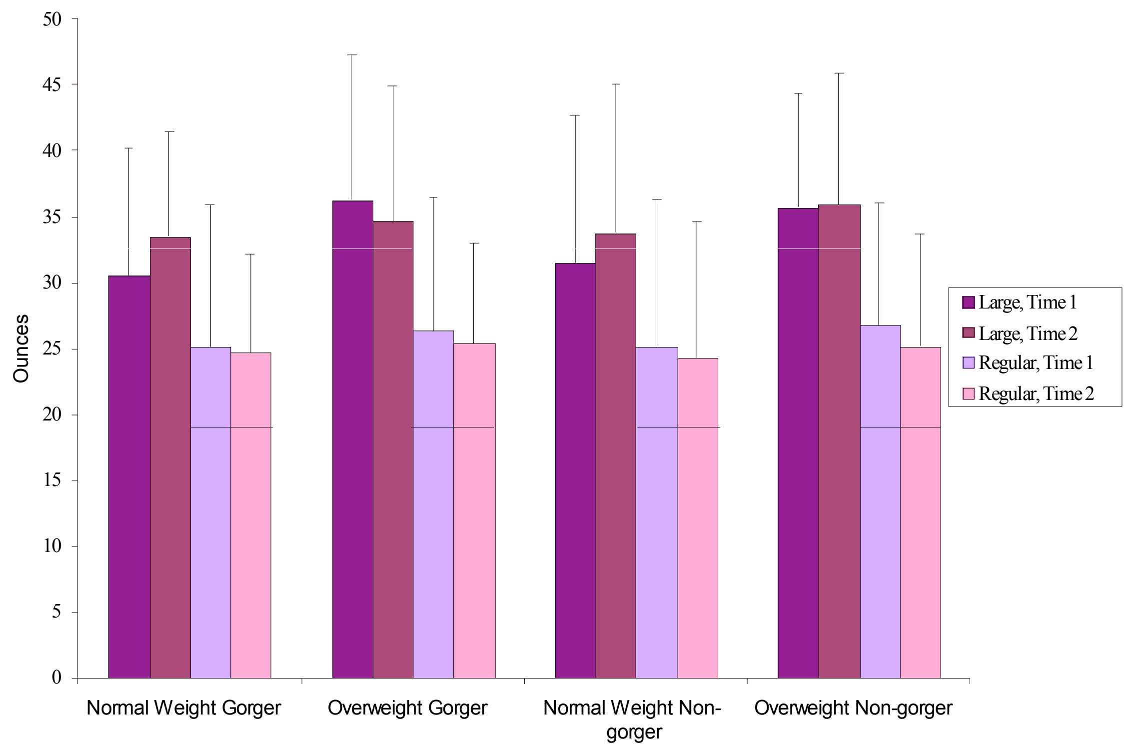


Figure 9.

Accuracy of Meal Size Estimation by Weight and Eating Style Groups for Ounces

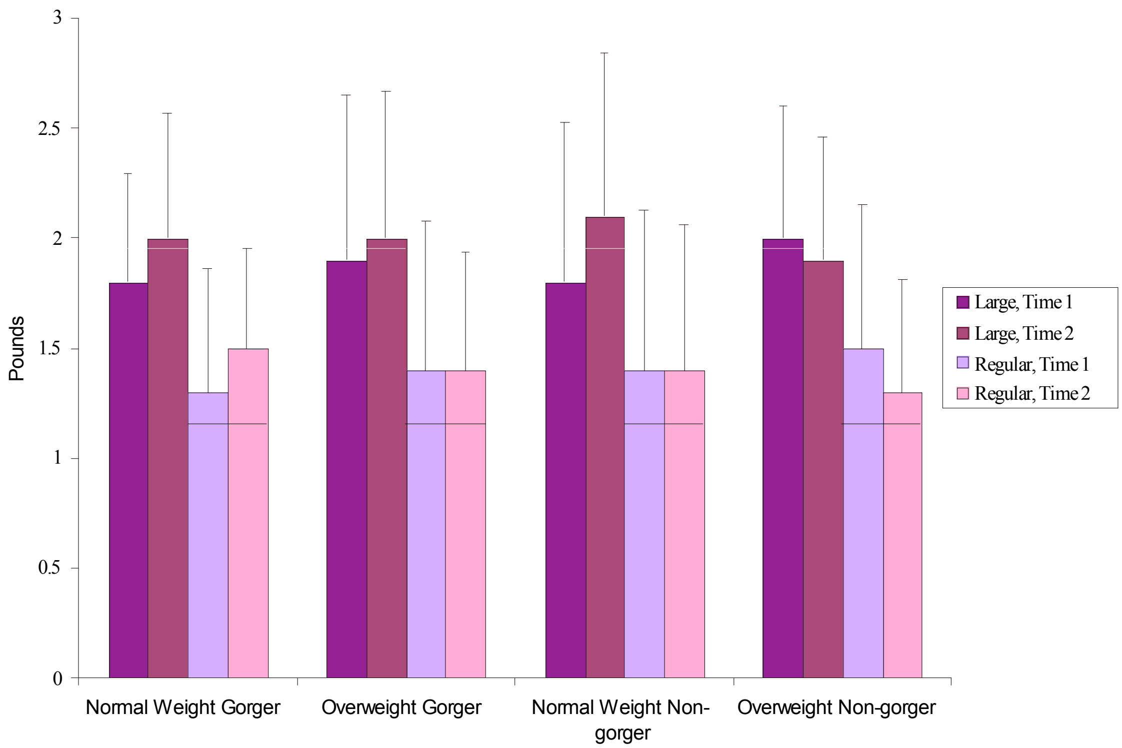


Figure 10.

Accuracy of Meal Size Estimation by Weight and Eating Style Groups for Grams

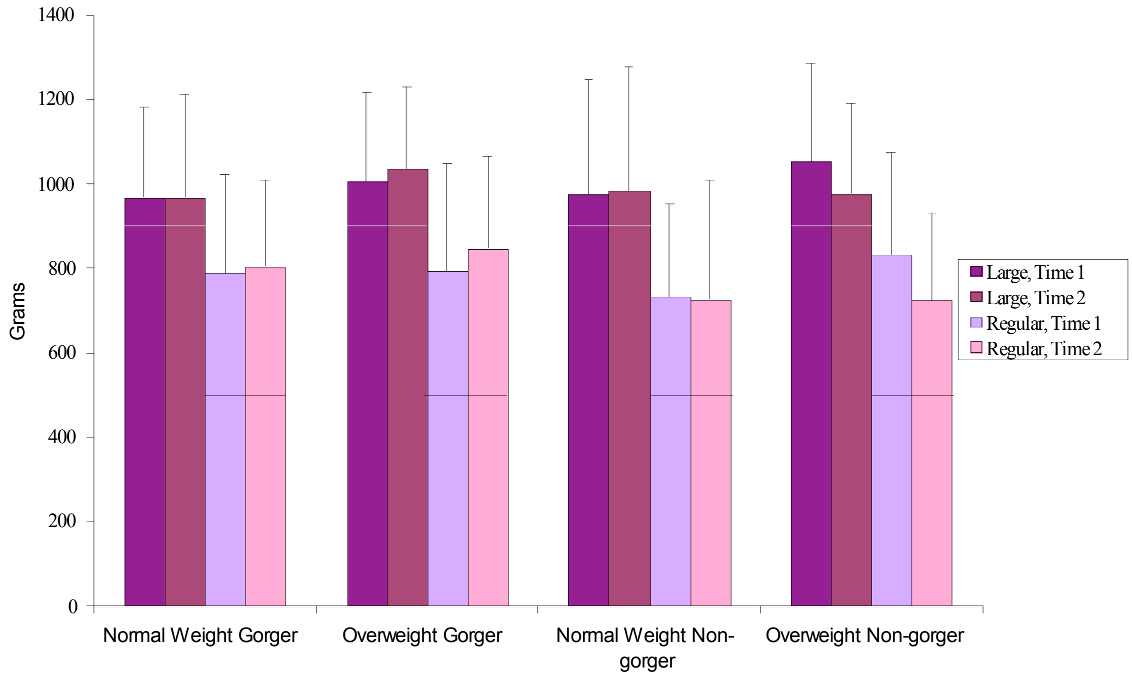


Figure 11.

Accuracy of Meal Size Estimation Over Time for Serving Size

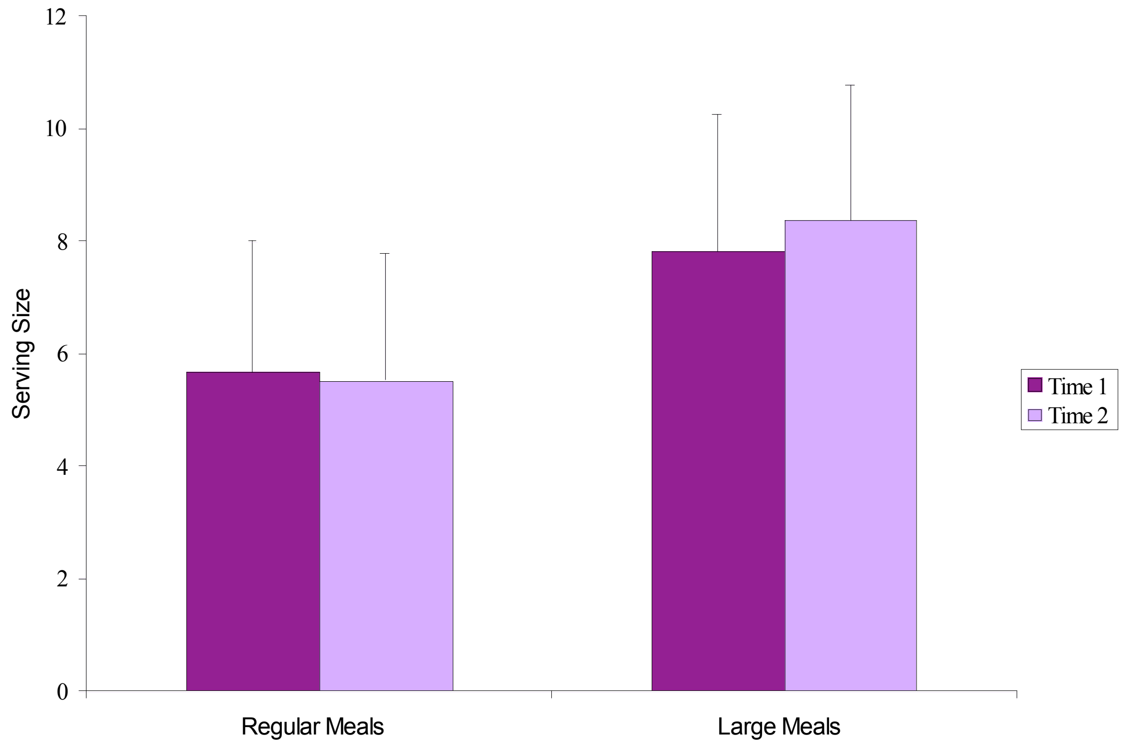


Figure 12.

