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Weight gain during pregnancy and weight retention 6 months postpartum are critical markers in predicting risk for life-long overweight in childbearing women. Pre-pregnancy weight, age, race, marital status, income, and parity are related to weight retention among postpartum women. Health behaviors, such as dietary intake, physical activity, and breastfeeding have also been associated with weight loss during the postpartum period.

The purpose of this study was to 1.) describe food group servings, nutrient intake and quality, and meal and snack intake of exclusively breastfeeding (EB), mixed feeding (MF), or formula feeding (FF) women and 2.) determine how breastfeeding, food choices, and physical activity impact weight change by 6 months postpartum.

In this sample of 450 women, the FF group consumed fewer calories and servings of grains, refined grains, and desserts. FF women were more likely to report dieting and not consume a multivitamin. All groups were at risk for vitamins A, E and C, calcium, folate and fiber inadequacies. MF women were also at risk for vitamins D, B-6, and zinc inadequacies, while FF women were also at risk for vitamin D inadequacy.

Among 188 women, breastfeeding duration was related to weight loss ($r = 0.23$, $P<0.01$); however, when controlling for other factors, breastfeeding was no longer significant. Physical activity was not related to weight loss ($r = 0.01$, $P= 0.87$). Women most likely to lose weight were those with higher income ($P<0.01$), lower weight at 2 months postpartum ($P<0.01$), higher gestational weight gain ($P<0.01$), and consuming

fewer daily servings of soda, sweetened beverages, weekly fast food ($P<0.01$), French fries, chips, and desserts and sweets ($P\leq0.05$) .

These findings suggest encouraging fruit, vegetable, dairy, grain, meat and beans, and healthy fat consumption may increase nutrients at risk for inadequacy in the diet. The behavioral factors significantly associated with weight gain were daily servings of soda, sweetened beverages, French fries, chips, desserts and sweets, and weekly fast food consumption. Decreasing these dietary behaviors may help promote weight loss during the postpartum period.

FOOD HABITS AND CHOICES, PHYSICAL ACTIVITY, AND BREASTFEEDING AMONG OVERWEIGHT AND OBESE POSTPARTUM WOMEN

by
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Committee Chair

To my mom and dad, brother and sister, family and friends

~ It is you and your unconditional love and faith that bring the "joie de vivre" to me. Each of you are treasured and loved. May we always walk forward in the sunshine, have the courage to follow our hearts, the passion to live out our wildest dreams, and the peace within to let our soul sing with laughter through it all.~

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

Maternal weight gain during pregnancy and weight retention six months postpartum are critical markers in predicting risk for life-long overweight and obesity in childbearing women (1;2). According to data from the 1988-1994 and 1999-2002 National Health and Nutrition Examination Survey (NHANES), the prevalence of women defined as overweight (body mass index (BMI) $\geq$ 25) has risen from 68.5% to 77.5% among African American women, 69.6% to 71.4% among Mexican women, and 47.2% to 57.0% among Caucasian women (3). Moreover, 33.2% of women are not just overweight but obese (BMI $\geq$ 30) (4).

Although the postpartum period serves as a critical time for weight-management interventions because weight retention and weight gain can be significant (1;5), few researchers have studied dietary behaviors characteristic to the postpartum period and strategies to effectively promote weight control among, exclusively breastfeeding (EB), mixed feeding (MF), or formula feeding (FF), overweight and obese women. Thus, examination of dietary behaviors and compliance with dietary guidelines would help determine nutritional characteristics and concerns specific to this group.

Gestational weight gain, pre-pregnancy weight, age, race, income and parity are also related to weight retention among postpartum women (6-12). In addition, modifiable behavioral factors have been associated with weight change during this period: dietary intake (13-16) and dietary habits (17-19), physical activity (1;2;12;13;15), and breastfeeding (1;2;20-22). However, the results from published research on the effects of these factors on postpartum weight loss are conflicting, and few studies demonstrate the combined effects of these factors on weight loss (12). Because the prevalence of overweight and obesity has increased among women (3;4), it is imperative we understand the relationship and relative contribution of these factors on postpartum weight loss to prevent further increases in the rate of overweight and obesity among women.

The first study of this dissertation describes food group servings, nutrient intake and quality, and meal and snack intake of 450, overweight and obese women at 9-15 weeks postpartum. The second study assesses how breastfeeding, selected food choices and habits, and physical activity impact weight loss by 6 months postpartum in lactating and non-lactating, overweight or obese postpartum women. Both studies were conducted using the following specific aims:

Study 1:

Aim 1: ***At 9-15 weeks postpartum, compare food group servings, nutrient intake and quality, meals and snacks, and dieting among overweight and obese postpartum women exclusively breastfeeding (EB), mixed feeding (MF), or formula feeding (FF).***

Hypothesis: At 9-15 weeks postpartum, EB women will consume more calories, satisfy the Estimated Average Requirement (EAR), Adequate Intakes (AI) and Acceptable Micronutrient Distribution Ranges (AMDR) for dietary intake, consistently consume three meals and snack throughout the day and be less likely to report dieting in comparison to MF & FF women.

Study 2:

Specific Aim 1: *Evaluate the relationship between amount and duration of breastfeeding and weight loss by six months postpartum in a cohort of overweight and obese postpartum women.* *Hypothesis:* There will be a positive relationship between breastfeeding duration and weight loss in the first six months postpartum.

Aim 2: *Evaluate the relationship between the amount of reported physical activity and weight loss by six months postpartum in a cohort of overweight and obese women.* *Hypothesis:* There will be a positive relationship between increase in reported physical activity and weight loss in the first six months postpartum.

Aim 3: *Evaluate the relationship between selected food habits and choices and weight loss by six months postpartum in a cohort of overweight and obese women.* *Hypothesis 1:* There will be a positive relationship between weight loss at six months postpartum and women reporting fewer servings of sweetened beverages, high sugar foods, fast foods, and chips. *Hypothesis 2:* There will be a positive relationship between women consuming at least three servings of dairy products (milk, cheese, and yogurt) and weight loss at six months postpartum.

Aim 4: *Determine the combined effect of breastfeeding, dieting, and physical activity on weight loss in the postpartum period.* *Hypothesis:* There will be a positive relationship between weight loss in the first 6 months postpartum and women reporting longer duration of breastfeeding; a reduction in servings of sweetened beverages, high sugar foods, fast foods, and chips; and an increase in physical activity.

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CHAPTER II

REVIEW OF LITERATURE

Overweight and obesity are major public health problems

The prevalence of adiposity is increasing, causing detrimental repercussions in human health and medical care. According to the National Center for Health Statistics, approximately 64% of Americans are either overweight or obese (1). The criterion for being considered overweight is a body mass index (BMI) 25-29.9 kg/m^2; the standard for obesity is a BMI $\geq$ 30 kg/m^2. This problem is not exclusive to the United States (US). The World Health Organization (WHO) has reported that obesity is a health concern in other countries (2). As a result, the WHO has characterized obesity as a global epidemic.

Medical hazards and chronic diseases associated with obesity have been increasingly well documented in recent years, and obesity has been described as a chronic disorder (3). In adults, increased adiposity is associated with an increased risk for cardiovascular disease, type 2 diabetes, and several cancers (4). Current research concludes that obesity contributes to 300,000 deaths per year in the United States and costs our nation over $100 billion a year directly and indirectly (5-7).

Maternal weight gain during pregnancy is a critical marker in predicting life-long risk for obesity

Pregnancy is a unique period for natural weight gain, but evidence indicates that women of childbearing age have experienced a substantial increase in the rate overweight and obesity (8;9). According to data from the 1988-1994 and 1999-2002 National Health and Nutrition Examination Survey (NHANES), a nationally representative sample of the United States population, the prevalence of women defined as overweight (body mass index (BMI) $\geq$ 25) has risen from 68.5% to 77.5% among African American women, 69.6% to 71.4% among Mexican women, and 47.2% to 57.0% among Caucasian women (10). Moreover, 33.2% of women are not just overweight but obese (BMI $\geq$ 30) (11). Research provides evidence that excessive gestational weight gain and failure to lose this weight during the postpartum period are critical predictors of long-term obesity (12;13). In fact, 40% of women gain substantially more weight than the Institute of Medicine's (IOM) recommended 25-35 pounds for normal weight women, 15-25 pounds for overweight women, and at most 15 pounds for obese women (14). Health care professionals should be knowledgeable of the IOM's recommendations for healthy weight gain during pregnancy and advise pregnant women appropriately, providing individualized target weight gain during pregnancy based on these recommendations (15). Pregnant women who receive a target weight gain from their health care professionals are more inclined to only gain this targeted amount of weight versus those women who are not advised, often gaining more than the IOM recommendations (15). Although most women will lose 80% of the weight gained during pregnancy by approximately 6 months postpartum, 14-20% of women are still more than 11 pounds heavier 6 to 18 months postpartum than before becoming pregnant (14). Evidence suggests that women who fail to adhere to these guidelines by gaining excessive weight during pregnancy and not losing this weight by 6 months postpartum are at increased risk for obesity later in life (12;13;16-18).

While gestational weight gain appears to be a critical predictor of overweight and obesity later in life; age, parity, and race should also be examined when evaluating lifetime weight gain in women (19;20). A study of 41,184 postmenopausal women revealed those giving birth to one or two children were less likely to be overweight at age 50, in comparison to nulliparous women and those women giving birth to 3 or more children. This study concluded aging appears to be a better indicator of weight gain than parity (21). Gunderson et al. also showed parity did not significantly increase the risk of overweight after pregnancy in four racially/ethnically diverse populations of women (20). A study comparing 17,688 Finnish women also revealed that, with age, average weight increased and so did the prevalence of obesity (22). However, in this study evidence showed parity was also associated with weight gain. Together, these studies suggest age and parity may function together to effect long term weight gain in women. While it appears women with more children are at increased risk for becoming overweight as age increases, other characteristics such as race, socioeconomic status, and education are also significantly impacting weight change (23).

Data from the 1988 National Maternal and Infant Health Survey show black postpartum women are twice as likely to be at least 20 pounds heavier compared to white postpartum women (24). Evidence suggests higher rates of overweight and obesity during the postpartum period in black women can be partially attributed to higher dietary intake and lower physical activity, in comparison to white postpartum women (25).

While maternal weight gain during pregnancy appears to be a critical marker in predicting life-long risk for obesity (12;13;16;17), research also indicates weight gain is not a result of one factor, instead numerous factors such as age, parity, and race may also function to affect long term maternal weight gain (19-24). Current research illustrates the necessity to better understand how these factors interact and further examine other potential predictors.

Weight loss during lactation is highly variable among postpartum women

During the postpartum period, many associate breastfeeding with accelerated weight loss. However, postpartum weight loss varies among women, with some women actually gaining weight during lactation (26). Primarily, research attributes such findings to differences within and across populations (26), as well as to the variation in breastfeeding frequency and duration among lactating women (13;17;25;27;28) .

Janney et. al (27) categorized 110 mothers as fully breastfeeding, partly breastfeeding, or bottle feeding at 0.5, 2, 4, 6, 12, and 18 months postpartum. Initially, women who bottle fed retained more weight than women who breastfed; however, when women stopped breastfeeding, weight loss occurred at a significantly slower rate. Weight retention at 18 months postpartum was greater in women who were older, unmarried, or had greater weight gain during pregnancy. While breastfeeding was significantly associated with weight loss, these other factors influenced weight retention more than infant feeding practices (27).

Dewey et. al (28) obtained weight and triceps-skinfold measurements until 24 months postpartum in matched cohorts of well-nourished women who breastfed for ≥12 months or ≤3 months postpartum and were not actively partaking in any dietary restrictions. Results from this study showed that women breastfeeding for the entire 12 months lost on average 2 kg more than those selecting to wean infants by 3 months (4.4 vs 2.4 kg, $P < 0.05$), due largely to weight loss between 3 and 6 months postpartum. However, weights of breastfeeding women and those women selecting to wean infants by 3 months were not significantly different from 12 to 24 months postpartum.

In contrast, Ohlin and Rossnen (17) collected data on 1423 Swedish women retrospectively from pregnancy records and collected data prospectively 6 and 12 months after delivery. Weight loss from 2.5 months to 1 year postpartum was measured in women breastfeeding at varying degrees of duration and intensity, as quantified by a "lactation score." "Lactation score" was created to estimate the degree of lactation. Through questionnaires, women were asked if they lactated fully or partially; a score was then calculated by multiplying the number of months women indicated that they lactated. This calculation provided a method to sum the periods of complete lactation with periods of partial lactation. A range from 0 to 48 points was derived, providing an approximation of the amount of milk produced after childbirth, and, therefore, a means to indirectly estimate the energy expenditure associated with lactation. Women with a high "lactation score" experienced greater weight loss than those with a lower score during the 6 months following delivery. Yet by 12 months postpartum, mean weight loss did not differ among groups (17).

Rooney and Schauberger (13) reported a unique long term epidemiological study of 540 primarily white, middle class women which examined whether excess weight gain 8 to 10 years after giving birth was associated with age, pre-pregnancy BMI, BMI at 6 months postpartum and 8 to 10 years after delivery, gestational weight gain, failure to lose weight by 6 months postpartum, parity, breastfeeding duration, participation in aerobic exercise, and pre-pregnancy smoking status. Maternal weights were collected in physician offices at the first prenatal visit, 20 weeks' gestation, at delivery, at discharge, and at 2, 4, 6, 8, 12, 24 weeks (6 months postpartum). Women also completed surveys regarding breastfeeding, use of tobacco or alcohol, sexual activity, return to work, and frequency of exercise at each of the follow-up visits. Ten years later, participant weights beyond 5 years postpartum (mean=8.5 years later) were obtained from medical records. While breastfeeding longer than 3 months and reporting aerobic exercise were predictors of less weight gain an average of 8.5 years postpartum, the most significant predictors were excessive gestational weight gain and retaining gestational weight by 6 months postpartum. In fact, women who lost the weight gained during pregnancy by 6 months postpartum were only 2.4 kg heavier at an average of 8.5 years compared those women who retained pregnancy weight at 6 months postpartum and were 8.3 kg heavier (13). Participant characteristics such as age, parity, and smoking status were not associated with BMI or weight gain at 8 to 10 years follow-up. Further, Linne et. al (29) showed that, at 15 years postpartum, women who were normal weight prior to pregnancy and became overweight had significantly lower lactation scores than women who were normal weight prior to pregnancy and remained normal weight (lactation scores: 21.7 ± 11.0 vs. 24.0 ± 9.4, P<0.05).

Overall, short term studies conducted from 0.5 to 24 months postpartum show breastfeeding women initially lose significantly more weight than formula feeding women (27;28). However, by 12 months postpartum or when the infant is weaned, mean weight loss occurs at a significantly slower rate and eventually weight does not significantly differ between breastfeeding and formula feeding women (17;27). In fact, other factors such as age, marital status, and weight gain during pregnancy appear to be better predictors of weight retention than infant feeding practices (27). Long-term studies revealed women who breastfed for a longer duration were less likely to be overweight 8.5 and 15 years postpartum (13;29); however, these studies also show the most significant predictors of weight gain are exceeding gestational weight gain recommendations and retaining excessive gestational weight by 6 months postpartum (12). While breastfeeding provides health benefits for the mother and infant (30), evidence shows breastfeeding interacts with other factors to promote weight loss (13;17;25;27;28).

Physical activity and exercise during the postpartum period

As defined by the Centers for Disease Control (31), physical activity is any bodily movement produced by skeletal muscles that results in an expenditure of energy. Whereas, exercise is defined as physical activity that is planned or structured that involves repetitive bodily movement done to improve or maintain one or more of the components of physical fitness—cardiorespiratory endurance (aerobic fitness), muscular strength, muscular endurance, flexibility, and body composition (31). Physical activity and exercise are well recognized as major contributors of health and overall well-being in men and women (32). Yet on average, women are less likely than men to participate in intense physical activity or even leisure-related exercise (32). During pregnancy and in the postpartum period, women further minimize physical activity and exercise because of physiological, behavioral, and psychosocial changes, leading to increased risk for weight retention (33-35). The integration of physical activity and exercise during pregnancy is extensively detailed in the *Guidelines by the American College of Obstetrics and Gynecologists* (36); however, no recommendations exist for physical activity during the postpartum period, and exercise is only briefly described. These guidelines explain many of the physiological changes characteristic of pregnancy can be expected to continue 4-6 weeks postpartum. Research thus far does not indicate harm in returning to exercise before 4-6 weeks; however, this individualized and therefore it is recommended women resume exercise gradually when physically and medically ready. (36). Although research is limited concerning the benefits of increased physical activity or regular exercise on maternal well being in the postpartum period, it is justifiability hypothesized that, just as any other time in a woman's life, both are beneficial for numerous health benefits during this period, as well.

It is also important to consider that, although research indicates physical activity decreases during the postpartum period, assessment and quantification of physical activity patterns specific to the postpartum period, such as household chores, family care and occupational activities are difficult to determine and often not captured in surveys, leading to misclassification of physical activity levels (37;38). Because many of the current physical activity surveys were designed and validated on men, they fail to measure the particular type, frequency, and duration of physical activity actually being performed by postpartum women; resulting in misclassification of activity level (37;39). In order to evaluate the possible misclassification of physical activity during this period and assess the most appropriate methods to capture physical activity and the patterns which occur during the postpartum period, a 7-day physical activity recall (PAR) was used to validate physical activity. Forty-four low-income, postpartum women were interviewed at 3 months using the PAR to assess physical activity. Women were also instructed to wear a pedometer for 3 days, allowing researchers to capture actual household and daily living activities. These step counts served as the validation measure (40). This method could be particularly informative in the postpartum population because it is an interview-based process where the interviewee shares individual activities he/she does with the interviewer. Through a PAR interview, an estimation of individual energy expenditure using metabolic equivalents (METS), a unit used to define the intensity of a particular physical activity by estimating the amount of oxygen the body uses while partaking in the activity (39). Results showed PAR was significantly correlated to the step counts (averaged 6,262 (SD = 2,712) steps per day). Further, mothers spent most of their time partaking in light activity (384.4 minutes) (40). When compared to physically active adults, postpartum women spent 50 more minutes sleeping and approximately 200 minutes more sitting each day (40;41). While some sitting cannot be avoided because of infant feeding, women still averaged 200 fewer minutes of light intensity activity on a daily basis, compared to inactive adults (40;41;41). Based on these measures, low-income postpartum women failed to meet national guidelines for moderate physical activity of at least 30 minutes, 5 days per week or high intensity physical activity or 20 minutes or more, 3 days per week to reap health benefits (42) . These postpartum women averaged fewer than 16 minutes per day in either of these activity levels (40).

