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Diet and Related Behaviors of Low-income, Overweight Women in Early Postpartum

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by

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Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

May, 2009

Dedication

This dissertation is dedicated to my parents, Renuka and Vinod Sanghani for their love throughout the years and my husband, Saumil for his patience and support.

Acknowledgements

I wish to thank the members of my committee for their support, patience, and guidance during my doctoral studies.

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I am indebted to my colleagues who provided me with intellectual and emotional support during all phases of my dissertation.

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Publication No._____________

Bijal Sanghani Shah, Ph.D.
The University of Texas at Austin, 2009

Supervisor: Jeanne Freeland-Graves

The purpose of this study was to determine the influence of diet and physical activity behaviors on weight status and lipid profiles in low-income women in early postpartum. In addition, the relationship of nutrition knowledge with dietary intakes was evaluated. A convenience sample of low-income mothers was recruited from public health clinics, community centers, and doctor's offices. Inclusion criteria was Hispanic, African American, or Caucasian ethnicity; body mass index (BMI) $\geq$ 25 kg/m^2, low-income (annual household income <185% federal poverty line); parity<3 and ability to speak and write English. Demographic, dietary (24-hr recalls and 2 day food intake recalls), psychosocial, anthropometric, serum lipids (LDL, HDL and total cholesterol and triglycerides) and physical activity (pedometer steps) data were collected. For study 1, the Healthy Eating Index-2005 (HEI-2005) scores were computed as a measure of diet quality in a sample of 125 women. Analysis of Covariance and linear regression was performed to determine the relationship between HEI-2005 and serum lipids. The mean total index score of the sample was 51.4 and was associated inversely with BMI ($\beta=-0.117$), LDL ($\beta=-.659$) and total ($\beta=-.690$) and positively with HDL ($\beta=.216$) ($P<0.05$). Less than 20% of the sample failed to meet the recommendations for fruits, total vegetables, whole grains and oil and 60% had overconsumption of solid fats, alcohol and added sugars. In study 2, snacking frequency and choices of 134 postpartum women were evaluated. Influence of snacking frequency on HEI-2005 scores and disparities in snack choices by BMI categories was assessed by performing ANCOVA. A majority of the sample (82%) consumed snacks and the most favored snack group was sweets and desserts. Increase in snacking frequency was associated with higher mean total HEI-2005 scores, and total fruit, dark green vegetables and legumes, total grains, and saturated fat ($P<0.05$) component scores when adjusted for energy intakes. Snacking frequency was also associated with higher intakes of protein, vitamins A and C, and calcium ($P<0.05$). In study 3, 66 new mothers participated and completed an 8-week weight loss intervention promoting exercise by using pedometers. Paired t test revealed improvement in physical activity after intervention. Linear regression analysis determined the ability of pedometer steps to predict weight loss ($\beta=0.465$), % body fat ($\beta=-0.316$), triglycerides ($\beta=-0.549$), LDL ($\beta=-0.391$) and total cholesterol ($\beta=-0.418$). In study 4, a nutrition knowledge scale was developed and validated in new mothers. Knowledge was associated with greater consumption of grains, low fat meats and dairy ($P<0.01$), fiber ($p<0.01$), calcium ($p<0.001$), and iron ($p<0.05$). Participants appeared to be

more cognizant of information about vitamins and minerals and weight management and less of energy nutrients and calorie counting. Hierarchical regression model identified age, education, ethnicity and income as determinants of knowledge.

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Chapter 1: Review of Literature

The prevalence of overweight/obesity in the United States has reached epic proportions. The rate of obesity, as defined by body mass index (BMI) $\geq$ 30kg/m^2, is higher in women than men (35.3% vs. 33.3%). This incidence also varies disproportionately according to ethnicity. For example, the percentage of obese in Caucasians is 30.2 %, as compared to 53% in African-Americans and 51% in Mexican American women (Ogden et al 2007). In minorities, gestational weight gain (Schieve et al. 1998), postpartum weight retention (Lederman 1993), lifestyle behaviors (Okosun and Dever, 2002), and socioeconomic status (Monteiro et al 2004, Shrewsbury et al. 2009) may account for these disparities.

It is critical to study weight gain related to pregnancy and postpartum because it impacts future weight status (Rooney et al. 2005, Rooney and Schauberger 2002). In a long term study, gestational weight gain was associated with weight status at both 1 and 15 years postpartum (Linne et. al. 2006). Women in the higher gestational weight gain group (>15.6 kg) had greater weight retention (2.4$\pm$ 4.0 kg) than those in the lower (<12.0 kg) and intermediate weight gain groups (12.0 to 15.6 kg) ($p<0.001$). On average, at least 14% (Gunderson and Abrams 1999) to 60 % (Walker et al. 2005a) of the mothers exceeded their pre-pregnancy weights and gained 5 kg or more by 6-18 weeks postpartum. The loss of pregnancy-related weight is highest during the first 2-3 weeks of postpartum and then it plateaus.

Low-income strata (Drewnowski and Darmon, 2005) and increased parity (Williamson et al. 1994) further exacerbate poor weight status. Excess consumption of energy dense foods (Irala-Estevez et al. 2000) and the lack of environments that facilitate physical activity (Booth et al. 2005) in low socio-economic groups further contribute to obesity. Parity also is linked to weight gain, as shown in a study by Wolfe et al. (1997). Each live birth was associated with weight retention of 2 kg in a sample of women, aged 25-45 years. The parity-associated weight gain was higher in minorities. Identification of the determinants of postpartum weight retention may assist in the development of successful weight loss interventions for this population. Thus, factors that influence weight loss during early postpartum warrant further investigation in order to prevent future obesity.

The increasing rate of obesity is a concern because of its association with complications such as increased risk of cardiovascular disease, cancer, hypertension, sleep apnea, and diabetes mellitus (Visscher and Seidell 2001). Other detrimental effects of excess body weight in women are negative body image, lower self-esteem, and reduced overall, health-related quality of life (Hassan et al. 2003). Identification of the determinants of postpartum weight status may assist in the development of successful weight loss interventions for this population.

The dynamics of weight are influenced by a variety of genetic, environmental and psychosocial factors. The exact contribution of each of these factors on weight status is still not clear. However, it is established that excessive weight gain shows familial aggregation, i.e., the risk of obesity is higher in individuals with familial incidence of obesity than for individuals without such relationships (Park et al. 2006). This familial aggregation of obesity has provoked much interest in genetic determinants of obesity. However, the rapid increase in the prevalence of obesity cannot be attributed to only genetic factors (Hill et al. 1999) because our genes have not changed in the past 20 years. It is estimated that approximately 40 % of the variance is related to genetic factors (Bouchard et al. 1996). The remaining influences are believed to be related to the modifiable factors of environmental and psychosocial influences which are the focus of this thesis.

An environment that is associated with unhealthful patterns of food consumption and diminished physical activity (Birch et al. 1998) can promote obesity in predisposed individuals. Components of the environment such as mass media directly, or indirectly, influence the socio-cultural aspects of food and physical activity (MacLaren 1997). Additional environmental factors such as availability of food (Moore & Diez Roux, 2006), cultural influences (Provencher et al. 2005), enhanced social facilitation (Nijs et al. 2006) and lack of recreational opportunities (Mobley et. al. 2006) have been established to contribute to dietary intake.

Physical activity is the other mediator of the effects of environment on weight status. It is negatively associated with BMI (Manson et al. 1991) and levels can be improved via enhanced self-monitoring and self-efficacy (Smith et al. 2005). Self-monitoring assessed by pedometer use, augments activity levels (Clarke et al. 2007). Self-efficacy is defined as the confidence to perform the activity (Bandura 1997) and individuals with higher levels tend to be more active (Teixeira et. al. 2004, Clarke et. al.

2007). An emphasis on self-monitoring activity and its self-efficacy can be the cornerstone of an intervention to improve weight status.

Obesity is strongly related to hypertriglyceridemia, elevated total and low HDL cholesterol (Scott, 2003, Szczygielska et al., 2003). Moreover, body mass index and visceral fat deposition are positively associated with plasma levels of lipids (Rainwater et al. 1999). Furthermore, adverse lipid and lipoprotein profiles have been established as risk factors for chronic conditions related to obesity, such as cardiovascular diseases and diabetes. For example characteristics of diabetic dyslipidaemia are elevated triglyceride concentrations (≥ 150 mg/dl), decreased HDL cholesterol concentrations (<40 mg/dl for men, < 50 mg/dl for women) and the presence of small, dense LDL cholesterol particles (≥ 130 mg/dl) (Ballantyne et al. 2000, Malloy et al. 2001, Beckman et al. 2002).

Improvement in lipid profiles has shown to be beneficial to individuals with risks for diabetes and cardiovascular diseases (Beckman, et al. 2002, Goff et al. 2006). Some of the goals for management of poor lipid profiles include regular physical activity, and a 10 % reduction in body weight and ≤ 30% total fat and < 7% saturated fat in diet. Consequently, understanding the factors that may impact serum lipids will be an important component of this research.

SPECIFIC AIMS

Aim #1: To assess diet quality as measured by the Healthy Eating Index-2005 and its association with lipid profiles in low-income women in early postpartum.

Hypothesis: Low-income women will have less healthy diet quality as compared to the recommendations of the 2005 Dietary Guidelines for Americans. Participants with a lower diet quality, as measured via Healthy Eating Index 2005, will have higher body weights and adverse lipid profiles.

Rationale: The postpartum period in low income mothers is accompanied by unique barriers that may affect food choices and, thus, diet quality. The Healthy Eating Index-2005 is a well established tool that measures multiple aspects of diet and evaluates the compliance with 2005 Dietary Guidelines. It is believed that participants with a lower score on the index will have higher body weights and unfavorable lipids.

Aim #2: To assess snacking frequency in low-income women in early postpartum and its association with diet quality and selected nutrient intakes.

Hypothesis: Early postpartum women will have higher snacking frequency and unhealthful food choices. Snacking frequency will be associated with energy intakes and body weight.

Rationale: Snacking incidence and its contribution to total energy has increased considerably. Frequent snacking is associated with high energy diets and greater consumption of fruits, milk, vitamin C, and vitamin A. However, these also were associated with higher level of discretionary calories, total fat and saturated fat. The relationship of snacking frequency with diet quality in low-income women is still unclear. The purpose of this aim was to identify snacking behaviors in low-income women following child birth and determine their influence on diet quality.

Aim #3: To assess physical activity using pedometer and the association with weight loss and lipid profiles in low-income, overweight women in early postpartum.

Hypothesis: Physical activity and its self-efficacy will be enhanced by a weight loss intervention. Higher pedometer steps will be related to lower body weight status and better lipid profiles.

Rationale: A high self-efficacy for physical activity has been documented to be positively related to exercise in overweight/obese women (Teixeira et. al. 2004), and low income mothers of young children (Clarke et. al. in 2007). The enhanced activity levels are inversely associated with weight status (Warburton et. al. 2006) and adverse lipids (Albright, et al. 2006). The emphasis on physical activity and its self-efficacy will further augment the success of the weight loss interventions.

Aim #4: To identify determinants of nutrition knowledge in low-income women in early postpartum and the relationship to dietary behavior.

Hypothesis: Early postpartum women will have low levels of nutrition knowledge. Nutrition knowledge will influence household availability of foods and dietary intakes of these women.

Rationale: Nutrition knowledge is a construct of a health behavior theory that has been reported to stimulate healthful dietary habits such as avoiding fats, and foods high in energy and fats. These associations have not been examined in low-income, overweight/obese women in early postpartum. Therefore, it is essential to determine the levels of nutrition knowledge in the low-income, early postpartum women to provide a need based intervention. In addition, evaluation of determinants of knowledge can assist in identification of segments of population within low-income, postpartum women that should be targeted for education programs.

DIET QUALITY

Diet in low-income, early postpartum women

The first aim of this research is to assess diet quality as measured by the Healthy Eating Index-2005 and its association with lipid profiles in low-income women in early postpartum.

Low-income women in early postpartum may have a compromised diet due to major lifestyle changes associated with being a new parent. This period may be stressful due to demands of infant care (Hershey et al. 2001), depression, fatigue and lack of knowledge (de Castro 1997). Factors that can further exacerbate poor diet quality are unhealthy weight loss efforts (Gennaro et al.1997), poor finances (Beck 2001), lack of transportation (Woelfel et al. 2004), increased adjustments associated with employment (Devine and Olson 2000, Gjerdingen and Chaloner 1994) and other psychosocial circumstances such as stress (Albers and Williams, 2002), depressive symptoms (Beck, 2001), weight–related distress (Walker, 1998), negative body image (Baker et al. 1999) and a greater need for social support (Gill, 2001).

Consequently, the above stresses may negatively influence the selection of healthful foods in this population. George et al. (2005a) observed food choices during pregnancy and postpartum in a sample of 149 low-income women. A food frequency questionnaire was administered at 6 weeks and 6 months postpartum. From pregnancy to postpartum, daily servings of grains (7.4 vs. 6.2, $P<0.004$), vegetables (2.5 vs. 2.0, $P<0.002$), and fruit (3.4 vs. 1.7, $P<0.001$) declined, while percentage of energy from fat (37.3% vs. 38.4 %, $P<0.23$) and added sugar (14.4% vs. 16.4%, $P<0.019$) increased.

These data indicate that food choices deteriorated in postpartum. Quan and colleagues (2000) also observed lower intake of fruit (1.7 servings) and vegetable intakes (2.2 servings) in low income women. In a subsequent study, George et al. (2005b) assessed the adherence to dietary recommendations in low income women (n=146) in postpartum. Only 30% of the participants met recommendations from 2000 dietary guidelines for grains, fruits, vegetables, dairy foods, total fat and sugar. Approximately, 23% had more than 6 servings of grains, 16% consumed ≥ 3 servings of vegetables, 25% consumed ≥ 2 servings of fruit, and 20% ate ≥ 2 servings of dairy per day. Also, only 7 % had ≤ 30% energy from fat and 6% had ≤ 10% energy from saturated fat daily. These poor food choices during postpartum suggests that this is a critical period to improve dietary intake in women. As healthy eating habits are established during early postpartum, maternal health and postpartum weight retention are likely to be improved (Morin et al. 1999).

One of the most important determinants of choosing foods in low income populations is cost. Other factors include nutritional knowledge, palatability and social marketing campaigns (Glanz et al. 1998). The availability of low cost convenient foods in the community also may influence eating patterns. The frequency of eating at fast food restaurants has been positively associated with total energy intake and percent energy from fat, and inversely with daily servings of fruits, vegetables and milk (French et. al. 2001) in adolescents and weight status (Thompson et al. 2004, Bowman et al. 2004, Ma et al. 2003) in adults. The accessibility (Jeffery & Utter 2003; Drewnowski, 2004) of fast food restaurants in poor neighborhoods further influences higher intakes of energy (Paeratakul et al. 2003). This can be contributed to high calorie and saturated fat and low fiber content of fast foods, as compared to home prepared meals (Lin et al. 1999, Clemens et al. 1999).

Unhealthful food choices results in an overall poor diet quality in this population (Fowles et al. 2006). Lower diet quality has been linked to reduced immunity (Gennaro et al. 1997) and hemoglobin levels, heart disease (Millen et al. 2004), cancer (Walker et al. 2005b), mortality (Kant 2004, Diehr et al. 2003), high glycemic load (Davis et al. 2004) and age-related eye conditions (Moeller et al. 2004). Poor diet quality, due to low compliance to dietary guidelines, also may contribute to the increased incidence of obesity in the U.S. (Bhargava & Guthrie 2002, Quatromoni et al. 2006).

Association of single nutrients with lipid has been reported in past research. The influence of carbohydrate intake on lipid profiles was evaluated in postmenopausal women in a multicenter, randomized trial, the Women's Health Trial: Feasibility Study in Minority Populations (Bowen et al. 1996). The participants were divided into the intervention and control groups. The intervention group was given nutrition information for 9 months. Data on dietary intakes, anthropometric variables and biomarkers was collected at 0, 6 and 12 months. At post study, the BMI and waist-to-hip ratio was negatively and significantly associated with HDL cholesterol and triglycerides. The ratio of fiber to energy intake was positively related to HDL cholesterol and negatively to triglyceride levels ($P<0.05$) (Bhargava et al. 2006). In a similar study in healthy adults, the association between dietary carbohydrate and serum lipids was evaluated (Ma et al. 2006) via blood samples, dietary and physical activity data obtained at intervals of 3 months for 1 year. Higher total carbohydrate intake was related to lower HDL cholesterol and triglycerol levels. Thus, dietary intake was shown to be associated inversely with total and LDL cholesterol and positively with HDL cholesterol. Diets with a high glycemic load and low fiber are related to reduction in HDL cholesterol (Ford and Liu, 2001, Amano et al. 2004, Flight and Clifton, 2006) and increased fasting serum triglycerides (Amano et al. 2004). In 2005 Kant and Graubard reported that the 1995 version of HEI was a negative predictor of serum LDL concentration in the Third National Health and Nutrition Examination Survey (NHANES III). Similar results were noted in another study using NHANES III data of adult men and women; HEI scores were negatively related with total and LDL cholesterol (Weinstein et al. 2004). In addition, Hann and colleagues (2001) observed an inverse trend between HEI score category and total cholesterol in adult women (n=340) recruited from a breast care center. However, the relationship of overall diet quality with serum lipids in low-income women in either early or late postpartum is still not documented.

Measures of diet quality

Diet quality can be measured using several instruments (Kant 1996). The specific instruments that have been widely used and validated and tested in multiple samples of adults, include the Recommended Foods Score (Kant et al. 2000), Diet Quality Index (Drewnowski et al. 1997), Diet Quality Index-Revised (Haines et al. 1999), Mediterranean Diet Score (Trichopoulou et al. 1995), Alternate Healthy Eating Index (McCullough et al. 2002), Dietary Guidelines Adherence Index (Fogli-Cawley et al. 2006), and Healthy Eating Index (Guenther et al. 2008). Many other indices are for specific populations such as adolescents or children or are a modification of the above mentioned indices.

The Recommended Foods Score (Kant et al. 2000) measures fruits, vegetables, whole grains, lean meats or meat alternates, and low-fat dairy products. This instrument is a 62-item food frequency questionnaire that includes 23 recommended foods such as tomatoes, apples, and cantaloupe. Participants receive 1 point for weekly consumption of each recommended food, independent of the reported amounts, for a maximum score of 23. This index has shown to be associated with mortality in women (Kant et al. 2000), biomarkers of diet and disease, (such as vitamin C, E, folate, carotenoids and serum homocysteine (Kant and Graubard, 2005)) and risk of cardiovascular disease (McCullough et al. 2002). Yet, the index does not address intake of fat, cholesterol and sodium or consider all the foods in a particular food group. For example, for fruits category the recommended fruits include apples or pears, oranges, cantaloupe, grapefruit, orange or grapefruit juice and other juices. Only the consumption of these selected foods is considered in the computation of the score.

The Diet Quality Index is a 5-point index that evaluates the compliance to five nutrient recommendations of the 2000 Dietary Guidelines (Drewnowski et al. 1997). These include: $\leq$ 30% energy from total fat, $\leq$ 10% from saturated fat, and $\geq$ 50% from carbohydrate, and $\leq$ 300 mg cholesterol and $\leq$ 2,400 mg sodium. Higher scores on index were shown to be related to lower weight gain at 8 year follow-up (Quatromoni et al. 2006). One limitation is that this scale does not measure the compliance to other components of Dietary Guidelines.