Accuracy of Meal Size Estimation Over Time for Ounces

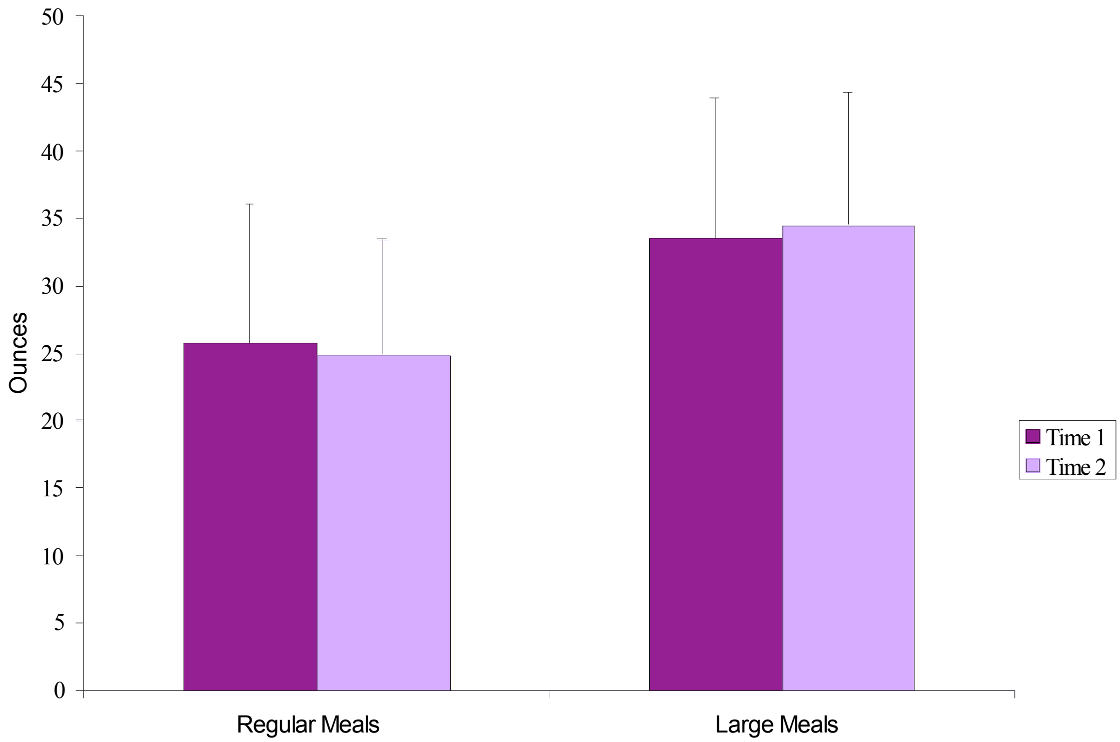


Figure 13.

Accuracy of Meal Size Estimation Over Time for Pounds

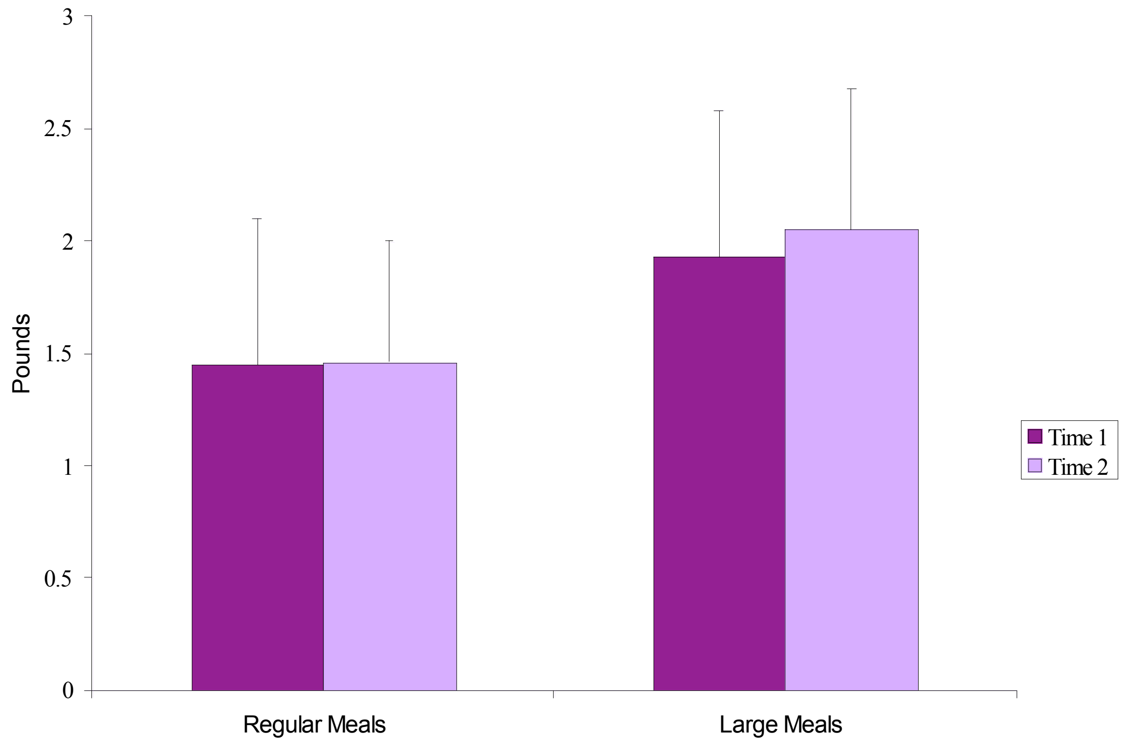
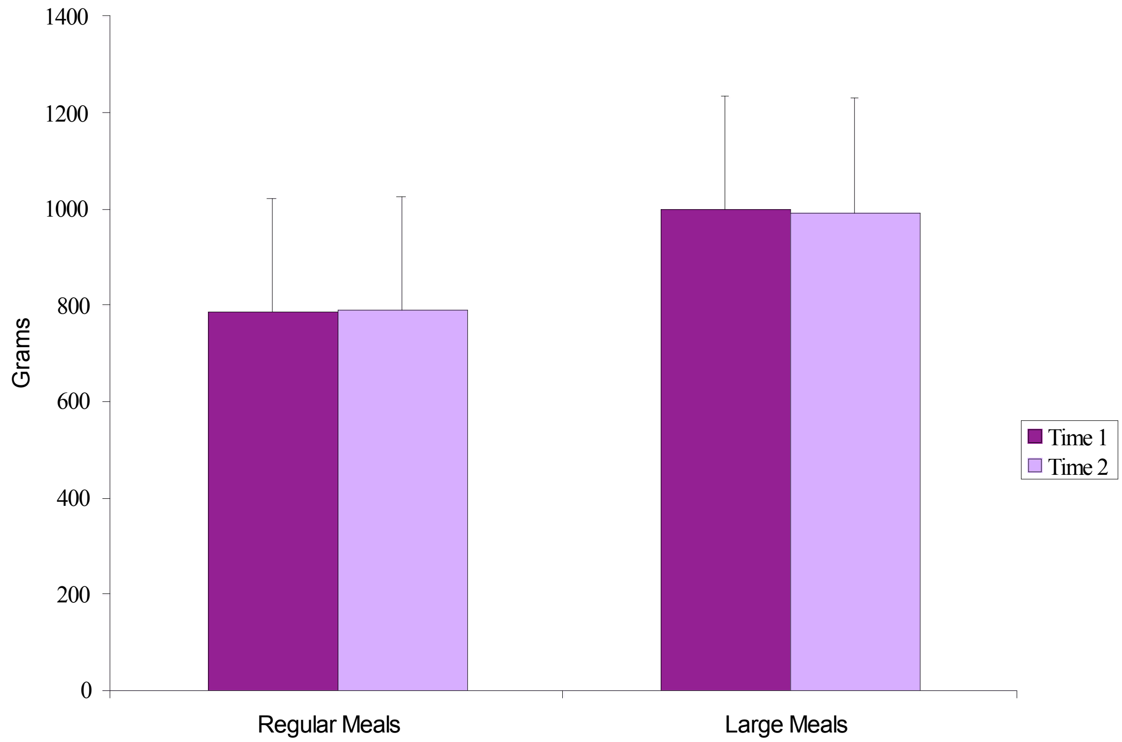


Figure 14.

Accuracy of Meal Size Estimation Over Time for Grams



APPENDIX B: Advertisements

General Advertisement for Newspaper
Targeted Advertisement for Newspaper
General Advertisement for Flyers
Targeted Advertisement for Flyers

SELF-MONITORING STUDY

Nonsmoking, pre-menopausal female volunteers without major medical or mental health problems ages and 18 to 50 are sought for a study on eating and metabolism. Participation requires: 1-week eating and exercise monitoring, 2 visits (approximately 3 – 4 hrs) including meal size estimation, assessment of metabolic rate and body composition. Participants will receive compensation for participation, feedback on their dietary food-intake, resting metabolic rate, and body composition. For more information please call Kris Morris at (301) 295-3672.

