INFLUENCE OF THE HOME ENVIRONMENT ON DIETARY INTAKE AND WEIGHT LOSS AMONG OBESE WOMEN FROM RURAL COMMUNITIES

By

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To my Dad, the biggest Gator fan I have ever known

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TABLE OF CONTENTS

LIST OF TABLES

Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Master of Science

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Rural communities in the U.S. have higher rates of obesity compared to the general population, and several studies have suggested that rural households have limited access to healthy foods. However, little research attention has been given to the contribution of the home food environment to dietary intake and weight in rural areas. The current study examined the influence of foods in the home on dietary intake and body weight in a sample of obese adults enrolled in a lifestyle intervention. The participants were 166 obese women from rural counties (M±SD, age = 59.7±6.2 years, BMI = 36.5±4.8 kg/m^2). During the intervention, participants were encouraged to make changes to their dietary intake. At baseline, height was determined using a stadiometer. At baseline and Month 6, weight was measured with a balance beam scale, and the home food environment and dietary composition were assessed using the Family Eating and Activity Habits Questionnaire and the Block Food Frequency Questionnaire, respectively. At baseline, the home food environment was not associated with BMI (p = .808). However, at Month 6, the home food environment was associated with BMI (r = -.16, p = .039). The mediating role of saturated fat, carbohydrates, protein and fiber was

examined. Results showed that consumption of saturated fat significantly mediated the relationship between the food environment and BMI (95% CI [-.24, -.01], $p < .05$). These findings suggest that modifying the home environment by decreasing the presence of high-fat foods may support weight loss in obese individuals from rural communities.

CHAPTER 1
INTRODUCTION

Overview

The increasing prevalence of obesity in the United States over the last 40 years has highlighted the influential role that the home environment plays in affecting obesity risk. The current study examined what aspects of the home food environment may change during the course of a behavioral lifestyle intervention, as well as how these changes may be related to dietary intake. In addition, this study attempted to identify specific factors within the home that may directly, or indirectly, affect body weight. This was done with the objective of identifying potential targets for change in future weight management interventions.

Prevalence and Risks of Obesity

Flegal, Carroll, Kit and Ogden (2012) estimated that approximately one-third of the population of the United States is obese, meaning that they have a Body Mass Index (BMI) greater than or equal to 30 kg/m^2. Further, it is estimated that another one-third of the population is overweight (BMI ≥ 25 kg/m^2), meaning that a greater number of individuals currently meet criteria for overweight and obese categories than for the normal weight category (Centers for Disease Control and Prevention, 2010). The dangers associated with obesity are numerous; including an increased risk for developing cardiovascular disease (CVD), diabetes mellitus, hypertension, pulmonary disease, stroke and some types of cancers (National Heart, Lung and Blood Institute, 2010). In fact, obesity is associated with increased all-cause mortality compared to normal weight (BMI = 18-25 kg/m^2) when controlling for age, race, gender, smoking status and alcohol consumption (Flegal, Graubard, Williamson, & Gail, 2005). Although

actual estimates of annual obesity-related deaths vary from 115,000 to greater than 300,000, it is clear that obesity is associated with an increased mortality rate particularly from cardiovascular disease, diabetes mellitus, kidney disease and obesity-related cancers (Allison, Fontaine, Manson, Stevens, & VanItallie, 1999, Flegal, Graubard, Williamson, & Gail, 2007, Morkdad, Marks, Stroup, & Geberding, 2005).

Influence of the Environment on Obesity Risk

Certain ethnic, socioeconomic and geographic groups are more likely to be obese than others, indicating a variety of cultural, environmental and biological factors that are contributing to obesity prevalence. For example, rates of obesity are higher in rural areas of the United States; in fact, it is estimated that adults in rural areas are 28% more likely to be obese than those living in urban and suburban areas (Eberhardt & Pamuk, 2004). In addition, there is a higher prevalence of cardiovascular disease in rural areas compared to urban areas (Bennett, Olatosi, & Probst, 2008). Multiple factors may contribute to this disparity, focused on the various contributors to cardiovascular disease and obesity risk. One hypothesis is based in the fact that a strong relationship has been observed between lower socioeconomic status and higher prevalence of cardiovascular disease, and higher rates of poverty have been found in rural communities. Although CVD risk factors decreased for all income groups between 1971 and 2002, there have been minimal improvements in income group disparities on this issue (Kanjilal et al., 2006, United States Department of Agriculture Economic Research Service, 2004). Additionally, while 20% of Americans live in rural areas; only 9% of the nation's physicians practice there. This disparity in access to medical services coupled with the fact that rural residents typically must travel extended distances to obtain these services may affect all aspects of health care, but particularly obtaining preventive

health services (van Dis, 2002). In rural areas, the limited health care services that are available are typically directed towards more acute care concerns with less focus on general health promotion and prevention (Flora, C., Flora, J., Fey, 2004).

Another conceptualization of this disparity is focused on a major contributor to obesity risk; physical inactivity. Individuals living in rural areas are more likely than ever to be physically inactive, potentially because the increased mechanization of jobs that previously required physical labor is leading to a more sedentary lifestyle and a decrease in caloric expenditure (Flora et al., 2004, Pearson & Lewis, 1998). This modern trend is evident when comparing physical inactivity during leisure-time between rural and suburban areas, where rural residents are 50% more likely to be physically inactive during leisure time (Eberhardt & Pamuk, 2004). As one might expect, there tends to be fewer physical activity and recreational facilities in areas that are less populated. However, Gordon-Larsen, Nelson, Page, and Popkin (2006) found that the odds of engaging in at least five bouts of moderate to vigorous physical per week increased by 3% with the addition of just one physical activity facility. These odds improved with each additional physical activity facility. Moreover, rural residents are least likely to meet the recommended physical activity guidelines, and there are typically fewer sidewalks and safe places to walk in rural communities; factors that are also associated with a more sedentary lifestyle (Parks, Housemann, & Brownson, 2003).