The Diet Quality Index-Revised is a complex instrument that measures the overall quality of diet (Haines et al. 1999). It evaluates food and nutrient indicators of diet quality, as well as diet diversity and moderation. This scale has ten components; grains, vegetables, fruit, total fat, saturated fat, cholesterol, iron, calcium, diet diversity, and moderation in added fat and sugar. Possible scores for each component range from 0-10, depending on the level of intake. The maximum possible score for the index is 100. The index was related positively with biomarkers of diet (such as alpha-carotene, beta-carotene, lutein, and alpha-tocopherol) and inversely with cholesterol (Newby et al. 2003). The limitation of this index is that it does not measure compliance to all diet related recommendations of the Dietary Guidelines for Americans for example meat and beans, whole grains and oil.

The Mediterranean Diet Score has eight components (grains, vegetables, fruits and nuts, milk and dairy products, meat and meat products, legumes, alcohol and ratio of mono-saturated to saturated fats) that evaluates the adherence to traditional Mediterranean diet (Trichopoulou et al. 1995). The score for each component ranges between 0 and 1 to give a maximum possible score of 8. This index was revised 2003 (Trichopoulou et al. 2003) and a component for fish was added. The limitation of this index is that it does measure adherence to the 2005 Dietary Guidelines for Americans.

The Alternate Healthy Eating Index (McCullough et al. 2002) has nine components that correspond to dietary patterns associated with lower risk of chronic diseases. The components include vegetables, fruits, nuts, ratio of white to red meat, cereal fiber, *trans* fat, ratio of polyunsaturated to saturated fats, alcohol and duration of multi vitamin use. The first eight components are scored between 0-10. A score of 0 represents least healthy dietary behavior and an increasing score indicates healthier behaviors. The last component contributes 2.5 points (for nonuse) or 7.5 points (for use) for multivitamins and maximum possible score is 87.5. The index has shown to be associated with cardiovascular disease risk in adults (McCullough et al. 2006), risk of breast cancer (Fung et al. 2006) and markers of inflammation (Fung et al. 2005). Limitations are that this index is not completely based on dietary guidelines and it does not measure cholesterol and sodium.

The Dietary Guidelines Adherence Index is a recently developed 20 item index that measures the compliance of dietary intake to the 2005 Dietary Guidelines recommendations (Fogli-Cawley et al. 2006). The first 11 items evaluate the intake of food groups, i.e. grains, five vegetable subgroups, fruits, meat and legumes, milk and milk products, discretionary energy and variety in fruits and vegetables. The remaining items measure the adherence to nutrient-based recommendations: % of whole grains, fiber intake, cholesterol, total fat, saturated fat, *trans* fat, % of lean meat, % of low fat dairy, sodium and alcohol intake. The total possible score on the scale is 20; each item scored in the range of 0-1, and 0.5 score for partial adherence. The participants with highest scores were more likely to be women, older, multivitamin users and had lower BMI. A limitation of this index was that it is based on food frequency questionnaire.

The Healthy Eating Index (Kennedy et. 1995) measures compliance to both food and nutrient recommendations included in the 2005 Dietary Guidelines for Americans (USDA 2005). This recently revised index (Guenther et al. 2006) is based on the recommendations found in MyPyramid (Britten et al. 2006) and consists of 12 components (Table 1.1). The first nine components evaluate the intake of food groups i.e. total fruits (includes 100% juice), whole fruit (not juice), total vegetables, dark green orange vegetables and legumes, total grains, whole grains, milk, meat and beans, and oils. The index also measures the adherence to guidelines for saturated fat and sodium and the calories from solid fat, alcohol and added sugar. Individuals received a maximum score of ten for meeting the recommendations for milk, meat, oil and selected nutrients (sodium and saturated fat); a score of five for fruits, vegetables and grain groups; and 20 points for calorie-based recommendations for a total score of 100. The associations of HEI-2005 with physiological variables have not been evaluated yet. However, the older version based on Dietary Guidelines 2000 (Kennedy 1995), has been shown to predict serum concentrations of vitamins C and E, folate, and carotenoids (Weinstein et al. 2004, Hann et al. 2001). The Healthy Eating Index also has been associated with obesity in populations in US adults (Guo et al. 2004, Kant and Graubard 2005) and Spanish men and women (Schroder et al. 2006). Higher scores on the index in these studies were related to lower BMI. The inability to penalize for overconsumption is a constraint of this index. This research will utilize the Healthy Eating Index-2005 to measure diet quality in terms of adherence to the 2005 Dietary Guidelines.

Table 1.1. Components of the Healthy Eating Index-2005[a]

Component	Standard for minimum score	Standard for maximum score[b]	Maximum score
Fruits			
Total	No total fruits	> 0.8 c	5
Whole	No whole fruits	> 0.4 c	5
Vegetables			
Total	No total vegetables	> 0.2 c	5
Dark Green, Orange Vegetables and Legumes	No dark green orange vegetables and legumes	> 0.1 c	5
Grains			
Total	No total grains	> 3.0 oz	5
Whole	No whole grains	> 1.5 oz	5
Milk	No milk	> 1.3 cup	10
Meat and Beans	No meats and beans	> 2.5 oz	10

Oils	No oil	> 12 gms	10
Saturated Fat	> 15% of total energy	< 7 % of energy	10
Sodium	> 2.0 grams per 1,000 kcal	< 0.7 gms	10
Solid Fats Alcohol Added Sugars	> 50% of total energy	< 20% of energy	20
Total Score			100

[a]Guenther et al. 2007 [b]Recommendations are based per 1000 kcalorie.

SNACKING FREQUENCY

The second aim was to assess snacking frequency in low-income women in early postpartum and its association with diet quality and selected nutrient intakes.

The influence of snacking in the development and maintenance of obesity is suggested by epidemiological studies. In the last decade the number of snacks in an individual's diet has considerably increased, and that of main meals has declined. Specifically, the percentage of population consuming three or more snacks daily has increased by fourfold (Cleveland et al. 2005). Snacks now account for a substantially larger percent of total daily energy intake (Nielsen et al. 2002). The main social factors that might be promoting this shift in meal patterns have been suggested to be urbanization, industrialization and convenience provided by food industry.

One limitation of studies on meal frequency is the ambiguous definitions for meals and snacks. This lack of consistency in definitions makes comparisons between studies hard to interpret. Some studies use physiological definitions of time periods (Drummond et al. 1998, Summerbell et al. 1995), energy levels (Longnecker et al. 1997) or nutrient composition such as fat (Lennernas et al. 1993, Johansson et al. 1992) to distinguish between meals and snacks. These differentiations do not necessarily coincide with cultural or individual perceptions. Chamontin and colleagues (2003) observed that the term 'snack' constituted different definitions between graduate students. Intake occasions also may be predefined and 'force' the respondent into certain patterns

(Summerbell et al. 1995) or be self-defined by the respondent (Roos et al. 1997, Booth et al. 1999).

Due to this problem in the categorization of meals, the influence of meal frequency and snacking on weight status is not well established. Studies have demonstrated an inverse relationship between number of eating occasions and obesity (Kant et al. 1995, Drummond et al. 1998, Berteus Forslund et al. 2005); however, others have found no relationship (Dreon et al. 1988, Edelstein et al. 1992, Hampl et al 2003). Kant and colleagues (1995) examined the association of eating frequency with BMI in adults from NHANES I (1971-75) data set. Frequency of eating occasions was inversely related to BMI in both men and women. Drummond and colleagues (1998) investigated the relationship of eating frequency with body weight status in adult men and women. A significant negative correlation was observed between eating frequency and body weight in men, but not in women. Moreover, in a cross-sectional study obese adults were reported to be more frequent snackers as compared to their normal weight counterparts (Berteus Forslund et al. 2005). In contrast, Dreon and colleagues (1988) failed to observe a significant relationship between meal frequency and % body fat, total weight, or fat free mass in sedentary obese men. Parallel results were found between meal frequency and BMI in adults that joined the Lipid Research Clinics Prevalence Study in California (Edelstein et al. 1992). Similarly, BMI did not differ by snacker categories in adults that participated in 1994-1996 Continuing Survey of Food Intakes by Individuals (CSFII) (Hampl et al. 2003) determined the association of meal frequency. Similarly, a higher frequency of snacking was associated with greater energy intakes in some studies (Titan et al. 2001, Berteus Forsuland et al. 2002), while no significant relationship was reported by others (Drummond et al. 1998, Ruidavets et al. 2002).

Thus, the relationship of snacking with diet quality is unclear. Sebastian and colleagues (2008) determined the impact of snacking on dietary intake of adolescents participating in the National Health and Nutrition Examination Survey, 2001-2004. Snacking frequency was associated positively with energy, carbohydrate, total sugars and vitamin C, and negatively with protein and fat intakes. As consumption of fruits was elevated and solid fat was reduced, the number of snacks increased. Moreover, participants with a higher frequency of snacks were more likely to meet the Dietary Guidelines recommendations for fruits, milk and oil. In the 1994-1996 Continuing Survey of Food Intakes by Individuals (CSFII) (Hampl et al. 2003), dietary intake stratified by snacking patterns was reported in adults. After controlling for energy intake, participants that snacked frequently had lower intakes of protein, cholesterol, calcium and sodium. In contrast, in a sample of obese French women (N=273), total daily energy intake was higher in snackers than in non-snackers (Basdevant et al. 1993). However, the influence of snacking on overall diet quality in low-income women has not yet been investigated.

PHYSICAL ACTIVITY

The third aim is to assess physical activity using pedometer and the association with weight loss and lipid profiles in low-income, overweight women in early postpartum.

Physical activity is another significant factor that may influence weight status and lipid profiles of this low-income, early postpartum population. It is well known that exercise positively influences body weight and decreases the risk of developing obesity (Warburton et. al. 2006), osteoporosis and cardiovascular disease (Dunn et al. 1999, Hardman, 1999). However, nearly 44% of the American adults do not engage in regular leisure-time activity (CDC 2005). Levels of physical activity differ with age, socioeconomic status and ethnicity (Bauman 2002), with lower rates in women with young children, older adults, and low socioeconomic populations (Brown et al. 2000, Verhoef et al. 1992). In terms of ethnicity, only 31.8% of White, 19.6% of African American and 21.8% of Hispanic women are considered to be physically active (Adams 2006). In addition, activity levels in postpartum women are lower than inactive adults and fail to meet the national recommendations of moderate and high intensity activity (Wilkinson et al. 2004). Studies have shown that women with children have higher inactivity levels than women without children (Scharff et al. 1999, Marcus et al. 1994, Verhoef et al. 1994). Therefore, exploration of the factors that influence activity levels will help in developing successful physical activity interventions for this population.

Leisure time physical activity levels in minority populations are low (Brown et al. 2000). It has been documented that a lifestyle approach that includes leisure-time physical activity is critical for preventing obesity in populations that do not engage in vigorous activities (Mannerkorpi & Hernelid 2005, Pate 1995). Leisure-time activity is defined as the exercise performed during leisure time for at least 20 minutes that will increase heart rate and breathing substantially (Sallis et al. 1989). Examples are jogging, brisk walking, climbing stairs, doing house and yard work. These leisure activities have positive health effects across different age groups and ethnicities (Crespo et al. 1996), as they are related to hypertension (Niu et al. 2005), (Pischon et al. 2003), insulin levels (Borodulin et al. 2006), HDL cholesterol (Verdeat et. al. 2004) and obesity (Suadicani et al. 2005, Verdeat et. al. 2004).

Opportunities to perform recreational activities also strongly influence the level of physical activity of individuals. Urbanization in recent years has resulted in neighborhoods that are not conducive for walking or other outdoor activities and have led to a trend of reduced activity in the home and work and, thus, overall decline of leisure time physical activity (Brownson et al. 2005). Poorer neighborhoods are especially less likely to have recreational facilities (Ainsworth et al. 2003), and have higher crime rates (Eyler et al. 2003) that may discourage exercising as compared to more affluent areas. Also, the availability of environment conducive to perform physical activity is higher for men than women (Brownson et al. 2001). Other barriers to perform physical activity that are more prevalent in minorities are societal influences, expectations, attitudes, lack of transportation and low socio-economic strata (Dergance et al. 2003).

Physical activity levels can be augmented by self-monitoring. In the present study self-monitoring will be encouraged by use of pedometers. Clarke et al. 2007 observed the positive influence of pedometers as a tool to increase activity levels. Low income, overweight/obese mothers (n=93) with children 1 to 4 yrs old were enrolled in an 8 week weight loss intervention. When physical activity was measured via pedometers at pre and post study, pedometer steps ($P<0.05$) and energy expenditure ($P<0.001$) increased by the end of intervention. Similarly, an intervention conducted on 85 adolescents tested the influence of pedometer use in increasing physical activity (Schofield et al. 2005). After a 12-wk physical activity self-monitoring and educative program, subjects increased their total activity (10,992 $\pm$ 7878), as measured by a 4-day step count ($P<0.05$). A study by Tudor-Locke et al. (2002) assessed the role of pedometers in promoting activity in nine diabetic patients participating in a First Step Program. The 8 week physical activity intervention consisted of an adoption and adherence phase that increased the walking time of nine participants by 34 minutes/day. These elevated activity levels remained constant at 2 months post-intervention. In a similar study, Stovitz et al. (2005) utilized pedometers to increase ambulatory activity in 94 patients from a family clinic. At 9 weeks, the average individual improvement was 41% and the frequency of walking short trips also increased significantly. To date, there have been no published interventions that have used pedometers to promote physical activity in women in early postpartum.

Self-efficacy also has been documented to have a strong association with physical activity (Teixeira et. al. 2004), since it influences the direction, intensity and the persistence of a behavior (Bandura 1997, 1989). Therefore, individuals with a higher self-efficacy will perceive fewer barriers to perform a behavior (Rothman et al. 2004).

Smith et al. (2005) documented that efficacy was positively related to activity levels in a survey on 226 postpartum women with recent gestational diabetes. Physical activity was measured via a self-administered activity recall questionnaire and participants were divided into vigorously active and sedentary groups. A multiple logistic regression analysis showed that active participants had higher self-efficacy (odds ratio=2.09 (CI-1.06-3.20)) than the sedentary subjects. Sharma et al. (2005) conducted a community based study with a sample of African-American women. Self-efficacy was tested by a self-efficacy questionnaire and leisure-time physical activity was measured via a self-reported 7-day recall administered at one occasion. In this population self-efficacy was a significant predictor of leisure time physical activity ($R^2 = 0.258$, $P \leq 0.01$). Similar results were observed in an intervention based on exercise efficacy with mothers of preschoolers (Miller et al. 2002a). The participants were divided into three groups: controls, intervention or efficacy. The intervention mothers received information on prevailing physical activity barriers and partner support, while those in the efficacy group also attended sessions to increase their self-efficacy. Participants in the efficacy group were more likely to meet physical activity guidelines predicted by self-efficacy (odds ratio=1.40, CI=0.76-2.36). Clarke et al. (2007) found similar results in a sample of 93 low income women at 1 year post-partum after an 8 week dietary and physical intervention was conducted to evaluate activity and self-efficacy levels. Physical activity levels, as measured by pedometers, increased post intervention (5969 ± 3123, 9757 ± 3843, P<0.001). Significant correlations were observed between self-efficacy and pedometer steps (r = 0.30, P<0.01) and pedometer calories (r=0.28, P<0.05). Thus, self-efficacy levels assisted in promoting physical activity in the participants. This proposal will investigate relationships between physical activity and its self-efficacy and evaluate their effects on successful weight loss in low-income women.

Sedentary lifestyles may also explain the development of abnormal lipid profiles early in postpartum (Bhargava et al. 2002, Barnett et al. 2004). Studies have compared the effects of physical activity on lipid levels and documented an inverse relationship (Haddock et al. 1998, DeSouza et al. 1998). The effects have been absent in both vigorously (Thune et al. 1998) and moderately active individuals (Sunami et al. 1999). Mora et al. (2006) conducted a cross-sectional study on middle aged women (n = 27, 158) to assess the association of physical activity and cardiovascular markers. The lipid profiles of the participants improved with higher activity, indicating linear relationship between physical activity and cardiovascular biomarkers was found independent of BMI. Participants in the highest quintiles of activity had lower LDL cholesterol (P<0.01) and total cholesterol (P<0.05), and higher HDL cholesterol (P<0.001) than the participants in the lowest quintile. Similar results were observed in the Fels Longitudinal Study (Schubert et al. 2006) in which serial longitudinal data was collected from 269 healthy white adults (126 men and 143 women) over the span of 20 years (between age 40 and 60). Active men were shown to have lower total and LDL cholesterol levels and women had higher HDL cholesterol as compared to their sedentary counterparts (P<0.05).

NUTRITION KNOWLEDGE

The last aim is to identify determinants of nutrition knowledge in low-income women in early postpartum and the relationship to dietary behavior.

Knowledge is an important factor that drives behavior; and might be one of the key factors that improve diet. Sharma and colleagues (2008) determined the association of nutrition knowledge with eating behaviors of Mexican American population on the Texas-Mexico border. Knowledge of the Food Guide Pyramid was measured by asking participants minimum number of recommended servings of various food groups such as grains, meats, beans, fruits, and vegetables. Knowledge was a significant predictor of intakes of grains (OR=6.42; 95% CI: 2.4, 17.1), dairy (OR=2.25; 95% CI: 1.5, 3.4), meats (OR=2.02; 95% CI: 1.5, 2.8), and beans (OR=8.18; 95% CI: 5.1, 13.0), but not for fruits and (nonstarchy) vegetables (OR =1.69; 95% CI: 0.89, 3.2).

In contrast, improvement in knowledge was a significant predictor of change in fruit and vegetable intake across 16 WIC sites participating in 5-A-Day Promotion Program (Langenberg et al. 2000). A nutrition knowledge scale comprised of nutrient content, recommended changes in consumption, and practical nutritional knowledge components was used to measure relationships with fruit intake in mothers of 9-11 year old children (N=92) (Gibson et al. 1998). Total scale scores were related positively with fruit consumption in the sample. Fitzgerald and colleagues (2008), also examined the associations of knowledge, food label use, and food intake patterns among Latinos. A 25-item dichotomous knowledge scale quizzed participants about fiber, recommended servings for Food Guide Pyramid food groups, sources of fats and carbohydrates and influence of nutrients on health. Participants with higher knowledge were more than twice as likely to use food labels to select healthful foods. Moreover, women with low knowledge compared to those with higher scores consumed meats (57.6% vs. 42.5%), fruits and vegetables (58.7% vs. 42.1%) more frequently and salty snacks (41.1% vs. 56.5%) less frequently, respectively. These results are supported by a cross-sectional study in White adults (Wardle et al. 2000). A 110-item previously developed and validated scale (Parmenter and Wardle 1999) assessed guidelines for food groups, nutrient content of foods, links between diet and disease and healthful food choices. Knowledge was significantly associated with healthy eating behavior after controlling for demographic variables; especially fruit (r=0.23), vegetables (r=0.36) and fat (r=-0.21) ($p<0.001$). Moreover, participants in the highest quintile for knowledge scores were 25 times more likely to meet recommendations for fruit, vegetable and fat intakes than those in the lowest.

Differences in nutrition knowledge are influenced by ethnicity. Higher scores were observed in Whites, as compared to other ethnicities (Sapp and Jensen 1997, Sherman et al. 1995, Winkleby et al. 1994). Similarly, higher income (Harnack et al. 1998, Morton and Guthrie 1997, Parmenter et al. 2000) and education (Boulanger et al. 2002, Parmenter et al. 2000, Sapp and Jensen 1997) was associated with better knowledge. Greater knowledge also has been documented in English-speaking (Boulanger et al. 2002), and breastfeeding (Dubois and Girard 2003, Nuss et al. 2007) participants, even after controlling for education levels. Thus, the determinants of nutrition knowledge in low-income women in early postpartum will be identified.