Late Day Eaters and Meal Skippers

Women who eat most of their food in the late afternoon and evening, most days of the week who are nonsmoking, pre-menopausal female volunteers without major medical or mental health problems (normal weight and overweight, ages and 18 to 50) are sought for a study on eating and metabolism. Participation requires: keeping a 1-week eating diary and 2 visits (a total of approximately 2 ½ hrs) including meal size estimation, assessment of metabolic rate, and assessment of body composition. Participants will receive compensation for participation, and feedback on their dietary food-intake and resting metabolic rate and body composition. For more information please call at (301) 295-3672.

METABOLISM AND EATING STUDY

Pre-menopausal women over the age of 18 are sought for a study on eating and metabolism.

The study requires:

- Keeping a computerized eating diary and monitoring physical activity for one week
- Two visits to the Uniformed Services University (a total of 3-4 hours)
- Assessment of dietary eating patterns
- Assessment of resting metabolic rate (energy needs)
- Assessment of body composition

Participants will receive compensation for participation, individualized feedback on their food intake, body composition, and metabolic rate.

Interested individuals please contact

Kris Morris at (301) 295-3672

Self-Monitoring
301-295-3672

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(301) 295-3672

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301-295-3672

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EATING STUDY

LATE DAY EATERS AND MEAL SKIPPERS

Female volunteers are sought for a study on eating and metabolism. We are looking for pre-menopausal women over the age of 18 who eat most food later in the afternoon and regularly skip meals

The study requires:

- Keeping a computerized eating diary and monitoring physical activity for one week
- Two visits to the Uniformed Services University (a total of 3-4 hours)
- Assessment of dietary eating patterns
- Assessment of resting metabolic rate (energy needs)
- Assessment of body composition

Participants will receive compensation for participation, individualized feedback on their food intake, body composition, and metabolic rate.

Interested individuals please

contact

Kris Morris at (301) 295-3672

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301-295-3672

Script for Phone Screen

"Hello, my name is _________________. I am calling you back regarding the eating and metabolism study. Do you have about 30 minutes to go through the screening process right now?"

If no: "When can I call you back?"
If yes: *go on*.

"I'd like to tell you a few things about the study first and then I'll be glad to answer any questions that you might have, OK? This study is designed to compare weight and eating style on caloric needs. Your caloric needs are determined by your metabolism, or metabolic rate. Your metabolic rate is the rate at which your body converts food into energy. We are interested in understanding how different eating behaviors affect metabolic rate.

If you are eligible and agree to participate, you will be assigned to an eating pattern group based on your reported and recorded eating behaviors. The members of both groups will be asked to complete the same questionnaires and body and health assessments. We will meet two times. The first meeting will require from 1 hour and 30 minutes – 2 hours and 30 minutes, during which time we will measure your height, weight and body composition. For the first visit you will be asked to come to the Uniformed Services University Human Performance Lab in a fasted state, having not eaten for at least 12 hours. We will also ask you to wear comfortable clothes, come hydrated (32 oz of water the previous day, 64 oz of water 48 hours before) and able to remove jewelry or stockings. Dehydration and metals or surfaces other than skin can interfere with the assessment of body composition.

We will ask you to estimate the size of meals we provide for you, and we will instruct you on the use of a computerized self-monitoring diary. We will also measure your resting metabolic rate, or calculate your caloric needs from the air that you breathe through a process called indirect calorimetry. In order to do this, we will have you wear a face mask that covers your nose and mouth and is connected to a computer with a tube which measures the air that you breathe. We will ask you to wear this face mask for 30-60 minutes during which time you will spend most of it lying still. This is a procedure that is regularly used in our laboratory. Although no problems are anticipated, at any time you will be able to let us know if you are uncomfortable. Do you think you would have any problems wearing such a face mask?

Because of the metabolic testing will need to schedule this first visit around your menstrual cycle and you will need to be available for your scheduled appointment before 7:00 A.M. In the week between your first and second visit we will ask you to record the foods that you eat in a computerized eating diary and your exercise activities by wearing a physical activity monitor for 7-days. We do not want you to change your eating or exercising patterns in that week, we just want you to record what you usually do. We will also ask you to complete a battery of questionnaires during this time. Your second visit will take approximately 40 – 45 minutes. During your second visit we will ask you to estimate the size of two pre-measured meal, and to return your eating diaries, physical activity monitors and questionnaires. During this time payment arrangements will be made, and any questions will be answered.

We are located at the Uniformed Services University, which is near the National Naval Medical Center and across the street from NIH in Bethesda, Maryland. The study is being run by a senior graduate student who has a Master's Degree in Clinical Psychology and has had 5 years of experience in working with individuals with a variety of eating patterns.

If you complete all of this, you will be paid $50 and be given feedback on your metabolism, body composition, and eating patterns. Since we need all of the information requested in order to use your data, you will have to complete all parts of the study before you will be paid.

Does this sound like something you would be interested in?"

If no: "Thank you for your interest."

If yes: "Do you have any questions about the study?

Ok, now I will need to ask you some questions to see if you meet criteria for this study. The questions I will ask you will determine your eligibility for participation depending on your answers. You may refuse to answer any questions; however this information is needed to determine your eligibility for participation."

COMPLETE PHONE SCREEN.

If the caller does not meet requirements: "I am sorry, but you do not meet the requirements for this study. This doesn't mean that there is something wrong with you, it simply means that we are looking at very specific things. It is very important for research purposes that our groups look as similar to each other as possible.

Thank you for you interest."

If caller meets requirement: "Do you have any questions?"

"I am pleased to inform you that you meet the requirements for this study. We will need to schedule your visit 3-9 days after the start of your next period."

If periods are regular, schedule visit

If periods are not regular

"We would like you to estimate when your next period will start and we will call you during that time."

"Also, for the sake of certainty, we would like for you to call us at the start of your next period so we can schedule your first visit."

"When you come in for your first visit on/around we would like you to come to the USU Human Performance Lab by 7:00 A.M. The room is located in Building C. You can park in the school's underground parking garage for free. At this meeting you will schedule the remaining visit. Due to heightened security, you must bring a picture ID with you in order to get on base. You will also need a visitor's pass that we can either mail or fax. Which would you prefer? (Collect pertinent contact information. Thank you in advance for your participation."

PHONE SCREEN

Interviewer: ____________________________ Date:___________

1. Are you in the military? YES NO
   If yes: Are you in the USU Medical School of Nursing Program? YES NO
2. How did you hear about the study? ___________________________________
3. Age_______ 4. Sex ___________
5. Height_________ inches 6. Weight____________ pounds
7. Are you going through menopause (perimenopausal)? YES NO
   If yes, do you still have regular periods? YES NO
8. Are you postmenopausal (stopped having periods)? YES NO
   If yes, volunteer is not eligible.
9. Have you lost more than 10 pounds in the past month? YES NO
10. Have you lost more than 25 pounds in the past 6 months? YES NO
11. Do you smoke? YES NO
12. Do you drink alcohol? YES NO
    If yes, how much, how often? ____
13. Do you drink caffeinated beverages (coffee, soda)? YES NO
14. Do you use any illegal drugs? YES NO

15. Have you been told by a physician that you had:
    A. Hypertension YES NO
    B. Heart Disease/Problems YES NO
    C. High Blood Sugar/Diabetes YES NO
    D. Thyroid Disease YES NO
    E. Kidney Disease YES NO
    F. Major Medical Problems YES NO

16. Have you been told by a psychiatrist or psychologist that you have or had:
    A. Depression YES NO
    B. Eating Disorder YES NO
    C. Anxiety Disorder (exclude for panic disorder) YES NO
    D. Schizophrenia YES NO

E. Bipolar Disorder YES NO

F. Major Psychological/Psychiatric Problem YES NO

If yes, what was the diagnosis? ___________________________________

G. Have you sought treatment for any of these problems? YES NO

If yes, when? ____

H. Are you claustrophobic YES NO

If yes to D, E, F, or H exclude from study

If yes to A, B, or C:

Have you been told that this condition is resolved? YES NO

17. Are you currently taking any medications? YES NO

If so, what are you taking? ____

Why and how much?____

18. Are you currently pregnant or nursing? YES NO

19. MENSTRUAL CYCLE

A. Are you currently taking birth control medication? YES NO

B. Do you have regular menstrual cycles? YES NO

C. How long is your menstrual cycle (i.e., 28 days)?: _______________

D. Date of Start of Last Period: _____________

E. (Dates for 1st visit: 7th day after start of period +/- 2 days)________________

20. MEAL PATTERN:

A. Do you have a condition or take any medications that dictate how often or what you should eat? YES NO

B. In the last month, how many meals did you eat per day? _____________

C. How frequently do you eat breakfast? ______________

D. On average, how many meals per day do you eat? _____________

E. How many days per week do you eat like this? _______________

F. How long between the time that you wake and your first meal? _____________

21. FOOD ALLERGIES:

Do you have any food allergies? YES NO

If yes, what foods are you allergic to? ______________________________

If still eligible to participate:

Name: __________________________

Address: ____

Home Phone: ___________ Work Phone: ______________ Fax: __________________

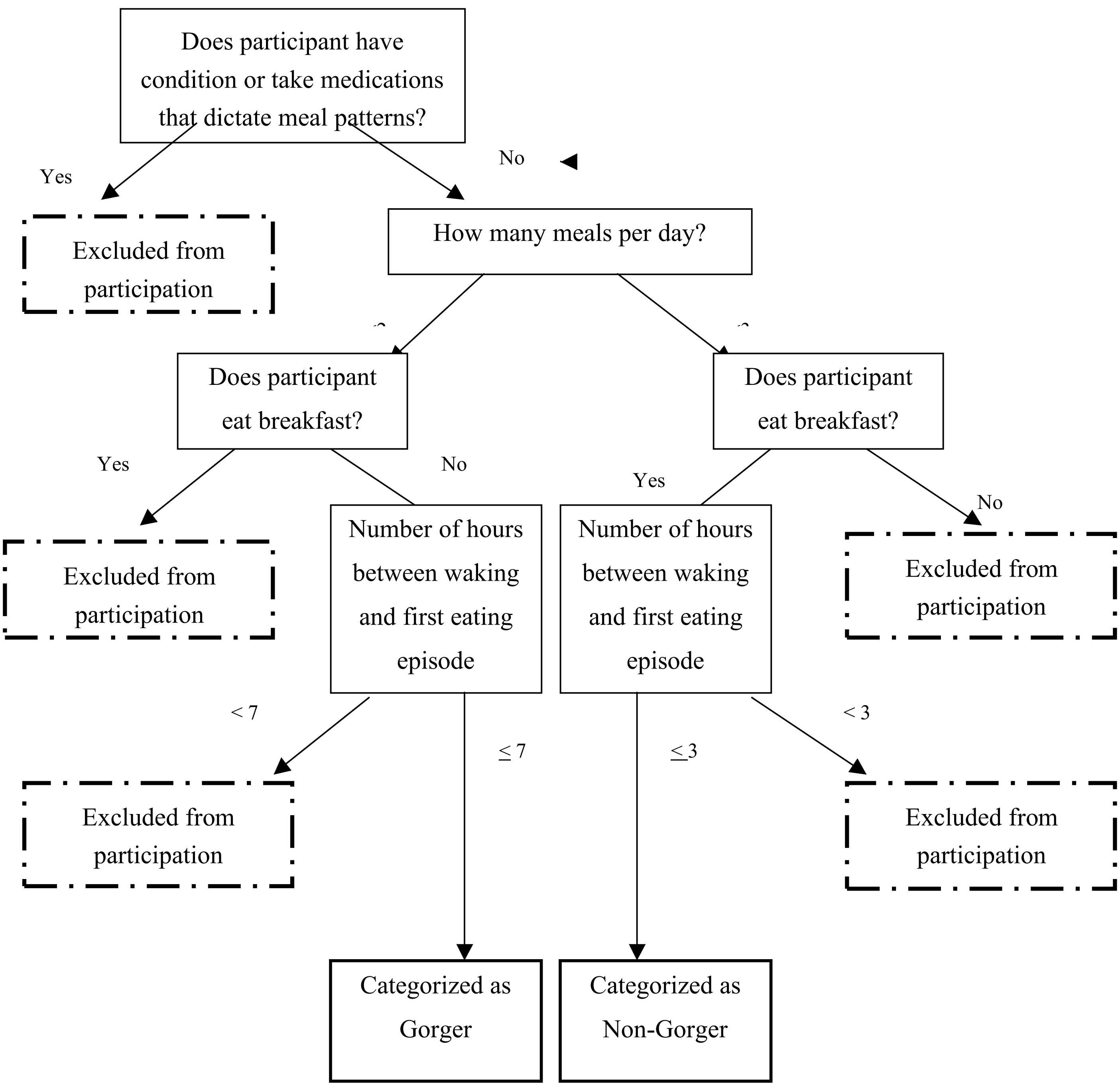
E-mail: ______________________

Participant prefers (circle one): Fax Mail E-Mail

APPENDIX D: Decision Tree for Eating Style Classification

Flowchart for participant classification of eating style

Decision Tree for Classification of Eating Style (Gorging and Non-gorging)



APPENDIX E: Informed Consent Form

Study Informed Consent

Consent for Participation in a Research Study

Title of Project: Understanding Eating and Metabolism

Principal Investigator: Kristy L Morris, M.A., M.S.

TO PERSONS WHO AGREE TO PARTICIPATE IN THIS STUDY:

The following information is provided to inform you about the research project and your participation in it. Please read this form carefully and feel free to ask any questions you may have about this study and/or about the information given below.

It is important that you understand that your participation in this study is totally voluntary. **You may refuse to participate or choose to withdraw from this study at any time**. If, during the course of the study, you should have any questions about the study or your participation in it, you may contact:

Kristy Morris, M.A., M.S. at 301-295-9664
Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799

Tracy Sbrocco, Ph.D. at 301-295-9674
Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799

1. INDICATED BELOW ARE THE FOLLOWING:
a. THE PURPOSE OF THIS STUDY
b. THE PROCEDURES TO BE FOLLOWED
c. THE APPROXIMATE DURATION OF THE STUDY

1a. THE PURPOSE OF THIS STUDY:

The American population is now more overweight than ever before. Since being overweight increases the risk for a number of health related problems including high blood pressure, heart disease, and diabetes mellitus, researchers are focusing on the ways in which we can change our behaviors to achieve and maintain a normal weight. Metabolic rate, the rate at which our bodies convert food into energy, is known to affect individuals' weights and to be affected by our behaviors. There are some factors that affect metabolic rate that we cannot change, such as gender, age, and genetics. But, there are other factors that impact metabolic rate that we can change, such as our muscle mass, how much we exercise, and our eating patterns. Although our eating patterns have been shown to be important in influencing our metabolic rate, not enough is known about this.

The purpose of this study is to compare how two different eating styles influence metabolic rate. You will be asked to monitor your eating and your physical activity for one week.

The information from the food diaries will be used to assess your eating style. The information from your activity monitoring will help us accurately assess the amount of energy you "burn" or expend by moving around throughout the day. The metabolic rate, daily physical activity, body fat, and caloric intake will be measured and compared between the eating styles. Approximately 100 (50 normal weight and 50 overweight) healthy females between the ages of 18 and 50 years old will take part in this study.

1b. THE PROCEDURES TO BE FOLLOWED:

Research designs often require that the full intent of the study not be explained prior to participation. Although we have described the general nature of the tasks that you will be asked to perform, the full intent of the study will not be explained to you until after the completion of the study. At that time, we will provide you with a full debriefing which will include an explanation of the hypothesis that was tested and other relevant background information pertaining to the study. You will also be given an opportunity to ask any questions you might have about the hypothesis and the procedures used in the study.

If you meet weight and other criteria (see inclusion and exclusion criteria listed below) you will be eligible to participate.

Inclusion criteria:

▪ Adult female between the ages of 18 and 50 years
▪ No major medical or mental health conditions

Exclusion criteria:

▪ History of heart disease
▪ History of renal failure
▪ Current tobacco use
▪ Diagnosed Mental Health Disorders
▪ History of thyroid disease
▪ Diabetes
▪ Pregnancy
▪ Claustrophobia
▪ Current use of anti-depressant and anti-psychotic medication
▪ BMI less than 18.4 or greater than 34.9

Participation in this study includes two visits to the Uniformed Services University. The summary of the study is below. Each of the sections will be discussed further in the next sections.

Step	Description	Time
Phone Screen	1. Phone Screen a. Inclusion/Exclusion determination b. Categorization based on eating style and weight c. Study requirements and instructions	30 min.

Visit 1	1. Study description and Informed Consent Form (20 min) 2. Height, weight, and body composition (5 – 10min) 3. Meal size estimation #1 (10 min) 4. Resting metabolic rate (20 min) 5. Meal size estimation #2 (10 min) 6. Demographics Information, Beck's Depression Inventory, Palm borrowing contract (5-10 min) 7. Palm Pilot and Activity Monitor Instruction (20 - 30 min) 8. Schedule for Visit 2	1hr 30 min to 1hr 50 min
Visit 2	1. Return Palm Pilot and Activity Monitor 2. Meal size estimation #1 (10 min) 3. Completion of the Three Factor Eating Questionnaire, Medical Information Form, and Physical Activity Level Assessment (20 min) 4. Meal size estimation #2 (10 min) 5. Participant Debriefing (5 - 10 min) 6. Payment	45 - 50 min
		Total Time: 2 hrs 45 min - 3 hrs 10 min.

Visit 1

Your first visit will take from 1 hour 35 min - 2 hours 35 minutes. At the first visit, you will be asked to wear comfortable clothing, wear jewelry that can be easily removed, avoid wearing nylons, and not wear clothes with metal in it. At the first visit we will measure your height, weight, and body composition. The body composition test allows us to calculate how much body fat and muscle you have. While you are lying in a supine position (on your back), dressed and on a metabolic table (which is similar to a massage table), an electrode (similar to the electrodes placed on the chest of someone having their heart monitored) will be attached to your foot and your hand. A quick, painless measurement is taken. You will not feel the measurement and it is in no way harmful to you.

During this visit we will ask you to estimate the size of foods presented to you at 2 times. These foods will be estimated, not eaten. We will also measure your metabolic rate. To do so we need you to be as close to “at rest” as you can be. You will be asked to lie still wearing either a face mask covering your nose and mouth or a canopy hood which covers your head. These devices measure the air that you breathe. You will lie still for about 20 minutes to let your body get into a resting state and to let you adjust to the feel of the face mask or the hood. After the 20 minutes has passed, the actual measurements will begin. This part will last for about another 30 minutes. The computer attached to the this device will calculate your resting metabolic rate telling us your caloric needs when you are at rest. Although, to date, no participant in any previous study in our laboratory has found wearing the face mask or the canopy hood to be a problem, we will encourage you to indicate if you experience discomfort or if you no longer wish to participate.

We will be asking you to fill out some questionnaires that will provide us information on your lifestyle, background and medical history. Please note that in filling out the medical history form, you are free to answer the questions that you feel comfortable responding to, as well as to skip questions that make you feel uncomfortable. One questionnaire, the Beck’s Depression Inventory – II, includes questions on symptoms of depression. If your score indicates a potential for clinical depression and/or you endorsed suicidality, we will ask you to be further assessed by an advanced graduate student in the Medical and Clinical Psychology program, Kristy Morris, under the supervision of Dr. Tracy Sbrocco, a licensed clinical psychologist. If it seems appropriate, we will offer referrals to local community mental health clinics. If you are a military medical or nursing student, if a referral seems appropriate after further assessment by Kristy Morris, you will be referred to the USU Family Clinic.