However, more research has focused on the environment of rural communities as it relates to food consumption, both within the home and at the neighborhood level. For the purpose of this review, the neighborhood is broadly defined as the “area around one’s place of residence” and can include such factors as number of stores within

walking distance of the home as well as types of restaurants within the county limits (Larson, Story, & Nelson, 2009). Rural areas may be considered “food deserts;” areas where it is often more difficult to purchase high quality, nutritional foods (Wrigley, Warm, Margetts, & Whelan, 2002). This is important because the greatest variety of these healthy foods is likely to be found in supermarkets, where they are also typically offered at the lowest cost. In contrast, convenience stores tend to sell high-calorie foods such as prepared meals and “junk” food (i.e., high-calorie, nutrient poor foods), and little fresh produce (Larson et al., 2009). Ford and Dzewaltowski (2008) found that less-populated areas tend to have fewer food stores, as well as a decreased availability and higher pricing of healthy foods within those stores. In fact, rural and farm areas have been shown to have 14% fewer chain supermarkets compared to urban areas (Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007). Another study found that almost 75% of rural food stores were convenience stores (Liese, Weis, Pluto, Smith, & Lawson, 2007). This differential access to chain supermarkets may be more influential than previously thought; Morland, Diez Roux, and Wing (2006) observed that having a supermarket within an individuals’ census tract was associated with lower rates of obesity. Census tracts with access to supermarkets only, and no access to convenience stores or grocery stores displayed the lowest levels of obesity (20.8%), whereas census tracts with access to only grocery stores or both grocery stores and convenience stores displayed the highest levels of obesity (35.7% and 40.3%, respectively). Another study found that a reduced access to supermarkets was associated with an increase in obesity risk, even after controlling for individual level characteristics (i.e., age,

education, income, smoking status, sex, black race, and Hispanic ethnicity) (Lopez, 2007).

Further complicating this problem are regional differences in food preference and meal selection, such that traditionally southern foods are typically higher in fat and salt content. Traditionally, the rural southern United States has been made up of relatively poor communities that developed specific eating patterns out of necessity. One of these eating patterns is the consumption of relatively large amounts of pork, given the availability and low cost of raising hogs. As a result, foods such as bacon, sausage, and ham are consumed in many rural southern diets. In addition, using salted pork fat or lard to flavor other foods is a common practice (Smith, Quandt, Arcury, Wetmore, Bell, & Vitolins, 2006). This disparity is further evident from observing differences in the home food environments of individuals living in a southern state compared to individuals living in a northern state, such that the homes of individuals in the South contain more high-fat foods, on average (Krukowski, Harvey-Berino, & West, 2010). Furthermore, in a study of middle school-aged children in rural Mississippi, results showed that intake of saturated fat and sodium exceeded the recommended daily levels while intake of calcium, fruits and vegetables were inadequate (Davy, Harrell, Stewart, & King, 2004). This is of particular relevance because rural counties in the South tend to have some of the highest rates of obesity (CDC, 2010).

Overall, the interaction of all of these factors (i.e., poverty, reduced access to preventive services, cultural factors related to diet and physical activity) has led rural areas to be slower in adopting changes in lifestyle behaviors that may alter obesity and CVD risk, such as decreasing intake of saturated fat and increasing physical activity

(Jones, Parker, Ahearn, Mishra, & Variyam, 2009, Patterson, Moore, Probst, & Shinogle, 2004).

Influence of the Home Environment

There has been an increased focus on the availability of healthy foods in the community and how this relates to obesity risk. Accordingly, additional research has found a similar relationship between the presence of healthy foods in the community and both dietary intake and household availability of these foods. The majority of this research; however, has been focused primarily on the consumption of fruits and vegetables. For example, one study showed a direct relationship between living in a census tract with at least one supermarket and meeting the U.S. Department of Agriculture and the U.S. Department of Health and Human Services 2000 Dietary Guidelines for fruit and vegetable intake, although the strength of this relationship varied by race. For black individuals, each additional supermarket within their census tract was associated with a 32% increase in meeting the fruit and vegetable recommendations, whereas for white individuals, each additional supermarket was associated with only an 11% increase (Morland, Wing, & Diez Roux, 2002). Despite racial differences in this sample, the effect of a greater variety of foods available within the community on dietary intake is discernible. Additionally, Rose and Richards (2004) found that households where the majority of food was purchased from a supermarket consumed more fruit per day than those where food was purchased from other stores. Importantly, the driving factors behind this relationship may be greater selection and greater variety of types of fruits and vegetables. This was illustrated in a random sample of 102 participants in New Orleans, where a positive relationship was found between vegetable shelf space and vegetable consumption, such that each additional linear meter of vegetable shelf

space was associated with an increase in vegetable intake of 0.35 daily servings. A similar relationship was found in this sample between more varieties of fresh vegetables and vegetable consumption, although no relationships were found for fruit (Bodor, Rose, Farley, Swalm, & Scott, 2008). Although this association has been demonstrated in various populations, further research into whether similar relationships exist for unhealthy foods as well as fruits and vegetables is relatively limited.

A limited number of studies have investigated the relationship between the availability of various foods in the community and the availability of foods in the home. Further, almost no research has examined the relationship between the availability of foods in the home and consumption of those foods in adults (e.g., at the micro-level). Although there is some evidence to suggest that the presence of healthy foods in local supermarkets and grocery stores is associated with a greater presence in the home as well as an increased intake of these foods (Fisher & Strogatz, 1999, Auchincloss, Diez-Roux, Brown, Erdmann, & Bertoni, 2008), these relationships have only been demonstrated with a few specific foods (i.e., fruits, vegetables, low-fat milk) and have not been examined within the context of a weight management intervention.