Treuth et al. (43) published research which evaluated pregnancy-related changes in physical activity, fitness, and strength in 63 predominantly white women with varying body mass index (BMI) measures prior to pregnancy and 6 and 27 weeks postpartum (43). Women were categorized as low-BMI group (BMI <19.8 kg/m^2), normal- BMI (19.8-26.0 kg/m^2) and high-BMI (>28.6 kg/m^2) groups and assessed. The study measured physical activity at each time point, using a version of the *Taylor Questionnaire for Assessment of Leisure Time Physical Activity* (39), which was modified to address leisure and occupational activities. Recounting the previous month, participants documented duration (number of minutes per occasion) and frequency (number of times per month) of walking, dancing, bicycling, conditioning exercises, water activities, winter activities, sports, lawn/garden activities, home activities, hunting/fishing, and occupational activities. These physical activities were measured in METs (39). According to this self-reported questionnaire, there were no significant BMI group by time interactions for physical activity. However, the reported time partaking in conditioning exercise was significantly higher in the low-BMI group (BMI <19.8 kg/m^2), as compared with the high-BMI (>28.6 kg/m^2) group. There were no significant differences in quantitative results, as indicated by total monthly METs between prepartum and postpartum, yet there were significant differences observed for qualitative results, as indicated by specific activities, such as walking, conditioning exercises, water activities, sports, occupational activities, and home activities, with the lower amounts of these activities recorded during the postpartum period. The survey showed occupational activities decreased and home activities increased, resulting in the participation of activities with lower energy expenditure during the postpartum period. Another prospective study cohort study of 622 predominately Caucasian women using self-reported questionnaire data concluded a higher BMI was associated with increased change in physical activity from pre-pregnancy to during pregnancy ($P < 0.05$), although specific physical activities subjects participated in during pre-pregnancy and pregnancy were not described (44).

In addition, research also indicates different subsets of postpartum women are at higher risk for long-term overweight and obesity than others. Evidence suggests that higher rates of overweight and obesity during postpartum period in black women can be partially attributed to higher dietary intake and lower physical activity, in comparison to white postpartum women (25). At 7-12 months postpartum 224 black and 121 white women were evaluated through the Special Supplemental Feeding Program for Women, Children, and Infants (WIC) for maternal dietary intake, physical activity level, mother's body weight pre-pregnancy and after delivery, infant's age and birth weight, mother's return to work, breastfeeding and formula feeding, parity, smoking behavior, and use of oral contraceptives (25). Weights were measured in the required WIC nutrition classes, and, subsequently, information was gathered using a self-administered questionnaire. Each participant reported physical activity information for specific activities, meaning the number of times per week (frequency), length of time engaged in the activity (duration), and exertion rating (intensity). An individual activity score was calculated by multiplying frequency, duration, and intensity for each activity and then summing together all activities. The activity score was the independent variable. Results showed black women were heavier before pregnancy (black 149.3 ± 36.5 lbs versus white 140.1 ± 33.5 lbs). However, despite similar gestational weight gain, black women were significantly heavier than white women (black 162.6 ± 44.3 lb versus white 146.9 ± 39.4 lbs) 7-12 months postpartum. White women reported significantly higher prenatal and postpartum activity score ($P<0.002$ and $P<0.047$, respectively) than black women (25). Overall, 27% of the variance in postpartum weight change was explained by the following variables through multiple linear regression modeling: pre-pregnancy weight, gestational weight gain, parity (primiparous or multiparous), race, prenatal activity score, and race by prenatal activity score. Race predicted a 6.4 lb increase in weight change for black postpartum women after adjusting for these factors.

Physical activity measured during the postpartum period should reflect various dimensions of a mother's life including occupation, household work, infant, child, and family responsibilities, exercise, and leisure activities. Evaluating these factors in conjunction with physical activity will provide more reliable evidence for effective strategies and recommendations for women to implement during the postpartum period.

Meal patterns, food habits and food choices among overweight and obese women and postpartum women

The Dietary Guidelines for Americans are in existence to provide nutrition recommendations that promote healthy eating practices and prevent chronic disease (45). Further, the United States Department of Agriculture (USDA) has developed MyPyramid, a tool to assist Americans in selecting a healthy diet that meets nutritional standards [as defined by the Dietary Reference Intakes (Recommended Dietary Allowances (RDA) , Adequate Intakes (AI), Acceptable Macronutrient Distribution Ranges (AMDR) and Estimated Average Requirement (EAR)) (46-51)] while still being moderate in energy (52). This food guide is defined by 6 major nutrient-bearing food groups (fruit, vegetable, dairy, grain, meat and bean and oils) and their subgroups, providing individualized recommendations for various populations, including postpartum women exclusively breastfeeding, mixed feeding, and formula feeding (52)

In many studies, researchers rely on participant's self-reported food intake(s) to make recommendations and draw dietary conclusions regarding a specific population. However, several points should be considered when evaluating self-reported dietary information. To best estimate self reported dietary intake, research suggest collecting 3 dietary intakes, meaning 2 week days and 1 weekend day (53). Further, evidence shows the prevalence of overweight and obese individuals are at increased risk for underreporting food intake when compared to normal weight individuals (54;55). For this reason, to minimize inaccurate nutrient measurements resulting from underreporting food intake, nutrients should be normalized for total caloric intake (56).

Alterations in specific meal and snack patterns, such as increases in the number of meals consumed at restaurants (57;58), large portion sizes (57), snacking (16;59), and meal-skipping (16;59;60) may partially explain the rising obesity epidemic. Unlike exercise, the *American College of Obstetrics and Gynecologists* has yet to adopt and publish dietary recommendations that focus on strategies for implementing healthy nutrition-related behaviors to achieve or maintain a healthy weight specific to the postpartum period that ideally promotes positive long-term health. Although the postpartum period serves as a critical time for weight-management interventions because weight retention and weight gain can be significant (13;14), few studies have been conducted detailing diet behaviors characteristic to the postpartum period and strategies to effectively promote weight control.

Ohlin and Rossner (16) assessed the meal patterns of 1423 participants enrolled in a prospective study known as the *Stockholm Pregnancy and Weight Development Study*, which focused on factors related to changes in body weight from pregnancy to 1 year postpartum. Meals patterns based on frequency of meals was investigated. Results showed women weighing within ±3 kg of their pre-pregnancy weight at 1 year postpartum displayed more regular eating patterns (not skipping meals regularly), in comparison to women who retained more weight gained during pregnancy. Postpartum women with high weight gain during pregnancy, (gained more than 20 kg during pregnancy), but weighing within ± 3kg of pre-pregnancy weight, were more likely to consume lunch regularly versus those individuals who retained more weight. Daily breakfast consumption and minimal snacking were also characteristic of women within ± 3kg of their pre-pregnancy weight.

Transitioning to motherhood, may alter a women's traditional diet behaviors as they acclimate to their maternal role and experience unfamiliar time constraints and alterations in daily routine (60). Few longitudinal studies exist evaluating alterations in food choices, food habits and diet related behaviors during the period transitioning into motherhood from pregnancy; those completed conclude women report alterations to dietary and exercise practices during this transition (59;61). Transitioning from pregnancy to motherhood was associated with alterations in food choices that were both positively and negatively associated with a healthy diet (60). Olson (60) reported results for a prospective cohort study of 360 healthy, predominantly white (96%), rural, socioeconomically diverse women from the middle of pregnancy to 2 years postpartum. Results showed the proportion of women consuming 2 or more cups of milk each day did not significantly change from pre-pregnancy to 2 years postpartum. However, positive changes were identified; the proportion of women consuming 3 or more fruits and vegetables and making breakfast part of their daily routine was significantly higher at 2 years postpartum versus pre-pregnancy. Further, first time mothers were more inclined to implement positive food choice changes and maintain them. Nutrition education for first time mothers may help minimize the number of negative food choices associated with future pregnancies (60).

Other research has also evaluated food choices using the food frequency questionnaire among multiracial, low-income women during the motherhood transition from pregnancy to the postpartum period (62). It is important to capture this transition among low income women because the challenges may be very different than women not faced with financial burden and restrictions (62;63). One hundred and forty-nine, racially diverse, Medicaid-qualified women (30% white, 24% black, and 46% Hispanic) were enrolled into a longitudinal cohort study at 0 to 1 day post-delivery (62). A food frequency questionnaire was administered at 6 weeks postpartum to document food choices during pregnancy and at 6 months postpartum to document food choices after childbirth. In addition, weights and heights were also gathered to calculate BMI at each visit. Results showed participants were overweight prior to pregnancy, as indicated by mean BMI (26.1 ± 0.50). Further, mean BMI significantly increased from pre-pregnancy to 6 months postpartum (26.1 ± 0.50 versus 28.7 ± 0.57, $P<0.05$). When stratified by lactating and non-lactating, mean BMI was significantly lower in lactating women vs. non-lactating women at pre-pregnancy (24.1 ± 1.1 versus 26.4 ± 0.56, respectively $P<0.05$) and 6 months postpartum (26.4 ± 1.1 versus 29.2 ± 0.65, respectively, $P<0.05$). Food frequency data revealed the mean daily servings of grains (7.4 vs. 6.2, $P<0.004$), vegetables (2.5 vs. 2.0, $P<0.002$), and fruits (3.4 vs. 1.7, $P<0.001$) significantly decreased from pregnancy to postpartum, yet the percentage of calories consumed from fat (37.3% vs. 38.4%, $P<0.023$) and sugar (14.4% vs. 16.4%, $P<0.019$) increased significantly. These results demonstrate low-income women in this study did not meet dietary guidelines for vegetable, dairy, fat intake both during pregnancy and into the postpartum period. Further, it appeared the transition to the postpartum period negatively altered food choices. When women were stratified by lactating (n=27) and nonlactating (n=122), those who were still breastfeeding at 6 months postpartum reported lower consumption of total fat intake (34.2% vs. 37.9%, $P<0.005$) during pregnancy and higher consumption of fruit (2.2 vs. 1.6, $P<0.05$) and vegetables (2.6 vs. 1.8, $P<0.02$) during postpartum. Others also support these findings, showing lactating women were more likely to have healthier diet than non-lactating women (64). As one might assume with a new infant, evidence shows meal sources also change during the transition from pregnancy to the postpartum period. Postpartum women are more likely to prepare larger percentage of their food at home versus eating at restaurants, with family or friends, or by obtaining grocery store carry-outs than when pregnant (56% vs. 50%, $P<0.05$) (62). Further, lactating women prepared and consumed more at home meals than non-lactating women during pregnancy and the postpartum period (62).

During lactation, nutrient requirements for vitamins A, B-6, and C, and zinc are substantially increased (48-50). The limited research assessing micronutrient status during lactation suggests calcium, zinc, folate, and vitamins E, D, and B-6 are often reported as being lower than recommendations suggest (65;66), which could be a result of lactating women consuming a diet below 2700 kcal/day (67). Dusdieker et al. showed when 22 exclusively breastfeeding women enrolled in a 10 week weight loss program restricted daily food intake by approximately 500 kcal/day, they still met 90% or more of the RDA for calcium, vitamin A, riboflavin, niacin, thiamin, vitamin C, and iron (68). However, Lovelady et al. (66) reported that, among lactating women, when decreasing daily intake by approximately 500 calories/day, the RDA for vitamin C, E, D, and calcium was not met. They recommended that lactating women incorporate more fruits and vegetables and high calcium and vitamin D sources into their diet plan (66). . Mackey et al. (65) reported that even when lactating women are not dieting, intakes energy intakes were below suggested recommendations and limited in calcium, zinc, folate, and vitamins E, D, and B-6. Berg et al. also showed diminished intake of folate and zinc during the postpartum period (69).

Evidence suggests that increased intake of specific foods may also be associated with weight loss in addition to decreasing risk of chronic disease. It has been hypothesized that calcium and fiber intake may independently promote weight and fat loss during energy restriction (70-78). A review by Parikh and Yanovski (79) concluded that increasing calcium or dairy intake may prevent weight gain. Zemel (70) suggest mechanistically when dietary calcium intake is low, circulating 1,25-dihydroxyvitamin D [1,25(OH)D_2] concentrations increase, which stimulates calcium into adipocytes, suppressing lipolysis, increasing lipogenesis and promoting lipid accumulation. Whereas, increasing dietary calcium appears to have the opposite effects and hasten fat loss. Zemel et al. (71) further studied healthy, obese individuals between the ages of 18-50 (predominately women) were placed on a 500 kcal/day deficit and then randomized to a low calcium group (400-500 mg Ca/day) or a yogurt supplemented group (1100 mg Ca/day or 3 servings) over a 12 week period. Results showed during energy restriction and isocaloric substitution of yogurt for other food items, a reduction in fat loss (-4.43+/-0.47 vs. -2.75+/-0.73 kg in yogurt and control groups; $P<0.005$) and central adiposity (-3.99+/-0.48 vs. -0.58+/-1.04 cm, $P<0.001$) was significantly lower in comparison to the low calcium, energy restricted group. However, little research has been conducted which demonstrates the influence of supplemental calcium on weight and fat mass in postpartum women as a means to prevent weight retention. Wosje et al. (80) completed a randomized, double-blinded calcium supplementation trial from 2 weeks to 6 months in 87 lactating and 81 non-lactating normal weight postpartum women. Results showed calcium supplementation (1000 mg/d) does not induce weight loss or fat loss among non-lactating or lactating. Further evidence shows increased fiber intake does not appear to promote additional weight loss with increased calcium supplementation (78).

Like physical activity, research also indicates higher rates of overweight and obesity among different ethnic groups can be partially attributed to higher dietary intake (25). At 7-12 months postpartum, 224 black and 121 white women were assessed through the Special Supplemental Feeding Program for Women, Children, and Infants (WIC) for maternal dietary intake (25). Women in the program completed a self-administered food frequency questionnaire based on how they had eaten since the delivery of their baby. Dependent variables were total energy intake and percentage of fat in the diet. Results showed mean caloric intake and the percentage of fat in the diet were significantly higher in black women versus white women during the postpartum period (2039 ± 947 kcal, $40.7 \pm 5.9\%$ of fat in diet and 1552 ± 626 kcal, $37.5 \pm 8.5\%$ of fat in diet , respectively, $P<0.001$ for both) (25).

Krummel et al. (81) assessed factors associated with stages of change for food choice behaviors and weight management among 151 low income, postpartum women participating in the WIC program. Although 55% of women were in the action stage for weight loss during the postpartum period, fewer women were in the action stage for weight loss behaviors, such as avoiding high fat foods (24%) and increasing fiber intake (19%). Researchers showed that the participants' confidence in selecting low-fat restaurant choices and properly reading the food label was positively associated with implementing weight loss behaviors, such as avoiding high fat food and increasing fiber intake (81).

Additional longitudinal studies are needed to evaluate food choices and habits during lifestyle alterations, such as motherhood. The postpartum period is a critical transition in a woman's live, when the potential to influence food habits and choices may be possible (60). During the postpartum period, women are more cognizant of their health and weight (82), potentially causing mothers to be more receptive to nutrition education. Evidence suggests that nutrition education during this period should primarily focus on meal and snack patterns (16), healthy food selections, such as fruit, vegetables, and dairy and low fat options (62). Findings indicate lactating women have more positive dietary behaviors than non-lactating women (62;64); thus, non-lactating women may benefit from supplementary nutritional guidance. Special attention should also be placed on young, socioeconomically diverse women who are at increased risk for not complying to the recommended dietary guidelines (83). Many government food and nutrition assistance programs often place primary focus on the child because of limited funds; however, it appears these programs would be strengthened, if they also incorporated the postpartum mother by providing education regarding diet during pregnancy and the postpartum period (60;62).

Interventions promoting weight loss during the postpartum period

Currently, few randomized-controlled trails have been published that assess behavioral weight loss interventions that promote increased physical activity and changes in dietary habits specifically for newly postpartum women. However, evidence shows that the postpartum period may in fact be the perfect time to educate women on healthy lifestyle behaviors (61) and have increased motivation for weight loss (82). The lack of weight loss interventions which target the postpartum period often reflects concerns that exercise and dieting may detrimentally affect production and quality of breast milk. However, several unique interventions have been conducted to prove that exercise and dieting are safe for the lactating mother and breastfeeding infant.

Lovelady et al. (84) conducted a cross-sectional study to determine the effect of vigorous exercise on lactation performance. The study compared eight sedentary women with eight highly trained, exercising women who were exclusively breastfeeding infants for 9-24 weeks. On average, the total energy expenditure was 720 kcal more/day in the exercising group (spent 88 min/day exercising), compared to the sedentary group. Further, milk volume was higher in the exercise group, despite the higher expenditure in energy. However, the energy deficit between groups did not significantly differ because the exercise group was consuming more calories than the sedentary group. This study showed vigorous exercise did not detrimentally affect the milk supply of the mother during lactation. However, it is important to remember the women in the exercise group were highly motivated and may be unique in their abilities to combine intense exercise with breastfeeding (84).