SUMMARY

The purpose of this research was to assess diet quality and physical activity levels of low-income women during early postpartum. The influence of these factors on markers of health such as weight status, % body fat, and serum lipids also was evaluated. Influence of snacking frequency on diet quality of this population was measured. In addition ability of weight loss intervention to augment physical activity using pedometers as a motivational tool was tested. Levels of nutrition knowledge and its impact on dietary intakes along with household availability of foods also were examined.

The following chapters will present data on the diet quality (study 1, chapter 2), snacking behavior (study 2, chapter 3), physical activity levels (study 3, chapter4) and nutrition knowledge (study 4, chapter 5). For study 1, diet quality was measured via computing a HEI-2005 score in low-income, overweight/obese mothers (N=125). The ability of the HEI-2005 scores to predict serum lipids was assessed. For study 2, snacking frequency and HEI-2005 scores were evaluated in low-income mothers (N=134). Snack choices of this population were also evaluated. Study 3 comprised of low-income, early postpartum women (N=66) participating in an 8-week weight loss intervention. Pedometer steps, anthropometrics were measured before and after intervention and influence of physical activity on weight loss and lipids were assessed. Finally, for study 4 nutrition knowledge was evaluated in early postpartum women (N=). A nutrition knowledge scale was administered and reliability and validity was assessed. Relationship of knowledge scores with household availability of foods and food groups and nutrient intakes also were assessed.

Chapter 2: Diet Quality as Measured by the Healthy Eating Index-2005 and its Association with Lipid Profiles in Low-Income Women in Early Postpartum

ABSTRACT

Objective: To evaluate the diet quality of women in early postpartum using the HEI-2005 and to examine the relationship of index scores with serum lipids and anthropometrics.

Study Design: A convenience sample of 125 multiethnic, women in early postpartum was recruited from local community centers, public health clinics and physician's offices. Dietary intake was measured via the average of a 24-hour recall and 2 day food intake records. The HEI-2005 scores were computed to assess diet quality and were compared to anthropometrics and serum lipids.

Subjects: Hispanic, African-American and Caucasian women in 1-4 months postpartum were recruited. Additional eligibility criteria were body mass index $\geq$ 25 kg/m^2, annual household income $\leq$ 185% federal poverty level, parity<3, ability to communicate in English, and absence of pregnancy or any chronic diseases.

Statistical Analysis Performed: Means and frequencies were computed for descriptive statistics. Analysis of variance was utilized to examine the disparity in HEI-2005 scores across demographics. Analysis of covariance was performed to determine the differences in anthropometrics and serum lipids. Multiple linear regression analysis identified the ability of HEI-2005 scores to predict weight status and lipid profiles.

Results: This sample had low mean scores in fruits, total vegetables, whole grains, and oil components. Conversely, subjects consumed more than recommended amounts of sodium, saturated fats and discretionary calories. The HEI-2005 scores inversely predicted BMI, LDL and total cholesterol, and positively, HDL.

Conclusions: Low-income women in early postpartum exhibited poor diet quality, as indicated by low total index scores. Further studies are warranted to identify appropriate dietary modifications in this population and to confirm the association of diet quality, as assessed by this HEI-2005 index, with lipids and other markers of health.

INTRODUCTION

Postpartum is a time of psychosocial and biological transitions that may affect dietary behavior and the future health of the mother. Consumption of unhealthful diets during this critical period may occur due to demands of infant care (Hershey, et al. 2001), greater need for social support (Gill 2001), depression (Beck 2001), fatigue (De Castro 1997), and weight–related distress (Baker, et al. 1999,George, et al. 2005). Low-income populations may be particularly vulnerable to dietary risks because of the additional challenges of poor finances (Beck 2001), lack of transportation (Woelfel, et al. 2004), and the perceived high cost of food (Hargreaves, et al. 2002). However, evaluation of diet quality in low-income postpartum women is limited (Fowles, et al. 2006,George, et al. 2005).

Diet quality, measured as adherence to the Dietary Guidelines, has been linked to reduced occurrence of diabetes (Fung, et al. 2007) and cardiovascular diseases (CVD)

(McCullough, et al. 2002). These conditions are highly prevalent in minorities (Abate, et al. 2003,Cowie, et al. 2008,Swenson, et al. 2002) and economically disadvantaged groups (Wamala, et al. 1997). Furthermore, dyslipidemia has been associated with the morbidity and mortality related to both CVD and diabetes (Beckman, et al. 2002,Goff, et al. 2006). Minorities are at additional risk, due to higher prevalence of dyslipidemia (Goff, et al. 2006), and lower treatment and control of this disease (Goff, et al. 2006,Hyre, et al. 2007,Kirk, et al. 2005). Although the association of abnormal lipid profiles with individual nutrients (Flight, et al. 2006,Ma, et al. 2006,Royo-Bordonada, et al. 2006,Ruixing, et al. 2008) and food groups (Kant 2004,Ruidavets, et al. 2007) has been well established, the relationship between diet quality and lipids in low-income women remains undocumented.

The Healthy Eating Index-2005 (HEI-2005) (Guenther, et al. 2008,Guenther, et al. 2008) is a composite tool that captures the multi-dimensionality of dietary behavior. It assesses the degree to which individuals adhere to recommendations of the 2005 Dietary Guidelines for Americans (U.S. Department of Health and Human Services and U.S. Department of Agriculture) and MyPyramid (Britten, et al. 2006). The HEI-2005 is a departure from previous versions of the HEI in that it uses a density-based approach, with the standards expressed per 1,000 calories or percentage of total calories. Previous versions of the HEI have been inversely related to the prevalence of obesity (Guo, et al. 2004,Kant, et al. 2005,Schroder, et al. 2006) and lipid levels (Hann, et al. 2001,Kant, et al. 2005,Weinstein, et al. 2004); however, these findings have yet to be confirmed using the 2005 edition.

The goal of this research is to evaluate diet quality in terms of adherence to the 2005 Dietary Guidelines among low-income women in early postpartum via the HEI-2005 (Guenther, et al. 2008). The index scores also will be compared to markers of health such as weight status and serum lipids.

METHODS

Study Design and Subjects

Diet quality and its association to weight status and lipid profile were estimated in 125 low-income, overweight/obese (BMI>25 kg/m^2) women at 0-4 months postpartum. Participants were recruited through flyers posted at physician's offices, Women, Infants and Children (WIC) clinics, and community centers, and then screened over the telephone. Eligibility criteria were: African-American, Caucasian, or Hispanic ethnicity; age of 18-40 years; parity < 3; ability to speak, read and write English; annual household income <185% federal poverty level; absence of pregnancy, chronic diseases or involvement in weight loss activities. A trained interviewer administered a 5-Step Multiple Pass 24-hr recall (Conway, et al. 2003) which includes 1) the quick list, 2) the forgotten food list, 3) a time and occasion at which foods were consumed, 4) the detail description and 5) review. Participants also were instructed to complete 2 day food records (one weekend and one weekday). Additionally, self-reported individual demographic data were elicited. Anthropometrics were obtained including height, weight, body fat % and waist circumference. Blood samples were collected after 8 hours of fasting and triglycerides, and total, high density lipoproteins (HDL) and low density lipoproteins (LDL) cholesterol were measured. The study protocols were approved by the Institutional Review Board of The University of Texas at Austin.

Dietary Intake

Dietary intake data were analyzed using Food Processor SQL 9.6.2 (ESHA Research, Salem, OR) and subjects were excluded if the 3-day average of energy intake was >4500 or <500 calories (George, et al. 2005,Patterson, et al. 2003,Yanek, et al. 2001). Foods were assigned to respective groups designated by the HEI-2005 (Guenther, et al. 2007) and MyPyramid (Britten, et al. 2006). Mixed foods were broken into their component ingredients and then assigned to the appropriate HEI-2005 category. For example, "beef taco" was listed as tortilla, beef, fat and vegetables and assigned to grain, meat and beans, saturated fat, and vegetables categories, respectively. Legumes were first calculated in meat and beans until the recommendation was met according to the HEI-2005; the remaining servings were counted towards the dark green and orange vegetables and legumes category (Guenther, et al. 2007).

Demographics

A 54-item sociodemographic questionnaire (Clarke, et al. 2007) was self-administered to collect information on age, ethnicity, income, education, employment, marital status, method of infant feeding, and self-reported weight at delivery.

The Healthy Eating Index

Diet quality was computed using the HEI-2005 (Guenther, et al. 2008,Guenther, et al. 2007). This index contains 12 components (Table 2.1) that are adjusted for energy density (per 1000 calories) or percent total energy, with a maximum possible total score of 100. The first six components - total fruit; whole fruit; total vegetable; dark green, orange vegetable and legume; total grain; and whole grain are awarded 0-5 points. Next five components – milk; meat and beans; oil; saturated fat; and sodium are worth 0-10 points and the last component of solid fat, alcohol and added sugar is allocated 0-20 points. Scores were calculated proportionally, except for saturated fats and sodium. For these components scores were prorated linearly between 0 to 8 points and 8 to 10 points (8 and 10 points represented acceptable and optimal levels, respectively) (Guenther, et al. 2007).

Anthropometrics

Height was measured without shoes via a stadiometer (Medico Resources, Columbus, OH) to the nearest 0.1 cm. Weight and body fat % were analyzed with a body composition analyzer (Model TBF-300A, Tanita Corporation, Arlington Heights, IL), with graduations of 0.2 lbs. Waist circumferences were measured, according to NHANES III protocol (1998). BMI was calculated as weight (kilograms)/height (meters)^2 and subjects were classified by BMI as overweight (25 to 29.9 kg/m^2), obese

(30 to 39.9 kg/m^2) or morbidly obese (>40 kg/m^2). Postpartum weight loss was computed as difference between self-reported weight shortly before delivery and weight at the visit.

Blood Analysis

Fasting venous blood samples were collected into tubes with clot-activator syringes (VWR, Inc. Bridgeport. NJ). Samples were stored at room temperature for 30 minutes and then separated by centrifugation at 2000 x g (gravity) for 10 minutes. Serum samples of lipids were analyzed within 12 hours by a commercial laboratory (Clinical Pathology Laboratories, Inc. Austin, TX).

Statistical Analysis

Version 15.0 of SPSS (2006, Chicago, IL) was used for analysis; $P<0.05$ was considered statistically significant. A descriptive score was calculated for HEI-2005, anthropometrics and lipids. The HEI-2005 scores were treated as continuous data, and, also divided into tertiles.

One-way analysis of covariance was utilized to examine the associations between HEI-2005 score tertiles and demographic variables. Analysis of covariance was used to compare the anthropometrics and lipid profiles across HEI-2005 score tertiles. Linear regression, with HEI-2005 score as the continuous independent variable computed *P* for trend to determine association of index scores with dependent variables (body fat %, waist circumference, and lipid profiles). Energy intake and BMI were selected as covariates for analyses since they significantly affected other dependent variables.

Models with HDL and triglycerides were further controlled for lactation status because these variables were significantly different between lactating and formula feeding women.

RESULTS AND DISCUSSION

A sample of 125 multiethnic women (63.6% Hispanic, 25.0% Caucasian and 11.4% African American) participated in the study (Table 2.1). Subjects were 38% overweight, 50% obese and 11.4% morbidly obese. The participants had an average age of 26 years, less than 50% graduated from high school and 76% had annual household incomes under $30,000. More than 60% were not employed, 81% lived with partner, 46% were breastfeeding and 80% received WIC benefits.

The total and component HEI-2005 scores, according to demographics and methods of infant feeding are presented in Table 2.1. The mean total HEI-score was approximately one-half of the total possible score. Moreover, the mean component scores were less than 60% of the maximum possible score for all groups, except for total grains, milk and meat and beans. These scores indicate that the diet of new mothers is lacking in fruits, vegetables, whole grains, and is abundant in saturated fats and discretionary calories. Low intake of fruits and vegetables (Dubowitz, et al. 2008) and high of fats (Siega-Riz, et al. 2001) have been previously reported in low-income women. The excessive consumption of fats in low-income populations may be related to lower cost of high fat foods (Hargreaves, et al. 2002), as compared to healthful foods such as fruits and vegetables (Darmon, et al. 2005), and a greater preference for foods with more fats and sugar (Drewnowski, et al. 2003). Intake of grains (George, et al. 2005) and meat and beans (George, et al. 2005) noted here parallels that reported for WIC eligible women by George et al (George, et al. 2005,George, et al. 2005).

Table 2.1 Total and component HEI-2005 scores by demographic variables in low-income postpartum women

HEI components	N	Total	Total Fruits	Whole Fruits	Total Vegetables	DGOVL[a]	Total Grains	Whole Grains	Milk	Meat	Oil	Sodium	Saturated Fats	SoFAAS[b]
		← *Mean ± Standard Error of Mean*[c] →												
Overall	125	51.4±0.9[d]	1.7±0.1	2.0±0.1	1.9±0.1	2.9±0.1	4.0±0.1	1.3±0.1	6.9±0.2	8.8±0.1	2.3±0.1	5.1±0.2	5.9±0.3	7.5±0.5
Ethnicity														
White[e]	30	51.5±1.9	1.8±0.2	2.1±0.3	1.5±0.3	2.6±0.3	4.1±0.1	1.2±0.2	7.8±0.4[y]	8.3±0.3	2.1±0.4	5.3±0.5	5.5±0.6	7.6±1.0
African American	15	46.9±3.1[x]	1.4±0.4	1.0±0.5	2.5±0.5	2.6±0.5	3.7±0.3	0.7±0.4	7.0±0.7[x]	8.6±0.5	2.0±0.6	5.1±0.9	6.0±1.0	5.3±1.7
Hispanic	80	52.2±1.2[x]	1.7±0.1	2.1±0.2	2.0±0.1	3.0±0.2	4.0±0.1	1.5±0.1	6.5±0.3[x,y]	9.1±0.1	2.4±0.2	5.1±0.3	6.0±0.3	7.6±0.6
Age(y)														
18-24	44	52.1±1.6	1.9±0.2	2.2±0.2[x]	1.5±0.2[x]	2.5±0.2[x]	3.5±0.1[x,y]	1.1±0.2	6.0±0.3[x,y]	8.9±0.2[y]	2.3±0.3	5.6±0.4	6.5±0.5	8.5±0.9
2 4-30	44	50±1.6	1.5±0.2	1.5±0.2[x,y]	1.6±0.2[y]	2.8±0.2[y]	4.2±0.1[x]	1.4±0.2	7.5±0.3[x]	8.4±0.2[x]	2.4±0.3	4.7±0.4	5.4±0.5	7.3±0.9
30-40	37	53.4±1.9	1.9±0.2	2.4±0.3[y]	2.6±0.3[x,y]	3.7±0.3[x,y]	4.3±0.1[y]	1.6±0.2	7.7±0.4[y]	9.5±0.2[x,y]	2.2±0.4	4.9±0.5	5.4±0.6	6.1±1.0
Education														
Partial High School	29	51.0±2.0	1.9±0.3	1.9±0.3	1.6±0.3	2.0±0.3	3.7±0.2	1.3±0.2	6.8±0.5	8.6±0.3	1.9±0.4	5.7±0.5	6.0±0.6	8.6±1.1
High School Graduate	31	50.0±1.9	1.4±0.2	1.7±0.3	1.9±0.3	3.0±0.3	3.8±0.1	0.8±0.2	6.0±0.4	8.9±0.3	2.2±0.4	5.5±0.5	6.6±0.6	7.6±1.1

Partial College	65	52.1±1.3	1.8±0.1	2.1±0.2	2.0±0.2	3.2±0.2	4.3±0.1	1.6±0.1	7.4±0.3	8.9±0.2	2.4±0.2	4.8±0.3	5.5±0.4	6.9±0.7
Household Income($)														
<15,000	35	50.4±1.8	1.8±0.2	1.9±0.3	1.7±0.3	2.4±0.3	3.8±0.1	1.3±0.2	6.9±0.4	8.8±0.3	2.6±0.3	5.3±0.5	5.9±0.6	6.6±1.0
15,000-29,999	61	51.9±1.4	1.6±0.2	2.0±0.2	1.9±0.2	3.2±0.2	4.0±0.1	1.4±0.1	6.7±0.3	9.0±0.2	2.5±0.2	5.1±0.3	5.7±0.4	7.6±0.8
30,000-44,999	29	52.2±2.0	1.7±0.3	2.0±0.3	2.0±0.3	3.0±0.3	4.2±0.2	1.2±0.2	7.3±0.5	8.6±0.3	1.5±0.4	5.4±0.5	6.3±0.6	7.9±1.1
Infant Feeding Method														
Breastfeeding	55	49.2±1.4^{x}	1.7±0.2	1.7±0.2	2.1±0.2	2.9±0.2	3.8±0.1^{x}	1.0±0.1^{x}	6.2±0.3^{y}	8.9±0.2	2.3±0.3	4.6±0.4	5.4±0.4	7.3±0.8
Formula feeding	70	53.1±1.2^{x}	1.7±0.1	2.2±0.2	1.7±0.2	2.8±0.2	4.2±0.1^{x}	1.5±0.1^{x}	7.5±0.3^{x}	8.7±0.2	2.2±0.2	5.5±0.3	6.3±0.4	7.6±0.7

[a] Dark Green and Orange vegetables and Legumes

[b] Solid fat, Alcohol and Added Sugar

[c] Mean scores adjusted for energy intake and Body Mass Index are reported.

[d] Total maximum possible score on HEI-2005 is 100.

[e] Analysis of covariance was utilized to evaluate difference in HEI-2005 scores by demographic variables.

[x,y] Similar superscripts across rows, within categorical variables indicate differences at P<0.05.

Similarly, a preference for milk observed in this study also has been demonstrated in Hispanic-American women (Block, et al. 1995,Hoerr, et al. 2008). The diet quality of this population may have been influenced by lack of nutrition knowledge (Klohe-Lehman, et al. 2006) and a readiness to consume low-fat foods (Krummel, et al. 2004), inadequate cooking skills (Chang, et al. 2005), economic constraints (Cade, et al. 1999), restricted accessibility (Chang, et al. 2005) and poor availability (Drewnowski, et al. 2005) of supermarkets.

After adjustment for energy consumption, the HEI-2005 scores predicted BMI and body weight (Table 2.2). These results confirm those found with the original 1995 HEI in postmenopausal women (Boynton, et al. 2008), Spanish adults (Schroder, et al. 2006) and a NHANES III sub-sample of adults (Guo, et al. 2004,Kant, et al. 2005). It is plausible that the enhancement of diet quality may facilitate energy balance and prevent excess weight gain in individuals. The weight retention of subjects in this study at 1-4 months postpartum showed a negative trend with tertiles of HEI-2005 scores. Since weight retention in early postpartum is associated with obesity at both 1 (Linne, et al. 2004) and 15 years (Linne, et al. 2006) following child birth, a better quality diet during this critical time period may be preventive against subsequent weight gain in future years.