Nationally, the trend over the last 30 years has been away from eating meals in the home and more towards eating meals at restaurants. However, Nielson, Siega-Riz, and Popkin (2002) estimated that up to 65% of calories are still being consumed in the home, suggesting that this environment remains highly influential on eating patterns. At the base of this influence may be a combination of operant and Pavlovian conditioning (Bouton, 2010). Bouton theorized that because eating occurs in many different contexts, individuals tend to develop associations between food and the environment over time.

In addition, the presence of certain foods may trigger a desire to eat even if the individual is satiated. Taken together, it is apparent how the home environment is an important influence on eating patterns.

These micro-level (i.e., home) factors related to obesity and dietary intake have been examined with some depth in children and adolescents. Results from these studies are relatively consistent and suggest that the presence of healthy foods in the home was associated with greater intake of fruits and vegetables (Blanchette & Brug, 2005, Hearn et al., 1998, O'Dea, 2003). Specifically, one study showed that 1.3 additional servings of fruits and/or vegetables were consumed by girls where fruits and vegetables were always available versus sometimes/never available (Hanson, Neumark-Sztainer, Eisenberg, Story, & Wall, 2004). Another study showed that the strongest predictors of childrens' eating behaviors were home food behaviors (i.e., eating meals as a family, eating breakfast) and parent's consumption (Hartley, Anderson, Fox, & Lenardson, 2011). However, a consistent theme noted in the literature related to the home food environment's effect on children and adolescents is that children are subject to the desires and preferences of the adults in the home. It is rarely taken into account that other individuals in the home (including children, spouses, etc.) can have an adverse effect on the adult purchasing food for the household. For example, a child in the home may insist that ice cream is available, which in turn can influence an individual attempting to make healthy lifestyle changes and the home environment in general.

Lifestyle Interventions Related to the Environment

Few studies have examined changes in the home food environment during the course of a weight management intervention and to our knowledge; no studies have

examined the simultaneous effects of the home food environment and dietary intake on body weight within this context.

Currently, the standard lifestyle intervention for obesity is comprised of three main components which are aimed at achieving the following; moderate reduction in caloric intake, increase in physical activity, and acquisition of cognitive-behavioral strategies that will aid in accomplishing the first two goals. This behavioral approach to treatment for obesity is typically delivered weekly in a group-based format for 16 to 26 weeks with the goal of producing weight losses of 0.4 to 0.5 kg per week (Butryn, Webb, & Wadden, 2011). After the initial intervention phase of group behavioral treatment, individuals typically lose 8-10 kg which is equivalent to 8-10% of initial weight (Wadden, Butryn, & Wilson, 2007). This has been demonstrated in multiple trials over the last twenty years, which is consistent with recommendations that even a 3-5% decrease in body weight is associated with health benefits such as reducing blood lipid levels and blood pressure, and decreasing the risk of cardiovascular morbidity and mortality (American Journal of Clinical Nutrition, 1998). Additionally, approximately 80% of individuals who begin a lifestyle intervention complete treatment indicating that this may be an effective way of administering treatment to obese individuals (Wadden et al., 2007). Unfortunately, participants on average regain one-third of their lost weight within one year of treatment ending, and nearly one-half of participants return to their original weight with five years (Curioni & Lourenço, 2005, Perri & Corsica, 2002, Wadden et al., 2007, Wing, 2002). This striking pattern of weight regain conveys that further research into means of supporting weight maintenance is greatly needed.

The cornerstone of any behavioral treatment for obesity is self-monitoring. This is typically done through use of food records to record types/amounts of foods and caloric intake, pedometers or other tools to measure physical activity and scales to monitor weight. Goals for dietary intake typically involve reducing daily calories consumed by 500 to 1000 kcal in a balanced fashion, meaning that there is no one nutrient group that is targeted for greater reductions than the others. However, there is some support for limiting fat intake to no more than 30% of total calories, and specifically decreasing saturated fat intake so that it makes up no more than 10% of daily total calories. Current research supports decreasing fat intake as well as total calories because some studies have shown improved weight loss when both aspects are targeted (Pascale, Wing, Butler, Mullen, & Bononi, 1995). This indicates that modifying the home environment to decrease the availability of high-fat foods may be particularly important in supporting weight management efforts over the long term.

One cognitive-behavioral strategy often discussed during an intervention for obesity is the implementation of stimulus control techniques. As previously outlined, there are many “high-risk” situations that can lead an individual to overeat, and over time the association between cues and eating can strengthen. Stimulus control techniques as they relate to behavioral treatment for obesity can help individuals manage cues that may lead to overeating or making unhealthy food choices. These cues (i.e., high-risk situations) can include certain restaurants or aisles of the grocery store, or an individuals’ home environment. Within the home, employing strategies such as storing unhealthy foods out of sight, cleaning plates immediately after eating, or keeping large serving dishes off the table during a meal can all decrease inappropriate

eating (Brownell, 2000). Conversely, positive cues can be used to increase desirable behaviors such as placing fruits and vegetables in visible locations to increase consumption and placing walking shoes at the front door to increase physical activity.