You will be instructed on keeping an eating diary and on measuring your physical activity, including both exercise and daily life activity. To measure your food intake we will ask you to keep this diary for one week. You will receive a handheld personal computer on loan to use for the purpose of recording your dietary intake for this study. You will also be given a portable scale to measure all foods. To measure your physical activity level you will wear a small physical activity monitor for one week, which will be attached to your chest via stick-on electrodes and will be virtually unnoticeable. You will be able to wear this activity monitor throughout the day. You have to option to take it off while you are sleeping. You must take it off before you shower or swim, as it is not water-proof. You will be asked to weigh and record all meals consumed and to record all physical activity for 7 days. You are expected to return the computer and activity monitor after each loan period in proper working order. You will be responsible for the computer and the activity monitor in the event it is lost, stolen, or damaged. Note: The replacement value of this computer is approximately $200.00. The replacement value of the Actiheart activity monitor is $750.00.

Visit 2

After one week of monitoring daily food intake and physical activity, you will return to the USUHS. This second visit will take from 40 – 45 minutes during which time you will estimate the size of two pre-measured meals, we will assess your physical activity using an interview process, and you will return your completed food diary and questionnaire packet.

When you have completed the individual visit, completed the self-report questionnaires, and turned in a complete diary the study will be complete. The total time required will be approximately 3 hours – 4 hours and 10 minutes.

1c. DURATION OF THE STUDY

The study will last approximately one to five weeks, depending on your menstrual cycle (period) and the scheduling of the individual visit. The total time spent participating will range from 3 hours - 4 hours 10 minutes.

2. THIS STUDY IS BEING DONE SOLELY FOR THE PURPOSES OF RESEARCH

3. DISCOMFORTS AND/OR RISKS THAT CAN BE REASONABLY EXPECTED ARE:

a. The risks associated with this study are minor. You may find the questionnaires make you slightly uncomfortable, as they are somewhat private questions about mood and eating behaviors. You will NOT be forced to do anything you do not want to do. You may decline to participate at any time and/or withdraw your participation at any time.

b. The study involves a time commitment that you may find inconvenient. You will be asked to appear at the Human Performance Lab at USUHS two times and keep to an eating diary for one week.

c. You may experience discomfort during the resting metabolic test only because of having to lie still for an extended period of time and because of the perception of confinement under the canopy hood, which covers your head and measures the air that you breathe. To date, no injuries have occurred because of indirect calorimetry (a method of calculating your metabolic rate by measuring the air you breathe); however, you reserve the right to stop this study at any time without penalty.

d. At least one participant has reported redness and irritation on the skin caused by the electrodes used as an adhesive for the physical activity monitor. If you have sensitivity to adhesives, you may be more prone to have a reaction that irritates your skin. To alleviate this discomfort you are encouraged to remove the electrodes to let the skin breathe overnight. Replacement electrodes will be provided for you. If the irritation is too severe, you can choose to discontinue use of the physical activity monitor.

4. POSSIBLE BENEFITS TO YOU THAT MAY BE REASONABLY EXPECTED ARE:

You may gain a better understanding of your eating behavior, your energy needs and your body composition. The testing is conducted at no charge. Through completing this study, you will be providing information that will be helpful in expanding scientific knowledge about eating behavior and metabolism. The results of this study will help us gain a better understanding of how eating style effects metabolism and how they relate to overweight and obesity. Our ultimate goal is to gain a better understanding of what factors are associated with overeating and successful weight maintenance.

5. ALTERNATE PROCEDURES THAT MAY BE ADVANTAGEOUS:

There are many commercial programs available for assessing metabolic rate and body composition. Other commercial methods for assessing your eating patterns and your body composition include visiting licensed nutritionists. The information collected in this program is a comprehensive assessment offered at no cost to you.

6. PRIVACY AND CONFIDENTIALITY:

All information you provide as part of this study will be confidential and will be protected to the fullest extent provided by law. Information that you provide and other records related to this study will be accessible to those persons directly involved in conducting this study and members of the Uniformed Services University of the Health Sciences Institutional Review Board (IRB), which provides oversight for protection of human research volunteers. All questionnaires, forms and charts will be kept in a restricted access, locked cabinet while not in use. To enhance the privacy of the answers you provide, data from questionnaires will be entered into a database in which individual responses are not identified. After verification of the database information, paper copies of the questionnaires containing identifiers will be shredded. If you are a military member, please be advised that under Federal Law, a military member's confidentiality cannot be strictly guaranteed.

Note: YOU ARE FREE TO WITHDRAW THIS CONSENT AND TO STOP PARTICIPATING IN THIS STUDY OR ANY ACTIVITY AT ANY TIME FOR ANY REASON.

7. COMPENSATION

The testing is conducted at no charge. You will be paid $50 for completing this study. You will also be sent reports on your metabolic rate, body composition, and eating patterns. If study requirements are not fully completed, you will be compensated $10 for your time.

Military:

Military personnel cannot be financially compensated for participation unless you are in non-working (leave) status. You will, however, receive information on your metabolic rate, body composition, and eating patterns. If you are active duty military and wish to be compensated for your participation because you are in non-working status during the course of this study, you must complete the form "Statement of Approval for Participation in Research" given to you by the study staff. If you do not wish to be compensated this form does not apply, but you are strongly encouraged to inform your command of your participation.

Federal Civilian:

Federal civilian employees cannot be financially compensated for participation unless you are in non-working (leave) status. You will, however, receive information on your metabolic rate, body composition, and eating patterns. If you are a federal employee and wish to be compensated for your participation because you are in non-working status during the course of this study, you must complete the form "Statement of Approval for Participation in Research" given to you by the study staff. If you do not wish to be compensated this form does not apply, but you are strongly encouraged to inform your supervisor of your participation.

8. RECOURSE IN THE EVENT OF INJURY:

This study should not entail any physical or mental risk beyond those described above. We do not expect complications to occur, but if, for any reason, you feel that continuing this study would constitute a hardship for you, we will end your participation in the study.

In the event of a medical emergency while participating in this study or medical treatment required as a result of your participation in this study, you may receive emergency treatment in the facility you are in or a nearby Department of Defense (military) medical facility (hospital or clinic). Treatment/care will be provided even if you are not eligible to receive such care. Care will be continued until the medical doctor treating you decides that you are out of immediate danger. If you are not entitled to care in a military facility, you may be transferred to a private civilian hospital. The attending doctor or member of the hospital staff will go over the transfer decision with you before it happens. The military will bill your health insurance for health care you receive which is not part of the study. You will not be personally billed and you WILL NOT be expected to pay for medical care at our hospitals. If you are required to pay a deductible you may make a claim for reimbursement through the Uniformed Services University Office of General Counsel.

In case you need additional care following discharge from the military hospital or clinic, a military health care professional will decide whether your need for care is directly related to being in the study. If your need for care is related to the study, the military may offer you limited health care at its medical facilities. This additional care is not automatic.

If at any time you believe you have suffered an injury or illness as a result of participating in this research project, you should contact the Office of Research at the Uniformed Services University of the Health Sciences, Bethesda, Maryland 20814-4799 at (301) 295-3303. This office can review the matter with you, can provide information about your rights as a subject, and may be able to identify resources available to you. If you believe the government or one of the government's employees (such as a military doctor) has injured you, a claim for damages (money) against the federal government (including the military) may be filed under the Federal Torts Claims Act. Information about judicial avenues of compensation is available from the University's General Counsel at (301) 295-3028.

Should you have any questions at any time about the study you may contact the principal investigator, **Kristy L Morris, M.A., M.S., Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799, at 301-295-9664.**

STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS RESEARCH PROJECT:

I have read this consent form and I understand the procedures to be used in this study and the possible risks, inconveniences, and/or discomforts that may be involved. All of my questions have been answered. I freely and voluntarily choose to participate. I understand I may withdraw at any time. My signature also indicates that I have received a copy of this consent form for my information.

SIGNATURES:

______________________________	______________________________
Signature of Witness	**Signature of Volunteer**
______________________________	______________________________
Witness Name (Printed)	**Volunteer Name (Printed)**
Date________________________	**Date**___________________________

I certify that I or my research staff have explained the research study to the above individual,, and that the individual understands the nature and purpose, the possible risks and benefits associated in taking part in this research study. Any questions that have been raised, have been answered.

Investigator's or Designee's Signature ______________________

Printed Name ______________________

APPENDIX F: Metabolic Procedures Checklist

Checklist for Body and Health Assessment Visit

Checklist for Body and Health Assessments

Participant ID #: _____ Interviewer: ____________ Date: _______ Time: _______

1. On what day did you start your most recent period _____________.
2. Is today 5 to 7 days after this date? ☐ Yes ☐ No
3. Are you wearing comfortable exercise clothing? ☐ Yes ☐ No
4. Does your bra have underwire in it? ☐ Yes ☐ No
5. Are you wearing jewelry? ☐ Yes ☐ No
   If yes, ask to remove
6. Are you wearing nylons? ☐ Yes ☐ No
   If yes, ask to remove
7. Have you had 32/64 ounces of **water** in the last 24/48 hours? ☐ Yes ☐ No
8. When was the last time you exercised? ___________
   Is this at least 12 hours from right now? ☐ Yes ☐ No
9. When was the last time you ate? ___________
   Is this after 9:00 p.m. ☐ Yes ☐ No
10. When was the last time you had caffeine? ___________
    Is this at least 12 hours from right now? ☐ Yes ☐ No

APPENDIX G: Pasta Bake Recipe

500 g Recipe
900 g Recipe

Italian Pasta Bake (4 servings)

(1.75 kcal/g, 500 g per serving)

Ingredient:	**Amount (g)**
Crisco Vegetable Oil	20.7
San Giorgio Medium Shells, cooked	873.6
Prego Mushroom Sauce	870.5
Kraft 2% Parmesan, grated, bottled	81.4
Weis Fat Free Parmesan, grated, bottled	73.0
Kraft Whole Milk Mozzarella	84.3
Maggio Part Skim Ricotta	98.3
Hanover Petite Broccoli, frozen	24.6
Hanover Crinkle Sliced Carrots, frozen	22.0
Finast Eye Chopped Onions, frozen	12.3
Zucchini, raw	30.8
Garlic, diced, bottled	13.2
Basil	2.64
Oregano	1.32

Directions

1. Wash and dry zucchini. Chop into little cubes.
2. Boil water. Add 450.0 g shells. Cook for 8 minutes. Drain well.
3. Thaw broccoli florets, carrots and onions. Finely chop broccoli florets and carrots using the food processor.
4. Combine all ingredients by following the order of the recipe. Mix well!!
5. Spray casserole dish with PAM. Place on scale and tare. Portion 500 g of pasta bake into each dish. Spread pasta bake out evenly into all corners of the dish. Cover dish with plastic lid. Lid should contain a label with condition of pasta bake. Place on appropriate shelve in freezer.