For HDL cholesterol, 31 % of the sample was below the suggested levels (2001). Similarly, levels of LDL and total cholesterol and triglycerides were above the recommended range for 34%, 42% and 26 % of the sample, respectively. The HEI-2005 scores were a negative predictor of LDL and total cholesterol and a positive predictor of

Table 2.2. Physiological parameters according to tertiles of the Healthy Eating Index-2005 in low-income women in early postpartum

Physiological Parameters	Healthy Eating Index-2005, tertiles[a]				
	1 (0-46)	2 (46.1-56)	3 (56.1-100)	β^b	*P* for trend[c]
Participants (n)	41	40	45		
Anthropometrics	← *Mean± SEM*[d] →				
Weight (kg)	91.3±2.6	84.7±2.4	84.6±2.5	-0.302	0.02
BMI[e] (kg/m^2)	35.5±0.89	32.0±0.81	32.3±0.83	-0.117	0.01
Body Fat (%)	40.8±0.54	42.9±0.48	42.7±0.49	0.052	0.07
Waist Circumference (cm)	97.8±0.05	102.9±0.01	100.7±0.01	0.039	0.22
Postpartum Weight Loss (kg)	5.10±1.40	7.47±1.25	8.6±1.27	0.146	0.05
Lipids (mg)					
Total cholesterol	215.9±6.3	201.8±6.13	201.9±5.93	-0.690	0.04
HDL cholesterol	52.3±1.87	55.7±1.79	56.9±1.73	0.216	0.03
LDL cholesterol	136.2±5.7	114.9±5.5	120.5±5.2	-0.659	0.033
Triglycerides	130.3±11.4	149.0±10.9	125.3±10.5	-0.591	0.333

[a]Subjects were classified into tertiles based on total Healthy Eating Index-2005 score.

[b]Standardized regression coefficient for each dependent variable after controlling for energy intake for BMI and weight status and both energy intake and BMI for other dependant variables and additionally for lactation for HDL and triglycerides.

[c]Determined by linear regression.

[d]Standard error of the mean for adjusted values of dependent variables.

[e]Body Mass Index.

HDL after adjustment for energy intake, body weight and lactation status when applicable (Table 2.2). It is well established that the risk of cardiovascular disease is lowered from consumption of diets which include an abundance of fruits, vegetables, whole grains, nuts and omega-3 fatty acids, and low levels of refined carbohydrates and saturated fats (Hu, et al. 2002). The HEI-2005 encompasses these dietary characteristics; therefore, its ability to predict lipid profiles is not surprising. Dietary patterns, derived from either factor analysis (Sadakane, et al. 2008) or diet scores (Panagiotakos, et al. 2006), also have been associated with lipid profiles. The inverse association of LDL (Kant, et al. 2005) and total cholesterol (Hann, et al. 2001,Weinstein, et al. 2004) observed with the 1995 HEI scores parallel those with the HEI-2005 reported in the current study. The comparison of the 1995 HEI scores with lipids showed a negative association with HDL (Hann, et al. 2001,Weinstein, et al. 2004). Data are not available for 2005 version of HEI, but the results presented here had the expected positive association. Future research is needed to compare the ability of the 1995 HEI and the HEI-2005 to predict lipid profiles in other populations to confirm these observations.

A limitation of this study is the use of 3-day food intake recalls because they do not capture the long-term nutritional status of individual. Since Dietary Guidelines recommendations are intended to be met over time, future studies may adopt a more comprehensive dietary measure. Another drawback is the underreporting on a 24-hour recall, commonly observed among obese/overweight individuals (Goris, et al. 2000). This might have resulted in a concomitant underreporting of discretionary calories or HEI-2005 components. Also the use of a convenience sample of low-income, postpartum women, may not be generalized to all low-income women. Consequently, utility of the HEI-2005 to predict lipids should be confirmed in a longitudinal study on a larger population.

CONCLUSIONS

The low-income, early postpartum women in this study appear to be at risk for dietary inadequacies. The areas of concern identified by HEI-2005 were low consumption of fruits, vegetables, whole grains, and a surplus of foods rich in solid fats and/or added sugars. Nutrition education programs and policies that are a part of WIC program should incorporate strategies to increase consumption of healthful foods and restrict use of foods rich in discretionary calories.

The strong relationship of the HEI-2005 with lipid profiles suggests that higher scores on this index may translate to reduced risk of cardiovascular disease in low-income women, independent of BMI. Future research should be conducted to determine which of the individual components of the index might be most responsible for the trends in lipid profiles observed in the study. Since HEI-2005 aligns with the 2005 Dietary Guidelines, the effectiveness of these guidelines as a whole in preventing risk factors of other types of diseases should be investigated.

Chapter 3: Snacking frequency in low-income women in early postpartum is positively associated with diet quality and selected nutrient intakes

ABSTRACT

Objective: To determine the influence of snacking frequency on diet quality and nutrient intakes in low-income, early postpartum women.

Study Design: Low-income, triethnic women were administered a 24-hr recall and 2 day food intake recalls. Snacking frequency was determined and HEI-2005 scores were computed to assess diet quality**.** The association of snacking frequency with diet quality was determined.

Subjects: A convenience sample of 134 women in early postpartum was recruited from the Special Supplemental Program for Women, Infants, and Children clinics. Primary enrollment criteria were household income <185% poverty level, Hispanic, African-American and White ethnicity, 1-4 months postpartum and parity ≤ 3.

Statistical Analysis Performed: Frequencies and means were computed for descriptive purposes. Chi-square with a follow-up test of independent proportion determined differences in percentage of mothers in snacking group, across body mass index (BMI) category. Analysis of covariance was performed to examine the difference in total HEI scores and mean nutrient intakes by snacking frequency.

Results: Majority of the sample (82%) snacked daily with snacks contributing to approximately 25% of the total energy intake. Snacks were higher in carbohydrates (58.7% vs. 47.7%) but lower in proteins (11.3% vs. 17.6%) and fats (32.0% vs. 35.3%) as compared to main meals. Snacking frequency was positively associated with total HEI scores after adjustment for energy intakes and BMI.

Conclusions: Snacking constitutes a major role in diet of low-income women. Higher snacking frequency was associated with better diet quality as measured by HEI-2005. Recommendations for snacking should be an integral part of dietary interventions.

INTRODUCTION

Postpartum is an important life transition that impacts dietary patterns of women. The demands of child care (Devine, et al. 2000) and employment , combined with stress caused by weight gain (Gjerdingen, et al. 1994), may promote consumption of a less than optimal diet. Low-income status further exacerbates unhealthful eating behavior due to challenges of meager finances (Beck 2001) and perceived high cost of healthful foods (Hargreaves, et al. 2002). Both compromised diet quality (Fowles, et al. 2006, George, et al. 2005) and food choices (George, et al. 2005) have been reported in new mothers. A concern over unhealthful diets in a population of postpartum women is the possible influence on the long-term, development of obesity and its associated co-morbidities.

Over the last 25 years, snacking incidence has increased by 15% and its contribution to total energy consumption by 10% (Jahns, et al. 2001,Nielsen, et al. 2002,Zizza, et al. 2001). However, relationships of snacking frequency with energy and nutrient intakes are unclear (Bellisle, et al. 1997,Drummond, et al. 1998). Frequent snacking is associated with high energy diets in several studies (Drummond, et al. 1998,Gatenby 1997,Grogan, et al. 1997,Hampl, et al. 2003,Zizza, et al. 2007), while others reported negative (Berteus Forslund, et al. 2005,Edelstein, et al. 1992,Kant, et al. 1995,NCEP 2001) or neutral findings (Ruidavets, et al. 2007,Summerbell, et al. 1996,Summerbell, et al. 1995,Titan, et al. 2001). More occasions of snacking were related to greater consumption of fruits, milk, vitamin C (Hallund, et al. 2008,Sebastian, et al. 2008), and vitamin A (Sebastian, et al. 2008); however, higher snacking frequency was associated with higher levels of discretionary calories, total fat and saturated fat (NCEP 2001,Ovaskainen, et al. 2006). The influence of snacking frequency on overall diet quality in low-income women in early postpartum is unknown.

Therefore, the goal of this study was to identify snacking frequency in low-income women following child birth and determine their influence on diet quality.

METHODS

Study Design

Snacking frequency and the relationship to diet quality was assessed in low-income women, 1-4 months postpartum (N=134). Mothers were recruited through flyers posted at public health clinics and interested individuals were screened on the telephone. At visit 1, participants were measured for height and weight and administered demographics questionnaire and a 24-hour recall. At visit 2, subjects returned 2-day food intake records. Dietary data were used to identify snack choices and frequency, as well as nutrient intakes, and the Healthy Eating Index-2005 scores. Diet quality and mean nutrient intakes across snacking frequency categories was determined.

Subjects

Participants were low-income (annual family incomes ≤185% of federal poverty level) women of Hispanic, African-American or Caucasian ethnicity. Additional inclusion criteria were: BMI ≥25 kg/m^2, age of 18-40 years; ≤ 4 months postpartum; parity ≤ 3; literate in English; absence of pregnancy, chronic health conditions (heart disease, diabetes) or consumption of special diets (low fat, low carbohydrates). Informed consent was obtained and the Institutional Review Board of The University of Texas at Austin approved the study protocols.

Dietary Intake

A 24-hour recall (Conway, et al. 2003) was administered by a trained nutritionist who noted the type of eating occasion for each food item consumed. Brand name, recipes for mixed foods, and additional comments were recorded when applicable. Portion sizes of each item were determined using food models and measuring cups and spoons, to enhance accuracy. Participants were instructed to record food intake for 2 additional days using similar protocols. Upon completion, all diet records were checked for accuracy, missing information and ambiguous responses were corrected via telephone interviews. Dietary intake data were analyzed using Food Processor SQL 9.6.2 (ESHA Research, Salem, OR), with exclusion criteria of 3-day average energy intakes ≥ 4500 and ≤ 500 calories (George, et al. 2005). Snacks were self-defined as any eating occasions apart from main meals such as breakfast, lunch and dinner. Participants were divided into three snacking frequency categories: ≥1, 2, and ≥3/day. Nutrient intake from snacks was calculated as an average from all snacking episodes; that from meals was computed as mean intake from main meals. Snack items were further aggregated into nine food groups: fruits; vegetables; grains; dairy; meat and meat alternatives; beverages; salty snacks; sweets and desserts and added fats and oils. To measure diet quality, foods were assigned to respective groups designated by the Healthy Eating Index-2005 (HEI-2005) (Guenther, et al. 2008). Mixed foods were broken into their component ingredients and then assigned to the appropriate HEI-2005 category.

Diet Quality

Diet quality in this study was measured using The Healthy Eating Index-2005 (Guenther, et al. 2007). This index measures the density-based (per 1000 calories) recommendations of MyPyramid (Britten, et al. 2006) and 2005 Dietary Guidelines for Americans (U.S. Department of Health and Human Services and U.S. Department of Agriculture.). The HEI-2005 is comprised of 12 components, the first eight measure the adherence for total fruit, whole fruit, total vegetable, dark green and orange vegetable and legume, total grain, whole grain, milk and meat. The later four components reflect adherence to recommended intakes of oil and sodium and % calories from saturated fat and solid fat, alcohol, and added sugars (discretionary calories). For each of the first eight components the maximum possible points were 5; 0 points were allotted if individuals did not consume any servings from that food group. Similarly, oil, sodium and % calories from saturated fat components were awarded a maximum score of 10, and discretionary calories, 20. The maximum possible total score for this index is 100.

Anthropometrics

A wall mount stadiometer (Medico Resources, Columbus, OH) was used to determine height; measurements were taken to the nearest 0.1 cm without shoes. Mothers were weighed using a Tanita measuring scale (Model TBF-300A, Tanita Corporation, Arlington Heights, IL), with graduations of 0.2 lbs, without shoes and heavy clothing. Height and weight were used to calculate body mass index as kg/m^2. Participants were classified into three categories of weight status; overweight (BMI $\geq$ 25), obese (BMI$\geq$30 - $\leq$ 39.99) and morbidly obese (BMI$\geq$40) using World Health Organization (1997) guidelines.

Statistical Analysis

Data were analyzed using the SPSS (2006, SPSS Inc, Chicago, IL) version 15.0. Frequencies and means were reported for descriptive purposes of demographic (e.g. ethnicity, age) and dietary variables (e.g energy and nutrient intakes). Standard errors of means were computed. Differences in energy and nutrient contributions by meals and snacks were determined.

Snack choices by BMI category were determined by counting distinct number of participants consuming each snack in Microsoft SQL (Microsoft Corp, Redmond, WA) and then computing percentage for each BMI group. The difference in percentage of mothers in each snacking food group, across BMI category was computed using χ^2, and follow-up test of independent proportions.

Within each snacking group, the top three most commonly consumed snacks were computed by sorting the frequency of each snack using Microsoft SQL. Analysis of covariance was performed to examine the associations between snacking frequency groups and mean HEI total and component scores and nutrient intakes. Energy intakes and BMI were treated as covariates. The criterion for statistical significance was P value <0.05.

RESULTS

The final sample consisted of 134 participants with median age of 26 years and BMI of 32.8 ± 5.7 kg/m^2 (mean ± standard error of mean). The demographic profile of the participants is shown in table 3.1. The majority of the sample was of Hispanic ethnicity, resided with a spouse or partner, had an annual income < $30,000 and was not employed. Less than one third of the population had a college degree and no differences were found in number of participants that breastfed or formula fed. Total energy intake and contributions from main meals and snacks did not vary by demographic variables or lactation status. Energy intake differed by BMI categories. Morbidly obese (2,474±150 kcals) participants had significantly greater total energy consumption as compared to their obese (2,055±73 kcals) and overweight (2,083±83 kcals) counterparts.

Average energy intake of low-income women in this study was 2110 ± 613 kcals, distributed as 49% carbohydrates (262.4 ± 89.8 g), 16% protein (85.4 ± 23.8 g), and 35% total fats (81.9 ± 27.8 g). Snacks represented 726 ± 39.2 kcals of total energy, distributed as 100 ± 5.4 g carbohydrates, 22.7 ± 1.9 g protein, and 26.9 ± 1.9 g of total fat (Figure

3.1). Maximum carbohydrates were derived from snacks and proteins and fats were found in greatest amount from dinner. Energy from snacks was higher than that from breakfast but not other meals (Figure 3.1). The mean macronutrient content of snacks was 58.7% carbohydrates, 32.0% fats and 11.3 % protein; that from meals was 47.7%, 35.3% and 17.6%, respectively.

The largest percentage of women (82%) snacked at least once a day with 39% consuming three or more snacks daily. Energy, carbohydrates, and fats intake did not differ significantly by snacking frequency (Table 3.2). In contrast, protein (%) from snacks improved with increasing snacking frequency, in addition to vitamins A and C, and calcium ($P<0.05$).

Table 3.3 reports the total and component scores of HEI-2005 according to snacking frequency, after adjusting for energy intake and BMI. Snacking frequency was associated positively with total HEI-2005 scores, and with the component scores of total fruit, dark green orange vegetables and legumes, total grains, and saturated fat. Of all snacks the most popular was sweets and desserts, which were consumed by 75% of the sample (Table 3.4). Within this group, cookies, candy and ice-cream were the top three choices. Almost half of the sample consumed fruits, grains, dairy products, meats and beverages for snacks. Fruit juice represented the greatest proportion of fruit followed by bananas and apples. Breads and cereals were common as snacks in the grain category; milk and yogurt represented a majority of the dairy group. Surprisingly, intake of tortillas as a snack was low. Peanut butter and lunchmeat were the top meats and soda was the most popular beverage snack. Vegetables were favored by 21.4% with potatoes

Table 3.1. Demographic characteristics of low-income women in early postpartum

Characteristics	N	%
Age (y)		
18-25.9	57	42.5
25-30.9	42	31.3
31-40	35	26.1
Race/Ethnicity		
African American	16	11.9[x]
Hispanic	84	62.6[x,y]
White	34	25.3[y]
Education		
<High school	26	19.4
High school	32	23.8
Partial college	55	41.0
≥ College graduate	21	15.6
Cohabitation		
Living with partner	108	80.5
Not living with partner	26	19.4

Lactation Status		
Breastfeeding	47	35.2
Combination Feeding	39	29.1
Formula Feeding	48	35.8

[a]Percentages are row percentages

[x,y] Percentages with common superscripts within column, within a demographic group indicates significant differences at $P<0.05$

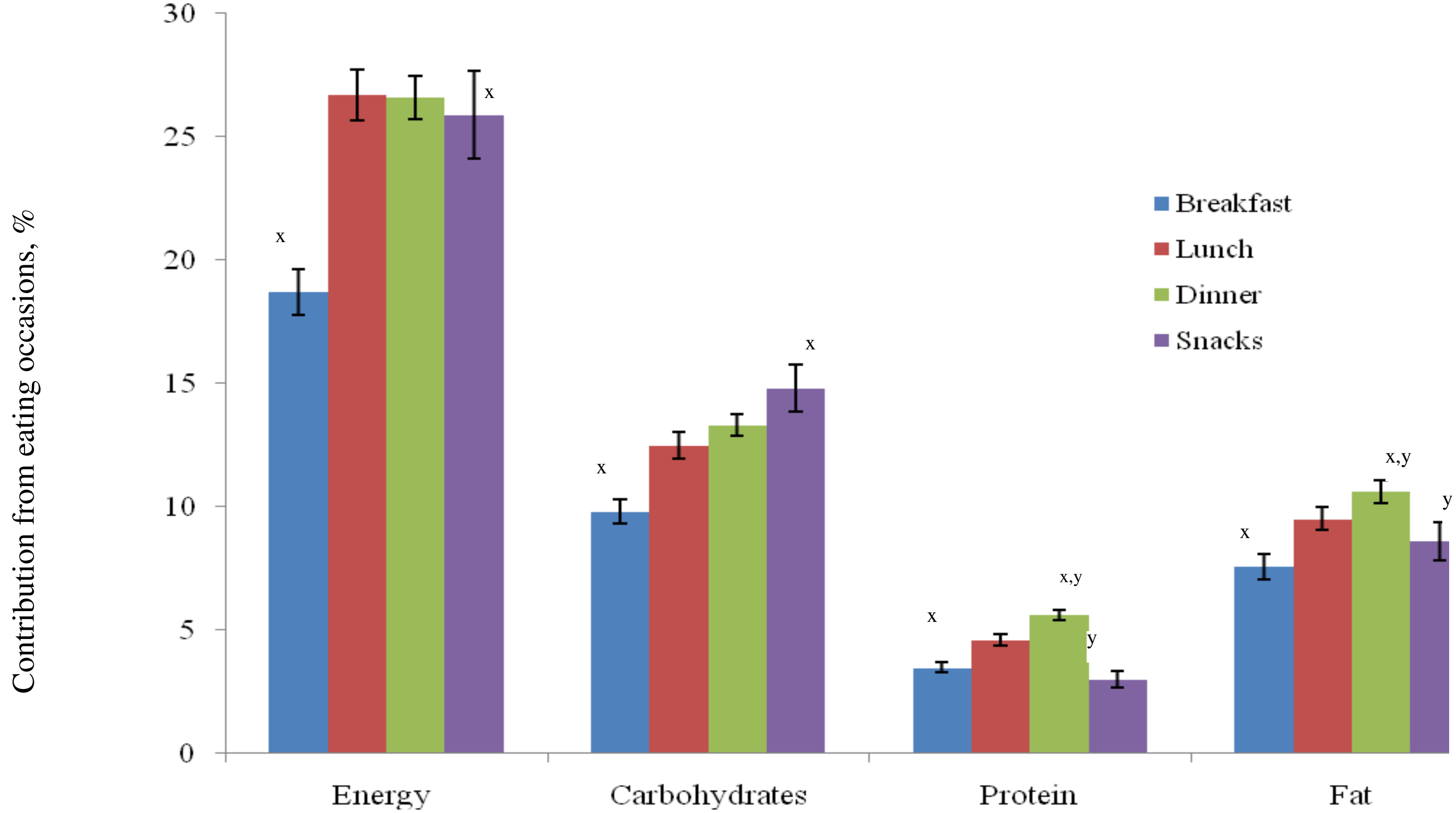
Contribution from eating occasions, %
30
25
20
15
10
5
0
x
x
x
x
x
x,y
y
x
x,y
y
Breakfast
Lunch
Dinner
Snacks
Energy
Carbohydrates
Protein
Fat

Figure 3.1. Contributions of energy (kcals) and macronutrients (gm) from meals and snacks in low-income postpartum women.