The body of research focused on stimulus-control techniques in the context of a behavioral lifestyle intervention is limited (Wadden, Crerand, & Brock, 2005). Some research studies that have examined the influence of an intervention on the home environment have been focused on the spouse of the research participant or within the context of a home grocery delivery program (Gorin et al., 2008, Gorin, Raynor, Niemeier, & Wing, 2007). However, Krukowski et al. (2010) attempted to quantify the influence of a behavioral lifestyle intervention on the home food environment and how that may differ for individuals living in a northern versus a southern state. Results from this study showed a significant decrease in presence of high-fat foods in the home following an intervention for individuals living in both the northern and southern state, but there was no significant change in availability of low-fat foods in the home. An interaction effect was also detected, such that individuals living in the southern state displayed greater reductions in the number of high-fat foods available in their homes following an intervention compared to individuals living in the northern state. This may have been detected in part because the homes in the southern state had, on average, more high-fat foods available in their homes at baseline. However, these decreases in high-fat food availability were not associated with weight change during treatment.

Specific Aims and Hypotheses

Specific Aim 1

Examine the relationship between the home food environment and dietary intake in a sample of obese adults prior to undergoing a weight management

intervention. We hypothesized that the home food environment would be significantly associated with eating patterns such that (a) a greater availability of “healthy” foods in the home would be associated with greater intake of fiber and (b) a greater availability of “unhealthy” foods in the home would be associated with greater intake of saturated fat. For the purpose of this study, healthy foods were defined as fruits and vegetables; which are significant sources of fiber. On the other hand, the category of unhealthy foods was defined as snack foods, ice cream, and baked goods; all of which are traditionally high in saturated fat.

Specific Aim 2

Determine the impact of a behavioral lifestyle intervention on dietary intake. There are three macronutrients that compose dietary intake; protein, carbohydrates and fat. However, for this study we also chose to include fiber as a major component of dietary intake, although it is not considered a macronutrient, because of its relationship with fruit and vegetable intake. We also chose to include saturated fat instead of total dietary fat. Total dietary fat is comprised of saturated fatty acids, polyunsaturated fatty acids, monounsaturated fatty acids and trans fatty acids. Saturated fat was included over total fat because of the body of research that states that saturated fat, more than total fat, is associated with CVD risk (Krauss et al., 1996). A preliminary analysis also indicated that total fat and saturated fat were highly correlated ($r = .951$, $p < .01$). In summary, fiber was included because of its relationship with “healthy” foods and saturated fat was included because of its relationship with “unhealthy” foods. We hypothesized that from baseline to Month 6, intake of saturated fat would significantly decrease and intake of fiber would significantly increase, again recognizing that we generally expect healthy food consumption to increase and unhealthy food consumption

to decrease. During the course of the intervention, consumption of saturated fat (rather than total fat) is targeted because of the health risks that are associated with an excessive intake of saturated fat specifically. Conversely, total fat was not exclusively targeted because this macronutrient group also includes “healthy” fats (i.e., unsaturated fats). We also expected decreases in both protein and carbohydrates because these macronutrient groups typically make up the largest percentage of daily caloric intake. Since the intervention is directed towards decreasing total caloric intake, individuals will likely decrease their intake of these macronutrients as they decrease portion sizes.

Specific Aim 3

Determine the impact of a behavioral lifestyle intervention on the home food environment. We expected that from pre- to post-treatment (i.e., baseline to Month 6), the mean number of healthy foods in the home would increase, and the mean number of unhealthy foods in the home would decrease. We also planned to examine whether the home food environment was associated with change in BMI at baseline and Month 6. However, previous studies have failed to uncover a relationship between weight change and changes in home food environment (Krukowski et al., 2010).

Specific Aim 4

Determine if consumption of fiber, protein, carbohydrates, and saturated fat mediated the relationship between the home food environment and BMI at Month 6. This was examined as a follow-up to Aim 3. Since the home environment and weight change have not been directly related in other studies, we examined potential indirect effects and multiple potential mediators of the relationship. In a model for multiple mediation, multicollinearity among potential mediators can compromise the significance of particular indirect effects leading the researcher to assume that there is no indirect

effect when in fact there is, and vice versa (Preacher & Hayes, 2008). Since total fat and saturated fat were highly correlated, we chose to include saturated fat over total fat in this model; again referencing the unique influence that saturated fat may have on CVD risk. Fiber was also included as a mediator, as it was indicated to be a component of dietary intake in the first aim. We hypothesized that intake of protein, carbohydrates, saturated fat and fiber would partially explain the relationship between the home food environment and BMI. We expect this because while the home environment may not affect weight directly, we might expect to see that the home environment is related to dietary intake, which in turn can affect BMI.

CHAPTER 2
MATERIALS AND METHODS

TOURS Study

The current study was a secondary data analysis that utilized data from the Treatment of Obesity in Underserved Rural Settings (TOURS) study, a randomized controlled trial (Perri et al., 2008). The TOURS study was conducted in six rural counties in north Florida and was aimed at determining the effectiveness of three models of extended care in rural populations. The study was conducted in two phases. During the first six months of the study (i.e., intervention phase), all women attended weekly group sessions at their local county cooperative extension office. Weekly sessions were focused on helping participants achieve a moderate reduction in energy intake (i.e., 500 to 1000 Kcal per day), increasing physical activity and implementing cognitive-behavioral strategies to support behavior change. In addition to an overall reduction in calories, participants were encouraged to improve their dietary intake by decreasing intake of saturated fat, choosing lean sources of protein, and increasing consumption of fiber through intake of fruits and vegetables. Participants were provided with food and physical activity records to aid in self-monitoring and goal setting. Sessions were focused on aiding individuals in achieving weight losses of approximately 0.4 kg per week. Individuals were also encouraged to set goals for physical activity and to consistently achieve an average of 30 minutes per day of walking at least six days per week. The physical activity aspect of the intervention also utilized pedometers to allow participants to track their “steps,” with the goal of increasing their daily steps by a minimum of 3,000 steps from their baseline (pre-treatment) level.