Subsequent research used a randomized intervention trial to assess milk volume and composition of previously sedentary women entering a 12-week exercise program (85;86). At 6 weeks postpartum, exclusively breastfeeding women were assigned to an exercise group (n=18) or a control group (n=15). The exercise group participated in 45 minutes of aerobic exercise, 5 times per week; whereas the control group did not exercise more than once per week. The exercise group expended 400 kcal/day, improving aerobic capacity, insulin response, and HDL cholesterol concentrations. Like the previous study, despite increased energy expenditure in the exercise group, there was no significant difference in weight loss or body composition because the exercise group increased caloric intake to compensate. Further, no significant differences between groups were seen in milk volume, milk composition, infant growth, or prolactin concentration (86). Together, these studies show breastfeeding women can start an exercise program without harm to their milk or the baby. Other studies also demonstrate exercise does not significantly alter immunological factors (87), polyunsaturated fatty acids (88), and lactic acid (89) levels found in breast milk . In the past, dieting and exercise during the postpartum period were of concern for lactating women, thought to detrimentally effect breast milk composition or infant growth (90) . Although evidence now exists to prove otherwise (90), many of the studies conducted in the last 12 years have primarily focused on postpartum exercise as it relates to weight retention and energy balance, predominantly in lactating women.

Experiments restricting calories in breastfeeding women are difficult to conduct due to the ethical and practical implications associated with implemtning this type of study. Early studies demonstrated that, during Ramadan, a period of short term fasting, there was no significant effect on milk volume (91). Strode et al. (92) compared 14 exclusively breastfeeding women who agreed to reduce their caloric intake over a seven day period to eight controls who did not. Among women in the dieting group, average caloric intake was 68% less than their baseline consumption. Results showed no decrease in milk volume during the seven days of caloric restriction. However, it should be pointed out that the study design did not make random group assignments, and milk samples were collected at only one feeding, rather than multiple feeding over a 24 hour period. This was short in duration and therefore the effects of extended energy restriction remains unknown (92).

At 4-14 weeks postpartum, Dusdieker et al. (68) evaluated milk volume and composition. Among 33 exclusively breastfeeding women participating in a 10-week weight loss program, consumed on average 77% of baseline dietary intake and lost on average 4.8 kg,, milk volume actually increased from 759 to 802 mL/day during this period. This study indicates among well-nourished women lactation performance and composition remain unaltered even with reasonable weight loss (~0.5 kg/wk). Because the study did not have a control group, these conclusions are limited; further, the dropout rate was higher among women with lower energy intake and milk volume at baseline (68). In addition, the sample size was small, and women were followed over a relatively short period of time.

Although exercise is advantageous for a woman's health and fitness, research demonstrates that exercise alone does not always result in significant weight loss because many women compensate with additional calories. Weight loss is more likely to occur when exercise and dietary restriction are combined. To date, there are limited intervention studies for postpartum weight loss specifically designed to increase exercise and promote dietary restriction. In fact, only three randomized controlled interventions have been published to reduce postpartum weight retention (90;93;94). The majority of studies have simultaneously investigated the impact of exercise and caloric restriction on lactation, in addition to assessing postpartum weight loss.

O'Toole et al. (93) completed a randomized controlled trial which assessed weight loss among 40 overweight, lactating and non-lactating postpartum women for one year. Women were randomly assigned to in an individualized structured (STR) diet and physical activity intervention or a self-directed (SELF) intervention. The STR group received individualized diet and exercise advice from a dietitian and exercise physiologist respectively, met once a week for 12 weeks regarding weight loss strategies, and documented food intake and activity; after this period, individuals met biweekly for the following 2 months and then monthly up to one year; whereas the SELF group did not receive diet or exercise prescription and only met for a single 1 hour education session regarding diet and activity. Body weight, percent body fat, daily caloric intake, habitual physical activity, and cardiorespiratory fitness were measured at baseline, 12 weeks postpartum and at 1 year. Results showed only 23 of the 40 participants remained in the study at 1 year postpartum. However, participants completing the STR (n=13) experienced significant weight loss by 1 year postpartum (7.3 kg, $P<0.01$) and a significant decrease in percent body fat (6%, $P<0.01$), with no change in fat-free mass. In contrast, the SELF group did not lose any weight or body fat. Lactation did not significantly impact weight loss; there were no significant within-group or between-group differences at 12 weeks and 1 year. Although this intervention did not overcome lifestyle barriers, such as time constraints, work and stress of motherhood, the study showed that overweight women attending classes and obtaining professional support were able to lose weight successfully, further showing overweight women are likely to experience weight retention from pregnancy at 1 year postpartum without formal intervention.

In order to overcome some of the lifestyle barriers associated with the postpartum period, Leermakers et al. (94), conducted a 6-month behavioral weight loss correspondence study delivered primarily implemented through mail. Ninety, non-lactating women between 3 and 12 months postpartum who exceeded their pre-pregnancy weight by 6.2 kg were randomly assigned to a correspondence group that received behavior modification instructions regarding exercise and diet or a control group that received no treatment. At baseline and 6 months postpartum, body weight, dietary intake, and physical activity were measured. Results showed by 6 months postpartum, the intervention and control groups had not significantly increased their reported daily exercise yet both groups had significantly decreased caloric and fat intake. However, women in the intervention group lost significantly more weight than the control group (7.8 kg vs. 4.9 kg, $P=0.03$). Moreover, the intervention group lost a greater percentage of their excess postpartum weight (79% vs. 44%, $P=0.01$) and were more likely to return to their pre-pregnancy weight or below in comparison to the controls (33% vs. 11.5 %, $P<0.05$). Overall, diet and exercise were unrelated to weight loss, while the amount of weight gained during pregnancy and participation in the correspondence intervention were the strongest predictors of returning to pre-pregnancy weight at 6 months postpartum ($P<0.001$ and $P<0.03$, respectively). A model including weight gained during pregnancy and participation in a correspondence intervention explained 34% of the variance in return to pre-pregnancy weight. While 68% of the women completed the study, only 30 subjects in the intervention group and 16 in the control group completed the diet and exercise questionnaires. As a result, the outcome could have been biased because those returning the questionnaires may have been those women more eager to implement healthy lifestyle behaviors and lose weight.

McCrory et al. (95) evaluated the effect of combining diet and exercise on lactation performance, using a randomized controlled intervention which divided 69, 12+/-4 wk postpartum women into three groups: 1.) caloric restriction (to 65% of energy needs) with no change in exercise 2.) combined caloric restriction and increased exercise (intake at approximately 65% of energy needs) 3.) control group- no change in diet or exercise level. To be in the study, subjects had to be exercising 3 times per week initially to minimize injury if assigned to the exercise group. The intervention lasted 11 days. All food was provided to mothers, and mothers assigned to group 2 exercised 60-90 min/day for 9 of the 11 total days. Results showed weight loss differed significantly among groups; average weight loss was 1.9 kg for the diet only group (one third of weight loss was fat-free mass), 1.7 kg for the diet plus exercise group (all weight loss was fat mass), and 0.2 kg in the control. No significant differences were found in milk volume, milk energy output, nursing frequency or infant weight gain during the intervention. Plasma prolactin was elevated in all subjects. This study shows that, when calories are restricted and high intensity aerobic exercise implemented, prolactin functions to increase body fat mobilization, essentially protecting the milk supply (95).

Lovelady et al. (90) conducted a longer (10 weeks) energy restriction and exercise intervention on infant growth at just 4 weeks postpartum. The study revealed that, in order to achieve weight loss, overweight, lactating women have to decrease caloric intake in addition to exercising regularly. This weight loss intervention, starting at 4 weeks postpartum, included 40 sedentary, overweight women (BMI= 25-30 kg/m^2), exclusively breastfeeding, who were randomly assigned to a 10-week intervention group or a control group. The intervention group restricted their energy intake by 500 kcal/day and did 45 minutes of aerobic exercise 4 times per week, while the control group maintained usual intake and did not exercise more than once per week. Results showed the intervention group lost more weight than the control group (4.8 ± 1.7 kg vs. 0.8 ± 2.3 kg, $P<0.001$). Maternal weight loss did not compromise growth of the infant. Therefore, it appears that, once lactation is achieved by 4 weeks postpartum in overweight women, it is safe to restrict intake by 500 kcal/day, thereby inducing a weight loss of 0.5 kg/wk. In order for women to achieve this 500 kcal/day deficit, they had to significantly decrease their consumption of fats, sweetened drinks, sweets and desserts, snack food and mean energy intake in addition to exercising (66). With the exception of calcium and vitamin D, mean intakes of micronutrients were also significantly lower in this group compared to the control group. Further, both groups failed to meet the RDA for vitamins E and C. Overall, these results show caloric restriction can be achieved by minimizing the amounts of food high in fat and simple sugar. However, women should be advised to take a multivitamin and calcium supplement, if adequate intake of the specified vitamins and mineral is not achieved through the diet. This study provides valuable information for clinicians in guiding overweight, lactating women to achieve weight loss.

Research has consistently shown that postpartum weight retention is a direct reflection of gestational weight gain, and weight change created by alterations in lifestyle that occur with motherhood (14;20;60;96;97). Existing information regarding lifestyle changes during the postpartum period suggest exercise and diet are critical for postpartum weight change (59;98). Based on the limited number of controlled intervention trails published, postpartum weight loss can successfully occur with the help of a formal exercise and diet intervention in both lactating (93) and non-lactating postpartum women (93;94). Postpartum weight retention is more likely in both overweight (93;94) and normal weight (94) women who do not enroll in a structured exercise and diet program. However, retention of even highly motivated women to participate in exercise and diet programs during the first year postpartum remains challenging. Research is still needed to investigate the most effective implementation of such programs. It is critical the potential barriers unique to this period are investigated and methods are developed to overcome these barriers that will promote adherence to a weight loss program during the postpartum period.

In the past, dieting and exercise during the postpartum period were considered dangerous for lactating women, in terms of detrimentally affecting breast milk composition or infant growth (90). Although evidence now exists to prove otherwise

(90), many of the studies conducted in the last 12 years have primarily focused on postpartum exercise and energy balance, in relation to weight retention in predominantly lactating women. As a result, weight loss related to postpartum exercise and energy restriction in non-lactating mothers has not been completely evaluated and compared to lactating women. Because non-lactating women account for 71% of mothers at 6 months postpartum (99), it is important we understand this relationship.

Conclusion

Research suggests women who lactate for >3months, consume meals in a consistent pattern, reduce caloric intake and /or partake in physical activity or exercise are more likely to return to pre-pregnancy weight or lose weight during the postpartum period and be less overweight later in life. However, few large scale trials have evaluated these behavior factors (breastfeeding, diet, and physical activity) among racially and socioeconomically diverse, women who are overweight or obese prior to pregnancy. Because obesity is on the rise, it is important that lifestyle behaviors characteristic to the postpartum period be better understood and reported, so that health care professionals can effectively and safely address weight control and even weight loss during this critical period, when many women are at increased risk for lifetime overweight but motivated to make lifestyle changes and lose weight.

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CHAPTER III

DIETARY INTAKE OF BREASTFEEDING AND FORMULA OVERWEIGHT WOMEN

INTRODUCTION

The postpartum period is a time of rapid transition, motherhood stresses and time constraints that may put women at increased risk for unhealthy dietary habits and long-term adiposity (1). Adjusting from pregnancy to the postpartum period leads to alterations in food choices that are both positively and negatively associated with a healthy diet (2). Olson et. al. (2) reported the percentage of women participating in positive lifestyle behaviors such as consuming 3 or more serving of fruits and vegetables and making breakfast part of their daily routine, was significantly higher at 2 years postpartum than prior to pregnancy. Milk consumption did not significantly change during this transition, despite recommendations to increase dairy servings during pregnancy and lactation (3). Further, primiparous women were more inclined to implement and maintain positive food choice changes (2). In contrast, Fowles et al. (4) found that among predominantly white women during the postpartum period: dairy consumption was adequate, yet vegetable intake was not.

George et al. (5) evaluated diets among 149 multiracial, low-income women from pregnancy to the postpartum period. Average daily servings of grains, vegetables, and fruits significantly decreased from pregnancy to postpartum, while the percentage of calories consumed from fat and sugar increased significantly. During pregnancy and the postpartum period most women failed to meet the dietary recommendations for vegetables, dairy and total fat (5;6). Further, higher rates of overweight and obesity among different ethnic groups can be partially attributed to food intake (7). At 7-12 months postpartum, mean caloric intake and the percentage of fat in the diet was significantly higher in black women, compared to white women. (7).

Studies indicate that lactating women have more healthy dietary behaviors than non-lactating women (5;8). Those who were still breastfeeding at 6 months postpartum reported lower total fat intake during pregnancy and higher consumption of fruit and vegetables during postpartum (5). Walker et al. reported that lactating women were more likely to have lower fat intake than formula feeding women (8). The limited research assessing micronutrient status during lactation suggests calcium, zinc, folate, and vitamins E, D, and B-6 intakes are often lower than recommended (9;10).

According to data from the 1988-1994 and 1999-2002 National Health and Nutrition Examination Survey (NHANES), the prevalence of women defined as overweight and obese (body mass index (BMI) ≥ 25 kg/m^2) has risen from 68.5% to 77.5% among African American women, 69.6% to 71.4% among Mexican women, and 47.2% to 57.0% among Caucasian women (11). The postpartum period is a critical time for weight-management interventions because weight retention and weight gain can be significant (12;13). Research on diet behaviors in the postpartum period among lactating and non-lactating, overweight and obese women would help to identify nutritional concerns specific to this population.

Therefore, the overall purpose of this study was to assess food group servings, nutrient intake and quality, meals and snack intake, and dieting among three groups of overweight and obese postpartum women: 1.) exclusively breastfeeding (EB), 2.) mixed feeding (MF), or 3.) formula feeding (FF). The first aim was to compare nutrient intake and food group servings among these three groups. The second aim was to determine characteristics of women who consumed breakfast, lunch, dinner or snacks. The third aim was to compare nutrient intakes of women who reported consuming or not consuming breakfast, lunch, dinner and snacks. The fourth aim was to determine characteristics of women who reported dieting at this early postpartum period. The final aim was to compare nutrient intakes among those women who reported dieting and not dieting.

MATERIALS AND METHODS

Study Design

We investigated food group servings, nutrient intake and quality, and meal and snack patterns among overweight and obese postpartum women enrolled in the behavioral intervention study, Active Mothers Postpartum (AMP). The overall aim of AMP was to evaluate the effect of increased physical activity and decreased overall caloric intake on weight loss among postpartum women who were overweight or obese prior to pregnancy.

We recruited participants from obstetric clinics in the Durham, North Carolina, area and through posters in public areas. Women with a pre-pregnancy BMI $\geq$ 25 kg/m^2, older than 18 years of age, English speaking and without contraindications to exercise were eligible to participate. Medical records were reviewed by a physician to confirm eligibility. After baseline measurements were completed (6-15 weeks postpartum), women were randomized into a control or intervention group.

Women in the intervention group received a newsletter geared to new mothers and had the opportunity to participate in 10 physical activity classes, 8 nutrition education classes and 6 motivational telephone-counseling sessions. The control group received only the monthly newsletter. A previous publication (14) described the study design for AMP in more detail. This paper reports only baseline measurements. The institutional review boards at the University of North Carolina at Greensboro and Duke University approved the protocol. All women gave written, informed consent.

Measures

Pre-pregnancy height and weight, gestational weight gain, race, age, and infant's birth weight were reported at 6-9 weeks postpartum. A trained research assistant measured height with a stadiometer (Seca, Columbia, MD) and weight on a digital scale (Tanita, Arlington Heights, IL) during the participant's postpartum obstetrics' visit. All participants were measured with clothes and without shoes. Demographic information, including education, income, marital status and parity, was obtained through a phone survey. Additionally, women were asked how many times per week they consumed fast food and how their infant was currently being fed: EB, MF, or FF.

A trained research assistant collected two 24 hour dietary recalls from each participant, using the Nutrition Data System software package (NDS) for Research [versions 5.0 and 2005 (15)]. NDS is a multiple pass approach that explicitly details daily food consumption in a phone interview format. Prior to the initial food intake, each participant was mailed a two-dimensional food portion guide to use in determining appropriate portion sizes with the interviewer's assistance. Additionally, during each intake, participants were asked about supplement use (vitamin, mineral, diet aides, or herbal supplements) and whether they considered themselves dieting at the time of the intake ("Are you currently following a formal diet plan?"). The multiple pass approach has proven to be an effective strategy to accurately record 24-hour recalls among women (16;17). In some instances, only one intake was completed, due to the participant's time constraints or refusal.

Statistical Analysis

Data were analyzed using JMP software (SAS Institute, Cary, NC). Means and standard errors (SE) were calculated for all continuous variables. Categorical variables were summarized as frequencies and percentages. Analysis of variance (*ANOVA)* and Chi-squared (X^2) analysis were performed to determine differences between groups. Tukey's post hoc analysis was used to determine where significant differences existed between groups. The significance level was set at $P \leq 0.05$.

The average of the two days of dietary intake was used for analysis, unless the participant only completed one intake, then this intake was used (18). Dietary data were analyzed for food group servings, nutrient composition, and meal and snack intakes using the NDS software. Food group serving sizes were defined in the NDS software per the *Dietary Guidelines for Americans 2005* (19). Food groups were consolidated into the following: fruits, vegetables, grains, dairy, meat, fish, poultry, eggs, nuts, seeds, meat alternatives, fats, beverages, miscellaneous foods (e.g. pickled foods, gravy, sauce, condiments), and desserts. Participant food group servings were compared to the MyPyramid (3) recommendations using a hypothetical reference woman who was either EB, MF, or FF. The reference participant was created based on the average AMP participant's level of physical activity, height, weight, age and infant's age. Therefore, the reference participant was entered as sedentary, 5'5, 89 kg, 31 years old, with a 3 month old baby who was EB, MF, or FF.

Dietary quality was evaluated using reported nutrient intakes adjusted for total calories, as described by Willet (20). Adjusted nutrient values were calculated as residuals using regression analyses with nutrient intake as the dependent variable and total calories as the independent variable. These adjusted values were used for further statistical analysis. The residual method was used to normalize total caloric intake among the 3 groups of women (breastfeeding, combining, and formula feeding only). Therefore, unlike measuring the absolute nutrient values, the adjusted values do not reflect variations in total caloric intake among participants. For this reason, the residual method also minimizes inaccurate nutrient measurements resulting from underreporting food intake (20).