Italian Pasta Bake (4 servings)

(1.75 kcal/g, 900 g per serving)

Ingredient:	**Amount (g)**
Crisco Vegetable Oil	37.2
San Giorgio Medium Shells, cooked	1540.0
Prego Mushroom Sauce	1540.0
Kraft 2% Parmesan, grated, bottled	143.6
Weis Fat Free Parmesan, grated, bottled	128.8
Kraft Whole Milk Mozzarella	148.6
Maggio Part Skim Ricotta	173.4
Hanover Petite Broccoli, frozen	43.5
Hanover Crinkle Sliced Carrots, frozen	38.8
Finast Eye Chopped Onions, frozen	21.7
Zucchini, raw	54.3
Garlic, diced, bottled	23.3
Basil	4.66
Oregano	2.32

Directions

1. Wash and dry zucchini. Chop into little cubes.
2. Boil water. Add 800.0 g shells. Cook for 8 minutes. Drain well.
3. Thaw broccoli florets, carrots and onions. Finely chop broccoli florets and carrots using the food processor.
4. Combine all ingredients by following the order of the recipe. Mix well!!
5. Spray casserole dish with PAM. Place on scale and tare. Portion 900 g of pasta bake into each dish. Spread pasta bake out evenly into all corners of the dish. Cover dish with plastic lid. Lid should contain a label with condition of pasta bake. Place on appropriate shelve in freezer.

APPENDIX H: Meal Size estimation Forms

Sample of Meal Size Estimation Assessment Form

FOOD ESTIMATION FORM

Subject ID:__________________
Form: __________________

We would like you to estimate the size of the food in front of you. We realize you may not be perfectly accurate, but please use your best judgment to answer the following:

Place a mark on the line that best indicates your response. For example:

5 10 15 20 25 30

1. Please indicate how many **serving size(s)** you think this food is

1 2 3 4 5 6

2. Please indicate how many **ounces (oz)** you think this food is

8 16 24 32 40 48

3. Please indicate how many **pounds** you think this food is

0.5 1 1.5 2 2.5 3

4. Please indicate how many **cup(s)** you think this food is

____

1 2 3 4 5 6

5. Please indicate how many **grams (g)** you think this food is

____

300 500 700 900 1100 1300

6. How large do you think this food is?

____

Not at all large — Extremely large

7. Compare this food to your usual serving of dinner.

____

Much smaller — Much larger

8. How **hungry** do you feel right now?

____

Not at all hungry — Extremely hungry

9. How **thirsty** do you feel right now?

____

Not at all thirsty — Extremely thirsty

10. How much food do you think you could eat right now?

____

Nothing at all — A large amount

11. How **nauseated** do you feel right now?

____

Not at all nauseated — Extremely nauseated

12. How **full** do you feel right now?

____

Not at all full — Extremely full

6. Additionally, we would like you to estimate the following. We realize that this is difficult, but please just do the best that you can.

a. How many calories is this food ______________________
b. What is the percent calories from fat (%fat) ______________________
c. What is the percent calories from carbohydrates ______________________
d. What is the percent calories from protein ______________________

APPENDIX I: Medical Information and Psychosocial Questionnaires

Medical Information Form
BDI-II
Eating Inventory

MEDICAL INFORMATION FORM

Subject ID: ___________

A. Medical History:

1. Do you receive regular medical care from a physician or clinic? No Yes

If yes, please provide the following information:

Name of physician or clinic ______________________ phone: ____________

2. Have you ever had to be hospitalized? No Yes

Year Reason

3. Have you ever had surgery, or been advised to have surgery? No Yes

Year Reason

4. Have you ever been told you have any of the following medical conditions?

	NO	YES	When/Explain	If yes, are you currently being treated or followed for these problems?
Heart Disease				
High Blood Pressure				
Diabetes or High Blood Sugar				
Cancer				
Thyroid Disease				
Other Hormone Problem				
Alcoholism				
High Cholesterol				

Gall Bladder Problems				
Digestive Disease				
Kidney Disease				
Peptic Ulcers (Stomach Ulcers)				
Colitis				
Meningitis or Encephalitis				
Tuberculosis				
Stroke				
Rheumatic Fever				
Asthma				
Birth Defects				
Gout				

5. Have you had any other disease? No Yes

If yes, explain:____

____

6. What is your current weight? _____________ lbs. __ estimate __ actual

7. What is the most you have ever weighed? _____________lbs. When? _____________

8. Have you recently lost or gained any weight? No Yes

Can you explain any recent weight loss or gain?___________________________

____

Weight gained last month _________ Weight lost last month _________

Weight gained last 6 months _________ Weight lost last 6 months _________

Weight gained last year _________ Weight lost last year _________

9. Have you recently had any of the following tests?

	NO	YES	What were the diagnoses?
Physical Exam			
Blood Tests			
Chest X-ray			
Electrocardiogram (EKG)			
Brain Scan or EMI			
EEG			

10. Are you in the habit of using any of the following?

	Amount Currently Using	Most Ever Used	When Stopped Using
Coffee (cups/day)			
Cigarettes (Packs/day)			
Alcohol			
Vitamins			
Sleeping Pills			
Aspirin			
Laxatives			
Diet Pills			

11. Are you currently on any medication (including oral contraceptives)? No Yes

If yes, explain:____

B. Personal Psychiatric History

1. Have you ever received any previous psychiatric or psychological evaluation or treatment?

No Yes If yes, complete the following:

Year	Reason	Medication Used

2. Have you ever attempted suicide in the past? No Yes If yes, complete the following:

Year	How did you attempt suicide?	What

3. Do you currently suffer from clausterphobia? No Yes

4. Have you currently suffer from panic disorder? No Yes

C. Review of Your Current Health:

1. Do you have any of the following?

	No	Yes		No	Yes
Fainting spells, blackout spells			Unusual excessive thirst		
Convulsion			Urine problems, blood in urine		
Paralysis			Indigestion, gas, heartburn		
Thyroid problem, goiter			Stomach pain or stomach ulcer		
Dizziness			Diarrhea		
Headaches			Constipation		
Cough or wheeze			Vomiting, vomiting blood		
Chest pain			Blood in stool		
Spitting up blood			Change in appetite or eating habits		
Shortness of breath at night or with exercise			Trouble sleeping		
Palpitation or heart fluttering			Weight loss or weight gain		
Problems with memory, thinking, concentration			Depression		
Suicidal thoughts			Dizziness		
Weakness or tiredness			Joint pain		

Please describe or explain any of the positive answers above

____

____

____

Date your last menstrual period began: _______

Do you use any contraceptive method?   No   Yes   If yes, what?___________

Patient's Signature ______________________________ *Date:* ______________

BECK DEPRESSION INVENTORY

Instructions: This questionnaire consists of 21 groups of statements. Please read each group of statements carefully, and then pick out the one statement in each group that best describes the way you have been feeling during the past two weeks, including today. Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than one statement for any group, including Item 16 (Changes in sleeping Pattern) or Item 18 (Changes in Appetite).

1. Sadness

0 I do not feel sad

1 I feel sad much of the time.

2 I am sad all the time.

3 I am so sad or unhappy that I can't stand it.

2. Pessimism

0 I am not discouraged about my future.

1 I feel more discouraged about my future than I used to be

2 I do not expect things to work out for me.

3 I feel my future is hopeless and will only get worse.

3. Past Failure

0 I do not feel like a failure.

1 I have failed more than I should have.

2 As I look back, I see a lot of failures.

3 I feel I am a total failure as a person.

4. Loss of Pleasure

0 I get as much pleasure as I ever did from the things I enjoy.

1 I don't enjoy things as much as I used to.

2 I get very little pleasure from things I used to enjoy.

3 I can't get any pleasure from the things I used to enjoy.

5. Gulity Feelings

0 I don't feel particularly guilty.

1 I feel guilty over many things I have done

2 I feel quite guilty most of the time.

3 I feel guilty all of the time.

6. Punishment Feelings

0 I don't feel I am being punished.

1 I feel I may be punished.

2 I expect to be punished.

3 I feel I am being punished.

7. Self-Dislike

0 I feel the same about myself as ever.

1 I have lost confidence in myself.

2 I am disappointed in myself

3 I dislike myself.

8. Self-Criticalness

0 I don't criticize or blame myself more than usual.

1 I am more critical of myself than I used to be.

2 I criticize myself for all of my faults.

3 I blame myself for everything bad that happens.

9. Suicidal Thoughts or Wishes

0 I don't have any thoughts of killing myself.

1 I have thoughts of killing myself, but would not

2 I would like to kill myself.

3 I would kill myself if I had the chance.

10. Crying

0 I don't cry any more than I used to.

1 I cry more than I used to.

2 I cry over every little thing.

3 I feel like crying, but I can't.

11. Activation

0 I am no more restless or wound up than usual.

1 I feel more restless or wound up than usual.

2 I am so restless or agitated that it's hard to stay still

3 I am so restless or agitated that I have to keep moving or doing something.

12. Loss of Interest

0 I have not lost interest in other people or activities.

1 I am less interested in other people doing things than before.

2 I have lost most of my interest in other people or other things.

3 It's hard to get interested in anything.

13. Indecisiveness

0 I make decisions about as well as ever.

1 I fine it more difficult to make decisions than usual.

2 I have much greater difficulty in making decisions than I used to.

3 I have trouble making decisions.

14. Worthlessness

0 I do not feel I am worthless.

1 I don't consider myself as worthwhile and useful as I used to.

2 I feel more worthless as compared to other people.

3 I feel utterly worthless.

17. Irritability

0 I am no more irritable than usual.

1 I am more irritable than usual.

2 I am much more irritable than usual.

3 I am irritable all the time.

18. Changes in Appetite.

0 I have not experienced any change in my appetite.

1a My appetite is somewhat less than usual.