The second phase (i.e., follow-up) consisted of random assignment to one of three extended care conditions: an Office-based Maintenance Program, Telephone-based Maintenance Program, or an Education Control Condition. During this phase, all individuals received contact twice per month, although the method of communication varied. The Office-based Maintenance Program received contact in the form of a Face-to-Face session, the Telephone-based Maintenance Program participated in an individual Telephone session, or the Education Control Condition received a direct Mailing/newsletter. The extended care phase of the study lasted for 12 months (Month 6 to Month 18) and in each of the three conditions individuals were encouraged to continue keeping self-monitoring records of their diet and physical activity.

Participants

Participants were women between the ages of 50-75 whose weight placed them in the obese category (BMI 30-50 kg/m^2). However, their weight had to be less than 159 kg (350 lbs). Women also had to be living in one of six rural counties in north Florida. Women were excluded if they had any uncontrolled medical conditions, any conditions that were likely to influence treatment outcomes, or any conditions for which eating and physical activity changes would be unsafe. These exclusionary criteria included any serious or uncontrolled medical conditions, such as uncontrolled hypertension or diabetes, recent myocardial infarction or stroke, history of solid organ transplantation, serious infectious disease, abnormal lab values, or any other physical conditions likely to interfere with an individuals' ability to participate in a lifestyle intervention involving eating and physical activity changes. If individuals reported use of antipsychotic medications, monoamine oxidase inhibitors, systemic corticosteroids, human immunodeficiency virus or tuberculosis antibiotics, chemotherapeutics medications or

weight loss medications, they were excluded from participation. In addition, individuals were excluded if they reported a psychiatric disorder or excessive use of alcohol, were unable or unwilling to provide informed consent, were unable to read English at a fifth-grade level, were currently participating in another research study, or were unwilling to be randomly assigned.

Of the 559 women who responded to the study recruitment announcements, 261 were excluded. Among the 261 women who were not eligible for participation, 82 were excluded due to elevated blood pressure, 76 had abnormal lab values, 29 had contraindications based on medical history, 27 had some other abnormal result during screening, 17 had a BMI that was out of range, and 30 declined participation. In addition, only cohorts 2 and 3 were asked to fill out the Family Eating and Activity Habits Questionnaire at both baseline and Month 6. The data from this questionnaire was a main outcome of the current study, and therefore another 132 women were excluded for missing data on this measure for at least one time point.

Procedures

Women in the current study were recruited through a variety of means, including mailings, newspaper study announcements, and in-person recruitment conducted at churches, community centers and community events. Interested women first completed a brief screening over the telephone and if they were deemed eligible, were scheduled for an in-person screening visit. At the screening visit, women received a more detailed description of the study and were given the opportunity to provide informed consent. At this time, women were also asked to complete detailed questionnaires about their demographics, diet, physical activity, medical history, medication use, quality of life, mental health status and home environment. In addition, a blood sample was collected

and height, weight, abdominal measurements, resting heart rate, and blood pressure were assessed. Women also completed a 6-minute walk test to assess their current level of physical fitness and mobility.

Women who were eligible after the first screening visit were asked to return for a second screening visit within two weeks prior to their first group session. At the second screening visit, women repeated the 6-minute walk test and a blood sample was collected to ensure that there had been no significant changes in their metabolic profile. Weight was also reassessed and women were excluded if they had gained greater than 4.5 kg since their first screening visit.

Measures

Body weight: At baseline, height was measured using a stadiometer and weight was taken using a balance beam scale. At Month 6, weight was measured again. At both time points, weight was measured by a study nurse masked to the treatment condition of the participants and rounded to the nearest tenth of a kilogram. Change in weight was calculated by taking the difference between weight at baseline and weight at Month 6.

Home environment: The home environment was evaluated using the Stimulus Exposure subscale of the Family Eating and Activity Habits Questionnaire (Golan & Weizman, 1998). This subscale is comprised of a food inventory for healthy foods (i.e., various fruits and vegetables) and unhealthy foods (i.e., snack foods, desserts) where individuals are asked to indicate whether or not these foods were present in the home within the past month (Golan & Weizman, 1998). From this, an estimate is obtained of the presence (i.e., number) of these various foods in the home. This questionnaire has been shown to have good test re-test reliability (r = .85).

Dietary intake: Dietary intake was assessed using the Block 95 Food Frequency Questionnaire (Block et al., 1986). This is a food inventory where individuals are asked about foods they have eaten within the past year, as well as how much of these foods they have eaten and how often they have eaten them. From this, an estimate of daily intake of various nutrients is obtained. For the purpose of this study, only daily estimates of saturated fat, carbohydrates, protein and fiber were used. All estimates are reported in mean grams of the given nutrient per day during the time period assessed (i.e., one year). The Block 95 FFQ was shown to be correlated with 4-day diet records (r = 0.5-0.6), suggesting a moderate to good ability to assess dietary intake (Block, Woods, Potosky, & Clifford, 1990).

Statistical Analyses

The statistical software package PASW SPSS® 18.0 for Windows (SPSS, Inc., IL) was used to conduct the statistical analyses for this research study.

For the first aim we conducted two sets of four correlations each (eight total correlations), all using variables from the baseline assessment. The first group of correlations was between availability of healthy foods in the home and dietary intake, and the second group of correlations was between availability of unhealthy foods in the home and dietary intake. In the current study, dietary intake was defined as estimated daily intake of saturated fat, carbohydrates, protein and fiber, all measured in grams. Availability of healthy and unhealthy foods in the home was taken from the Family Eating and Activity Habits Questionnaire and dietary intake estimates were taken from the Block Food Frequency Questionnaire.