Unadjusted nutrient intakes were compared to the Adequate Intakes (AI), Acceptable Macronutrient Distribution Ranges (AMDR), or Estimated Average

Requirement (EAR) for lactating and adult women (18). The nutrient specific AIs and EARs for lactation were also used as reference for MF women. For nutrients with a defined AI and EAR, the percent of participants with intakes less than the AI or EAR were calculated. The EAR for protein was calculated for each participant, using 1.05 g/kg/day for women EB and MF feedings and 0.66 g/kg/d for formula feeding women (21). Risk of dietary nutrient inadequacy was defined as ≥ 50% of the group not meeting the AI or EAR for the specified nutrient (18).

Multinomial logistic regression was used to determine the participant characteristics (pre-pregnancy BMI, age, race, education, income, marital status and infant feeding group) that best predicted whether or not participants consumed breakfast, lunch, dinner, and snacks. Breakfast, lunch, dinner, and snacks were entered into separate models as the dependent variables and scored as 0 (participant did not consume the specified meal or snack for intakes 1 and 2), 1 (participant consumed the specified meal or snack for only 1 intake), and 2 (participant consumed the specified meal or snack for both intakes). Participant characteristics were entered into the models as continuous and dichotomous independent variables. Four logistic regression models were designed each using the same independent variables; however, each dependent variable was entered separately. Women with only 1 recorded intake day were eliminated from this analysis. The significance level was set at $P \leq 0.05$.

Binomial logistic regression was used to determine the participant characteristics (pre-pregnancy BMI, age, race, education, income, marital status and infant feeding group) that best predicted whether or not a participant reported dieting. Dieting status was entered into separate model as the dependent variable and scored as 0 (participant reported they were not dieting) and 1 (participant reported they were not dieting). Participant characteristics were entered into the model as continuous and dichotomous independent variables. The significance level was set at $P \leq 0.05$.

Analysis of covariance (*ANCOVA*) was used to determine whether there was a difference between infant feeding groups in adjusted nutrient intakes and servings of food groups and to determine whether there was a difference between meal intake and dieting groups for adjusted nutrient intakes. Tests were controlled for participant characteristics that were significantly different between infant feeding groups (pre-pregnancy BMI , race, age, education, income, marital status). The Bonferroni correction was used to avoid Type 1 error that is often associated with multiple comparisons. The Bonferroni correction for multiple significance testing was carried out by dividing the p-value of 0.05 by the number of nutrient (34 categories) and food group categories (36 categories). Therefore, the significance levels were set at $P \leq 0.001$ for analysis of all nutrients and food group servings.

RESULTS

Food intakes were collected from 450 women; of these, 428 completed 2 intakes and 22 completed 1 intake, due to time constraints or unavailability. Participant characteristics are shown in **Table 1**. Of the total 450 women, 36% were breastfeeding only, 28% were mixed feeding, and 36% were formula feeding. Women EB and MF were significantly older than FF women. In comparison to MF and FF women, EB women were more likely to have a lower pre-pregnancy BMI and be white, married, college graduates, with household incomes over $60,000. Gestational weight gain and percentages of primiparous and multiparous women were similar among groups. EB women were more likely to report consuming a vitamin, mineral, and or fish oil supplement than FF women. Further, MF women were more apt than EB and FF women to report taking an herbal supplement, primarily to increase milk production (example Fenegreek). The use of weight loss dietary aides was negligible among all women (n= 4).

Nutrient Intakes

As shown in **Table 2**, EB women reported consuming significantly more calories than MF and FF women. Reported nutrient intakes were not significantly different among groups, after adjusting for caloric intake and group differences (pre-pregnancy BMI, age, race, education, income and marital status). Based on the AI, AMDR, or EAR, all groups were at risk for inadequate dietary intakes of vitamins A, E and C, calcium and folate. Additionally, MF women were also at risk for inadequate dietary intakes of vitamins D and B-6 and zinc, while FF women were at additional risk for inadequate dietary intake of vitamin D (Table 2).

Servings of Food Groups

As shown in **Table 3**, servings of grains, refined grains, and desserts were significantly different among EB, MF and FF women, after adjusting for group differences in baseline characteristics. EB and MF women consumed significantly more servings of refined grains and desserts than FF women. EB women consumed significantly more servings of total grains than FF women, while MF women consumed similar amounts to EB and FF women.

Using the reference participant created based on the average AMP woman, EB, MF, and FF participants did not meet My Pyramid (3) recommendations for servings of fruits, vegetables, grains, whole grains, dairy, meats and beans, and fat (Table 3). EB women reported consuming more servings of most food groups when compared to MF and FF women. There was not a significant difference in fast food intake between groups.

Meal and Snack Intake

Breakfast

There were no differences in breakfast consumption among infant feeding groups. Women with a lower pre-pregnancy BMI that were college graduates were most likely to consume breakfast on both intake days. Adjusted nutrient intakes of dietary fiber, riboflavin, and vitamin B-6 were significantly lower among women who consumed no breakfast (n=16) or only on 1 intake day (n=48), in comparison to women who reported consuming breakfast on both intake days (n=364) (None: 10 (1.7) vs.1 intake day: 10 (1.0) vs. 2 intake days: 16 (0.4) gm/day, $P \leq 0.001$, None: 1.1 (0.2) vs. 1 intake day: 1.5 (0.1) vs. 2 intake days: 2.1 (0.1) mg/day, $P \leq 0.001$), and None: 1.0 (0.2) vs. 1 intake day: 1.3 (0.12) vs. 2 intake days: 1.8 (0.04) mg/day, $P \leq 0.001$, respectively).

Lunch

White, college graduates, who were exclusively breastfeeding, were most likely to consume lunch on both intake days. Niacin and the percentage of calories from protein were significantly lower among women who consumed no lunch (n=17) or only on 1 intake day (n=71), in comparison to women who reported consuming breakfast on both intake days (n=340) (None: 15 (2.1) vs. 1 intake day: 18 (1.0) vs. 2 intake days: 23 (0.5) mg/day and None: 14 (1.1) vs. 1 intake day: 16 (0.5) vs. 2 intake days: 17 (0.2) gm/day, $P \leq 0.001$, respectively).

Dinner

Adjusted nutrient intakes were not significantly different among participants who reported consuming no dinner (n=2), dinner on only 1 intake day (n=27), or dinner on 2 intake days (n=399). There were no significant predictors of consuming dinner among women.

Snacks

Women who were college graduates and exclusively breastfeeding were most likely to snack on both intake days. Unlike meals, women who reported snacking for both intakes (n=258) consumed significantly higher calories than those reporting snacking for 1 intake (n=120) or not snacking (n=50) (2084 (38.0) vs. 1610 (55.0) vs. 1435 (85.0) kcal/day, $P \leq 0.001$).

Dieting

Race, household income, and infant feeding group were the most significant predictors of dieting ($P \leq 0.05$). White women with household incomes between $30,001-60,000 and formula feeding their infants were more likely to report dieting. Participants who reported dieting consumed significantly less protein in comparison to those who reported not dieting (73 (1.3) vs. 77 (4.4) grams/day, $P \leq 0.001$). Whereas, the reported percentage of calories from protein were significantly lower among women not dieting compared to those dieting (17 (0.2) vs. 20 (0.6) % /day, $P \leq 0.001$). There were no other differences in reported adjusted nutrient intakes among dieters and non- dieters.

DISCUSSION

Among this sample of overweight and obese women, FF women were heavier, yet consumed fewer calories, fewer servings of grains, refined grains and desserts, and were at risk for not meeting the AI or EAR for specific nutrients. Further, FF women were more likely to diet and not supplement with a multivitamin when compared with EB or MF women. These findings agree with other studies assessing dietary differences and quality among FF and EB women. George et al. (5) reported lactating women had more positive dietary behaviors than formula feeding women when assessing food group servings, while Walker and Freeland-Graves (8) reported that lactating women consumed a lower fat diet and participated in an overall healthier lifestyle than non-lactating mothers.

The National Academy of Sciences (NAS) recommends lactating women consume 330 additional calories in the first 6 months postpartum (22). EB women in this study consumed on average 2107 calories, 450 more calories than FF women and 241 more than MF. Energy intake among EB women was similar to other studies assessing caloric intake among lactating women (5;9;10), yet less than the recommended amount (22). The additional calories consumed by EB women came from snacking and not meals. According to the food servings consumed, these snacks were likely to be grains, refined grains, and/or dessert foods.

During lactation, nutrient requirements for vitamins A, B6, and C, and zinc are substantially increased (22-25). Dusdieker et al. reported when exclusively breastfeeding women restricted daily food intake by approximately 500 kcal/day, they still met 90% or more of the RDA for calcium, vitamin A, riboflavin, niacin, thiamin, vitamin C, and iron (26). However, Lovelady et al. showed, the RDA for vitamin C, E, D, and calcium was not met by lactating women decreasing intake by 500 calories/day (10). They recommended that lactating women incorporate more fruits and vegetables and high calcium and vitamin D sources into their diet. Our study revealed similar findings: overweight and obese EB women were at risk for inadequate intakes of vitamins A, E, C, folate, and calcium. Additionally, MF women were also at risk for inadequate intakes of vitamins D and B-6 and zinc, while FF women were also at risk for vitamin D inadequacy. Our study also showed nutrient quality (adjusted nutrient intakes) was not worse among dieters, rather overall low food intake by dieters and non-dieters contributed to the risk of inadequate nutrient intakes. Mackey et al. (9) reported that, even when lactating women were not dieting, reported dietary intakes were limited in calcium, zinc, folate, and vitamins E, D, and B-6. Among all nutrients analyzed in this study of primarily non-dieting women, the prevalence of inadequacy was also greatest among all groups for vitamin E and calcium. When lactating women consume less than 2700 calories/day, nutrient intakes of vitamin B6, calcium, zinc, folate are at risk for not meeting the recommendations (22). Berg et al. also showed decreased intakes of folate and zinc during the postpartum period (27)

Overall servings were inadequate for all food groups when compared to the MyPyramid (3) recommendations for the study reference participant. None of the groups consumed at least half of their grain servings from whole grains, as recommended by MyPyramid (3). These results are similar to those from other studies, who reported that dietary quality remained inadequate during the postpartum period, often not meeting the recommendations for bread (5), milk (5), vegetable (2;5) and fruit (2). George et al. (5) reported that lactating women were more likely to have lower fat intake than formula feeding women. We observed fat intake was similar among all groups. However, it is important to consider the type of fats consumed. While all groups fell within the AMDR for percent of calories from fat, EB, MF, FF women reported higher amounts of saturated fat and lower amounts of polyunsaturated fat.

We found consuming lunch and snacks, but not breakfast and dinner, differed significantly among infant feeding groups. EB women were more likely to report consuming lunch and snacks, while still having a significantly lower BMI at 9-15 weeks postpartum. These findings are similar to those of Ohlin and Rossner (28), who assessed meal patterns among postpartum women and reported that women with stable body weight 1 year postpartum displayed more regular eating patterns (not skipping meals regularly), compared to women who retained more pregnancy weight. In our study, snacking contributed to additional calories among groups. Consuming breakfast regularly contributed to a higher fiber, riboflavin and vitamin B-6 intake among women. While women who consumed lunch regularly had a higher niacin intake and consumed more calories from protein than those who did not. However, total dietary intake remained inadequate for vitamins A, E, C, folate, and calcium, regardless of whether women consumed breakfast or lunch on both intake days.

To our knowledge, this is the first study to not only compare nutrient intake and quality, servings of food groups, meals and snack intake, and dieting among exclusively breastfeeding, mixed feeding, and formula feeding women, but to do so among a diverse cohort of overweight and obese postpartum women. Secondly, we assessed nutrient intake, while adjusting for energy intake and participant characteristics. In addition, we made comparisons among groups, using the AI and EAR recommendations, in order to draw more accurate conclusions about food intake during the postpartum period.

The main limitation of this study was all food intakes were self-reported. To best estimate self reported dietary intake, research suggests collecting 3 dietary intakes, 2 week days and 1 weekend day (29). However, because of participant availability and time constraints during the postpartum period, it was not feasible to obtain 3 intakes during the week and weekend and in most instances recalls were scheduled on any day of the week. Further, underreporting food intake among overweight participants has been shown to be higher than normal weight participants (30;31). For this reason, to minimize inaccurate nutrient measurements resulting from underreporting food intake, nutrients were adjusted for total caloric intake using the residual method (20). Another limitation was nutrient intake and quality for MF women was compared to the recommendations for exclusively breastfeeding women, possibly overestimating requirements for consumption for this population.

CONCLUSIONS

FF women consume fewer calories and servings of grains, refined grains, and desserts, are more likely to diet, and not consume a multivitamin than EB or MF women. While nutrient intakes adjusted for total calories were not different among EB, MF, and FF, the quality of the diet remained inadequate for specific nutrients. Overweight and obese, EB, MF, and FF women were at risk for inadequate dietary intakes of vitamins A, E, C, folate, and calcium. Additionally, MF women were also at risk for inadequate dietary intakes of vitamins D and B-6 and zinc, while those FF were also at risk for vitamin D inadequacy. Being at risk for nutrient inadequacies appears to be a reflection of not meeting the number of recommendations for specific food group servings. Encouraging consumption of a healthy breakfast, lunch, and/or snacks and incorporating fruits, vegetables, dairy, whole grains, lean meat and beans, and healthy types of fat may help to increase intakes of nutrients that are lacking in the diets of overweight and obese postpartum women.

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TABLES

Table 1. Participant characteristics

	Exclusively Breastfeeding (n=160)	Mixed feeding (n= 128)	Formula Feeding Women (n=162)
Participant Characteristics			
Age (y)	32.1 ±0.43 [a]	31.3 ±0.48 [a]	29.4 ±0.43 [b]
Gestational Weight Gain (kg)	15.0 ±1.50	15.2 ±1.68	15.0 ±1.50
Pre-Pregnancy BMI (kg/m^2)	29.0 ±0.57 [b]	31.2 ±0.64 [a]	33.0 ±0.57 [a]
BMI (kg/m^2 at 9-15 weeks)	31.0 ±0.49 [a]	33.1 ±0.55 [b]	35.0 ±0.49 [c]
Race *			
White	109 (68%)	56 (44%)	63 (39%)
Black	51 (31%)	72 (56%)	99 (61%)
Other	10 (6%)	10 (8%)	3 (2%)
Education *			
≤ High school graduate	15 (9%)	20 (16%)	58 (36%)
Some college	31 (19%)	33 (26%)	46 (28%)
≥ College graduate	114 (71%)	75 (56%)	58 (36%)
Income *			
Up to $15,000-30,000	22 (14%)	40 (32%)	60 (38%)
$30,001 - $60,000	43 (28%)	38 (30%)	50 (32%)

$60,0001 or more	90 (58%)	47 (38%)	48 (30%)
Marital Status [*]			
Single, never been married	5 (3%)	24 (19%)	47 (29%)
Living with a partner	10 (6%)	16 (13%)	23 (14%)
Married	141 (88%)	81 (63%)	87 (54%)
Separated/divorced/widowed	4 (3%)	7 (5%)	5 (3%)
Parity			
Primiparous	61 (38%)	56 (44%)	68 (42%)
Multiparous	99 (62%)	72 (56%)	94 (58%)
Dieting Status [*]			
Not Dieting	149 (95%)	109 (87%)	116 (79%)
Dieting	8 (5%)	16 (13%)	31 (21%)
Vitamin/Mineral/Fatty Acid Supplementation [*]			
No	32 (20%)	36 (28%)	92(57%)
Yes	128 (80%)	92 (72%)	69 (43%)
Herbal Supplementation			
No	152 (96%)	120 (94%)	159 (99%)
Yes	7 (4%)	7(6%)	1 (1%)

Mean ± SE or n(%)

Groups with different letters are significantly different, P≤0.05.

*** Significantly different between groups, P ≤ 0.05.**

Table 2. Comparison of nutrient intake across groups

	RDA and EAR or AMDR or AI for Lactating	RDA and EAR AMDR or AI for Non-Lactating	Exclusively Breastfeeding (n=160)	Mixed feeding (n= 128)	Formula Feeding Women (n=162)
Energy Intake (kcal)			2107 ±50 [a]	1866 ±56[b]	1657±50 [c]
Fat (g)			82 ±3	70 ±3	66 ±3
Carbohydrates (g)	210, 160	130, 100	264 ±7	236 ±8	202 ±7
% < EAR			11%	18%	10%
Protein (g)	71, 60	46, 38	85 ±2	77 ±2	68 ±2
% < EAR			0%	0%	0%
% Fat (% of total kcal)	20-35%	20-35%	34% ±1	33% ±1	35% ±1
% Carbohydrates (% of total kcal)	45-65%	45-65%	50% ±1	51% ±1	49% ±1

% Protein (% of total kcal)	10-35%	10-35%	16% ±0	17% ±0	17% ±0
% kcal from Total Saturated Fatty Acids (SFA)			12 ±0	12 ±0	12 ±0
% kcal from Total Monounsaturated Fatty Acids (MUFA)			13 ±0	12 ±0	13 ±0
% kcal from PUFA	10%	10%	7 ±0	7 ±0	7 ±0
PUFA 18:2 (linoleic acid) (g)	13	12	14 ±1	12 ±1	11 ±1
PUFA 18:3 (linolenic acid) (g)	1.3	1.1	1.6 ±0	1.3 ±1	1.2 ±1
PUFA 22:6 (docosahexaenoic acid [DHA]) (g)			0.10 ±0	0.09 ±0	0.08 ±0
Total Trans Fatty			5 ±0	4 ±0	5 ±0

Acids (TRANS) (g)					
Cholesterol (mg)			317 ±15	281 ±16	270 ±14
Alcohol (g)			1 ±0	1 ±0	1 ±0
Total Fiber (g)	29	25	18 ±1	14 ±1	12 ±1
Total Vitamin A Activity (Retinol Activity Equilvants (µg)),	1300, 900	770, 550	910 ±51	794 ±57	566 ±50
% < EAR			57%	75%	62%
Vitamin D (calciferol) (µg)	5	5	6 ±0	5 ±0	4 ±0
% < AI			49%	61%	73%
Vitamin E (Total Alpha-Tocopherol) (mg)	19, 16	15, 12	8 ±0	7 ±0	6 ±0
% < EAR			100%	98%	95%
Vitamin C (ascorbic acid) (mg)	120, 100	75, 60	88 ±5	92 ±6	68 ±5

% < EAR			65%	70%	53%
Vitamin B-6 (pyridoxine, pyridoxyl, & pyridoxamine) (mg)	2.0, 1.7	1.3, 1.1	2.0 ±0	1.7 ±0	1.5 ±0
% < EAR			41%	53%	28%
Total Folate (µg)	500, 450	400, 320	498 ±17	423 ±19	340 ±17
% < EAR			55%	63%	52%
Calcium (mg)	1000	1000	1029 ±35	814 ±39	670 ±35
% < AI			54%	75%	81%
Iron (mg)	9, 6.5	18, 8.1	17 ±1	15 ±1	13 ±1
% < EAR			2%	5%	24%
Zinc (mg)	12, 10.4	8, 6.8	12 ±1	12 ±1	9 ±1
% < EAR			44%	55%	31%
Sodium (mg)	1500	1500	3522 ±100	3155 ±112	2921±100

Mean ±SE

Groups with different letters are significantly different, $P \leq 0.001$

Nutrient intake amounts shown are unadjusted for energy intake.