^{x,y} Meal occasions with common superscripts within a macronutrient category indicate significant differences at P<0.05.

Table 3.2. Association of snacking frequency with nutrient intakes in low-income women in early postpartum

Nutrients	Number of Snacks/day ≤1 (n=50)	2 (n=30)	≥3 (n=54)	*P* value[a]
	Mean± SEM[b]			
Energy (kcal)	2030±123	2100±105	2190±84	0.765
Protein (gm)	79.5±4.5[x]	85.1±4.1	89.8±3.2[x]	0.045
Carbohydrate (gm)	248.5±17.0	262.3±15.4	274.4±12.3	0.345
Total fat (gm)	79.6±5.21	80.5±4.79	85.1±3.89	0.265
Fiber (g)	16.5±1.21	17.7±1.28	18.0±1.02	0.465
Iron (mg)	15.4±0.81	16.6±0.88	16.9±0.88	0.313
Vitamin A (mcg)	415.7±24.8	486.8±20.5	590.7±25.1	0.046
Vitamin C (mg)	85.2±14.3	92.3±10.9	103.7±14.3	0.025
Calcium (mg)	812.8±46.5	847.9±38.9	930.7±50.7	0.030
Sodium (mg)	3298.5±140.2	3335±218.0	3447±174.6	0.345
Potassium (mg)	2074.5±165.3	2201±154.6	2427±123.8	0.056

[a] Analysis of covariance was utilized with energy intake and Body Mass Index as covariates.

[b]Standard Error of Mean for adjusted means.

[x,y]Means with common superscripts within a row indicate significant differences at $P<0.05$

as the major vegetable. Almost 50% of the sample had habitual intake of salty snacks, consisting mainly crackers, chips and cheese puffs. Choices of snacks differed by BMI categories (Figure 3.2). For fruit consumption as snacks was reported by 44% of overweight, 33% obese and 32% morbidly obese women. The difference remained significant after fruits were further stratified into whole fruits and fruit juice. A similar trend was observed for vegetables (16.1% vs. 9.7% and 4.3%), dairy (32.6% vs. 27.7% and 21.7%) and beverages (42% vs. 34% and 30%) among overweight, obese and morbidly obese mothers, respectively. In contrast, participants with BMI<40 kg/m^2 preferred more grains (52%), sweets and desserts (65%), meats (43.4%) and dairy as snack choices as compared to those overweight (42.2%, 51%, 28.5%, respectively).

DISCUSSION

This study demonstrated that greater snacking frequency was associated with better diet quality and intakes of select nutrients in low-income, early postpartum women, even when total energy consumption was controlled. Regular meals were the primary source of energy in this population, yet snacks provided one third of daily energy intake. The contribution of snacks for this total energy intake (34%) is comparable to that previously observed in adult women (Roos, et al. 1997). In this study snacks were higher in carbohydrates and lower in fats and proteins, in comparison to standard meals. Similar nutrient distributions have been observed in diets of normal weight (Summerbell, et al. 1995) and obese women (Basdevant, et al. 1993).

Table 3.3. Association of snacking frequency with the Healthy Eating Index-2005 components in low-income women in early postpartum

	Number of Snacks/day			
HEI-2005	**≤1 (n=50)**	**2 (n=30)**	**≥3 (n=54)**	***P* value[a]**
	Mean± SEM[b]			
Total Score	49.1±1.48[x]	53.7±1.67	54.8±1.29[x]	0.022
Fruits				
Total	1.26±0.22	2.08±0.20	2.07±0.37	0.030
Whole	1.64±0.26	2.23±0.34	2.35±0.26	0.080
Vegetables				
Total	2.08±0.23	1.73±0.30	1.98±0.24	0.697
Dark Green, Orange and Legumes	2.75±0.23	3.67±0.42	4.69±0.92	0.048
Grains				
Total	3.95±0.23[x,y]	2.19±0.16[y]	2.10±0.13[x]	0.027
Whole	1.33±0.35	1.45±0.25	1.34±0.19	0.996
Milk	6.00±0.36	5.66±0.43	6.41±0.35	0.552
Meats and Beans	4.28±0.32	4.17±0.17	4.64±0.13	0.135
Oils	2.10±0.43	2.27±0.41	2.75±0.31	0.241
Saturated Fat	4.88±0.56[x,y]	6.16±0.50[x]	6.24±0.46[y]	0.022

Sodium	4.58±1.38	5.29±0.49	5.00±0.38	0.103
Solid Fats, Alcohol Added Sugars	14.6±0.35	15.8±0.66	14.96±0.71	0.542

[a]Analysis of covariance was utilized with energy intake and Body Mass Index as covariates.

[b]Standard Error of Mean for adjusted means.

[x,y]Means with common superscripts within a row indicate significant differences at $P<0.05$

Table 3.4. Description of snacks in low-income women: proportion of consumers (%) and contribution (%) of top three snacks per day to total energy intakes

Food Item	Participants (%)	Energy from snacks/day (%)
Fruit and Fruit Juice	**53.3**	
Fruit Juice	20.0	4.53
Banana	17.7	2.12
Apples	9.62	0.05
Vegetables	**21.4**	
Potatoes	9.62	3.86
Tomatoes	8.81	0.06
Lettuce	7.40	0.07
Grains	**50.3**	
Breads	24.4	2.34
Cereals	20.7	3.53
Tortillas	2.96	0.08
Meat and Meat Alternatives	**50.3**	
Peanut Butter	15.5	3.93
Lunchmeat	12.5	0.04
Chicken	8.14	1.19

Milk, Cheese and Yogurt	**52.9**	
Milk	37.7	3.66
Cheese	22.9	2.80
Yogurt	8.82	
Salty Snacks	**48.1**	
Crackers	20.7	4.08
Chips	17.7	3.94
Cheese Puffs	8.14	3.56
Sweets and Desserts	**74.0**	
Cookie	27.4	6.71
Candy	15.5	4.44
Ice Cream	15.5	4.43
Beverages	**48.1**	
Soda	40.0	3.43
Sweetened Drink	11.1	3.57
Sports Drink	2.94	0.05
Fats and Oils	**11.8**	
Butter	4.40	0.04

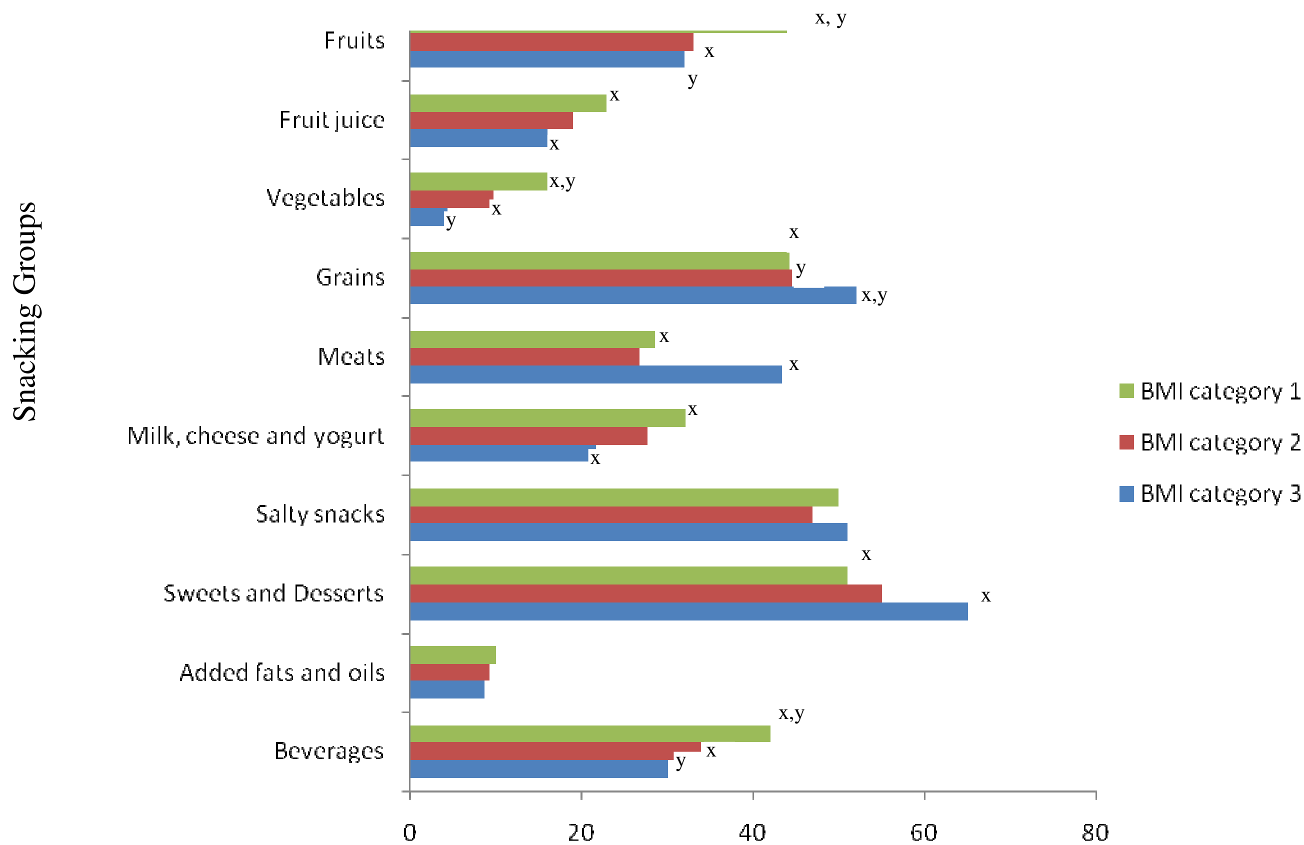

Figure 3.2. Proportion of low-income women consuming selected snacks, by Body Mass Index (BMI) categories. Overweight = BMI ≥ 25 and ≤ 29.9 kg/m^2, Obese= BMI ≥ 30 and ≤ 39.9 kg/m^2 and morbidly obese = BMI ≥ 40 kg/m^2.^{x,y}Similar superscripts are significantly different at P<0.05.

The HEI-2005 components that were positively influenced by higher snacking frequency were total fruits, dark green leafy vegetables and legumes, meat and beans, total grains, and saturated fats. Although a positive trend was observed between snacking frequency and saturated fats component, it did not impact the relationship with the total HEI-2005 score.

Snacking occasions also were positively associated with greater consumption of fiber, vitamins A and C, and calcium, thus supporting the idea that snacks contributed to a healthful diet in this study. Few studies have measured the relationship of snacking frequency and diet in women. A study in African women has highlighted the role of snacks as an important contributor of Vitamin A and C (Hallund, et al. 2008). Similarly, snacking was positively associated with nutrient intake in US adults (Kerver, et al. 2006), elderly (Redondo, et al. 1997) and adolescents (Sebastian, et al. 2008). Therefore, more focus on healthy snacks offers a greater potential to improve overall diet quality of low-income women in early postpartum.

The most popular snacks in the current study were sweets and desserts, followed by dairy, fruits and salty snacks. These are similar to the results in young adults (Zizza, et al. 2001). Almost half of the sample consumed grains and beverages as snacks of which breads and soda were top contributors. Snack choices in low-income, postpartum women have not been studied before and therefore comparative data is unavailable. When stratified by BMI, overweight participants had significantly better snack choices than obese and morbidly obese mothers. Overweight mothers showed a higher intake of fruits and vegetables as snacks while obese participants consumed more sweets and desserts, grains, and meats. However, mean BMI did not elevate by snacking frequency. Thus, choice of snacks may have a greater impact on weight status as compared to snacking frequency. These results will provide health professionals with specific information about snacking patterns and choices of low-income, overweight/obese women in early postpartum, allowing them to develop target messages to improve diet quality of this population.

This research found that greater snacking frequency was associated with lower BMI. Research studies have either reported an inverse association (Drummond, et al. 1996,Drummond, et al. 1998,Titan, et al. 2001) or have failed to find any relationship between snacking frequency and BMI (Bellisle, et al. 1997,Edelstein, et al. 1992,Hampl, et al. 2003). In contrast to the concept that snacks have poor nutrient density, frequent snacking in the postpartum women in this population was associated with improved diet quality. These ambiguous results may be due to lack of consistency in the definition of snacking. A limitation of snacking studies is that different time periods (Roos, et al. 1993,Summerbell, et al. 1995) and a energy contents (Bernstein, et al. 1981,de Castro 1993) are used to define snacks, that do not account for individual differences. For the current study, snacking was self-defined by the respondents, which is a method that has been successfully implemented in previous studies (Berteus Forslund, et al. 2005,Sebastian, et al. 2008).

A constraint of this study was that it focused on a special population of overweight/obese, low-income women in early postpartum. Therefore, the results may not be representative of the general population. Also, the cross-sectional design prohibits defining causality. Future prospective studies should assess the impact of snacking frequency on diet quality in a wider range of BMIs and larger sample size of low-income women in early postpartum. Finally it should be noted that 3-day food intake records were utilized for dietary analysis. Obese individuals have been shown to under-report energy intake with this method. Perhaps the underreporting of energy amount may have extended to snacking frequency assessment (Berteus Forslund, et al. 2005). However, food intake records and 24-hour recalls have been extensively used to assess habitual intake frequency in overweight and obese populations (Zizza, et al. 2007). In addition, the methods for reporting snacking frequency reported here are comparable to those used with low-income women (USDA 2008).

CONCLUSIONS

This study demonstrated that snacking contributed 33% of total energy intake in low-income, early postpartum women. Furthermore, snacking frequency was associated with better diet quality as assessed by the HEI-2005 scores. Dietitians may encourage consumption of healthful snacks as an integral part of the diet. Tailored nutrition education messages should be developed that focus on quality of food choices for snacks. Snacking frequency and choices need to be considered in general dietary recommendations. Future studies may assess the influence of snacking frequency on physiological variables and preventing risk for chronic diseases.

Chapter 4: Physical activity measured using pedometers is associated with weight loss and lipid profiles in low-income, overweight women in early postpartum

ABSTRACT

Objective: This study tested the influence of physical activity measured using pedometer on weight-loss and lipid profiles in low-income women in early postpartum.

Study Design: An 8-week weight loss intervention based on diet, physical activity and behavior modification was conducted in low-income women during early postpartum. Demographics, anthropometrics, physical activity via pedometers, self-efficacy, and serum lipids were measured at weeks 0 and 8; pre-pregnancy activity survey was administered at week 0.

Subjects: A convenience sample of low-income women in early postpartum was recruited from local community centers, public health clinics and physician's offices. Eligibility criteria were body mass index $\geq$ 25 kg/m^2 and Hispanic, African-American, or Caucasian ethnicity.

Statistical Analyses Performed: Descriptive statistics including means and frequencies described characteristics of the sample. Paired sample t-tests were utilized to determine the differences between pre/post intervention. Multivariate logistic regression and multiple regression analysis determined the influence of pedometer steps on anthropometrics and lipid profiles. One way analysis of variance was performed to determine the differences in physical activity across ethnicity and body mass index (BMI) categories.

Results: Only 4.5% of the sample was performing high activity at pre-study. After the intervention, significant improvement were found in pedometer steps (5298 vs. 8413/day) and calories (238 vs.348 kcals/day) and self-efficacy scale scores (28 vs. 31) ($P<0.01$). Both the pre-pregnancy activity survey (β =0.27, β =0.34) and self-efficacy scores (β =0.30, β =0.32) were positive predictors of pedometer determined steps and calories at post-study, respectively. Moreover, pedometer steps at post intervention predicted weight loss (β =0.465), percent body fat (β =-0.316), and serum triglycerides (β = -0.549), LDL (β = -0.391) and total cholesterol (β =-0.418), but not HDL cholesterol. Chances of losing $\geq$2.25 kg elevated by 40% for any 1000 steps/day increase in pedometer steps and by 10% with each point increase in self-efficacy scale.

Conclusions: A weight loss intervention administered in low-income women in early postpartum elevated physical activity levels and these were associated with lipid profiles. Thus pedometers are an effective measure of physical activity levels in low-income women in early postpartum.

INTRODUCTION

Activity levels among individuals in the United States are declining, as less than half (48.8%) of the population meets the recommendation of 30 minutes of daily moderate physical activity (BRFFSS). Furthermore women (72%) are more likely to by sedentary as compared to men (65%) (Albright et al 2004) and activity levels further deteriorate following childbirth (Albright et al. 2005, Olson 2003). Studies have shown that women with children are more likely to be sedentary than women without children

(Scharff et al.1999, Sternfield et al. 1999, Marcus et al. 1994, Verhoef et al. 1994, Brown et al. 2001). In addition, activity levels in postpartum women are lower than inactive adults (Wilkinson et al. 2004). Although the guidelines are to gradually start exercising 4-6 weeks postpartum (Mueller 2001), most new mothers fail to do so (Wilkinson et al. 2004). One possible reason may be that traditional postpartum medical care generally ceases around 6 weeks after delivery, and importance of physical activity has not been emphasized. Therefore, this study will assess the activity in low-income women and augment its levels by administering a nutrition and physical activity intervention.

One economical method to increase physical activity is the use of pedometers. In overweight/obese, low-income mothers of 1-3 year children, Clarke and colleagues (2007a) examined the influence of pedometer-determined steps on weight loss. Pedometer steps per day were positively related with weight loss after an 8-week diet and physical activity intervention. Similarly, associations between physical activity, as measured by pedometer and anthropometrics, were observed in a sample of healthy adults (Tudor-Locke 2001). Daily steps were negatively related to body mass index (BMI) ($r=-0.30$) and percent body fat ($r=-0.27$) ($P<0.01$). These relationships have been further observed in a population of middle-aged (Thompson 2004), African-American (Hornbuckle 2005) and postmenopausal (Krumm 2006) women. Recent studies also have utilized pedometers to explore relationships between physical activity and markers of chronic diseases (Woolf et al. 2008, Bravata et al. 2007).

Self-efficacy for exercise is one of the factors that may predict physical activity (Teixeira et. al.2004). Efficacy influences the direction, intensity and the persistence of a behavior (Bandura 1997, 1989) and has been used as tool to elevate physical activity in mothers of young children (Clarke et al. 2007, Miller et al. 2002). However, this tool has not been previously utilized in early postpartum women. Therefore, this study will investigate relationships between physical activity, self-efficacy, and weight loss in low income women.

The purpose of this study is to assess prevalence of physical activity in low-income women in early postpartum and to explore the relationships between activity, exercise self-efficacy, weight status and lipids in this population.

METHODS

Study Design

A total of 66 low-income, overweight/obese ($BMI \geq 25\ kg/m^2$) women with 1-4 months old infants participated in an 8-week weight loss intervention with a physical activity component. At pre-study participants completed a demographics questionnaire and a pre-pregnancy activity survey. Exercise self-efficacy, anthropometrics, serum lipids, pedometer steps and calories for 3 days were measured at pre and post intervention.

Subjects

A convenience sample of low-income women in early postpartum was recruited from local communities through flyers posted at Special Supplemental Nutrition Program for Women, Infants, and Children clinics, public health clinics, physician's offices and community centers. Women were screened over the telephone and eligible participants were scheduled for a visit at the research center. Criteria for eligibility were: Hispanic, African American or Caucasian ethnicity; 18-40 years old and annual household income $\leq$ 185% of federal poverty level; BMI$\geq$25; ability to speak and read English; youngest child aged 1 to 4 years; and absence of pregnancy. The procedures were approved by The Institutional Review Board of the University of Texas at Austin and informed consent was obtained from all participants.