The second aim was evaluated using dependent samples t-tests using intake of saturated fat, carbohydrates, protein and fiber as the variables. These variables were

assessed at baseline and Month 6, and participant responses were used from these two time points to determine if the change in these variables following the intervention was significant.

The third aim was evaluated in the same way, using dependent samples t-tests with number of healthy foods in the home and number of unhealthy foods in the home as the two variables. Again, the values at baseline and Month 6 were used to assess change. In addition, as a follow-up to the third aim, a Pearson's product-moment correlation was also used to determine if these changes in healthy and unhealthy foods in the home were associated with change in BMI. For this additional aim, a composite score of the home environment was created from the Stimulus Exposure subscale of the Family Eating and Activity Habits Questionnaire. The items in this subscale were divided into presence of healthy foods in the home and presence of unhealthy foods in the home. Half of the items (i.e., items measuring the unhealthy foods in the home) were reverse scored and combined with the remaining items. The result is an overall score that represents the home environment, where a higher score indicates a "healthier" environment (i.e., more healthy foods in the home).

As a preliminary analysis to the fourth aim, the relationship between the home environment and BMI (both at Month 6) was assessed in order to test for a direct relationship between the two variables. If this relationship was determined to be significant, the Preacher and Hayes model for multiple mediation was used for the final aim to determine if estimates of dietary intake mediated the relationship between the home food environment and BMI at Month 6. The composite score of the home food environment at Month 6 was entered into the model as the independent variable and

BMI at Month 6 was entered as a dependent variable. Baseline BMI was included in the model as a covariate to account for weight change during the intervention. Both time points were used in the model instead of change scores because changes scores have not been shown to have consistent validity (Cronbach & Furby, 1970). Intake of saturated fat, carbohydrates, protein and fiber were entered into the model as mediators. The Preacher and Hayes model for mediation was chosen over the Baron and Kenny model to reduce the familywise error rate. The Preacher and Hayes model also allows for the meditational analysis in the context of a non-significant original relationship. The composite score of the home environment was used in this analysis as well.

CHAPTER 3
RESULTS

Baseline Characteristics: The study sample consisted of 166 obese women from rural communities in north Florida, with a mean age of 59.7 years and a mean BMI of 36.5 kg/m^2. The sample was predominantly white (78.9%), married (72.7%), with an associate's degree or trade/vocational school (41.8%). Baseline characteristics of the sample are summarized in Table 3-1.

Relationship between the home food environment and dietary intake at baseline: Pre-treatment examination of the association between the home food environment and dietary intake showed a significant association between number of unhealthy foods in the home and intake of fiber, as well as number of unhealthy foods in the home and intake of carbohydrates. These results suggest that a greater availability of unhealthy foods in the home is associated with a greater intake of fiber and carbohydrates. The relationships between number of unhealthy foods in the home and intake of protein and between number of unhealthy foods in the home and saturated fat were non-significant. Results also showed a trend towards significance for the relationship between number of unhealthy foods in the home and intake of saturated fat. In addition, there were no significant associations between healthy foods in the home and intake protein, fiber, carbohydrates or saturated fat. Results are shown in Table 3-2.

Impact of a behavioral lifestyle intervention on dietary intake: For the second aim, we assessed whether dietary intake significantly changed from baseline to Month 6, defining dietary intake as mean daily consumption of saturated fat, carbohydrates, protein and fiber. Results from this analysis showed that individuals decreased their consumption of protein by a mean of 10.6g (SD = 36.9g). This change from baseline to

Month 6 reflected a significant decrease. Individuals also decreased their saturated fat intake by a mean of 9.3g (SD = 12.3g), which represented a significant difference. Mean intake of carbohydrates decreased by 27.9g (SD = 12.3g). This decrease in carbohydrate consumption also reflected a significant change. Although consumption of fiber increased by a mean of .91g (SD = 9.3g), this was not a significant change. Results from this analysis are shown in Table 3-3.

Impact of a behavioral lifestyle intervention on the home food environment: From baseline to Month 6, the mean number of unhealthy foods in the home decreased by 1.05 (SD = 3.73). This represented a significant change. In addition, the mean number of healthy foods in the home also significantly changed from baseline to Month 6, such that the mean number of healthy foods increased by 1.04 (SD = 3.65). These results are shown in Table 3-4.

At baseline, there was no significant association between the home food environment and BMI (p = .808). However, an assessment of the relationship between the home environment and BMI revealed a significant association at Month 6 (r = -.16, p < .05). These results suggest that a greater availability of healthy foods in the home was related to a lower BMI.

Estimates of dietary intake as mediators of the relationship between the home food environment and BMI: As noted, the relationship between the home environment and BMI at post treatment was significant, and the Preacher and Hayes model for mediation was utilized to determine if intake of saturated fat, carbohydrates, protein and fiber mediated the relationship between the home food environment and BMI at Month 6. One thousand bootstrapped samples were used. When these four

mediators were entered into the model, results showed that the overall set of mediators was significant (95% CI [-.24, -.01], $p < .05$). Because the strength of the relationship between the predictor and the dependent variable is reduced when the mediators are included, a partial mediation is indicated. These results suggested that having more healthy foods in the home was associated with a lower intake of saturated fat, carbohydrates and protein and a greater intake of fiber, which is consequently associated with a lower BMI. However, although four mediators were hypothesized, further examination showed that only intake of saturated fat was a significant mediator of this relationship (95% CI [-.32, -.01], $p < .05$), meaning that intake of carbohydrates (95% CI [-.03, .05]), protein (95% CI [-.03, .13]) and fiber (95% CI [-.13, .04]) did not contribute any additional significance above and beyond the contribution of saturated fat.