Nutrient intakes were adjusted for energy intake to determine significant differences between groups

All variables adjusted for group differences in participant characteristics (pre-pregnancy BMI, age, race, education, income, and marital status).

Table 3. Average number of food group servings across groups

Food Groups	Exclusively Breastfeeding (n=160)		Mixed feeding(n= 128)		Formula Feeding Women (n=162)	
	Recommended	Actual	Recommended	Actual	Recommended	Actual
Fruits	**4**	**1.3 ±0.1**	**4**	**1.4 ±0.1**	**4**	**0.83 ±0.1**
Vegetables	**6.5**	**3.2 ±0.1**	**6**	**2.6 ±0.2**	**6**	**2.3 ±0.1**
Vegetables		2.4 ±0.1		1.9 ±0.1		1.6 ±0.1
Fried potatoes		0.2 ±0.0		0.2 ±0.0		0.2 ±0.0
Legumes		0.1 ±0.0		0.1 ±0.0		0.1 ±0.0
Starchy vegetables		0.4 ±0.0		0.4 ±0.1		0.3 ±0.1
Grains	**9**	**6.7 ±0.2 [a]**	**7**	**6.0 ±0.2 [a b]**	**7**	**5.0 ±0.2 [b]**
Whole wheat and some whole wheat grains	4.5	2.0 ±0.1	3.5	1.4 ±0.1	3.5	1.1 ±0.1
Refined grains		4.3 ±0.2 [a]		4.3 ±0.2 [a]		3.5 ±0.2 [b]
Snack chips		0.4 ±0.0		0.2 ±0.1		0.3 ±0.0
Protein	**6.5**	**5.6 ±0.2**	**6**	**5.6 ±0.3**	**6**	**5.2 ±0.2**
Regular and lean beef and pork		1.5 ±0.1		1.8 ±0.1		1.3 ±0.1

Regular and lean poultry		1.7 ±0.1		1.8 ±0.2		2.1 ±0.1
Fish		0.7 ±0.1		0.7 ±0.1		0.5 ±0.1
Cold cuts and sausage		0.7 ±0.2		0.7 ±0.1		0.7 ±0.1
Egg		0.5 ±0.1		0.4 ±0.1		0.5 ±0.1
Nuts and seeds		0.4 ±0.1		0.2 ±0.1		0.1 ±0.1
Meat alternatives		0.1 ±0.0		0.1 ±0.0		0.02 ±0.0
Dairy	**3**	**2.3 ±0.1**	**3**	**1.9 ±0.2**	**3**	**1.7 ±0.2**
Milk whole and reduced fat		0.4 ±0.1		0.4 ±0.1		0.4 ±0.1
Milk low fat and skim		0.6 ±0.1		0.4 ±0.1		0.2 ±0.1
Cheese		0.7 ±0.0		0.6 ±0.1		0.6 ±0.0
Yogurt		0.1 ±0.0		0.1 ±0.0		0.05 ±0.0
Cream		0.5 ±0.1		0.4 ±0.1		0.5 ±0.1
Fats	**8**	**3.5 ±0. 2**	**6**	**3.0 ±0.2**	**6**	**2.5 ±0.4**
Beverages		**2.5 ±0.2**		**2.2 ±0.2**		**2.7 ±0.2**
Regular soft drinks		0.4 ±0.1		0.5 ±0.1		0.8 ±0.1
Diet soft		1.3 ±0.1		0.9 ±0.1		1.0 ±0.1

drinks, unsweetened tea & unsweetened coffee			
Sweetened fruit drinks and tea	0.7 ±0.1	0.8 ±0.1	0.7 ±0.1
Alcoholic beverages	0.1 ±0.0	0.1 ±0.0	0.1 ±0.0
Miscellaneous			
Gravy	0.01 ±0.0	0.03 0.0	0.02 ±0.0
Sauces and condiments	0.9 ±0.1	0.7 0.1	0.9 ±0.1
Pickled foods	0.1 ±0.0	0.1 0.0	0.1 ±0.0
Desserts	**1.2 ±0.1** [a]	**1.0 ±0.1** [a]	**0.7 ±1.0** [b]
Weekly fast food servings			
None			
less than one time	20 (13%)	22 (17%)	13 (8%)
1 time	45 (28%)	20 (16 %)	24 (15%)
2 times	45 (28%)	26 (20%)	40 (25%)
3 to 5 times	30 (19%)	36 (28%)	44 (27%)
more than 5	18 (11%)	21 (16%)	34 (21%)

times	2 (1%)	3 (2%)	7 (4%)

Mean ±SE, n (%)

Groups with different letters are significantly different, P ≤ 0.001

These variables adjusted for group differences in participant characteristics (pre-pregnancy BMI, race, age, education, income, marital status).

Recommended food group servings based on MyPyramid guidelines for reference participant who represents the average AMP participant (sedentary, 5’5, 89 kg, 31 years old, with a 3 month old baby) (3).

CHAPTER IV

BEHAVIORAL PREDICTORS OF WEIGHT CHANGE FROM 2 TO 6 MONTHS POSTPARTUM AMONG OVERWEIGHT AND OBESE WOMEN

INTRODUCTION

Maternal weight gain during pregnancy and weight retention 6 months postpartum are critical markers in predicting risk for life-long overweight and obesity in childbearing women (1;2). Approximately 14-20% of women are still more than 5 kilograms (kg) heavier 6 to 18 months postpartum than before becoming pregnant (5). According to data from the 1988-1994 and 1999-2002 National Health and Nutrition Examination Survey (NHANES), the prevalence of women defined as overweight and obese (body mass index (BMI) ≥ 25 kg/m^2) has risen among various ethnic groups (3;4). Gestational weight gain, pre-pregnancy weight, age, race, income and parity are also related to weight retention among postpartum women (6-12). In addition, modifiable behavioral factors have been associated with weight change during this period: dietary intake (13-16) and dietary habits (17-19), physical activity (1;2;12;13;15), and breastfeeding (1;2;20-22).

Rooney and Schauberger (1) reported that women breastfeeding longer than 3 months or exercising aerobically had significantly less weight gain at 8.5 years postpartum than those women who breastfed less than 3 months or did not exercise. However, the most significant predictors of weight gain were gaining more weight than recommended during pregnancy and retaining weight gained during pregnancy at 6 months postpartum. Age, parity, and smoking status were not associated with BMI or weight gain.

Olson et al. (12) reported that gaining less gestational weight than recommended, exercising often, consuming “a lot less food”, and breastfeeding at 1 year postpartum were significantly associated with retaining less weight during this period. However, among those women retaining a substantial amount of weight at 1-year postpartum (≥ 4.55 kg), gestational weight gain, postpartum exercise and food intake were the critical behaviors significantly impacting weight retention, while breastfeeding duration was not. Similar to other studies, age and marital status were associated with significantly more weight gain (12).

While studies show weight loss in first 6 months postpartum (1;2) and lifestyle behaviors (12;97).are critical in the prevention of postpartum weight retention, this has not been investigated among a socially diverse cohort of women who were overweight or obese prior to pregnancy. Therefore, the purpose of this study was to assess how health behaviors (food habits, physical activity, and breastfeeding) impact weight change by 6 months postpartum in overweight and obese women.

MATERIALS AND METHODS

Study Design

In this observational study, we investigated the effects of breastfeeding, food habits, and physical activity on weight loss among a subset of overweight and obese postpartum women enrolled in the intervention arm of a larger-scale study called Active Mothers Postpartum (AMP) study. The overall aim of AMP was to evaluate the efficacy of an intervention which promotes increased physical activity and decreased overall caloric intake among postpartum women who were overweight or obese prior to pregnancy.

Participants were recruited from obstetric clinics in the Durham, North Carolina, area, and through posters in public areas such as grocery stores and libraries. Women with a pre-pregnancy BMI $\geq$ 25 kg/m^2, older than 18 years old, English speaking, and without contraindications to exercise were eligible to participate in the study. Medical records were reviewed by physician to confirm eligibility. Baseline measurements were made at 6-9 weeks postpartum.

AMP was a two-arm, randomized controlled trial (n = 225 control participants and n = 225 intervention participants). Women in the intervention arm had the opportunity to attend 10 physical activity classes and 8 nutritional classes and to receive 6 motivational telephone counseling sessions. In addition, they were provided with a sports stroller at 6 months postpartum. Women completed a survey at the time of their stroller pickup, and weight was measured by a trained research assistant. The study design for AMP is described in more detail in a previous publication (103). For purposes of this study's analyses, only women in the intervention arm of AMP were evaluated because the control group did not participate in measurements at 6 months. The protocol was approved by the institutional review boards at the University of North Carolina at Greensboro and Duke University. All women gave written informed consent.

Measures

Pre-pregnancy height and weight, gestational weight gain, race, age, and infant's birth weight and demographic information including education, income, marital status and parity were reported by participants at approximately 2 months (baseline). A trained research assistant measured height with a stadiometer (Seca, Columbia, MD) and weight on a digital scale (Tanita, Arlington Heights, IL) during the participant's postpartum obstetrics' visit. All participants were measured with clothes and without shoes. Weight was measured again at 6 months postpartum and weight change was calculated by subtracting baseline weight from 6 month weight.

At 6 months postpartum, participants completed a survey, documenting how their infant was fed each month during the first 6 months postpartum. For each month, women were assigned a 0 if formula feeding only, a 1 if combining formula with breastfeeding, or a 2 if breastfeeding only. A lactation score was calculated by totaling the assigned values for each month. The scores ranged from 0 to 12, with 0 meaning exclusively formula feeding and 12 exclusively breastfeeding. This score was used as an indicator of the amount and duration of lactation for the first six months postpartum.

Physical activity at 6-months postpartum, such as brisk walking, bicycling, vacuuming, gardening, or other activities that caused at least small increases in breathing or heart rate, was assessed using questions from the Behavioral Risk Factor Surveillance System (BRFSS) (110). Women reported the number of minutes each day and the number of days each week that they engaged in physical activity. (See appendix.)

Food habits at 6-months postpartum were evaluated using a mini food frequency questionnaire that is currently being used by some health agencies in North Carolina to assess food intake among participants. The questionnaire was validated for content by five nutrition health professionals. Participants were asked the number of daily servings and amount of soda and sweetened beverages, weekly fast food servings, number of daily French fry and chip servings, number of daily milk servings, type of milk consumed, yogurt servings, desserts and sweets servings and number of daily vegetable and fruit servings consumed. (See appendix.)

Statistical Analysis

Data were analyzed using JMP software (version 6.0; SAS Institute, Cary, NC). Means and standard deviation (SD) were calculated for all continuous variables. Categorical variables were summarized as frequencies and percentages. The significance level was set at $P \leq 0.05$.

Principal components analysis was used to derive food habit factors. A varimax rotation was applied to generate uncorrelated food habit factors from the correlation matrix of the eleven dietary questions (111). To identify the final number of factors for further statistical analysis, several criteria were used. These were eigenvalues ≥ 1.0, variable loadings on a single factor (≥ 0.45) on one and only one factor, communalities $\geq$ 40% and interpretability of factors. For each participant, standardized factor scores were calculated from the final factor solution and used in subsequent analysis.

Pearson correlations were used to examine the relationships between weight change and each of the following behavioral factor variables: food habit factors, lactation duration and physical activity. The significance level was set at $P \leq 0.10$. Subsequently, multivariate analysis was completed to identify significant predictors of weight change at 6 months postpartum. Only those behavioral factors that were significantly related to weight loss in the Pearson correlations analysis were included ($P \leq 0.10$). Interactions among the significant behavioral factors, and subject characteristics, including gestational weight gain, baseline weight, race, age, education, income, marital status and parity, were entered into the model as the independent variables. Weight change at 6 months postpartum was the outcome variable. Using stepwise regression procedure with backward elimination, non-significant variables were dropped from the model ($P \leq 0.05$). In the final model, the total effects of the independent variables on the outcome variable were reported, using regression coefficients for each significant variable and R^2 for the overall model. The significance level was set at $P \leq 0.05$.

RESULTS

Baseline data were collected from 225 women; however, 35 women did not complete the 6 month measurements. These women had significantly less household income and education, were younger, primarily black, less likely to be married, and gained less weight during pregnancy than women completing the survey. Of the remaining 190 women, 2 participants were eliminated from analysis: one participant had a weight gain of more than two standard deviations above the mean during pregnancy, as did the other participant, during the first 6 months postpartum. Twenty-two participants partially completed the survey. The final multivariate model included 166 women.

Participant baseline characteristics are shown in **Table 1**. From various education and income levels, this diverse cohort was 39% black and 61% white women. Six women reported their race as Asian; their characteristics were similar to whites; therefore, these participants were categorized as white for statistical analyses. Most of the women were married. Percentages of primiparous and multiparous women were similar. Gestational weight change ranged from a loss of 10.0 kg to a gain of 36.0 kg. Average BMI increased from pre-pregnancy to 6 months postpartum. Average weight change of participants from 2 to 6 months postpartum was -0.3 ± 4.7 ranging from a loss of 9.0 kg to a gain of 13.0 kg.

Sixty-five percent of women breastfed, versus 19% formula fed at one month postpartum; however, by six months postpartum, breastfeeding decreased to 28%, and formula feeding increased to 52% (**Figure 1**). The average lactation score was 6.5 ± 4.5. There was a significant relationship between lactation score and weight change ($r = -0.23$, $P<0.01$) (**Figure 2**) at 6 months postpartum. Women reported participating in 154.9 ± 253.1 minutes of light physical activity each week (**Table 2**). However, physical activity was not significantly related to weight change ($r = 0.01$; $P= 0.87$). Pre-pregnancy and baseline weight were highly correlated; therefore, pre-pregnancy weight was not entered into the final model.

At 6 months postpartum, the majority of women reported minimal consumption of foods and beverages generally perceived as unhealthy (daily soda and sweetened beverage, weekly fast food, daily French fries, chip, and dessert and sweets servings) (Table 2). Four food habit factors were defined, using principal components analysis, and, together, they explained 60% of the variance of overall food intake (**Table 3**). Positive factor loadings indicated a positive association with other food habits or choices; negative loadings were indicative of an inverse association with food habits or choices. Factor 1 (scores ranged from -1.43 to 2.42) and Factor 3 (scores ranged from -2.10 to 3.38) was consistent with unhealthy food habits, including amount and servings of regular soda and sweetened beverage, fast food consumption, French fries, chips, and desserts and sweets; all typically associated with excess caloric intake and minimal nutrient density. Factor 2 (scores ranged from -2.72 to 2.27) demonstrated that consumption of nutrient dense vegetable servings were positively associated with fruit intake and negatively associated with weekly yogurt intake. Finally, factor 4 (scores ranged from -2.27 to 3.05) defined milk consumption. There was a significant relationship between each of the four factors and weight change [(factor 1 ($r = 0.41$, $P<0.01$), factor 2 ($r = 0.14$, $P=0.07$), factor 3 ($r = 0.13$, $P=0.10$), and factor 4 ($r = 0.17$, $P=0.02$)]. Therefore, each factor was included in the multivariate analysis.

Lactation scores, food habit factors; interactions between these behaviors; and all subject characteristics were entered into a stepwise regression analysis. The final multivariate model included food habits factor 1 (soda, sweetened beverage, and fast food intake) and 3 (French fries, chips and dessert and sweets consumption), household income level, baseline weight and gestational weight gain. These variables explained 40% of the variation in weight change from baseline to 6 months postpartum (**Table 4**). The most significant predictors of weight change were soda, sweetened beverage, fast food (partial $R^2=0.06$, $P<0.05$), French fries, chips and dessert and sweets consumption (partial R^2=0.02, P<0.05), household income (partial R^2=0.04, P < 0.05), baseline weight (partial R^2=0.06, P<0.05), and gestational weight gain (partial R^2=0.06, P=0.01). There were no significant interactions among the behavioral factors.

Women who consumed higher amounts of regular soda, sweetened beverage, fast food, French fries, chips, and desserts and sweets weighed more at baseline, gained less weight during pregnancy and had a household income ≤ $30,000 were at greater risk for weight gain by 6 month postpartum than their corresponding reference groups. For example, a woman reporting a gestational weight gain of 13 kg, baseline weight of 73 kg, with a income ≤$30,000, a factor 1 score of 0.80, and a factor 3 score of 3.38 would gain 4 kg by 6 months postpartum. Whereas, as woman reporting a gestational weight gain of 12 kg, baseline weight of 88 kg, with a income >$60,000, a factor 1 score of -1.16, and a factor 3 score of -0.81 would lose 8 kg by 6 months postpartum.