1b My appetite is somewhat greater than usual.

2a My appetite is much less than before

2b My appetite is much greater than usual.

3a I have no appetite at all.

3b I crave food all of the time.

19. Concentration Difficult

0 I can concentrate as well as ever.

1 I can't concentrate as well as usual.

2 It's hard to keep my mind on anything for very long.

3 I find I can't concentrate on anything.

20. Tiredness or Fatigue

0 I am no more tired or fatigued than usual.

1 I get more tired or fatigued more easily than usual.

2 I am too tired or fatigued to do a lot of things I used to do.

3 I am too tired or fatigued to do most of the things I used to do.

15. Loss of Energy

0 I have as much energy as ever.

1 I have less energy than I used to have.

2 I don't have enough energy to do very much.

3 I don't have enough energy to do anything.

16. Changes in Sleep Pattern

0 I have not experienced any change in my sleeping pattern.

1a I sleep somewhat more than usual.

1b I sleep somewhat less than usual.

2a I sleep a lot more than usual.

2b I sleep a lot less than usual.

3a I sleep most of the day.

3b I wake up 1-2 hours early and can't get back to sleep.

.

21. Loss of Interest in Sex

0 I have not noticed any recent change in my interest in sex.

1 I am less interested in sex than I used to be.

2 I am much less interested in sex now.

3 I have lost interest in sex completely.

Eating Inventory

Subject ID | Subject Code

DIRECTIONS: Please answer the following questions by filling in true or false.

1. When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal. ○ True ○ False
2. I usually eat too much at social occasions, like parties and picnics. ○ True ○ False
3. I am usually so hungry that I eat more than three times a day. ○ True ○ False
4. When I have eaten my quota of calories, I am usually good about not eating any more. ○ True ○ False
5. Dieting is so hard for me because I just get too hungry. ○ True ○ False
6. I deliberately take small helpings as a means of controlling my weight. ○ True ○ False
7. Sometimes things just taste so good that I keep on eating even when I am no longer hungry. ○ True ○ False
8. Since I am often hugry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat. ○ True ○ False
9. When I feel anxious, I find myself eating. ○ True ○ False
10. Life is too short to worry about dieting. ○ True ○ False
11. Since my weight goes up and down, I have gone on reducing diets more than once. ○ True ○ False
12. I often feel so hungry that I just have to eat something. ○ True ○ False
13. When I am with someone who is overeating, I usually overeat too. ○ True ○ False
14. I have a pretty good idea of the number of calories in common food. ○ True ○ False
15. Sometimes when I start eating, I just can't seem to stop. ○ True ○ False
16. It is not difficult for me to leave something on my plate. ○ True ○ False
17. At certain times of the day, I get hungry because I have gotten used to eating then. ○ True ○ False
18. While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it. ○ True ○ False
19. Being with someone who is eating often makes me hungry enough to eat also. ○ True ○ False
20. When I feel blue, I often overeat. ○ True ○ False
21. I enjoy eating too much to spoil it by counting calories or watching my weight. ○ True ○ False
22. When I see a real delicacy, I often get so hungry that I have to eat right away. ○ True ○ False
23. I often stop eating when I am not really full as a conscious means of limiting the amount that I eat. ○ True ○ False
24. I get so hungry that my stomach often seems like a bottomless pit. ○ True ○ False
25. My weight has hardly changed at all in the last ten years. ○ True ○ False
26. I am always hungry so it is hard for me to stop eating beore I finish the food on my plate. ○ True ○ False
27. When I feel lonely, I console myself by eating. ○ True ○ False
28. I consciously hold back at meals in order not to gain weight. ○ True ○ False
29. I sometimes get very hungry late in the evening or at night. ○ True ○ False
30. I eat anything I want, any time I want. ○ True ○ False
31. Without even thinking about it, I take a long time to eat. ○ True ○ False
32. I count calories as a conscious means of controlling my weight. ○ True ○ False
33. I do not eat some foods because they make me fat. ○ True ○ False

Subject ID

34. I am always hungry enough to eat at any time. ○ True ○ False

35. I pay a great deal of attention to changes in my figure. ○ True ○ False

36. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods. ○ True ○ False

Part II

DIRECTIONS: Please answer the following questions by filling in the circle above the response that is appropriate to you.

37. How often are you dieting in a conscious effort to control your weight?

○	○	○	○
1 rarely	2 sometimes	3 usually	4 always

38. Would a weight fluctuation of 5 lbs. affect the way you live your life?

○	○	○	○
1 not at all	2 slightly	3 moderately	4 very much

39. How often do you feel hungry?

○	○	○	○
1 only at mealtimes	2 sometimes between meals	3 often between meals	4 almost always

40. Do your feelings of guilt about overeating help you to control your food intake?

○	○	○	○
1 never	2 rarely	3 often	4 always

41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?

○	○	○	○
1 easy	2 slightly difficult	3 moderately difficult	4 very difficult

42. How conscious are you of what you are eating?

○	○	○	○
1 not at all	2 slightly	3 moderately	4 extremely

43. How frequently do you avoid 'stocking up' on tempting foods?

○	○	○	○
1 almost never	2 seldom	3 usually	4 almost always

44. How likely are you to shop for low calorie foods?

○	○	○	○
1 unlikely	2 slightly likely	3 moderately likely	4 very likely

45. Do you ever eat sensibly in front of others and splurge alone?

○	○	○	○
1 never	2 rarely	3 often	4 always

46. How likely are you to consciously eat slowly in order to cut down on how much you eat?

○	○	○	○
1 unlikely	2 slightly likely	3 moderately likely	4 very likely

Subject ID

47. How frequently do you skip dessert because you are no longer hungry?

O	O	O	O
1	2	3	4
almost never	seldom a week	at least once a day	almost every day

48. How likely are you to consciously eat less than you want?

O	O	O	O
1	2	3	4
unlikely	slightly likely	moderately likely	very likely

49. Do you go on eating binges though you are not hungry?

O	O	O	O
1	2	3	4
never	rarely	sometimes	at least once a week

50. On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want) and 5 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

O 0--eat whatever you want, whenever you want it

O 1--usually eat whatever you want, whenever you want it

O 2--often eat whatever you want, whenever you want it

O 3--often limit food intake, but often "give in"

O 4--usually limit food intake, rarely "give in"

O 5--constantly limiting food intake, never "giving in"

51. To what extent does this statement describe your eating behavior? "I start dieting in the morning but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow."

O	O	O	O
1	2	3	4
not like me	little like me	pretty good description of me	describes me perfectly

APPENDIX J: Palm Borrowing Contract and Payment Information Form

Demographics Information Form
Sample Borrowing Contract
Payment Information Form

DEMOGRAPHICS

SUBJECT CODE:____________

DATE:___________

Date of Birth ________________________ Age ________________________

Height ________________________ Weight ________________________

Ethnicity:

Groups with a common culture:

_______ Hispanic or Latino

_______ Not Hispanic or Latino

Please check one or more.

_______ Caucasian
_______ African
_______ Hispanic or Latino
_______ Multi-racial ___________________
_______ Middle Eastern
_______ Other _________________

_______ Black or African American
_______ West Indian or Caribbean
_______ Asian
_______ Pacific Islander
_______ Native American
_______ Native Hawaiians

Marital Status:

Please check one.

_______ Single, Never Married
_______ Married
_______ Divorced

_______ Separated
_______ Widowed
_______ Living Together

Education:

Highest degree earned ______________

Please circle highest grade completed:

1 2 3 4 5 6 7 8 9 10 11 12 | 13 14 15 16 | 17 18 19 20 21 22

Please check one.

________	Some high school	________	Completed College
________	Competed high school/GED	________	Partial Graduate/Professional school
________	Some College	________	Completed Graduate school/Professional school

Occupation: ______________________

Employment Status:

Please check one.

________	Retired	________	Homemaker
________	Full-time	________	Disabled
________	Part-time	________	Unemployed

Annual Household Income:

Please check next to the amount that most closely indicates your total yearly household income.

________	Below $20,000	________	$40,000-$50,000
________	$20,000-$30,000	________	$50,000-$60,000
________	$30,000-$40, 000	________	$60,000-$70,000
		________	Above $70,000

For Office Use Only:
Palm #: _________
Pattern Group: G NG Weight Group: NW OB

BORROWING CONTRACT

I have received both a Palm Pilot handheld personal computer and an Actiheart physical activity monitor on loan from the Uniformed Services University to use for the purpose of logging my dietary intake and daily activity. These are on loan and considered the property of the Uniformed Services University. I am expected to return the computer and activity monitor after the loan period in proper working order. I am responsible for the Palm m100 and the Actiheart activity monitor in the event they are stolen, lost, or damaged. If lost, filing a police report is requested. The replacement value of the computer is $200.00 and the activity monitor is $750.00.

Please complete the following:

Print your full name: ______________________________
Home Address: ______________________________
____

Home Phone: ____________________________
Work Phone: ____________________________
Alternate Phone: ____________________________
Social Security #: ____________________________

Loan Period: ______________ to _____________

My signature below indicates that I am borrowing the computer and the Actiheart activity monitor for the time period indicated and that I understand my responsibilities in doing so.

________________________________ ____________________
Participant's Signature Date

________________________________ ____________________
Witness Signature Date

PAYMENT INFORMATION FORM

Name ____

Address ____

City ____________________ State ______ Zip Code _______

Home phone ____________________ Work Phone ____________________

E-mail ____________________ Alt. Phone ____________________

Social Security Number (required for payment): __________-______-___________

APPENDIX K: Physical Activity Measures

International Physical Activity Level Questionnaire (IPAQ) Description
IPAQ Semi-structured Phone Interview
Self-report Physical Activity Log

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE
(August 2002)
TELEPHONE FORMAT

For use with Young and Middle-aged Adults (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health–related physical activity.