Taken together, the results for the fourth aim show that individuals made changes to their home environment and dietary intake in the suggested directions and these changes were associated with a lower BMI following an intervention.

Table 3-1. Baseline Characteristics

Variable	*n* = 166
Age, in years, *M* (*SD*)	59.7 (6.2)
BMI, in kg/m^2, *M* (*SD*)	36.5 (4.8)
Weight, in kg, *M* (*SD*)	95.7 (14.7)
Race/ethnicity	
White, Non-hispanic, *n* (%)	131 (78.9)
African-American, *n* (%)	27 (16.3)
Hispanic/Latina, *n* (%)	2 (1.2)
Other, *n* (%)	6 (3.6)
Education	
Less than 12 years of education, *n* (%)	58 (35.2)
Associate's degree/	69 (41.8)
Trade or vocational school, *n* (%)	
Bachelor's degree, *n* (%)	21 (12.7)
Post-baccalaureate education/training, *n* (%)	17 (10.3)
Marital Status	
Never married, *n* (%)	3 (1.8)
Divorced/separated, *n* (%)	20 (12.1)
Widowed, *n* (%)	16 (9.7)
Presently married, *n* (%)	120 (72.7)
Living in marriage-like relationship, *n* (%)	6 (3.6)

Table 3-2. Associations Between Dietary Intake and the Home Food Environment at Baseline

	Protein	Fiber	Carbohydrates	Saturated fat
Unhealthy foods	.111	.194*	.175*	.152
Healthy foods	-.032	.049	-.050	-.069

Note: * $p < .05$

Table 3-3. Mean Intake of Various Nutrient Groups at Baseline and Month 6

	Baseline		Month 6		*t*(165)
	M	SD	M	SD	
Protein	66.06	40.48	55.41	23.91	3.71**
Fiber	16.22	8.71	17.13	7.18	-1.26
Carbohydrates	200.14	103.47	172.22	65.94	3.74**
Saturated fat	22.75	13.63	13.41	6.95	9.74**

Note: All variables are measured in mean grams per day of each nutrient. ** $p < .01$

Table 3-4. Mean Number of Healthy and Unhealthy Foods in the Home at Baseline and Month 6

	Baseline		Month 6		*t*(165)
	M	SD	M	SD	
Healthy foods	12.47	3.95	13.51	3.77	-3.68**
Unhealthy foods	9.33	4.55	8.27	3.89	3.65**

Note: ** $p < .01$

CHAPTER 4
DISCUSSION

The objective of the current study was to determine the effects of a behavioral lifestyle intervention on the home food environment and dietary intake. This study also examined how these changes directly affected body weight during the course of an intervention. In addition, the indirect effect of the home food environment on body weight was examined using intake of protein, carbohydrates, fiber and saturated fat as potential mediators for this relationship.

The major findings from the current study are as follows. First, a significant association was found between number of unhealthy foods in the home and daily intake of fiber as well as between number of unhealthy foods in the home and intake of carbohydrates. There was also a trend towards significance for the relationship between number of unhealthy foods in the home and saturated fat. There were no significant associations found between healthy foods in the home and dietary intake.

The current study also found that individuals significantly changed their dietary intake following a behavioral lifestyle intervention. Results showed that individuals significantly decreased their daily protein, saturated fat and carbohydrate intake. Although consumption of fiber increased following the intervention, this did not represent a significant change.

In addition, results from the current study showed that individuals significantly changed their home food environment following an intervention. These changes occurred in the expected directions given the focus on behavior change and nutrition education during the intervention. This means that on average the number of healthy

foods in the home significantly increased following an intervention, and the number of unhealthy foods in the home significantly decreased following an intervention.

Finally, a significant direct effect between the home food environment and body weight was found at Month 6. Therefore, this relationship was examined further to determine if intake of saturated fat, fiber, protein and carbohydrates mediated the relationship between the home food environment and body weight. As a set of mediators, this group was determined to indirectly affect the relationship, but further examination revealed saturated fat as the only significant mediator.

Generally, these results suggested that individuals' dietary intake was related to the types of foods that were available in their home; this relationship is stronger for a greater presence of unhealthy foods but may not necessarily generalize to presence of healthy foods in the home. Results from the first aim also showed that the relationship between presence of unhealthy foods in the home and intake of saturated fat was trending towards significance, which supports previous research that suggests the presence of unhealthy foods may be more influential on dietary intake than the presence of healthy foods. A significant positive association was also found between intake of fiber and unhealthy foods in the home, which was not hypothesized. A potential explanation for this finding may be found when examining the types of foods participants are asked about on the "unhealthy" foods portion of the Family Eating and Activity Habits Questionnaire. For example, popcorn can be found on the unhealthy foods list as a "snack." In addition, participants are asked to enumerate other "snacks" that may be found in their home in free response form. Popcorn, along with some muffins, granola bars, and other foods that would be considered "snacks" can be high in

fiber. This particular questionnaire does not differentiate between these high-fiber snacks and snacks such as donuts or potato chips that may provide little to no nutritional value.