DISCUSSION

The reported amount of soda, sweetened beverage, fast food, French fries, chips, and desserts and sweets consumed; weight at 2 months, gestational weight gain and household income were significantly related to weight change among overweight and obese women at 6 months postpartum. These results are similar to those of Olson et. al. (12), who asked participants how their food intakes changed over the first year postpartum. While specific foods were not defined, women who reported increasing food intake during the second 6 months postpartum were more likely to experience a weight gain of ≥ 4.5 kg at 1 year postpartum (12). Fowles and Walker (102) evaluated the "healthiness of groupings of food regularly consumed" or dietary quality of foods consumed by women 4 to 5 months postpartum and found dietary quality was not associated with postpartum weight retention. Boardley et al (15) reported higher rates of overweight and obesity among different ethnic groups was partially attributed to higher mean caloric intake and the percentage of fat in the diet at 7-12 months postpartum.

While evidence suggests increased calcium intake from specific dairy foods may also be associated with weight loss (76;84), neither daily milk nor daily yogurt consumption were associated with weight change in this study when controlling for other variables. Wosje et al. (85) completed a calcium supplementation trial from 2 weeks to 6 months in lactating and non-lactating, normal weight women. They reported calcium supplementation (1000 mg/d) did not promote postpartum weight loss or fat loss (85).

Fast food intake was significantly associated with postpartum weight retention. As weekly intake increased, so did weight retained at 6 months postpartum. Such findings correspond to a study conducted by Duffey et al. (65) over a 10 year period, which demonstrated for each additional fast food meal consumed per week during this time, BMI increased 0.13 and 0.24 at 7 and 10 years, respectively in young men and women.

Currently, Healthy People 2010's goal is for 75% of women to breastfeed in the early postpartum period (112). For our study, rates of breastfeeding at 1 month postpartum were 65%, versus 19% formula feeding. This was a unique finding because overweight and obese women generally have lower rates of breastfeeding initiation than normal weight women (113-115). During the postpartum period, many associate breastfeeding with weight loss. However, postpartum weight loss varies among women, with some women actually gaining weight during lactation (35). While lactation score in our study was associated with weight change, other factors were more significant at 6 months postpartum. Our findings are similar to Janney et. al (20), who reported, while breastfeeding was significantly associated with weight loss; age, marital status and gestational weight gain influenced weight retention more than infant feeding practices.

There is a paucity of research concerning the benefits of increased physical activity and exercise on maternal well being and weight in the postpartum period. We did not find a relationship between physical activity and weight loss. However, the survey question did not ask specific types of physical activity. Rooney et al. (1) assessed the effects of exercise, not physical activity, on long term weight retention. They reported women participating in aerobic exercise during the postpartum period experienced significantly less weight gain 8.5 years later, than women who did not report this type of exercise. Similar results have also been shown in short term studies; women who reported exercising more often are at decreased risk for weight gain at 1 year postpartum (12). Higher rates of overweight and obesity during postpartum period in black women can be partially attributed to lower physical activity, in comparison to white postpartum women; however, the most significant predictor of weight retention during postpartum among both races was prenatal exercise, which was not measured in our study (15).

Similar to other research, our results indicate that women with higher baseline weight were at increased risk for substantial postpartum weight retention. Ohlin and Rossner (34) compared weight change after 1 year postpartum with pre-pregnancy body weight. While there was no significant linear relationship between pre-pregnancy weight and weight retention at 1 year postpartum, women with a gain of $\geq$ 5 kg had a higher pre-pregnancy body weight than women who gained < 5 kg during the first year postpartum. Soltani and Fraser (116) grouped women as underweight, normal weight, overweight, and obese during their first trimester of pregnancy and reported that, by 6 months postpartum, weight loss among groups was not significantly different. However, obese women experienced an increase in total skin fold thickness while normal and overweight women reduced total skin fold thickness. The relationship between pre-pregnancy BMI and postpartum weight retention indicates that being overweight or obese prior to pregnancy increases a woman's risk of gaining more weight during the postpartum period.

While gestational weight gain in this study was substantially more than the Institute of Medicine's (IOM) recommendation for this population (117), we found a significant inverse relationship between pre-pregnancy BMI and gestational weight gain. That is, the heavier the woman, the less weight gained during pregnancy. In addition, gestational weight gain was negatively related to postpartum weight retention; i.e., no gestational weight gain or weight loss during gestation increased the likelihood of weight gain during the postpartum period. These results contradict findings in other studies (1;2;12;18;34). This may be explained by our different sample of participants. We studied only women who were overweight and obese prior to pregnancy, while other researchers included underweight and normal weight women in their analyses.

Income level was related to weight change. Women with a total yearly household income of more than \$60,000 were likely to lose weight; whereas, women with household income less than or equal to $30,000 gained weight. While comparisons are difficult to make when multiple behavioral factors are not considered, Adams and Parker (11) concluded that, when income and education are grouped together categorically as socioeconomic status, black and white mothers with a low socioeconomic status are at increased risk for postpartum weight retention. Ohlin and Rossner (34) reported opposite findings; education was not associated with increased risk for becoming overweight after pregnancy.

Results from this overweight and obese cohort from Central North Carolina did not find race, age, marital status, or parity as significant predictors of weight change in multivariate analysis, while other studies have found these various subject characteristics to be positively associated with lifetime weight gain in women. Our results may be different because income level was significantly related to education, marital status, race and age in this cohort. In addition, other studies have not included behavioral factors such as food habits, lactation and physical activity among overweight and obese postpartum women in their analyses (6-11).

There were several limitations of this study. First, this was an observational analysis; with physical activity and dietary intake self-reported. Further, both were only reported at 6 months, the end of the weight change period. Therefore, it is important to be cautious in implying causality when referring to these variables. However, few large scale trials evaluating postpartum weight change in only women who are overweight or obese prior to pregnancy have been completed. Therefore, this study uniquely contributes to existing literature regarding maternal health.

CONCLUSIONS

Our results show food choices, weight at 2 months postpartum, gestational weight gain, and household income are significantly related to postpartum weight change among overweight and obese women. Decreasing daily servings and amount of soda, sweetened beverages, chips, French fries; desserts and sweets, and minimizing weekly fast food consumption may result in weight loss among this population. Health care professionals should encourage these appropriate behaviors among women during this critical period, when they are at increased risk for lifetime obesity and may be motivated to lose weight.

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TABLES

Table 1. Participant characteristics

Characteristics	**Women (n=188)**
Age (y)	31.3 ± 5.5
Gestational Weight Gain (kg)	15.9 ± 8.0
Pre-Pregnancy BMI (kg/m^2)	30.6 ± 6.8
BMI (kg/m^2) at 2 months pp[1]	32.7 ± 6.6
BMI (kg/m^2) at 6 months pp[1]	32.6 ± 7.5
Average weight change from 2 to 6 months (kg)	-0.3 ± 4.7
Race	
White	109 (58%)
Black	73 (39%)
Asian	6 (3%)
Education	
≤ High school graduate	27 (14%)
Some college	43 (23%)
≥ College graduate	118 (63%)
Income	
$15,000-30,000	45 (25%)
$30,001 - $60,000	51 (28%)
$60,0001 or more	84 (48%)
Marital Status	
Single, never been married	27 (14%)
Living with a partner	14 (7%)
Married	142 (76%)
Separated/divorced/widowed	5 (3%)
Parity	
Primiparous	77 (41%)
Multiparous	111 (59%)
Lactation Score	6.5 ± 4.5

Mean ± SD, n (%),[1] **pp= postpartum**

Table 2. Physical activity and food habits at 6 months postpartum

	Mean ± SD, n(%)
Physical Activity	n=168
Number of minutes/day	39.0 ± 52.6
Number of days/week	3.5 ± 1.7
Number of minutes/week	154.9 ± 253.1
Food habits*	
Soda servings (excluding diet soda)/day	n= 187
None	117 (63%)
1 time	39 (21%)
2 times	20 (11%)
3 or more	11 (6%)
Sweetened beverage servings (excluding 100% fruit juice and diet drinks)/day	n= 188
None	99 (53%)
1 time	44 (23%)
2 times	25 (13%)
3 or more	20 (11%)
Amount of soda or sweetened beverage/serving	n= 105
4-6 ounces	12 (7%)
8-12 ounces	74 (40%)
16-20+ ounces	19 (10%)
Fast food/week	n= 188
less than once a week	71 (38%)
1 time	42 (22%)
2 times	41 (22%)
3 to 5 times	30 (16%)
more than 5 times	4 (2.1%)

French fry and chip servings consumed (includes potato chips, tortilla chips, Cheetos®, corn chips, and snack chips)/day	n= 186
None	88 (47%)
1 time	82 (44%)
2 times	8 (2%)
3 or More	8 (2%)
Milk consumed/day	n= 187
typically don't drink	46 (25%)
less than glass	41 (22%)
1 glass	56 (30%)
2 glasses	27 (14%)
3 glasses	12 (6%)
4 or more glasses	5 (3%)
Type of milk typically consumed	n= 187
None	22 (12%)
Skim or non-fat	45 (24%)
Low fat (1/2-1%)	32 (17%)
Reduced fat (2%)	51 (27%)
Whole	27 (14%)
Flavored 2% or whole	3 (2%)
Soy milk	3 (2%)
Other, non-dairy milk	4 (2 %)
Consume yogurt daily	n= 184
yes	109 (59%)
no	75 (41%)
Vegetable serving consumed/day	n= 185
None	5 (3%)
1 serving	49 (27%)
2 servings	79 (43%)
3 or more servings	52 (28%)

Fruit servings/day	n= 187
None	28 (15%)
1 serving	85 (46%)
2 servings	62 (33%)
3 or more servings	12 (6%)
Dessert or sweet servings consumed/day	n= 187
None	38 (20%)
1 serving	97 (52%)
2 servings	41 (22%)
3 or more servings	11 (6%)

*** The number of women answering each question varies for the food habits on the 6 month survey. Therefore, specific samples sizes have been denoted for each category.**

Table 3. Principal components analysis of dietary questions.

Food Habits and Choice at 6 month postpartum	Factor 1	Factor 2	Factor 3	Factor 4	[1]Communalities
Factor 1: Soda, sweetened beverage, and fast food					
Daily soda servings (excluding diet soda)	**0.77**[2]	-0.14	0.02	-0.11	0.62
Daily sweetened beverage servings (excluding 100% fruit juice and diet drinks)	**0.83**	0.04	0.15	0.15	0.74
Amount of soda or sweetened beverage typically drank for each time	**0.86**	0.03	-0.01	0.09	0.74
Weekly fast food servings	**0.45**	-0.40	0.32	-0.01	0.46
Factor 2: Yogurt, vegetables, and fruits					
Consume yogurt weekly	0.07	**-0.59**	-0.18	-0.18	0.42
Daily vegetable servings	0.11	**0.57**	-0.28	-0.40	0.57
Daily fruit serving	-0.05	**0.82**	0.02	0.03	0.68
Factor 3: French fries, chips, and sweets					
Daily French fry and chip servings consumed (includes potato chips, tortilla chips, Cheetos®, corn chips, and snack chips)	0.32	-0.08	**0.70**	-0.08	0.60
Daily dessert or	-0.08	0.14	**0.83**	-0.003	0.72

sweet servings					
Factor 4: Milk					
Daily milk servings (1 glass= 8 ounces)	-0.09	0.09	-0.08	**0.77**	0.61
Type of milk typically consumed	0.21	0.00	-0.00	**0.66**	0.47
Percent variance explained	21.77	14.17	12.95	11.41	60.30

[1] Communalities- The proportion of the total variance that is shared by common factor variance (shared by two or more factors). It is calculated by summing the squared factor loadings of a variable.
[2] Loadings (≥ 0.45 are denoted in bold). Loadings represent the correlation between each factor and variable. Higher loadings (absolute value) shows the variable shares more variance with the specific factor. The sign defines the direction the relationship the variable has with the factor.

Table 4. Significant predictors of weight change from 2 to 6 months postpartum

	Weight change from consent to 6 months postpartum		
Predictor	**Regression coefficient**	**Standard Error**	**P-value**
Intercept	-2.66		
Baseline weight (kg)	0.07	0.02	< 0.01[1]
Gestational Weight Gain (kg)	-0.13	0.03	0.01[1]
Income			< 0.01[1]
≤ $30,000	0		
$30,001-$60,000	-1.54	0.80	0.07
> $60,000	-2.57	0.70	0.10
Food habits: Factor 1 (Soda, sweetened beverage, and fast food)	1.20	0.31	< 0.01[1]
Factor 3 (French fries, chips, and sweets)	0.56	0.28	0.05[1]
R^2 for multivariate model = 0.40			

[1] Significant, P≤0.05

FIGURES

Figure 1. Infant feeding at 1, 3, & 6 months postpartum among overweight and obese women

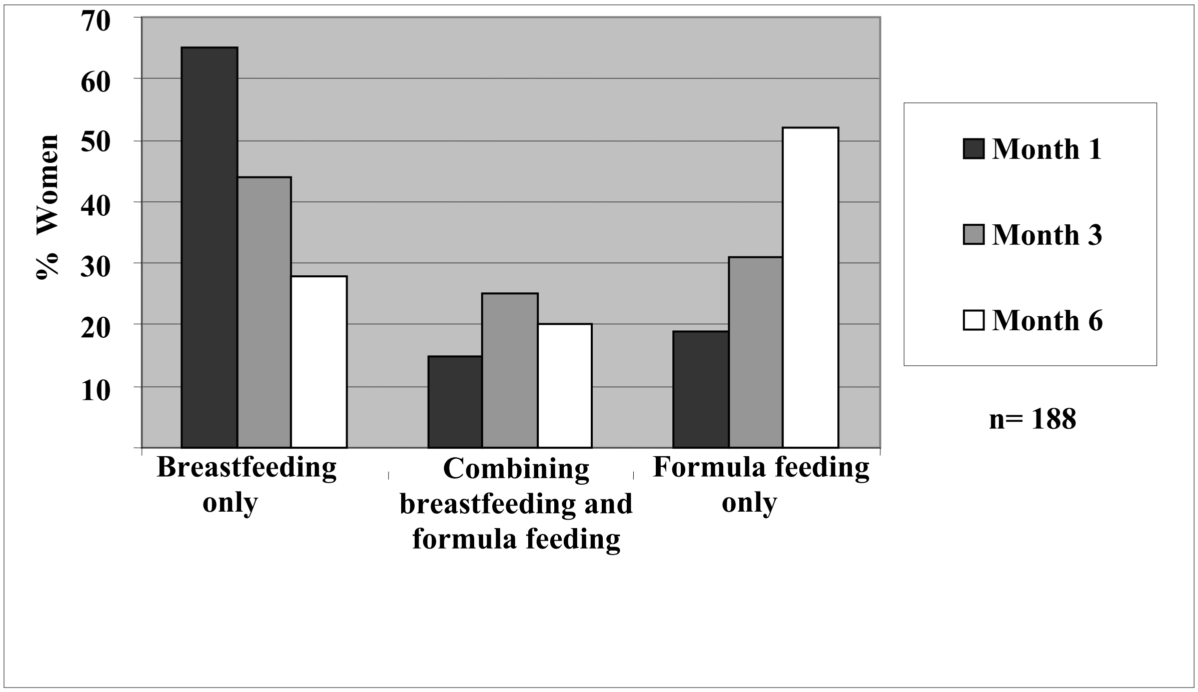
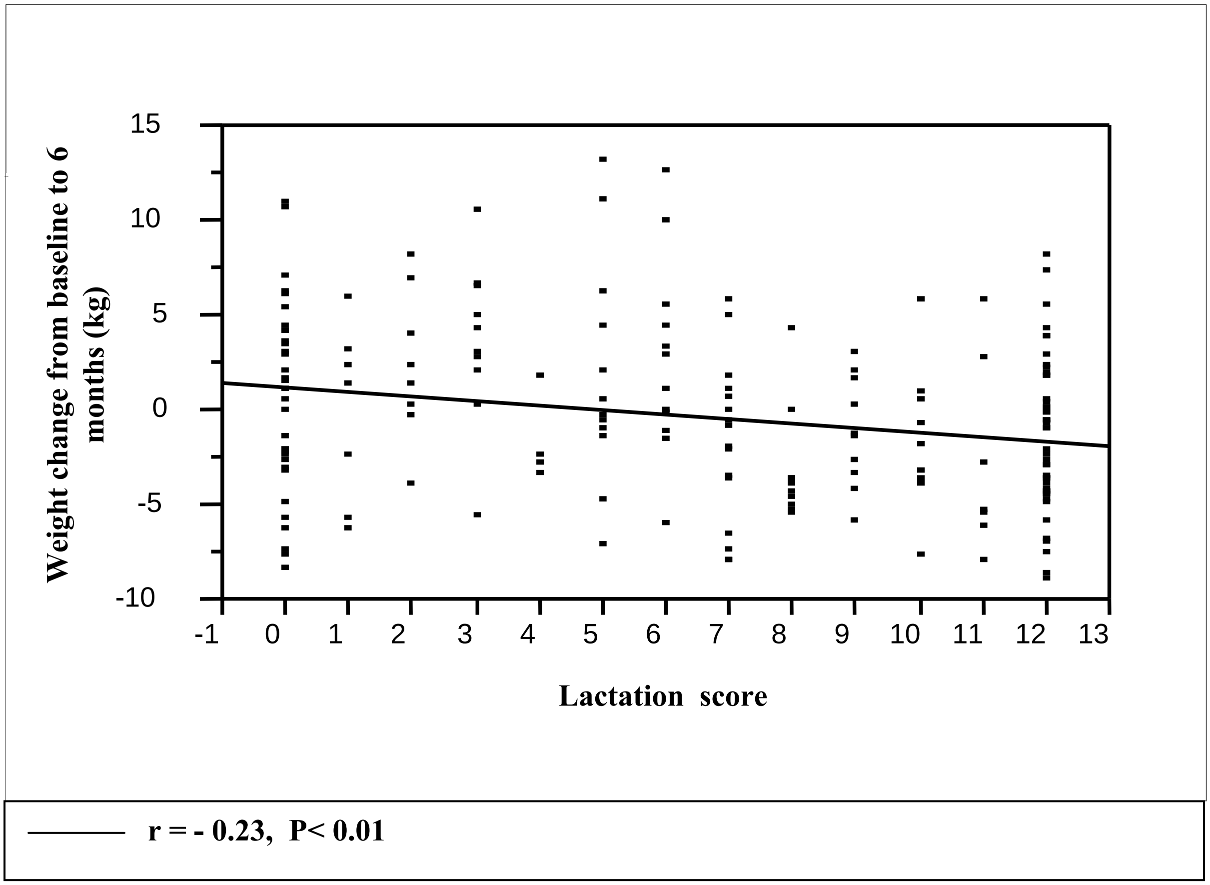


Figure 2. Lactation score and weight change from 2 to 6 months postpartum



EPILOGUE

The studies presented in this dissertation reveal that adherence to dietary guidelines is limited among exclusively breastfeeding (EB), mixed feeding (MF), and formula feeding (FF), overweight and obese postpartum women for specific nutrients and food groups. This appears to be a reflection of dietary selection that does not meet the number of recommendations for specific food group servings. Dietary intake, food habits, and choices greatly impact nutritional status during the early and late postpartum nutritional status. The research presented shows that, by decreasing daily servings of soda, sweetened beverages, French fries, and chips, sweets, and minimizing weekly fast food consumption, overweight and obese postpartum women can lose weight in the first 6 months postpartum. Health care professionals should encourage these behaviors during this critical period, when many women are at increased risk for lifetime obesity but motivated to lose weight. However, it is also important that guidance be appropriately given to postpartum women, stressing food sources of nutrients likely to be limited in self selected diets which may result in nutrient inadequacies. This study showed all overweight and obese women were at risk for inadequate dietary intakes of vitamins A, E, C, folate, and calcium. Additionally, MF women were also at risk for inadequate dietary intakes of vitamins D and B-6 and zinc, while those FF were also at risk for vitamin D inadequacy. Further, this study revealed women EB, MF, and FF did not met the *MyPyramid* recommendations for food group servings. Therefore, women should be encouraged to consume more fruits, vegetables, dairy, whole grains, lean meat and beans, and healthy types of fat in an effort to increase specific nutrients, vitamins A, E, C, D, B-6, zinc, folate, and calcium, which are known to be inadequate in the diet and to limit consumption of unhealthy choices that may induce weight gain during the postpartum period. While the impact of supplementing onutrients lacking in the diet was not assessed, EB and MF women were more likely to supplement the diet with a multivitamin than FF women, who consumed less calories and were more likely to diet than EB and MF women. This study provides modifiable behaviors that can effectively prevent nutrient inadequacies and weight gain among overweight and obese postpartum women.