Intervention

The new mothers participated in a weight loss intervention previously developed and validated in low-income, mothers of 1-3 year old children (Klohe-Lehman et al. 2007). Briefly, the curriculum included recommendations for physical activity, healthful eating and behavioral modification. The physical activity component of the program included 30 minutes exercise at the end of each weekly session. Additionally, class discussions informed participants about advantages of exercise for both physical and mental well-being and encouraged self-monitoring and establishment of exercise and weight loss goals. Classes also centered on enhancing skills, increasing confidence and reducing barriers and identifying social support. Instructors also demonstrated various exercises in class and advised participants to exercise for at least 5 days a week for 45 minutes at moderate intensity (55-65% of maximum heart rate)(American College of Sports Medicine). Physical activity was monitored by weekly recording of steps and energy expended via pedometers.

The second component of the program was consumption of a healthful diet designed to promote weight loss. Menu planning was taught with emphasis on culturally appropriate foods, portion control, and energy content of foods. Recipe modification, cooking demonstrations and tastings were incorporated for interactive participation. The third major component of the intervention was behavior modification. Techniques included: self monitoring via the use of pedometers and food records; social support via group classes; reinforcements by weekly non-food rewards for appropriate behavior changes; emotional coping responses by contingency management, and stimulus control by identification of environmental cues associated with unhealthy eating.

Anthropometrics

Anthropometric data were collected at both baseline and post intervention, according to National Health and Examination Survey III protocols (NHES 1998). Height was measured without shoes via a wall mounted stadiometer (Medico Resources, Columbus, OH) to the nearest 0.1 cm of accuracy. Weight and body fat % were analyzed with a body composition analyzer (Model TBF-300A, Tanita Corporation, Arlington Heights, IL), with graduations of 0.2 lbs. Waist circumferences were assessed with a flexible tape measure. BMI was calculated by dividing weight (kilograms) by height (meters) squared. Subjects were classified by BMI into overweight ($\geq$ 25 kg/m^2) and obese ($\geq$30 kg/m^2) based on guidelines developed by World Health Organization (WHO 1998). Participants were divided into categorizes of responder ($\geq$2.25 kg) and non-responder (< 2.25 kg) category based on weight loss at week 8.

Physical activity and self-efficacy

Physical activity was determined by pedometers and survey questions regarding duration and type of exercise performed the previous week. The pedometer (Model AE-170, Accusplit, San Jose, CA) was worn by the subject for 3 days including two weekdays and one weekend day. The pedometer was worn on the waistband of the clothing for the entire day, with the exception of bathing or swimming. All were advised not to alter their usual physical activity habits during the 3 days. Classification of activity levels were: sedentary (steps <4000), moderately active (steps >4000 and <7,500) or highly active (steps >7,500) according to Lindberg and colleagues (2000).

A 4-item, pre-pregnancy activity survey assessed participation of new mothers in activity before pregnancy. A sample question is 'Did you exercise for 30 minutes every day before you were pregnant?' Exercise self-efficacy was assessed by the scale by Laffrey and colleagues (2001). This 11-item scale (Likert scale ranged from 1=strongly agree to 5= strongly disagree) demonstrated reliability, with an internal consistency of 0.87 and validity inter-scale correlations coefficients ranged from 0.30 to 0.70 in Hispanic men (n=70) and women (n=118) (Laffrey et al. 2001).

Blood Collection and Analysis

Fasting blood samples were collected from antecubital vein after 12 hour fast into tubes with clot-activator syringes (VWR, Inc. Bridgeport. NJ). Samples were stored at room temperature for 30 minutes and then separated by centrifugation at 2000 x g (gravity) for 10 minutes. Serum concentrations of high density lipoproteins (HDL), low

Table 4.1. Predictors of physical activity in low-income women in early postpartum participating in a weight-loss intervention

	Pedometer					
	Week 0[a]		Week 8		Improvement	
Physical Activity Variables	**Steps**	**Calories**	**Steps**	**Calories**	**Steps**	**Calories**
Pre-pregnancy activity survey	-0.021[b]	-0.026	0.274*	0.347**	0.424**	0.385**
Exercise self-efficacy[c]						
Week 0	-0.048	-0.110	0.066	0.027	0.095	0.137
Week 8	-	-	0.305*	0.322*	0.278*	0.265*

[a]Individual regression models were conducted with pre-pregnancy activity survey and exercise self-efficacy as independent predictors and pedometer steps and calories as dependent variables.

[b]Standardized regression coefficient for each predictor variable.

[c]Laffery et al. 2001

*,**Significant at P<0.05 and P<0.01 respectively.

density lipoproteins (LDL), total cholesterol and triglycerides were assessed by a commercial laboratory (Clinical Pathology Laboratories, Inc. Austin, TX).

RESULTS

A sample of 66 low-income, overweight women in early postpartum participated in a weight loss intervention. The distribution of participants was 51.5% Hispanics, 31.8% Caucasian and 16.7% African Americans. The BMI averaged 34 kg/m^2, with 42% overweight, 39% obese and 18% morbidly obese. The mean age of the mothers was 26 years and parity was 1 to 2. About half of the new mothers were lactating and 42% cohabitated with a partner. The majority of the women had partial college education (39.4%), were not employed (60%) and reported annual household income between $15,000 and $30,000 (76%).

Pedometer steps increased significantly from pre to post intervention (5298±289 vs. 8413±437, p<0.001). Participants classified as sedentary at 0 and 8 weeks were 11.3% vs. 37.9%, moderate 51.6% vs. 57.6%, and high, 37.1% vs. 4.5%. Similarly, energy expenditure as calculated by pedometers, increased from 238.7±16.6 kcals to 348.4±20.6 kcals (P<0.05). Overweight (509.8±32.2) participants had significantly higher energy expenditure, as reported by pedometer than obese (366.5±24.6) participants at week 8 (P<0.05), these values were not different at baseline (292.6±21.4 vs. 246.4±24.6), respectively. Within ethnicity, Caucasians (521.4±33.9) had significantly greater calories from pedometer, as compared to African-Americans (383.5±45.7) and Hispanic (403.8±27.2)(P<0.01). A similar trend was seen for

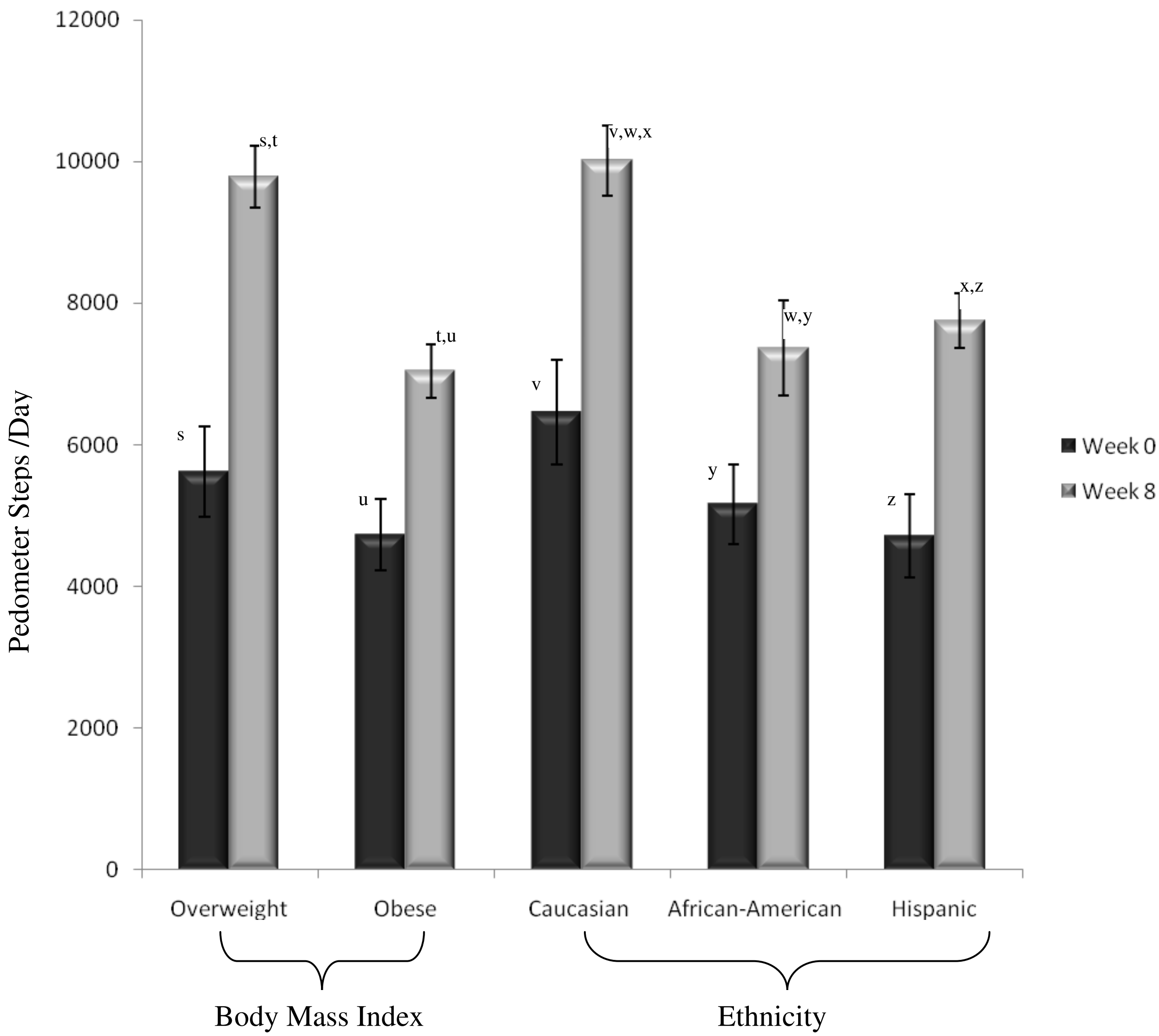

Figure 4.1. Pedometer steps across body mass index (BMI) groups and ethnicity at week 0 and 8 of a weight-loss intervention in low-income women in early postpartum. [s,t,u]Within BMI groups, bars with similar superscripts are significantly different (*P*<0.05). [v,w,x,y,z]Within ethnic groups, bars with similar superscripts are significantly different (*P*<0.05).

pedometer steps within BMI and ethnic groups at week 8 (Figure 4.1). Mothers with BMI< 30 kg/m^2 had greater pedometer steps, as compared to those with BMI≥30 and <40 kg/m^2at post-study (P<0.05). Similarly, Caucasian participants were more active than Hispanics and African-Americans at the end of intervention (P<0.05). Parallel associations were observed for improvement in calories and steps across BMI categories and ethnicity. Overweight participants had greater improvement in both calories (P<0.05) and steps (P<0.01). Within ethnicity Hispanics showed a larger change in physical activity as compared to African Americans (P<0.05). No difference was observed between Caucasians and other ethnic groups.

The pre-pregnancy activity survey significantly predicted pedometer steps and energy expenditure and improvement in physical activity at the end of the intervention (Table 4.1). Significant positive associations were observed between exercise self-efficacy and pedometer steps and energy at week 8, but not at the beginning of the program. A higher self-efficacy also was related to greater improvement in pedometer steps (P<0.05) and energy (P<0.01).

The participation in walking at a slow (63% vs. 82.7%) or fast (22% vs. 36.5%) pace, and jogging (10% vs. 31%) (P<0.05) improved significantly at post intervention. Aerobics was reported by only 5% of the participants at pre-study, but it was elevated significantly at post-study to 15% (P<0.01). The percentage of subjects who were dancing (14.1% vs. 16%) or weightlifting (6.6% vs. 8%) at pre/post program did not significantly change.

Table 4.2. Relationship between physical activity variables and anthropometrics and serum lipids at week 8 of a weight-loss intervention in low-income women in early postpartum[a]

	Waist Circumference (cm)			Body Fat (%)			BMI[c] (kg/m²)			Weight loss (kg)			HDL cholesterol (mg/dl)			LDL cholesterol (mg/dl)			Total cholesterol (mg/dl)			Triglyceride (mg/dl)		
Physical Activity Variables	R^2[b]	β[c]	P Value	R^2	β	P value	R^2	β	P value	R^2	β	P value	R^2	β	P value	R^2	β	P value	R^2	β	P value	R^2	β	P value
Pedometer Steps																								
Week 0	.012	.020	.351	.004	.052	.433	.014	.132	.543	.006	.067	.341	.005	.050	.234	.167	.421[y]	.010	.289	.563[y]	.001	.008	.028	.546
Week 8	.137	.156	.886	.088	.316[x]	.057	.147	.340[x]	.014	.203	.465[x]	.001	-.024	.045	.610	.137	.391[y]	.018	.323	.418[y]	.001	.217	.549[z]	.001
Change (%)	.662	.173[x]	.001	.817	.177[x]	.001	.971	.069[x]	.001	.080	.274[x]	.068	.059	.068	.543	.025	.021	.354	.208	.013	.282	.084	.023	.435
Exercise Self-efficacy[e]																								
Week 0	.016	.077	.234	.019	.028	.345	.026	.121	.546	.027	.189	.564	.022	.034	.543	.022	.002	.324	.023	.029	.586	.013	.004	.324
Week 8	.086	.084	.453	.049	.007	.054	.234	.381[x]	.024	.153	.417[y]	.022	.001	.121	.739	.241	.220	.081	.153	.387[x]	.031	.014	.048	.435
Change (%)	.008	.100	.432	.019	.038	.553	.010	.097	.532	.175	.445[y]	.011	.019	.084	.342	.041	.241	.202	.123	.301[x]	.075	.024	.055	.546

[a]Individual regression model were conducted with anthropometrics and lipids as dependent variables and physical variables as independent predictors.

[b]R^2 adjusted for energy intake, baseline scores of the respective dependent variables, and BMI at week 8.

[c]Standardized regression coefficient for each predictor variable.

[d]Body Mass Index.

[e]Laffery et al. 2001

*,**,***Significant at P<0.05, P<0.01, P<0.001 respectively.

At the end of the 8-week intervention, participants significantly lost weight (mean 185.3 ±4.7 vs. 179.3±4.8 lbs), % body fat (mean 41.3±0.7 vs. 39.7±0.85), and waist circumference (mean 39.0±0.6 vs. 37.6±0.6 cm) ($P<0.001$). Pedometer steps and self-efficacy significantly predicted weight loss and percent body fat (Table 4.2). Body mass index also was influenced by pedometer steps ($P<0.01$) and self-efficacy ($P<0.05$) at week 8. Waist circumference was not affected by physical activity variables. Pedometer steps were significant predictors of LDL and total cholesterol and triglycerides. Exercise self-efficacy was associated with total cholesterol at the end of intervention.

Logistic regression analyses measured the influence of physical activity steps and efficacy on responder categories. After adjusting for energy intake, responders had significantly higher pedometer determined steps and self-efficacy scores. In particular, the probability of being classified in the responder category increased by 20% for each 1000 steps/day; and by 34% for a 1% improvement in pedometer steps (Table 4.3). Also, chances of losing ≥ 2.25 kg (responder category) was elevated by 10%, with each one point increase in self-efficacy scale.

DISCUSSION

The intervention was successful in improving physical activity as assessed by pedometers. Moreover, pedometer steps predicted serum lipids and weight status in low-income, overweight women in early postpartum. Initially, this population was minimally active, with more than 35% in low and less than 10% in high activity category. However,

Table 4.3. Logistic regression model to predict weight loss ≥ 2.25 kg in low-income women in early postpartum

Physical Activity Variables	OR[a]	Confidence Interval	P value
Pedometer Steps			
Week 0	0.996	0.813-1.032	0.973
Week 8	1.201	1.110-1.302	0.047
Change in pedometer steps (%)	1.345	1.162-1.556	0.040
Self-efficacy score			
Week 0	0.984	0.756-1.341	0.653
Week 8	1.100	1.001-1.203	0.037
Change in self-efficacy score (%)	0.998	0.768-1.345	0.239

[a] Odds ratio for multivariate logistic regression analyses adjusted for energy intake.

a 63% increase from baseline was observed by the end of intervention, which is remarkably similar to the 63.5% reported by Clarke and colleagues (2007) in low-income women with young children. These results also corroborate the influence of pedometer in increasing activity in obese (Fogelholm et al 1999), sedentary (Sidman et al. 2004) and working women (Speck et al.2001).

The significant negative association of pedometer steps with body fat % and BMI is consistent with that reported by others. Tudor-Locke and colleagues (2001), documented that pedometer (steps/day) were in inversely related with BMI (r=-0.30) and percent body fat (r=-0.27) (P<0.01) in adult men and women. Similar negative associations were observed between BMI (r=-0.24) and % body fat (r=-0.42) (P<0.01) in adult women (Woolf et al. 2008). These relationships were further examined in a group of healthy adults by Thompson and colleagues (2004). Greater pedometer steps were related to lower BMI and percent body fat. In addition, Hornbuckle and colleagues (2005) reported that pedometer-determined physical activity was related negatively with BMI and % body fat.

It is well established that physical activity is positively associated with desirable lipid profiles (Albright, et al. 2006). Sugiura and colleagues (2002) reported that lipid profiles of sedentary menopausal women improved with activity levels. Steps per day were significantly positively associated with HDL, and inversely, with total cholesterol. Similarly, physical activity levels in premenopausal women were related with favorable lipids profiles (Duncan et al. 1991). Moreover, pedometer steps were associated with significant reductions in triglycerides in Japanese men (Kobayashi et al. 2006).

Self-efficacy and pre-pregnancy exercise history significantly improved activity levels in low-income women. These results support the other documented associations of exercise self-efficacy and activity levels in obese African-American women (Annesi et al. 2007) and overweight/obese women with young children (Clarke et al. 2007). Mothers that were active before pregnancy had a greater change in pedometer steps and calories, leading to higher physical activity levels at week 8 when controlled for self-efficacy. This influence of previous exercise experience as a predictor of physical activity has also been reported in older adults (Lee et al. 2006). Participants who exercised during youth or middle age were more likely to be active later in life. Similar associations of previous activity history as a determinant of exercise levels in older women have been illustrated by other studies (Conn et al. 1998, Hellman et al. 1994, Resnick et al 2001, Plonczynski et al. 2003). Even though we do not assess long term history, our results demonstrate that even recent exercise history is predictive of physical activity levels at postpartum. Thus an intervention focused on augmenting activity levels should take into consideration participants exercise history for maximum success.

The results of logistic regression analysis revealed a positive association between activity levels measured via pedometer and weight loss category. Participants in the responder category had higher pedometer steps and self-efficacy scores at post intervention. They also had greater improvement in both areas at the end of the program. Moreau and colleagues (Moreau at al. 2001) observed a weight loss of 1.3 kg with an increase in pedometer steps in postmenopausal women. Similarly, an increase in 1000 steps/day was shown to be associated with greater probability (20%) of losing 5-10% of initial body weight in overweight/obese adults.

A small sample size and short duration of the intervention was one of the limitations of this study. A longer intervention and larger sample size was not feasible during this critical period of early postpartum. Nonetheless, the fact that pedometer steps increased at the end of this 8 week intervention suggests that it had a notable influence on activity levels of this population. Use of pedometer to measure physical activity, restricts the ability to measure intensity of exercise, and patterns and types of activity. For example upper body activities, such as weight-lifting or water based activities such as swimming cannot be assessed using pedometers. Accelerometers may be a better assessment tool; however, their high costs ($500), as compared to pedometers ($15 to $30), and technical expertise and additional hardware required to analyze data prohibits it use for demonstration programs for low-income mothers in WIC programs.

CONCLUSIONS

A nutrition and physical activity intervention, tailored to postpartum women, effectively increase physical activity and self-efficacy. Walking, jogging and aerobics were the most preferred type of activities and should be encouraged in this population to enhance efficacy of the program. Physical activity levels and exercise self-efficacy may predict weight loss and lipid levels. Since losing pregnancy related weight is a concern; physical activity should be encouraged in early postpartum women. Future studies may assess the retention of exercise behavior and its effect on physiological variables in a longitudinal research design to confirm our results and conclude causality.