The results also showed that individuals made changes to their eating patterns as encouraged by the lifestyle intervention. Given these results, these changes may have included eating smaller portions of high-fat protein sources and decreasing consumption of foods that are high in saturated fat, which could include red meat, snack foods, dessert foods and high-fat dairy. In addition, these results showed decreases in consumption of carbohydrates. Considering that carbohydrates may make up the largest portion of daily caloric intake, this may indicate that individuals were decreasing their calories overall. The results also showed that intake of fiber did not significantly change during the course of the intervention, which is consistent with previous research that individuals tend to decrease the amount of unhealthy foods in their diet without increasing their intake of healthy foods such as fruits and vegetables (Krukowski et al., 2010). In terms of the home food environment, the results showed that individuals both increased the availability of healthy foods in the home and decreased the number of unhealthy foods in the home simultaneously during the course of a lifestyle intervention. These results differed from those in a previous study that suggested that individuals tend to eliminate unhealthy foods from the home (and their diet) without actually adding healthy foods (Krukowski et al., 2010). The changes detected in the home food environment were relatively small; however, this inability to detect larger changes may represent the lack of standardization in home food environment questionnaires or a reporting bias. Further, when it is considered that even minimal changes in food

consumption can result in a rather significant caloric reduction, it can be argued that these seemingly minor modifications represent clinically significant findings.

Finally, the results from the current study indicated that there was a direct effect of the home food environment on BMI following a behavioral lifestyle intervention, such that a greater availability of healthy foods in the home was associated with a lower BMI at Month 6. Our findings are unique when compared with a previous study that found that no association between changes in the home food environment and body weight (Krukowski et al., 2010) While the notion that the food environment affects the consumption of certain foods has been demonstrated in children and adolescents and frequently considered in adult populations, this has never been examined within the context of a lifestyle intervention for obesity. The results from this study show that the beneficial changes made during the course of an intervention do, in fact, affect dietary intake and consequently body weight.

There are some important limitations to this study that should be addressed. First of all, only self-report measures were used. Given that the individuals who participated in the study were aware that the goals of the study were to improve their eating patterns and environment in order to promote weight loss, they could have potentially responded to questionnaires in a way that is more socially desirable. Another limitation of the study is the sensitivity of the Family Eating and Activity Habits Questionnaire. This questionnaire only asked about a limited number of foods and may therefore not have been able to detect subtle differences between individuals' home environments. In addition, the questionnaire can only give accurate data on the specific foods that the individuals are queried about rather than a complete picture of the home food

environment. Finally, there is a question of whether these results could generalize to other populations. Given the characteristics of the current sample, it is unlikely that the results shown here could generalize to men, adults under the age of 50, and individuals living in non-rural areas.

Taken together, the results from the current study indicate that the home food environment may be an important target for future weight management interventions. There have been a limited number of studies that have managed to find environmental differences between the homes of weight-loss maintainers and treatment-seeking obese individuals. One such study found individuals that have successfully lost weight and maintained this weight loss tended to have more physical activity equipment available in the home, fewer TVs, and fewer high-fat foods (Phelan et al., 2009). Results from another study showed that the home food environment could be manipulated in a beneficial way by use of a home grocery delivery service (Gorin et al., 2007). Modifying the home food environment in these ways can help provide support for weight management efforts in the long term. Considering the weight regain pattern typically seen in many long-term behavioral lifestyle interventions, such that on average participants regain one-third of lost weight within one year of treatment ending, further research into methods of supporting weight maintenance is necessary (Curioni & Lourenço, 2005, Perri & Corsica, 2002, Wadden et al., 2007, Wing, 2002). Finally, if individuals typically eat the types of foods that are available in their home, then increasing the number of healthy foods available in the home as well as decreasing the number of unhealthy foods in the home can help to improve the health of all family members living within a household.

There is considerable potential for future research related to the topic of the home food environment as it relates to dietary intake and body weight. For example, a direct observation of the home food environment could be implemented instead of a self-report questionnaire. This would allow for greater accuracy in determining the types and amounts of foods available in an individual's home food environment. Another method of improving accuracy in reporting would be to utilize a 24-hour food recall in addition to the Block 95 Food Frequency Questionnaire. Considering that this dietary recall questionnaire asks the individual about types of foods eaten as well as amounts over the past year, it is likely that an individual may be more accurate in estimating their dietary intake during a more recent time period. Additionally, future research could examine whether the home food environment, beyond being associated with body weight, is also associated with biomarkers of health (e.g., triglycerides, serum cholesterol levels).

The results from the current study answer a number of key questions. The outcomes outlined here show that the availability of various types of foods in the home is associated with an increased consumption of those foods indicating that individuals tend to eat the types of the foods that are readily available. Additionally, it is evident that a behavioral lifestyle intervention for obesity produces beneficial changes in dietary intake such that consumption of protein, saturated fat and carbohydrates all decrease following an intervention. Positive changes were also apparent in the home food environment during the course of the intervention as the results showed that the number of healthy foods in the home increased and the number of unhealthy foods decreased. Finally, a direct effect was detected between the home food environment and BMI such

that having more healthy foods in the home was associated with a lower BMI. An indirect effect was also indicated in the current study when daily intake of protein, carbohydrates, saturated fat and fiber were considered as mediators. Further analysis showed that only saturated fat was a mediator of this relationship which suggested that individuals improve their home environment (i.e., increased number of healthy foods and decreased number of unhealthy foods), which improves their dietary intake and in turn is associated with a lower BMI. Overall, the current study highlights the importance of targeting the home food environment as part of a lifestyle intervention.

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BIOGRAPHICAL SKETCH

Stacey Nicole Maurer was born in Jacksonville, Florida. She graduated from Stanton College Preparatory School in 2005. Stacey attended the University of Florida and graduated in 2009 with a bachelors degree in psychology and a minor in family, youth and community sciences. Following graduation, Stacey worked as a research assistant in the UF Weight Management Lab at the University of Florida from 2009-2010. In this capacity, Stacey co-led treatment groups promoting weight loss and increased nutrition for adults living in rural counties Rural LITE trial, a behavioral lifestyle intervention for obesity. She also assisted in screening potential participants for entrance into the study as part of the assessment team. In fall of 2010, Stacey entered the Clinical and Health Psychology doctoral program at the University of Florida in Gainesville, Florida.