Strengths and Limitations:

<u>Strengths:</u>

1.) Few large scale trials have evaluated a racially and socioeconomically diverse cohort of women who were overweight or obese prior to pregnancy. Therefore, this study uniquely contributes to existing literature regarding maternal health.

2.) To our knowledge, this is the first study not only to compare nutrient intake and quality, servings of food groups, meals and snack intake, and dieting among exclusively breastfeeding, mixed feeding, and formula feeding women, but also to do so among a diverse cohort of overweight and obese postpartum women.

3.) We assessed nutrient intake, while adjusting for energy intake and participant characteristics. In addition, we made comparisons among groups, using the AI and EAR recommendations, in order to draw more accurate conclusions about food intake during the postpartum period.

4.) The research did not rely on self-reported weight at 6 to 9 weeks or 6 months postpartum; rather, a research assistant weighed all participants using a standard protocol.

Limitations:

1.) Food intakes were self-reported. To best estimate self reported dietary intake, research suggest collecting 3 dietary intakes, meaning 2 week days and 1 weekend day. However, because of participant availability and time constraints during the postpartum period, it was not feasible to obtain 3 intakes during the week and weekend and in most instances recalls were scheduled on any day of the week and not random.

2.) Due to participant availability, in some instances, two 24-hour dietary intakes, using NDS, were not completed; rather, only one intake was obtained. With only one intake, individual validity of the dietary intakes may have been minimized. There were a limited number of participants with only one intake because research assistants were flexible and catered to the participant schedules.

3.) Because our cohort was overweight and obese, the risk of underreporting food intake among participants has been shown to be prevalent. For this reason, to minimize inaccurate nutrient measurements resulting from underreporting food intake, nutrients were adjusted for total caloric intake using the residual method.

4.) Initially, research assistants did not account for whether or not participants were dieting. Because 24-hour dietary intakes using NDS were excessively low (<500 kcal), this question was asked to account for those dieting and not dieting. Therefore, the first 11 participants do not have data on dieting status.

5.) Nutrient intake and quality for MF women was compared to the recommendations for EB women, possibly overestimating requirements for consumption for this population.

6.) Study 2 was an observational analysis; therefore, participants were not randomly assigned to groups and compared. The Principal Investigators and co-investigators agreed that a 6-month assessment, although not originally in the study, was needed to measure the progress of the study. Therefore, the research team agreed to conduct a 6-month survey and measure weights; however, it was feared that extra burden would be placed on the participants randomized to the control arm, potentially altering the effectiveness of the intervention at the end of the study's 12 month period, when data would be analyzed for the entire AMP study. As a result, it was agreed that conducting the 6 month survey and obtaining weights was only appropriate in the intervention cohort. Therefore, Study 2 focused on outcome measures only pertaining to participants in the intervention cohort and not the control group; therefore n = 225. As a result, comparisons of individuals participating in the intervention could not be made to the group.

Future Work

Currently, our research team is in the process of evaluating how the AMP intervention impacted weight loss at 2 years postpartum among this population. The relationship between weight loss and the changes in food habits and choices, physical activity, and breastfeeding from 9-15 weeks to 1 year postpartum will also be evaluated. Further, changes in food servings, nutrients and quality, and meal/snack patterns during this period will be assessed. Currently, no long term studies have addressed these factors in a population of only overweight and obese women; these studies would be insightful due to the increase in overweight among women. Therefore, there is a cogent need for research which determines the effect of food habits and choices, physical activity, and breastfeeding on weight retention from the early postpartum period to 10 years later among overweight and obese women.

Overall, this study found modifiable behaviors which can impact nutritional adequacy and weight loss among this population. These results can build on future studies and provide unique findings that can help an under-studied population at risk for negative health problems associated with high BMI and the postpartum period. I look forward to seeing other studies among overweight and obese postpartum women, conducted over a longer period of time, assessing the impact of diet, physical activity and breastfeeding on weight retention. I have enjoyed working on these research projects and gaining a better understanding of this population on both a personal and professional level.

APPENDIX A. BASELINE SURVEY

AMP BASELINE QUESTIONNAIRE

[Anthropometric /Health]

BS_Hthstat13. What is your height? ___ FT 7=RF; 8=DK _____IN 97=RF; 98=DK

BS_Hthstat14. What is your current weight? PROBE FOR BEST ESTIMATE _____

997=RF; 998=DK

BS_Hthstat19. When you think about how you feed your baby, are you:

1 = breastfeeding only
2 = combining breastfeeding with formula feeding
3 = formula feeding only
7 = RF
8 = Don't Know

BS_Hlthstat20. To what extent do you think breast feeding helps women lose weight. On a scale from 1 to 7, where 1 is certain not to happen and 7 is certain to happen…

1 2 3 4 5 6 7 97=RF; 98=DK

[Brief PA assessment]

Now I would like to ask you a few general questions about physical activity or exercise. I realize that you just had a baby, but I'd like you to think back over the past 7 days. If the past week was not an average week of physical activity for you, (let's say you were vacationing), please think about an average week since delivering the baby and answer the questions based on that week. We are interested in exercise that is at least moderate (it should cause small increases in breathing or heart rate.)

BS_BriefPA1. Now, thinking about the physical activities you did last week, how many days did you do activities, such as brisk walking, bicycling, vacuuming, gardening, or anything else that caused at least small increases in breathing or heart rate? ___________
(Please specify a number. No ranges or decimals. Enter 0 if NONE.)

(1-7) days 998 = DK 997 = REF (*0 days, REF, DK go to BS_BriefPA3)*

BS_BriefPA2. On those days when you participated in some physical activity or exercise, for how many minutes were you active? That is, on average, how many minutes each day were you active? ___________ (Please specify a number. No ranges or decimals. Enter 0 if NONE.)

(1-7) days 998 = DK 997 = REF (*0 days, REF, DK go to BS_BriefPA3)*

BS_BriefPA3. How does this level of physical activity compare to before you became pregnant? Is it…?

1= A lot less
2 = A little less
3 = About the same
4 = A little more
5 = A lot more than before you became pregnant.
7 = RF
8 = DK

BS_BriefPA4. How many hours of television do you watch on the typical week day?

1 = 1 hour or less
2 = 2 hours
3 = 3 hours
4 = 4 hours
5 = 5 hours
6 = 6 hours or more
8 = None
97 = Ref
98 = DK

BS_BriefPA5. How many hours of television do you watch on a typical weekend day?

1 = 1 hour or less
2 = 2 hours
3 = 3 hours
4 = 4 hours
5 = 5 hours
6 = 6 hours or more
8 = None

97 = Ref
98 = DK

[7-day Physical Activity Recall (PAR)]

This next section of the survey involves more detailed questions about your physical activity. Now would be a good time to use the purple grid that I mentioned at the beginning of the phone call. I will ask you to think about the past 7 days and describe the different activities you have done. First, I need to ask a few questions about your employment.

BS_7dayPAR1. How many days of the last 7 days did you work for pay? _____

97=RF; 98=DK

BS_7dayPAR2. How many total hours in the last 7 days did you work for pay? _____

997=RF; 998=DK

Now, I need to know which days of the week you consider to be your weekend days. Many people consider Saturday and Sunday to be their weekend days, but they may be different for other people.

BS_7dayPAR3. What days of the week are your weekend days?

a. Monday (BS_7dayPAR3A, 1=yes, 2=no, 7 =RF, 8=DK)
b. Tuesday (BS_7dayPAR3B, 1=yes, 2=no, 7=RF, 8=DK)
c. Wednesday (BS_7dayPAR3C, 1=yes, 2=no, 7=RF, 8=DK)
d. Thursday (BS_7dayPAR3D, 1=yes, 2=no, 7=RF, 8=DK)
e. Friday (BS_7dayPAR3E, 1=yes, 2=no, 7=RF, 8=DK)
f. Saturday (BS_7dayPAR3F, 1=yes, 2=no, 7=RF, 8=DK)
g. Sunday (BS_7dayPAR3G, 1=yes, 2=no, 7=RF, 8=DK)

Now, I'd like to look at the time you spent sleeping in the past week. By sleeping, I mean the time you went to bed one night and the time that you got out of bed the next morning. I realize that you have a newborn and may have been out of bed many times throughout the night, and for long periods each time. You should still just tell me the time you went to bed until the time you got out of bed <u>for good</u> the next morning.

Today is [DAY OF WEEK TODAY], so yesterday was [DAY BEFORE TODAY].

COMPLETE TOP LINE OF GRID FOR SLEEPING – DAYS 1-7 Question should be worded as follows for each day: "What time did you go to bed and what time did you get up on [Monday, etc.]?"

Now, I am going to ask you about the physical activities you did during the past 7 days, starting with yesterday and going back 7 days. Please remember this is a recall of actual activities for the past week, not a history of what you usually do.

We want you to tell us about activities that are in one of three categories.

- *The moderate category is similar to how you feel when you're walking at a normal pace.*
- *The very hard category is similar to how you feel when you're running.*
- *The hard category just falls in between. In other words, if the activity seems harder than walking but is not as strenuous as running, it should go in the hard category.*

I am going to ask you to tell me what time of day you did these activities - - morning, afternoon, or evening. Morning is considered from the time you get up in the morning to the time you have lunch. Afternoon is from lunch to dinner, and evening is from dinner until the time you go to bed.

After you've thought about the moderate, hard, and very hard activities you have done each day, I will also ask you to tell me about the strength/flexibility activities you have done that day. Strength activities include pushups, pull-ups, sit-ups, lifting free weights, and using Nautilus machines. Flexibility activities include holding stretches for several seconds as well as yoga.

For all of these activities, I will ask how long you did the activity and will exclude times when you may have taken breaks.

Let's go ahead and start. Today is [DAY OF WEEK TODAY], so yesterday was [DAY BEFORE TODAY = Day 7]. Let's think about yesterday. Did you do any physical activity [DAY BEFORE TODAY = Day 7] in the morning? (Prompt for moderate, hard, or very hard and length of time) And in the afternoon? What about the evening? Did you do any flexibility or strength activities that day? For how long?

Great. Let's think about [DAY 6]. Did you do any physical activity on [Day 6]?

Suggestions/prompts for completing PAR grid:

- Calendars are useful since that can help some people visualize their week, so if participant has one handy, that's great.
- Use holidays and weather events as anchors to jog women's memories ("Tuesday was the day we got that hail storm. Did you do any exercise that day?").

- Some people have regular exercising patterns and this can help them in filling out the grid. For example, participants may have a weekend/weekday change in exercise or a day they always take an exercise class.
- Refer back to an event a women mentions (e.g., “You said your baby had a doctor’s appointment last Friday. Does that help you remember the day?”)

		Day 7	Day 6	Day 5	Day 4	Day 3	Day 2	Day 1
SLEEP		BS_7dayPARsleep7	BS_7dayPARsleep6	BS_7dayPARsleep5	BS_7dayPARsleep4	BS_7dayPARsleep3	BS_7dayPARsleep2	BS_7dayPARsleep1
ACTIVITY								
Morning	Mod	BS_7dayPARmornmod7	BS_7dayPARmornmod6	BS_7dayPARmormod5	BS_7dayPARmormod4	BS_7dayPARmormod3	BS_7dayPARmormod2	BS_7dayPARmormod1
	Hard	BS_7dayPARmornhard7	BS_7dayPARmornhard6	BS_7dayPARmornhard5	BS_7dayPARmornhard4	BS_7dayPARmornhard3	BS_7dayPARmornhard2	BS_7dayPARmornhard1
	Very hard	BS_7dayPARmornvh7	BS_7dayPARmornvh6	BS_7dayPARmornvh5	BS_7dayPARmornvh4	BS_7dayPARmornvh3	BS_7dayPARmornvh2	BS_7dayPARmornvh1
Afternoon	Mod	BS_7dayPARnoonmod7	BS_7dayPARnoonmod6	BS_7dayPARnoonmod5	BS_7dayPARnoonmod4	BS_7dayPARnoonmod3	BS_7dayPARnoonmod2	BS_7dayPARnoonmod1
	Hard	BS_7dayPARnoonhard7	BS_7dayPARnoonhard6	BS_7dayPARnoonhard5	BS_7dayPARnoonhard4	BS_7dayPARnoonhard3	BS_7dayPARnoonhard2	BS_7dayPARnoonhard1
	Very hard	BS_7dayPARnoonvh7	BS_7dayPARnoonvh6	BS_7dayPARnoonvh5	BS_7dayPARnoonvh4	BS_7dayPARnoonvh3	BS_7dayPARnoonvh2	BS_7dayPARnoonvh1
Evening	Mod	BS_7dayPARevemod7	BS_7dayPARevemod6	BS_7dayPARevemod5	BS_7dayPARevemod4	BS_7dayPARevemod3	BS_7dayPARevemod2	BS_7dayPARevemod1
	Hard	BS_7dayPARevehard7	BS_7dayPARevehard6	BS_7dayPARevehard5	BS_7dayPARevehard4	BS_7dayPARevehard3	BS_7dayPARevehard2	BS_7dayPARevehard1
	Very hard	BS_7dayPAReveVH7	BS_7dayPAReveVH6	BS_7dayPAReveVH5	BS_7dayPAReveVH4	BS_7dayPAReveVH3	BS_7dayPAReveVH2	BS_7dayPAReveVH1
FLEX & STRENGTH		BS_7dayPARflex7	BS_7dayPARflex6	BS_7dayPARflex5	BS_7dayPARflex4	BS_7dayPARlfex3	BS_7dayPARflex2	BS_7dayPARflex1

We are done thinking about individual activities over the past 7 days.

BS_7dayPAR4. How does this level of activity, compare to before you became pregnant? Is it?

1 = A lot more
2 = A little more
3 = About the same
4 = A little less
5 = A lot less
7 =RF
8 = DK

[Brief Nutrition Assessment]

Next, we are going to talk about the food you are eating.

BS_BfNutAssess1. On a typical day, how many times do you drink soda (do not include diet sodas)?

1= 1 time
2 = 2 times
3 = 3 or more times
8 = None
97 = Refused
98 = Don't Know

BS_BfNutAssess2. On a typical day, how many times do you drink sweetened beverages such as sweet tea, punch, Kool-aid, sports drinks or fruit drinks? Do not count 100% fruit juices or diet drinks.

1= 1 time
2 = 2 times
3 = 3 or more times
8 = None
97 = Refused
98 = Don't Know

BS_BfNutAssess3. How much soda or other sweetened beverages do you typically drink each time?

1 = Small glass (4-6 ounces)
2 = Medium glass (8-12 ounces)
3 = Large glass (16-20+ ounces)
4 = One can (12 ounces)
5 = One bottle (16-20 ounces)

8 = Typically don't drink soft drinks or soda
97 = Ref
98 = Don't Know

BS_BfNutAssess4. How many times a week do you eat from a fast food restaurant like Burger King, Chick-Fil-A, Bojangles or Pizza Hut?

1 = Less than once a week
2 = Once a week
3 = Two times a week
4 = Three to Five Times a Week
5 = More than Five Times a Week
97 = Ref
98 = Don't Know

BS_BfNutAssess5. On a typical day, how many times do you eat French Fries or chips? Chips are potato chips, tortilla chips, cheetos, corn chips or other snack chips.

1 = 1 time
2 = 2 times
3 = 3 or more times
4 = None
97 = Ref
98 = Don't Know

BS_BfNutAssess6. On a typical day, how many glasses of milk do you drink? A glass is the amount in an eight ounce drinking glass.

1 = less than one glass
2 = 1 glass
3= 2 glasses
4 = 3 glasses
5 = 4 or more glasses
6 = None
97 = Ref
98 = Don't Know

BS_BfNutAssess7. What type of milk do you usually drink?