Background on IPAQ

The development of an international measure for physical activity started in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ

Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation

Translation from English is supported to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Data Entry and Coding

Attached to the response categories for each question are suggested variable names and valid ranges to assist in data management and interviewer training. We recommend that the actual response provided by each respondent is recorded. For example, "120 minutes" is recorded in the minutes response space. "Two hours" should be recorded as "2" in the hours column. A response of "one and a half hours" should be recorded as either "1" in hour column and "30" in minutes column.

Telephone IPAQ

READ: I am going to ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. Remember, you do not have to answer any questions you do not want to; however we do need this information to determine physical activity status.

READ: Now, think about all the *vigorous* activities which take *hard physical effort* that you did in the last 7 days. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, aerobics, or fast bicycling. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities?

   _____ Days per week [VDAY; Range 0-7, 8,9]

   8. Don't Know/Not Sure
   9. Refused

[**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time.]

[**Interviewer note**: If respondent answers zero, refuses or does not know, skip to Question 3]

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   __ __ Hours per day [VDHRS; Range: 0-16]

   __ __ __ Minutes per day [VDMIN; Range: 0-960, 998, 999]

   998. Don't Know/Not Sure
   999. Refused

[**Interviewer clarification**: Think only about those physical activities you do for at least

10 minutes at a time.]

[**Interviewer probe**: An average time for one of the days on which you do vigorous activity is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "How much time in total would you spend **over the last 7 days** doing vigorous physical activities?"

__ __ Hours per week [VWHRS; Range: 0-112]

__ __ __ __Minutes per week [VWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about activities which take *moderate physical effort* that you did in the last 7 days. Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, bicycling at a regular pace, or doubles tennis. Do not include walking. Again, think about only those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities?

____ Days per week [MDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure

9. Refused

[**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time]

[**Interviewer Note**: *If respondent answers zero*, refuses or does not know, skip to Question 5]

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

__ __ Hours per day [MDHRS; Range: 0-16]

__ __ __ Minutes per day [MDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer clarification**: Think only about those physical activities that you do for at least 10 minutes at a time.]

[**Interviewer probe**: An average time for one of the days on which you do moderate activity is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent in multiple jobs, ask: "What is the total amount of time you spent over the **last 7 days** doing moderate physical activities?"

__ __ __ Hours per week [MWHRS; Range: 0-112]

__ __ __ __Minutes per week [MWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

____ Days per week [WDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure

9. Refused

[**<u>Interviewer clarification</u>**: Think only about the walking that you do for at least 10 minutes at a time.]

[**<u>Interviewer Note</u>**: <u>*If respondent answers zero*,</u> refuses or does not know, skip to Question 7]

6. How much time did you usually spend **walking** on one of those days?

__ __ Hours per day [WDHRS; Range: 0-16]

__ __ __ Minutes per day [WDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer probe**: An average time for one of the days on which you walk is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent walking over **the last 7**

days?”

__ __ __ Hours per week [WWHRS; Range: 0-112]

__ __ __ __Minutes per week [WWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure

9999. Refused

READ: Now think about the time you spent sitting on week days during the last 7 days. Include time spent at work, at home, while doing course work, and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

7. During the last 7 days, how much time did you usually spend ***sitting*** on a **week day**?

__ __ Hours per weekday [SDHRS; 0-16]

__ __ __ Minutes per weekday [SDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

[**Interviewer clarification**: Include time spent lying down (awake) as well as sitting]

[**Interviewer probe**: An average time per day spent sitting is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: “What is the total amount of time you spent *sitting* last **Wednesday**?”

__ __ Hours on Wednesday [SWHRS; Range 0-16]

__ __ __ Minutes on Wednesday [SWMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

Self-report Physical Activity Log

Subject Code: ________________

Please fill in ALL information each time you exercise.

Day	Time (circle one)	Activity	Minutes	Distance
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				
Sunday				
Total				

APPENDIX L: Debriefing Form

Debriefing Form

Participation Debriefing Form

Title of Project: Effects of eating style and portion size on the accuracy of dietary self-monitoring.

Principal Investigator: Kristy L. Morris, M.A., M.S.

TO PERSONS WHO AGREED TO PARTICIPATE IN THIS STUDY:

As noted in the original consent form you signed at the beginning of this study, the full intent of the study was not explained to you until after the completion of your participation. The following information is provided to inform you about true purpose of the research project and your participation in it. Please read this form carefully and feel free to ask any questions you may have about this study and/or about the information given below.

If, after consideration of the true nature of this study or the use of less than full disclosure, you should have any questions about the study or your participation in it, you may contact:

Kristy Morris, M.A., M.S. at 301-295-9664

Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799

Tracy Sbrocco, Ph.D. at 301-295-9674

Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799

Office of Research at (301) 295-3303

USUHS, Bethesda, Maryland 20814

1. INDICATED BELOW ARE THE FOLLOWING:

a. THE TRUE BACKGROUND OF THIS STUDY

b. THE TRUE PURPOSE OF THIS STUDY

b. THE RATIONAL FOR LESS THAN FULL DISCLOSURE

1a. THE PURPOSE OF THIS STUDY: Dietary self-monitoring is considered the "gold standard" for self-report food intake and is relied upon in both empirical research and clinical settings regarding body weight and food consumption. In spite of this, dietary underreporting is a fundamental problem in the self-monitoring of food intake. Although the use of dietary self-monitoring records is widely variable, there are no practical alternatives for getting detailed prospective reports of eating patterns. Research consistently shows that dietary underreporting is associated with increased weight, however, few studies to date have examined factors that can explain the relationship between weight and accuracy of reporting. Two factors hypothesized to affect eating behaviors include portion size and eating patterns, and are therefore the focus of the present investigation of accuracy of dietary self-report. To date, there is no study that has systematically dismantled the role of weight status and eating patterns on accuracy of dietary self-monitoring. Knowledge of the role of both the ability to accurately assess portion size and eating style will improve dietary self-monitoring and ultimately increase our understanding of the role of diet and health.

1b. THE TRUE PURPOSE OF THIS STUDY: The purpose of the current study is to more thoroughly examine how eating style (gorging and non-gorging) and portion sizes (regular, 500 g and larger, 900 g) affect the accuracy of dietary self-monitoring. Gorging is defined as two or fewer meals per day with at least seven hours between waking and the first meal for at least three days per week.

Aim 1: Examine the effect of meal size on dietary underreporting. Studies to date have examined the role of meal size on dietary intake, but not on dietary self-monitoring. The first aim of the current study is to examine whether underreporting of meal size is more likely to occur with larger meals. This aim will be addressed by calculating the differences between actual and estimated weight of foods (in grams), caloric composition, macronutrient composition (including percent carbohydrate, protein and fat composition), and serving size. It is hypothesized that all individuals are more likely to underreport larger (900 g) meals compared to regular size (500 g) meals because of the challenges of estimating larger meal sizes. It is expected that gorgers will underestimate meal size because of habitual consumption of large meals. An additional question is whether all individuals, regardless of eating style or weight status, are susceptible to dietary underreporting of larger meals. The following differences in estimating weight, calories, macronutrient composition, and serving size are expected:

Hypothesis 1.a. It is expected that larger (900 g) meal sizes will be associated with less accurate estimation of portion sizes than regular meal sizes, irrespective of an individual's eating style or weight status.

Hypothesis 1.b. It is expected that regular meal size will be associated with more accurate estimation among non-gorgers compared to gorgers, whereas no significant differences are anticipated between gorgers and non-gorgers for large size meals, independent of weight status.

Hypothesis 1.c. It is expected that the accuracy of meal size estimation for regular and large meals will improve after one week of prospective dietary self-monitoring for both gorgers and non-gorgers.

Aim 2: Examine the effect of weight status and eating style on the accuracy of dietary self-monitoring. Few of the studies that have examined the role of weight status on accuracy of dietary intake have considered underlying factors associated with weight itself. Of those that have, only recently have any examined eating style. The second aim of the current study is to determine whether eating style impacts the accuracy of dietary self-monitoring, independent of weight status. This aim will be addressed by comparing energy intake reported using prospective computerized self-monitoring diaries with measured energy needs using indirect calorimetry to measure resting metabolic rate. Accuracy will be determined by calculating cut-off scores using the Goldberg equation (Goldberg, 1991).

It is hypothesized that overweight and obesity, per se are, not accountable for accuracy of dietary self-monitoring, but rather it is eating style, specifically gorging. Gorgers eat larger amounts of food per sitting compared to non-gorgers, therefore their reference standard for meal size is larger. If it is this difference in reference standard that contributes to dietary underreporting, it is likely that gorgers will underreport to a greater extent than non-gorgers, regardless of weight status.

Hypothesis 2. Gorgers will underreport ambulatory food intake over a 1-week period to a greater than non-gorgers, as reflected by a main effect of eating style. No main effect of weight status or interaction between eating style and weight status is expected.

1c. THE RATIONAL FOR LESS THAN FULL DISCLOSURE:

Participants were initially told that the purpose of this study was to examine the effects of eating behavior on metabolism. The true purpose of this study was to examine the effects of eating behavior and portion size on the accuracy of dietary self-monitoring. Less than full disclosure regarding the true purpose of this study was used in order to get more valid data on dietary self-monitoring. Research has shown that the accuracy of dietary recording improves when participants are aware that the accuracy of their monitoring is being evaluated. Such effects will render data unreliable such that the true relationship between eating style and portion size on the accuracy of dietary self-monitoring will be unclear.

Should you have any questions at any time about the study you may contact the principal investigator, **Kristy L Morris, M.A., M.S., Department of Medical & Clinical Psychology, USUHS, Bethesda, MD 20814-4799, at 301-295-9664.**

Thank you for your participation.

Sincerely,

Kristy L. Morris, M.A., M.S.