Chapter 5: Determinants of Nutrition Knowledge in Low-Income Women in Early Postpartum and the Relationship to Dietary Behaviors

ABSTRACT

Objective: To assess nutrition knowledge of low-income, postpartum women and determined its influence on diet.

Study Design: A convenience sample of low-income mothers completed a demographics questionnaire, nutrition knowledge questionnaire, household availability of food survey, and a 24 hr recall and 2-day food intake records.

Subjects: Participants (n=171) were recruited from the Special Supplemental Program for Women Infants and Children (WIC) clinics and public health clinics. All subjects were Hispanic, African American, or Caucasian mothers of children 1 – 3 years old, ≥ 18 years of age, income < 200% of the federal poverty level, and were literate in English.

Statistical Analysis Performed: Pearson's correlation and intraclass correlation coefficient (ICC) measured test-retest reliability. Independent *t* test compared the scores of new mothers with students to examine discriminant validity. Kuder Richardson's KR-20 determined internal consistency reliability. Pearson's bivariate and partial correlations evaluated the relationship of knowledge scores with food group and nutrient intakes and household availability of foods. A hierarchical regression model identified the determinants of knowledge.

Results: The mean correct responses on the scale were 54% with mean component scores for weight management, 76%, vitamins and minerals, 73%, energy nutrients, 50% and calorie counting, 52%. Scores were significantly higher in participants that were overweight, White, younger, with partial college education and household income $\geq$ 30,000$. Higher knowledge was associated with greater types of fruits, vegetables, whole grains, yogurt, low-fat frozen yogurt and unsweetened beverages at home. Total scores were related to higher intakes of grains, low fat meat and beans, dairy, fiber, calcium, and iron and lower of energy and protein.

Conclusions: Low-income women in early postpartum had less than optimal nutrition knowledge. The areas of concern were energy nutrients and calorie counting, however, participants also displayed cognizance for weight management and vitamins and minerals components. Higher scores on index were associated with healthful food groups and nutrient intakes and household availability of fruits and vegetables, whole grains, yogurts and unsweetened beverages.

INTRODUCTION

Dietary behaviors are associated with leading causes of death such as coronary heart disease and type 2 diabetes and with osteoporosis and iron deficiency anemia. Unfortunately these diseases are highly prevalent in the low socioeconomic strata; a population that has unhealthful diet quality. Individuals of lower economic strata have been found to consume diets high in fats and low in fruits and vegetables and micronutrients (Subar et al. 1995, Ball et al. 2004, De Irala-Estevez et al. 2000, Johansson et al. 1999). Healthful eating behaviors further deteriorate in new mothers (George et al. 2005) which may lead to long term obesity (Lahmann et al. 2000).

Nutrition knowledge has been shown to stimulate healthful dietary behaviors such as avoiding fats (Neuhouser et al. 1999) and adopting low-fat dietary patterns that reduced intake of foods that are high in energy and fats, and meal planning (Petrovici et al. 2006, Boulanger et al. 2002). In addition, Fitzgerald and colleagues (2008) reported that individuals with higher knowledge were more likely to select healthy foods. However, the association of nutrition knowledge and food intake has been debated. Many studies have failed to find a strong relationship (Axelson et al. 1984, Shepherd and Stockley, 1987, Shepherd and Towler, 1992, Stafleu et al. 1996) between knowledge and diet, while others have reported positive links with dietary change and food intakes (Kristal et al. 1990, Guthrie et al. 1995, Variyam et al. 1998, Satia et al. 2005).

However, nutrition awareness in low-income women is limited. For example, low-income caretakers with children did not read food labels or have low-fat, eating habits as readily as their higher income counterparts (Morton and Guthrie 1997). Kruger and Gericke (2003) also found that low-income mothers had suboptimal knowledge of nutrition and adhered to cultural food practices. Moreover, low-income and minority mothers of elementary school children may lack fundamental nutrition knowledge related to health of their families (Ivanovic et al. 1997, Touliatos et al. 1984). In addition, Baughcum and colleagues (1998) documented the primary source of nutritional information in WIC qualified women was their mothers, and most of this information may not be correct. Since, mothers also play an important in role in the nutritional status of family (Lang et al. 1992) and children (Lehman-Klohe et al. 2007), it is important to assess knowledge levels of this population and their influence on food intake.

Availability of foods at home has been shown to influence eating patterns (Kratt et al. 2000, Raynor et al. 2004, Cullen et al. 2003, Campbell et al. 2007, Gattshall et al. 2008). Variety is another important factor that is related to better nutritional status (Giskes et al. 2002, Bernstein et al. 2002) and is used in promotion of fruits and vegetables (Havas et al. 2005, National Cancer Institute, USDA-2005). However, lower variety in diet is reported in adults from low-socioeconomic groups (Estaquio et al. 2008, Giskes et al. 2002). Therefore we will assess household availability of types of foods among overweight/obese postpartum women.

In addition, evaluation of determinants of knowledge is also essential as it can assist in identification of segments of population within low-income, postpartum women that should be targeted for education programs. Moreover, it will enable dissipation of demographically and culturally appropriate health information. Therefore, the goal of the present study was to assess knowledge of nutrition in low-income, early postpartum women and to assess relationships with types of food available in the household as well as dietary behaviors. A secondary purpose will be to identify the determinants of knowledge in these women.

METHODS

Study Design

Nutrition knowledge scores were assessed in low-income, overweight (Body Mass Index >25 kg/m^2) women, at 0-4 months postpartum (N=171). Participants were measured for height and weight and completed a demographic, health history and nutrition knowledge questionnaire. A 24-hour recall and 2-day food intake records were collected by a trained interviewer.

Subjects

Low-income mothers were recruited via flyers posted at Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) clinics, doctor's offices, and community centers. Applicants were screened over the telephone and were enrolled if they met the inclusion criteria. Participants were of Hispanic, African-American, or White ethnicity, low-income (annual household income<185% federal poverty level or qualification for WIC), 18-40 years old, had body mass index (BMI) ≥ 25 kg/m^2 and infant 0-4 months old. Additional eligibility criteria were ability to read, speak, and write English, parity ≤ 3, and absence of pregnancy and chronic health conditions (heart disease, renal disease or diabetes). No differences were observed between mothers recruited from different locations. All subjects provided informed consent and the study protocols were approved by the Institutional Review Board of The University of Texas at Austin.

Anthropometrics

Height and weight were assessed according to the protocols of the National Health and Nutrition Examination Survey III (30). Height was measured with a stadiometer (Perspectives Enterprises, Portage, MI) to the nearest 0.1 cm and weight with an electronic weighing scale (Model HS-100-A; Fairbanks Scales, St Johnsbury, VT) to the nearest 0.1 kg. BMI was calculated as kg/m2. Postpartum weight loss was computed as the difference in weight just before delivery of child and at the visit.

Demographics Questionnaire

Sociodemographic data were obtained with a 54-item self-administered questionnaire (Clarke et al. 2007). Information regarding age, ethnicity, income, education, employment, parity, method of infant feeding, gestational weight gain and self-reported weight at delivery was collected.

Dietary Intake

A trained interviewer collected 3 days of dietary data including a 24-hr recall and 2 days (1 weekend day) of food intake records. The US Department of Agriculture five-step method was employed for 24-hour recall (Conway et al. 2003). Visual tools such as food models and household measures were used to aid accuracy in measuring portion sizes. All dietary records were checked for completeness and ambiguous responses. Missing information was collected via the telephone. Nutrient data such as mean daily energy, macronutrients, and vitamins and minerals was obtained using the Food

Processor SQL 9.6.2 program (ESHA Research, Salem, OR). Dietary information was judged as unreliable if the energy intake was higher than 4500 or lower than 500 calories. Similar exclusion criteria have been previously used in other studies of multiethnic/minority women (Patterson et al. 2003,Yanek et al. 2001) in postpartum (George et al. 2005). All foods were assigned to appropriate food groups designated by MyPyramid (Britten et al. 2006). Mixed foods were first broken down into their component ingredients and then assigned to the respective food groups. For example, "cheeseburger" was listed as bun, beef patty, cheese, and vegetables and assigned to grain, meat and beans, dairy and vegetables categories, respectively.

Nutrition Knowledge

A 45-item test (original version) was developed to measure nutrition knowledge in low-income, early postpartum women. Content validity was assessed by an expert panel of ten nutritional professionals who evaluated the items for readability and conceptual agreement. The content validity index for the instrument was 0.92. The final 33-item instrument contained four areas of interest; energy nutrients (11 items), vitamins and minerals (6 items), weight management (8 items) and calorie counting (8 items).

Test-retest reliability was established by administering the questionnaire to an additional sample (n=28) at two occasions with 2 weeks between time points. Pearson's correlations and intraclass correlation coefficient (ICC) were utilized to examine test-retest variation (Yen et al. 2002). Total score were strongly associated between both time points (Pearson's $r=0.54$, $P<0.001$) with an ICC value of 0.70.

Discriminant validity was measured by comparing the scores of new mothers with undergraduate students enrolled in a nutrition class (N=82) using an independent sample *t* test. The undergraduate students scored significantly better than low-income mothers with mean correct responses of 63.3% and 54%, respectively (P<0.001). These results confirm validity and indicate that the questionnaire was able to differentiate between those with higher and lower levels of knowledge.

Internal consistency reliability was determined using Kuder Richardson's KR-20; a preferred test for dichotomous variables. The KR-20 for the final scale was 0.71. This value is considered a good scale because KR-20 produces more conservative estimates than Cronbach's α (McDonald 1999).

Household Food Availability

The availability of different foods at home was determined by a survey. The questions inquired about presence of foods at home a along with number of types. A sample question is "Do you have chips at your home" – Yes/No and "If yes, list the types".

Statistical Analysis

Statistical analysis was conducted using SPSS (version 15.0, 2006, SPSS Inc, Chicago, IL). Demographics were described via frequencies and means. Analysis of variance with Bonferoni post hoc was used to compare differences in nutrition knowledge total and component scores within demographic groups. Pearson's correlation evaluated the association of knowledge scores with types of foods available at home. Partial correlations measured the relationship of knowledge scale scores with nutrient and food group intakes while controlling for energy intake and BMI.

A hierarchical regression model was computed to identify determinants of knowledge in low-income women. The associations of the predictors with knowledge scores were first determined using an analysis of variance. Factors that were significantly related to knowledge were added to the hierarchical regression model. Statistical significance was assigned at the level of $P<0.05$.

RESULTS

The demographic profile of the participants in reported in Table 5.1. Mean BMI of the sample (N=171) was 33.3 kg/m^2, with a majority (59%) having a BMI $\geq$30 kg/m^2. Most participants identified themselves as Hispanic or Caucasian; only 19.8% were African-American. Over 60% were high school graduates and the rest completed partial high school. The most commonly reported annual household income fell between $15,000 and $29,999 group; and 17.5% were above $30,000. Approximately, 38.5% were employed and 80% collected benefits from WIC clinics. Similar numbers of the sample breast fed and formula fed.

Participants had more awareness about vitamins and minerals with 73% correct responses and weight management (76%); weakest areas were energy nutrients (50%), and calorie counting (52%) (Table 5.1). Differences in nutrition knowledge by demographics are shown in Table 5.1. Overweight participants had significantly better

Table 5.1. Nutrition knowledge scores of low-income women in early postpartum

Characteristics	N	Total Score	Knowledge Subscale Scores: Energy Nutrients	Vitamins and Minerals	Weight Management	Calorie Counting
		Mean ± SEM[a,b]				
All Sample	171	18.4±0.36	4.9±0.15	3.9±0.10	5.6±0.10	3.8±0.10
Body Mass Index (kg/m²)						
25-29.99[c]	69	21.0±0.70[x,y]	5.5±0.13[x,y]	4.4±0.20[y,z]	6.1±0.13[x,y]	4.2±0.13[x,y]
30-39.99	65	17.6±0.82[y]	4.8±0.18[y,z]	3.8±0.24[x,z]	5.6±0.13[x]	3.8±0.12[x,z]
≥40	37	16.7±0.42[x]	4.3±0.26[x,z]	3.4±0.12[x,y]	5.4±0.18[y]	3.6±0.18[y,z]
Age (y)						
18-25.9	60	16.8±0.61[x,y]	4.3±0.26[x,y]	3.4±0.17[x,y]	5.4±0.18	3.6±0.18
26-30.9	54	19.0±0.62[y]	5.2±0.26[y]	4.0±0.17[x]	5.8±0.18	3.9±0.18

31-40	57	19.4±0.71^{x}	5.3±0.30^{x}	4.3±0.20^{y}	5.7±0.21	4.0±0.12
Ethnicity						
White	69	21.8±0.70^{x,y}	6.0±0.30^{x,y}	4.8±0.20^{x,y}	6.1±0.21^{x,y}	4.8±0.20^{x,y}
African American	34	14.6±0.82^{x,z}	3.4±0.36^{x,z}	2.9±0.24^{y,z}	5.0±0.25^{x,z}	2.9±0.24^{y,z}
Hispanic	68	18.1±0.42^{y,z}	4.8±0.18^{y,z}	3.8±0.12^{x,z}	5.6±0.13^{y,z}	3.8±0.12^{x,z}
Education						
Partial High School	65	14.6±0.74^{x,y}	3.9±0.31^{x}	2.8±0.20^{x,y}	4.6±0.21^{x,y}	3.2±0.21^{x}
High School Graduate	70	17.2±0.64^{x,z}	4.4±0.25	3.7±0.18^{x,z}	5.5±0.25^{x,z}	3.6±0.25
Partial College	36	20.4±0.45^{y,z}	5.5±0.13^{x}	4.4±0.13^{y,z}	6.1±0.13^{y,z}	4.2±0.13^{x}
Income ($)						
<15,000	58	15.9±0.59^{x,y}	4.1±0.26^{x,y}	3.4±0.17^{x,y}	5.3±0.17^{x}	3.1±0.17^{x,y}
15,000-29,999	83	19.0±0.49^{x}	5.1±0.21^{x}	4.1±0.13^{x}	5.8±0.14	4.2±0.14^{x}
30,000-44,999	30	21.4±0.85^{y}	6.0±0.37^{y}	4.7±0.23^{y}	6.1±0.24^{x}	4.5±0.24^{y}
Employment Status						
Employed	66	18.7±4.3	5.1±0.23	4.0±0.15	5.8±0.17	3.8±0.14

Not Employed	105	18.8±5.2	4.8±0.20	3.9±0.13	5.6±0.12	3.9±0.14
Infant Feeding Method						
Formula Feeding	72	16.7±0.53[y]	4.4±0.23[x]	3.5±0.15[y]	5.2±0.15[y]	3.5±0.15[y]
Combination	32	17.6±0.83[x]	4.5±0.36[y]	3.8±0.24[x]	5.6±0.24[x]	3.6±0.24[x]
Breastfeeding	67	20.4±0.55[x,y]	5.5±0.24[x,y]	4.3±0.16[x,y]	6.0±0.16[x,y]	4.4±0.16[x,y]

[a]Standard Error of the Mean

[b]Mean scores adjusted for weight status, except for Body Mass Index group

[c]Analysis of covariance was utilized to evaluate difference in nutrition knowledge scores by demographic variables.

[x,y]Common superscripts within column, within group indicate significant differences at $P<0.05$

total and component scores as compared to both obese ($P<0.001$) and morbidly obese ($P<0.01$). Scores for total, energy nutrients, vitamins and minerals were positively associated with age ($P<0.001$). In particular, scores were higher in mothers in age group 18-25.9 years as compared to those in groups 26-30.9 years and 31-40 years. Within ethnicity, Caucasians scored significantly higher than African Americans ($P<0.001$) and Hispanics ($P<0.001$) for total and subscale scores. Caucasians had highest scores, followed by Hispanics and African Americans. Knowledge also improved with years of formal education. Those with only partial high school education had less knowledge than those with either high school degree ($P<0.01$) or partial college education ($P<0.001$). Participants with partial college had better knowledge than all of their lesser qualified counterparts. Although the target sample was below federal poverty line, differences in knowledge were observed across income levels. Higher knowledge was reported in $30,000 and above income groups compared to those in lower economic strata. Mothers who breastfed their infants had significantly higher scores than those who fed only formula ($P<0.001$). In addition, participants that skipped meals had lower scores (15.2 ± 1.0) than those who did not (18.9 ± 0.3). Scores also correlated negatively with number of children in the household ($r=-0.229$, $P<0.01$) and positively with postpartum weight loss ($r=0.159$, $P<0.05$).

Association of knowledge scores with household availability of foods is demonstrated in Table 5.2. Women who had a higher overall knowledge had a greater variety of fruits, vegetables, whole grains, yogurt, low-fat frozen yogurt and unsweetened beverages at home. In addition, knowledge of energy nutrients was related with more

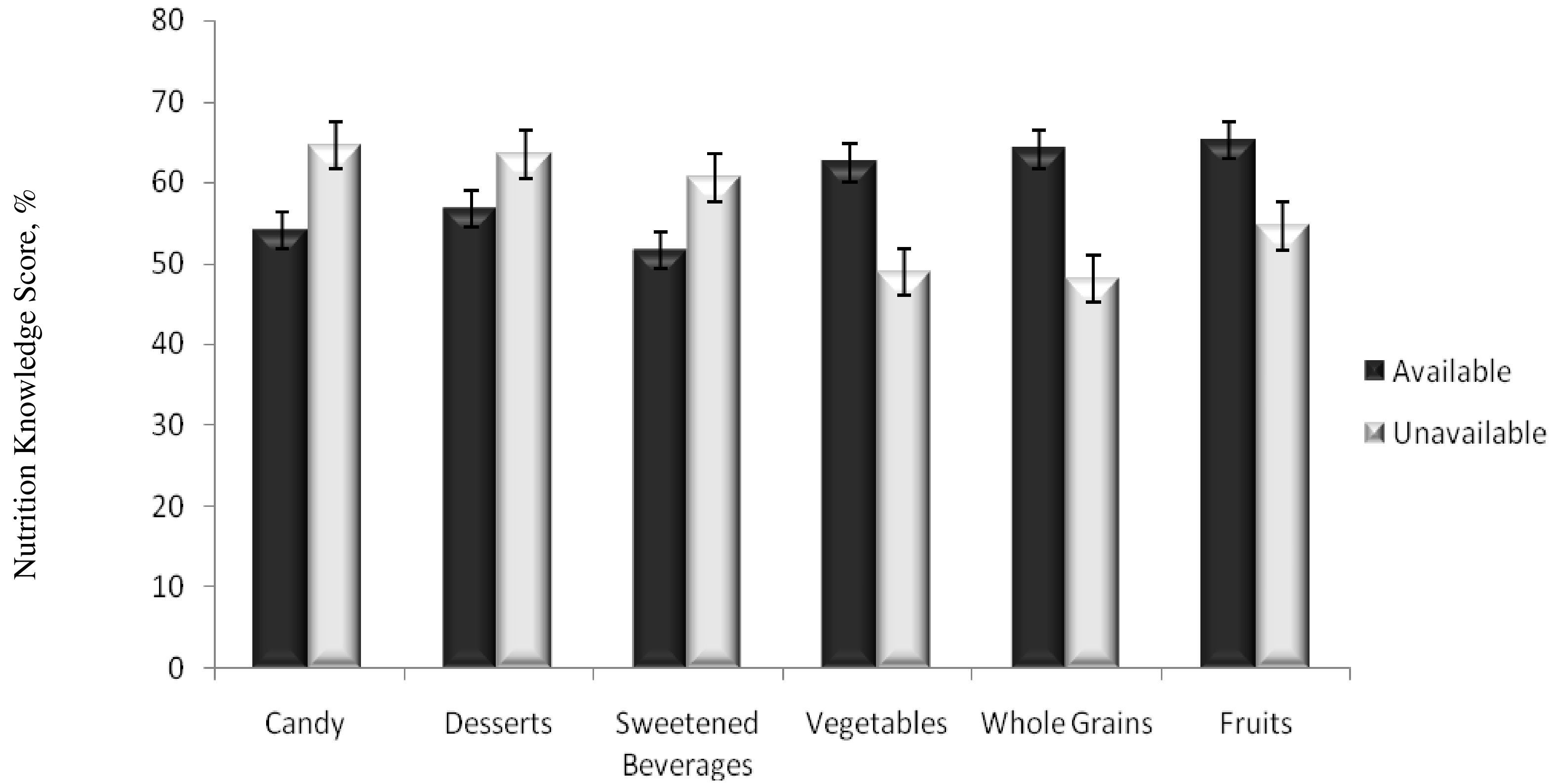
Nutrition Knowledge Score, %
80
70
60
50
40
30
20
10
0
Candy
Desserts
Sweetened Beverages
Vegetables
Whole Grains
Fruits
Available
Unavailable

Figure 5.1. Nutrition Knowledge scores differ by household availability of foods in low-income women in early postpartum. Significant differences in knowledge scores ($P<0.05$) was observed between participants that food groups available or unavailable.

types of whole grains, yogurt, frozen yogurt and less of sweetened beverages. Similarly, vitamins and minerals component was associated with more yogurt and weight management subscale with fewer types of desserts. Better scores in calorie counting correlated with greater variety of fruits, vegetables, whole grains and yogurt. Intakes of food groups were also linked with knowledge after controlling for energy intake and weight status. Total knowledge was related to greater consumption of total and whole grains, low fat meat and beans and total and low fat dairy (Table 5.3). Dairy and low-fat meat and beans intake was also associated with component scores. Moreover, knowledge of vitamins and minerals and energy nutrients influenced grains and vegetables consumption. Overall knowledge influenced energy intake and protein intakes negatively ($P<0.01$) and fiber ($P<0.01$), calcium ($P<0.001$), iron ($P<0.05$) and potassium ($P<0.001$) positively (Table 5.4). Knowledge of weight management was related negatively with energy ($P<0.05$) and fats ($P<0.01$) and that of energy nutrients positively with iron, sodium and potassium ($P<0.05$). Protein and fiber were related positively with all components except weight management.