1 = Skim or non-fat
2 = Low fat (1/2-1%)
3 = Reduced fat (2%)
4 = Whole
5 = Flavored lowfat or skim
6 = Flavored 2% or whole
7 = Soy Milk
8 = Other, non-diary milk (please specify):_______________

97 = Ref
98 = Don’t Know

BS_BfNutAssess8. On a typical day, how many servings of vegetables do you eat? Do not include French fries.

1= 1 serving
2 = 2 serving
3 = 3 or more servings
8 = None
97 = Refused
98 = Don’t Know

BS_BfNutAssess9. On a typical day, how many servings of fruit do you eat? DOES NOT INCLUDE JUICES.

1= 1 serving
2 = 2 servings
3 = 3 or more servings
8 = None
97 = Refused
98 = Don’t Know

APPENDIX B: SIX MONTH SURVEY

Active Mothers Postpartum (AMP)

6-MONTH SURVEY

Please answer the questions by placing a check ("✓"), circling, or by filling in the blank with the response that best represents your choice. You may refuse to answer any question and stop at any time.

GENERAL HEALTH

2. How much do you think you weigh? *(Fill in the blank)*

_______________ Pounds or ☐ Don't Know

INFANT FEEDING

6. When you think about how you feed your baby, are you currently *(Check one)*:

☐ Breastfeeding only
☐ Combining breastfeeding with formula feeding
☐ Formula feeding only
☐ Don't Know

7. If you breastfed at any time, did you breastfeed to *(Check **all** that apply)*:

☐ Did Not Breastfeed
☐ Lose weight?
☐ Keep baby healthy?
☐ Bond with baby?
☐ Convenience?
☐ Keep infant feeding costs low?
☐ Improve your baby's IQ?
☐ Other: ____________________________
☐ Don't Know

8. The following table asks how you fed your baby **each month** during the last 6 months. For each month, please place a check in the appropriate box.

When Baby Was	Breastfed Only	Combined Breast and Formula Feeding	Formula Fed Only
1 Month	☐	☐	☐
2 Months	☐	☐	☐
3 Months	☐	☐	☐
4 Months	☐	☐	☐
5 Months	☐	☐	☐
6 Months	☐	☐	☐

9. On a scale from 1 to 7, where 1 is certain not to happen and 7 is certain to happen, to what extent do you think breastfeeding will help women lose weight? *(Circle one)*

1 2 3 4 5 6 7 or ☐ Don't Know

PHYSICAL ACTIVITY

12. Think about the physical activities you did **last week.** If the past week was <u>not</u> a typical week of physical activity for you, (let's say you were vacationing), please think about **an average or typical week**. How many days did you do activities, such as brisk walking, bicycling, vacuuming, gardening, or anything else that caused at least small increases in breathing or heart rate? *(Circle one)*

Days

0 1 2 3 4 5 6 7 or ☐ Don't Know

[If "0" (NO DAYS), please go to Question 14]

13. On those days when you participated in some physical activity or exercise, on average, how many minutes each day were you active? *(Fill in the blank)*

_______________ Minutes or ☐ Don't Know

NUTRITION

14. On a typical **<u>day</u>**, how many times do you drink soda? Do not include diet sodas. *(Check one)*

- ☐ None per day
- ☐ 1 Time per day
- ☐ 2 Times per day
- ☐ 3 or More Times per day
- ☐ Don't Know

15. On a typical **<u>day</u>**, how many times do you drink sweetened beverages such as sweet tea, punch, Kool-Aid®, sports drinks or fruit drinks? Do not count 100% fruit juices or diet drinks. *(Check one)*

- ☐ None per day
- ☐ 1 Time per day
- ☐ 2 Times per day
- ☐ 3 or More Times per day
- ☐ Don't Know

16. How much soda or other sweetened beverages do you typically drink each time? *(Check one)*

- ☐ Typically don't drink soda or sweetened beverages
- ☐ Small glass (4-6 ounces)
- ☐ Medium glass (8-12 ounces)
- ☐ Large glass (16-20+ ounces)
- ☐ One can (12 ounces)
- ☐ One bottle (16-20 ounces)
- ☐ Don't Know

17. How many times a **<u>week</u>** do you eat from a fast food restaurant like Burger King®, Chick-Fil-A®, Bojangles® or Pizza Hut®? *(Check one)*

- ☐ Less than once a week
- ☐ 1 Time per week
- ☐ 2 Times per week
- ☐ 3 to 5 Times per week
- ☐ More than 5 times per week
- ☐ Don't Know

18. On a typical **<u>day</u>**, how many times do you eat French Fries or chips? Chips are potato chips, tortilla chips, Cheetos®, corn chips or other snack chips. *(Check one)*

- ☐ None per day
- ☐ 1 Time per day
- ☐ 2 Times per day
- ☐ 3 or More Times per day
- ☐ Don't Know

19. On a typical **<u>day</u>**, how many glasses of milk do you drink? A glass is the amount in an eight-ounce drinking glass –Include milk used when eating cereal. *(Check one)*

- ☐ Typically don't drink milk
- ☐ Less than 1 glass per day
- ☐ 1 Glass per day
- ☐ 2 Glasses per day
- ☐ 3 Glasses per day
- ☐ 4 or More Glasses per day
- ☐ Don't Know

20. What type of milk do you usually drink? *(Check one)*

- ☐ None
- ☐ Skim or non-fat
- ☐ Low fat (1/2-1%)
- ☐ Reduced fat (2%)
- ☐ Whole
- ☐ Flavored lowfat or skim
- ☐ Flavored 2% or whole
- ☐ Soy Milk
- ☐ Other, non-dairy milk (specify):_____________
- ☐ Don't Know

21. Do you eat yogurt? *(Check one)*

- ☐ Yes **[If YES, how many servings do you eat in a typical <u>week</u>? Note that 1 serving = 6 oz. container _______]**
- ☐ No
- ☐ Don't Know

22. On a typical **<u>day</u>**, how many servings of desserts or sweets do you eat? *(Check one)*

- ☐ None
- ☐ 1 Serving per day
- ☐ 2 Servings per day
- ☐ 3 or More Servings per day
- ☐ Don't Know

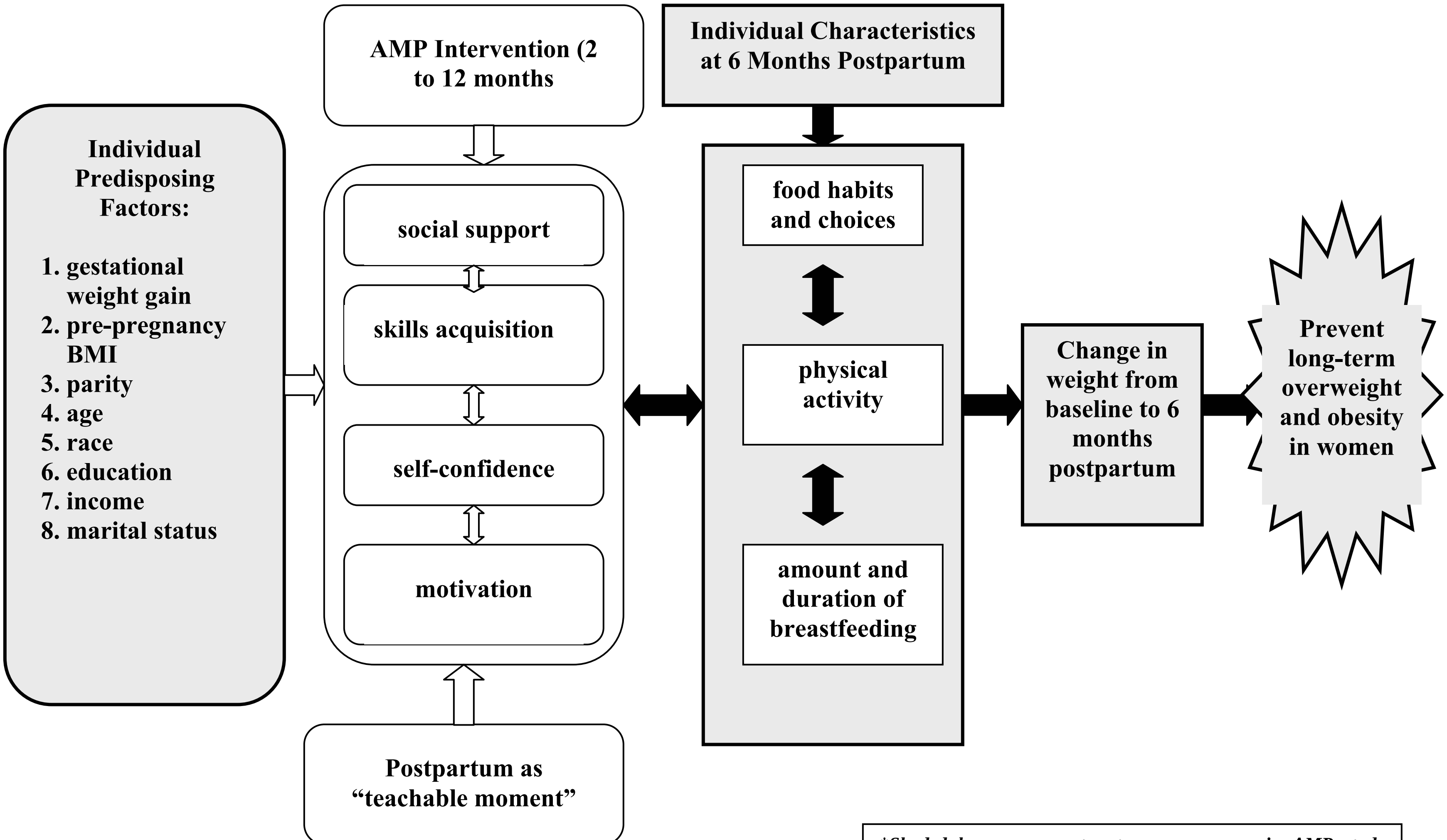
23. On a typical **<u>day</u>**, how many servings of vegetables do you eat? Include dishes with lots of vegetables (one serving size is the size of a fist). –Do not include French fries. *(Check one)*

- ☐ None
- ☐ 1 Serving per day
- ☐ 2 Servings per day
- ☐ 3 or More Servings per day
- ☐ Don't Know

24. On a typical **<u>day</u>**, how many servings of fruit do you eat? –Do not include juices. *(Check one)*

- ☐ None
- ☐ 1 Serving per day
- ☐ 2 Servings per day
- ☐ 3 or More Servings per day
- ☐ Don't Know

APPENDIX C: CONCEPTUAL MODEL



**Shaded boxes represent outcomes measures in AMP study directly impacting aims of this study*

APPENDIX D: CONSENT FORM

Research Study: Active Mothers Postpartum (AMP)
Truls Østbye, MD, MPH, PhD
IRB Registry number: 4399

Introduction

The Duke University Medical Center is conducting a research study about the importance of weight-loss in the postpartum period (the time immediately after giving birth). As a woman who has recently given birth, you are eligible to participate in this study. This study is being sponsored by a grant from the National Institutes of Health. Portions of Dr. Østbye's and the research team's salaries are being paid by this grant.

Purpose of the Study

The goal of the study is to determine whether an intervention targeted to the postpartum period can promote weight loss, encourage lower overall calorie intake and calorie intake from fat, and increase the level of physical activity among postpartum women.

How the Study Works

The study will take place over the course of nine months, beginning about 6 weeks after your baby is born. All participants will be called for follow-up surveys at 12 month, 18 months, and 2 years after the baby was born, to find out how they are progressing. At those same time points, we will meet you at a convenient location to weigh you. Women who recently had a baby, are English speaking, and are age 18 or older will be eligible to participate. A total of 450 women will be enrolled. These women will be randomized to one of two groups, using a process like the flip of a coin.

Women in **Group 1** will receive a newsletter full of healthy tips. Women in **Group 2** will receive a newsletter. In addition, they will be asked to 1) participate in group classes emphasizing physical activity and healthy eating habits (classes will take place at the Center For Living off of Erwin Road in Durham) and 2) may receive consultation from a wellness coach (in person or over the phone) during the study period to ask how they are progressing and encourage them to adopt healthy physical activity and eating habits. Healthy eating will be encouraged. However, we discourage the use of dietary supplements such as pills, herbal preparations, or other supplements unless prescribed by your doctor. There is very little information available on the safety and effectiveness of dietary supplements, and, in some cases, they can be dangerous. At 5-6 months, women in Group 2 will be asked to complete a survey to find out how body image, social support, infant feeding, contraception use, diet, and physical activity relate to weight loss. They will return the completed survey when they come to be weighed and receive the study's sport stroller.

Research Study: Active Mothers Postpartum (AMP)

Truls Østbye, MD, MPH, PhD

IRB Registry number: 4399

Benefits of participation

Expected benefits to participants include increased health and well-being, increased weight loss in the postpartum period, an increase in physical activity and improved nutrition and dietary habits. The indirect benefit of the study is a better general understanding of successful interventions to increase weight loss and healthy weight-related behaviors.

Risks or discomforts

When promoting increased physical activity, there is a small risk of injury or other adverse events. We have taken precautions to minimize this risk, however, there may be unforeseen problems that we have not anticipated. In case of injury during physical activity that is directly related to this study, please inform us immediately by calling the project coordinator at 1-866-681-0860 and describing the event, and what actions you have taken as a result (for instance, if you called a doctor).

Immediate necessary medical care is available at Duke University Medical Center in the event that you are injured as a result of your participation in this research study. However, there is no commitment by Duke University, Duke University Health System, Inc., or your Duke physicians to provide monetary compensation or free medical care to you in the event of a study-related injury. Further information concerning this or your rights as a research subject may be obtained from the Duke University Health System Institutional Review Board (IRB) Office at (919) 668-5111.

Remuneration and/or expense reimbursements

As part of this study, you may be asked to participate in physical activity classes or educational activities about healthy eating. You will not be charged fees for any of these activities. For the sessions where you do not bring your baby, you will be given $10 per session (for up to 2 sessions) to put toward childcare fees. Also, some participants will be asked to complete a brief mailed survey, and will be provided a sport stroller, for walking with their babies, and a pedometer, for measuring how much they walk. You also will receive baby gifts for completing the baseline survey, and money for completing the 12 month, 18 month and 2 year follow-up surveys/weigh-ins. These are in the amounts of $15, $30, and $55, respectively ($100 over 2 years).

Additional costs to participate

Transportation to and from study activities will be the responsibility of the participant. The only additional costs to participants may be childcare fees that exceed the $10 we will give you per session. The sponsor of the study, the National Institutes of Health, is providing the newsletter, nutrition/exercises classes, sport strollers, pedometers, and wellness coach consultations to women free of charge.

Research Study: Active Mothers Postpartum (AMP)
Truls Østbye, MD, MPH, PhD
IRB Registry number: 4399

Participation
You may choose not to be in the study, or, if you agree to be in the study, you may withdraw from the study at any time. If you withdraw from the study, no new data about you will be collected for study purposes unless the data concern an adverse event (a bad effect) related to the study. If such an adverse event occurs, we may need to review your entire medical record. All data that have already been collected for study purposes, and any new information about an adverse event related to the study, will be sent to the study sponsor.

Your decision not to participate or to withdraw from the study will not involve any penalty or loss of benefits to which you are entitled, and will not affect your access to health care at Duke. If you do decide to withdraw, we ask that you contact Dr. Østbye in writing and let him know that you are withdrawing from the study. His mailing address is DUMC Box 2914, Durham, NC 27710.

Confidentiality
As part of this study, you will be asked questions about your weight and weight history, your eating patterns and habits, and your level of physical activity, in surveys conducted by telephone (and through an additional mailed survey for those in Group2). We will also retrieve information from your medical chart and weigh you four times. Data stored electronically will be in files and computers protected by password access. Any hardcopy records will be kept in locked metal filing cabinets at the study sites.

Study records that identify you will be kept confidential as required by law. Federal Privacy Regulations provide safeguards for privacy, security, and authorized access. Except when required by law, you will not be identified by name, social security number, address, telephone number, or any other direct personal identifier in study records disclosed outside of Duke University Health System (DUHS). For records disclosed outside of DUHS, you will be assigned a unique code number. The key to the code will be kept in a locked file in Dr. Østbye's office.

In addition, your records may be reviewed in order to meet federal or state regulations. Reviewers may include, for example, representatives from the National Institutes of Health, or the Duke University Health System Institutional Review Board.

The study results will be retained in your research record for at least six years or until after the study is completed, whichever is longer. At that time either the research information not already in your medical record will be destroyed or information identifying you will be removed from such study results at DUHS. Any research information in your medical record will be kept indefinitely. This information may be further disclosed by the sponsor of this study, the National Institutes of Health. If disclosed by the sponsor, the information is no longer covered by the federal privacy regulations

Research Study: Active Mothers Postpartum (AMP)

Truls Østbye, MD, MPH, PhD

IRB Registry number: 4399

A professional survey company has been contracted to conduct the follow-up telephone surveys with all participants. Dr. Cheryl Lovelady from the Nutrition Department of the University of North Carolina at Greensboro (UNC-G) will also conduct two interviews regarding healthy eating. The survey company and UNC-G will have access to some information about you (your name and telephone number) so that they can contact you. The survey company and UNC-G will be conducting the surveys on Duke's behalf and acting as agents of Duke, and therefore are held under the same confidentiality standards as Dr. Østbye's study team.

Questions

If you have any questions, you may contact either Dr. Truls Østbye at (919) 661-0331, or the study coordinator, Rebecca Brouwer, at (919) 681-0858/(866)-681-0860. For questions about your rights as a research participant, contact the Duke University Health System Institutional Review Board (IRB) Office at (919) 668-5111.

Authorization

"The purpose of this study, procedures to be followed, risks and benefits have been explained to me. I have been allowed to ask questions, and my questions have been answered to my satisfaction. I have been told whom to contact if I have additional questions. I have read this consent form and agree to be in this study, with the understanding that I may withdraw at any time. I have been told that I will be given a signed copy of this consent form."

Signature of subject:________________________________Date: _____________

Signature of person obtaining consent: _______________________ Date: ______