A hierarchical regression model for the prediction of nutrition knowledge is presented in Table 5.5. Impact of infant feeding method on knowledge demonstrated significance $P<0.01$. Addition of age significantly increased the adjusted R^2 by 6%; ethnicity was a stronger determinant, contributing 14.6% to the variance. Education and income further contributed increments of 7.5% and 4.2%, respectively, so that the final model explained 44.5% of the variance in knowledge scores. The β weights suggest

Table 5.2. Association of nutrition knowledge scale scores and household availability of foods in low-income women in early postpartum[a].

		Subscale Scores			
Types of foods	Total Score	Energy Nutrients	Vitamins And Minerals	Weight Management	Calorie Counting
Fruits	0.166*	0.162	0.110	0.059	0.176*
Vegetables	0.191*	0.158	0.112	0.011	0.310**
Whole grains	0.205*	0.216*	0.109	0.129	0.172*
Yogurt	0.297**	0.318**	0.315**	0.036	0.231**
Low-fat frozen yogurt	0.192*	0.257**	0.088	0.019	0.186*

Sweetened Beverages	-0.145	-0.197*	-0.084	-0.063	-0.072
Unsweetened Beverages	0.170*	0.137	0.127	0.110	0.156
Desserts	-0.144	-0.120	-0.127	-0.248**	0.041

[a]Correlation coefficients are reported.

*, **, *** Significant at $P<0.05$, 0.01, 0.001, respectively.

Table 5.3. Association of nutrition knowledge scale scores and food group intake in low-income women in early postpartum[a].

		Subscale Scores			
Food Groups	**Total Score**	**Energy Nutrients**	**Vitamins And Minerals**	**Weight Management**	**Calorie Counting**
Grains (oz)					
Total	0.210*	0.231**	0.208*	0.072	0.074
Whole	0.256*	0.162*	0.102	0.071	0.077
Fruits (cups)					
Total	0.020	0.032	0.014	0.040	0.044
Fruit Juice	-0.243*	0.132	0.116	-0.072	0.175
Vegetables (cups)					
Total	0.193*	0.033	0.250*	0.012	0.032

Dark Green Leafy Vegetables	0.155	0.147	0.362*	0.081	0.060
Meats and Beans (oz)					
Total	-0.022	0.136	-0.013	-0.034	0.008
Low Fat	0.234**	0.174*	0.091	0.197*	0.215*
Dairy (cups)					
Total	0.323***	0.299**	0.171*	0.127	0.289**
Low Fat	0.372***	0.314***	0.339***	0.225*	0.260**

[a] Partial correlation coefficients after adjusting for total energy (kcals) intake and Body Mass Index.

*, **, *** Significant at P<0.05, 0.01, 0.001, respectively.

Table 5.4. Association of nutrition knowledge scale scores and nutrient intakes in low-income women in early postpartum[a].

Nutrients	Total Score	Subscale Scores: Energy Nutrients	Vitamins and Minerals	Weight Management	Calorie Counting
Energy (kcals)[b]	-0.322**	-0.115	-0.041	-0.214**	-0.341***
Carbohydrates (g)	-0.054	-0.096	-0.119	0.057	-0.037
Protein (g)	0.229**	0.187*	0.180*	0.089	0.159*
Total Fat (g)	-0.096	0.081	0.023	-0.236*	-0.072
Saturated Fat (g)	-0.189	0.041	-0.023	-0.284**	-0.161
Fiber (g)	0.256**	0.165*	0.147*	0.172*	-0.116

Calcium (mg)	0.299***	0.282***	0.172*	0.169*	0.228**
Iron (µg)	0.188*	0.165*	0.112	-0.087	0.025
Sodium (mg)	0.094	0.154*	0.019	0.125	0.071
Potassium (g)	0.204**	0.147*	0.161*	0.056	0.137

[a]Partial correlation coefficients after adjusting for total energy (kcals) intake and Body Mass Index.

[b]Partial correlation coefficients after adjusting for Body Mass Index.

*, **, *** Significant at P<0.05, 0.01, 0.001, respectively.

Table 5.5. Hierarchical regression models for prediction of nutrition knowledge in low-income women in early postpartum

Variable	Adjusted R^2 change	Standardized β	P value
Step 1	0.119***		
Infant Feeding Method			
Formula Feeding		-0.345	0.001
Breast Feeding[a]	----------	---------	--------

Step 2	0.060**		
Age (yrs)			
18-25.99		-0.278	0.002
25.99-29.99		-0.068	0.438
30-40[a]	----------	---------	--------
Step 3	0.146***		
Ethnicity			
Hispanic Ethnicity		-0.208	0.011
African American		-0.472	0.001
Caucasian[a]	-----------	-----------	----------

Step 4	0.075***		
Education			
Partial High School		-0.335	0.001
High School Graduate		-0.211	0.002
Partial College[a]	----------	----------	--------
Step 5	0.042**		
Income ($)			
<15,000		-0.317	0.001
15,000-29,999		-0.152	0.088
>30,000[a]	------------	---------	--------

Model adjusted R^2	0.445

,* Significant prediction of nutrition knowledge score, $P<0.01$, 0.001, respectively.

[a]Reference category for each group.

knowledge was related negatively to formula feeding, Hispanic and African American ethnicity, age <26 years, education < partial college, and income < $15,000.

DISCUSSION

Low-income, overweight/obese women in early postpartum had relatively low levels of nutrition knowledge. Areas of significant weakness were energy nutrients and calorie counting. Moreover, knowledge scores were associated with household availability of healthful foods especially of fruits and vegetables, whole grains, yogurts and unsweetened beverages. Moreover, knowledge was related positively with consumption of grains, vegetables, low fat meat and beans and dairy, and negatively with fruit juice. Scores improved with age, education, and income and were higher in Caucasians and breastfeeding mothers.

The observations of this study are consistent with other research that links nutrition knowledge with diet. The positive associations of knowledge test scores with vegetable consumption observed in present study have been documented in adults in both upper (Wardle et al. 2000) and lower socio-economic strata (Ball et al. 2006). Moreover, adults in the highest nutrition knowledge category were almost 25 times as likely as those in the lowest category to be eating a healthy diet. (Wardle et al. 2000). Fitzgerald and colleagues (2008) demonstrated that knowledge was associated with more frequent consumption of meats, fruits, and vegetables and less of salty snacks in Latinas. Similarly, awareness of recommended servings of various food groups in Mexican Americans, predicted eating behavior of those food groups except fruits and vegetables (Sharma et al. 2008). Beydoun and colleagues (Beydoun et al. 2009) showed a significant and graded positive association of knowledge on diet quality as measured by Healthy Eating Index-2005 independent of socio-economic, lifestyle and geographic factors. Therefore enhancing nutrition knowledge can help promote healthy eating in individuals.

Another important finding of the present study was the relationship between nutrition knowledge and household availability of types of fruits, vegetables, whole grains, yogurts and unsweetened beverages. Previous research highlights the impact of household availability and consumption of foods such as fats (Raynor et al. 2004), fruits and vegetables (Cullen et al. 2003) Moreover, choosing a variety of foods such as fruits and vegetables is recommended by the Dietary Guidelines for Americans-2005. Therefore, knowledge component may improve dietary intakes by influencing availability of foods at home.

The mean test score in these women was 54% of the total possible score, with approximately 50% correct responses for energy nutrients and calorie counting sections. These results indicate significant lack of nutrition knowledge in low-income, early postpartum women. Since, women impact dietary behaviors of the entire family (Lang et al. 1992), including children (Lehman-Klohe et al. 2007), nutrition education programs in this population should be emphasized. There were no differences in nutrition knowledge between WIC participants and non-participants. Gupta and colleagues, reported a poor performance on questions related to identification of iron-rich foods in WIC mothers of children with and without anemia. Improvements in health-related knowledge of WIC enrollees has been observed after completion of an intervention designed to enhance acquired immunodeficiency syndrome/human immunodeficiency virus knowledge (55) and fruit and vegetable consumption (56,57). Thus, education of WIC mothers can promote specific health behaviors.

Differences in knowledge by demographic profiles observed here are comparable to previous studies. Higher scores were reported in Caucasians (Sapp et al. 1997, Sherman et al. 1995, Winkelby et al. 1994) compared to other ethnicities participants. Awareness of nutrition was higher in older, more educated and in participants with higher household income, as compared to younger, less educated and those with incomes <$15,000. The interaction of knowledge with age (Wardle et al. 2000), education (Sapp et al. 1997, Boulanger et al. 2002, Parmenter et al. 2000) and income (Morton et al. 1997, Parmenter et al. 2000, Harnack et al. 1998) has been documented previously. In addition, association of greater nutrition knowledge levels with fewer number of children found in this research is comparable to others (Morton et al. 1997, Boulanger et al. 2002, Ivanovic et al. 1997). Breastfeeding mothers in our study had better test scores. Havas and colleagues noticed in a study of WIC participants that the awareness of the recommended servings of fruits and vegetables was more in breastfeeding participants regardless of ethnicity. However, it is unclear if breastfeeding was an attribute of knowledge or vice versa. Thus, knowledge test may discern population at risk to develop poor diet quality. Consequently, including a strong component of nutrition education at earlier grade levels and public health programs involving mother and child may alleviate the discrepancies in knowledge.

A majority of our sample was recruited and collected benefits from WIC (80%), therefore this sample is quite representation of WIC participants in Austin, Texas. However, it would be improper to make generalizations to all low-income, postpartum women. Moreover, the design of this research was cross-sectional; therefore causality cannot be inferred from the findings. A longitudinal study that includes theory based intervention and dietary and physiological variables as outcomes may be needed.

CONCLUSION

The positive associations of knowledge with household food availability and dietary intakes suggest inclusion of a strong knowledge component in nutritional interventions to promote specific dietary behaviors.

In this sample of low-income, early postpartum women, socioeconomic disparities were found in nutrition knowledge. Scores differed by age, ethnicity, education and income and therefore special attention should be given to African-Americans and Hispanics, young women, partial high school graduates and individuals below $15,000 household income. To develop effective nutrition education programs messages should be targeted towards specific demographic groups. The WIC qualified population was cognizant in the sections of vitamins and minerals and weight management; but scored poorly in energy nutrients and calorie counting sections. Consequently, to promote diet quality, WIC programs should also incorporate these weaker areas in its successful curriculum that already includes vitamins and minerals component.

Chapter 6: Conclusions and Recommendations

The results of this study indicate that diet and physical activity are related to weight status and lipid profiles in low-income women in early postpartum. This population did not meet the recommendations of the 2005 Dietary Guidelines for Americans, especially for fruits, total vegetables, whole grains and oils, leading to a poor diet quality. Diet quality as measured by HEI-2005 influenced weight status, and lipid profiles. The frequency of snacking was related to diet quality, but not with body weight. Moreover, the majority of the sample was sedentary and activity levels were predictors of weight-loss and serum lipids. The levels of nutritional knowledge were associated with food choices and nutrient intakes.

In study 1, the aim was to measure diet quality of low-income women in early postpartum and determine its influence on lipid profiles. This population had minimal adherence with the 2005 Dietary Guidelines for Americans, as assessed by the HEI-2005. The areas of major concern were total and whole fruits, total vegetables, whole grains, and oil with less than 20% of the population meeting the recommendations. Similarly, more than 80% of the sample had over consumption of saturated fats and sodium. The adherence to meat and beans (60%), total grains (40%) and dairy groups (30%) was highest, indicating strong preferences for these groups. An abundance of solid fats, alcohol and added sugars was also observed in the diets, resulting in lower scores for this component. Discrepancies in total HEI-2005 scores were between ethnicities and infant feeding groups. Hispanic women had significantly better diet quality scores, as compared to African-American. Surprisingly, formula feeding participants scored higher on the index as compared to their breastfeeding counterparts. Moreover, diet quality was inversely associated with weight status, and positively with adverse lipid profiles.

Specifically, total and LDL cholesterol concentrations of the mothers were reduced, and that of HDL improved, with increasing tertiles of HEI-2005, independent of weight status, energy intakes and lactation status. Thus, educational programs designed for low-income women should focus on improving overall diet quality to reduce risks associated with CVD. Emphasize should be placed on specific techniques to promote consumption of fruits, vegetables, whole grains and reduce intakes of saturated fats, and added sugars.

A limitation of this study was use of 3-day food intake records to assess dietary intakes, which may not reflect the actual eating habits of the participants. Moreover, the underreporting that is commonly observed in overweight/obese groups may have resulted in underreporting of solid fats alcohol and sugars. In addition, causality cannot be determined from associations presented because of the cross-sectional nature of the study. These results need to be confirmed in a longitudinal study on a larger population. Finally, the use of convenience sample, limits the generalizability to low-income women in early postpartum.

For study 2, the objective was to assess snacking frequency in low-income, women in early postpartum and its association with diet quality and selected nutrient intakes. It was observed that a majority of low-income women (82%) snacked at least once a day and 32% had more than three snacks daily. Frequency of snacking was associated with better quality of diet and intakes of select nutrients. Snacks represented 30% of the total energy intake and were higher in carbohydrates and lower in fats and proteins in comparison to main meals. Interestingly, the number of snack occasions was positively associated with greater consumption of vitamin A and C, and calcium. Thus, snacks contributed to important nutrients, as well as energy. The most popular snacks were sweets and desserts, followed by dairy, fruits and salty snacks. Frequency of snacking did not differ by BMI categories; however, food choices were significantly different. Overweight mothers had significantly greater consumption of fruits, vegetables, dairy, and beverages than other groups. In contrast, morbidly obese women preferred more grains, sweets and desserts and grains as snack choices. Health practitioners may educate individuals about both snacking frequency and choices to improve overall diet quality.

In study 3, the goal was to assess physical activity using pedometers and association with weight loss and favorable lipid profiles in low-income women. Physical activity levels of this population were also very low. A majority of the sample was sedentary or exhibited low levels of activity. The 8 week physical activity and dietary intervention administered was successful at raising activity levels and exercise self-efficacy of low-income women. The most preferred type of activity was walking, jogging and aerobics. Maximum improvement for these activities also was noted at the end of the intervention, indicating that new mothers may prefer moderate intensity activities and promotion of the same may assure maximum success of a weight loss program. Both pre-pregnancy activity levels and self-efficacy were significant predictors of pedometer steps at the end of the intervention. In addition, pedometer steps were a significant predictor of weight loss, percent body fat, triglycerides and LDL and total cholesterol. The findings of this study indicate that pedometers may assist in increasing physical activity in low-income mothers. The history of activity and exercise self-efficacy are important predictors of activity levels and should be considered while designing an intervention. The significant associations between pedometer steps and anthropometrics and lipids further confirm the link between exercise and markers of health. Therefore, health care professionals can utilize pedometers as a motivational and self-monitoring tool to augment activity levels and reduce risks for chronic diseases in this vulnerable population.

The findings of this study are limited by short length of the intervention and small sample size. An 8 week intervention does not permit assessment of long term influence of physical activity on lipid profiles. However, the transient nature and chaotic lifestyle, lack of transportation and demands of child care prevented implementation of a longer intervention. These reasons are also responsible for a high attrition rate. Another drawback may be use of pedometers as a measure of physical activity; this method does not the ability to assess intensity of exercise.

In study 4, the aim was to identify determinants of nutrition knowledge among early postpartum women and the associations to dietary behavior. The findings of this study document that the levels of nutrition knowledge in early postpartum women were low. New mothers were cognizant of vitamins and minerals and weight management but not about energy nutrients and calorie counting. Disparities in knowledge were observed by BMI, age, ethnicity, education and income categories. Overweight, younger, White, and participants with partial college education and household income $\geq$ 30,000$ had greater awareness of nutrition as compared to their counterparts. Moreover, new mothers with higher knowledge had greater types of fruits, vegetables, whole grains, yogurt, low-fat frozen yogurt and unsweetened beverages in the home. Total scores were related to higher intakes of grains, low fat meat and beans, dairy, fiber, calcium, and iron, and lower levels of energy and protein. The present study adds to the body of evidence in examining the association of nutrition knowledge and consumption of several food groups in a population of low-income women at high risk for chronic disease. Health promotion programs for weight loss should incorporate a strong education component to provide participants with the knowledge and skills required to develop healthful eating habits. Limitations of the study include small sample size that may have resulted in diminished correlations. Lack of longitudinal data and the cross-sectional design prohibits concluding causality.

Future directions for research targeting low-income, overweight/obese women in early postpartum include implementation of a dietary and physical activity intervention by public health clinics to improve overall health. Further research is needed to measure the long term dietary intake of this population. Since the HEI-2005 is based on the 2005 Dietary Guidelines, the effectiveness of these guidelines as a whole in preventing risk factors of other types of diseases should be investigated. Also, which of the 12 components of HEI-2005 might have most impact on lipid profiles also needs to be identified. For snacking frequency, interventions are needed to educate low-income women about low cost, healthful snack choices. The influence of snacking on long term diet quality and weight status also needs to be determined to be able to develop recommendations for meal frequency. Since pedometers provide immediate feedback and motivate individuals to engage in more active behaviors, use of pedometers should be promoted by community centers to augment physical activity. Modifiable psychosocial factors such as nutrition knowledge also should be considered as an integral part of dietary interventions.

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