Sociodemographic, Perinatal, Behavioral, and Psychosocial Predictors of Weight Retention at 3 and 12 months Postpartum

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Abstract

Postpartum weight retention plays an important role in the pathway leading to obesity among women of childbearing age. The objective of this study was to examine predictors of moderate (1–10 pounds) and high (>10 pounds) postpartum weight retention using data from a prospective pregnancy cohort that followed women into the postpartum period; n=688 and 550 women at 3 and 12 months, respectively. Analysis included descriptive statistics and predictive modeling using log-binomial techniques. The average weight retained at 3 and 12 months postpartum in this population was 9.4 lbs (SD=11.4) and 5.7 lbs (SD=13.2) respectively. At 3- months postpartum, prepregnancy weight, gestational weight gain, and hours slept during the night were associated with moderate or high weight retention while having an infant hospitalized after going home and scoring in the upper 75th percentile of the eating attitudes test were associated only with high weight retention. At 12- months postpartum, prepregnancy weight, gestational weight gain and maternal education were associated with moderate weight retention and gestational weight gain, maternal age, race, employment status, and having an infant hospitalized at birth were associated with high weight retention. The results of this study illustrate the importance of prepregnancy weight and gestational weight gain in predicting postpartum weight retention. Furthermore, given the lack of successful intervention studies that exist to date to help women lose weight in the postpartum period, the results of this study may help to inform future interventions that focus on such aspects as hours of sleep, dealing with stress associated with a hospitalized infant, and non-clinical eating disorder symptomatology.

Keywords

Postpartum; weight retention; gestational weight gain; dietary intake; physical activity; psychosocial behavior

INTRODUCTION

Overweight and obesity among women of childbearing ages is one of the major obstetrical problems facing prenatal care providers today. It is associated with more prenatal fetal tests, obstetrical ultrasonographic examinations, medication use, prenatal visits, and longer hospital stays.1 It is also a major risk factor for the development of several chronic diseases later in

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life, including type 2 diabetes, hypertension, cardiovascular disease, and breast and endometrial cancers.[2⁻4] The high prevalence of overweight and obesity in women of childbearing ages and its related co-morbidities emphasizes the importance of elucidating the pathways involved in excess weight development; one critical pathway that has been identified is postpartum weight retention. Several studies documented in a recent systematic review [5] have shown that a majority of women gain weight in excess of the recommended gestational weight gain guidelines, established by the Institute of Medicine (IOM) in 1990.[6] Gestational weight gains that are in excess of these guidelines are associated with greater postpartum weight and an inability to return to pregravid weight status by one year postpartum [7⁻11] and in the long-term. [7,9,12] However, there are several other lifestyle, psychosocial, and behavioral characteristics that are altered during the postpartum period, such as breastfeeding,[10] depression, [13] sleep duration, [14] and physical activity[15] that are thought to contribute to a woman's postpartum weight. Furthermore, there is some evidence to suggest that postpartum weight retention is influenced by pregravid factors, such as body mass index status (BMI), [16] and sociodemographic factors, such as race.[17]

Few prospective studies from large pregnancy cohorts have simultaneously examined the associations of multiple key sociodemographic, perinatal, behavioral, and psychosocial factors and postpartum weight retention in a comprehensive manner. Understanding these factors may aid women in managing their weight during the postpartum period and help identify those who are at risk for becoming overweight or obese. The current study uses data collected from the Pregnancy, Infection, and Nutrition (PIN) and the PIN Postpartum studies to examine important predictors of weight retention at 3 and 12 months postpartum.

METHODS

Study Population

A total of 2006 pregnant women, <20 weeks' gestation, were recruited into the PIN study between January 2001 and June 2005 from the University of North Carolina prenatal care clinics. Women who were less than age 16, non-English speaking, not planning to continue care or deliver at the study site, or carrying multiple gestations were not eligible to participate. Information on pre- and perinatal factors including sociodemographic characteristics and medical history were assessed by interviews, self-administered questionnaires, and information from medical records. Medical charts were abstracted for all women in the cohort to collect data on reproductive history, weight gain, pregnancy complications, and labor and delivery events.

Recruitment for the PIN Postpartum study occurred between October 2002 and December 2005. Only women who participated in the PIN study, delivered of a live-born infant during the recruitment period, and lived within the study's catchment area (2 hour driving time from UNC required to conduct home visits) were eligible (n=1169). A total of 231 women were excluded for the following reasons: 24 had medical constraints which did not allow them to participate, 153 were unreachable, and 54 were greater than 5 months postpartum by the time we located them. Of the 938 women who were asked to participate, 688 (73.3%) agreed to participate and completed a three-month interview in their home. There were no significant differences in any of the socio-demographic characteristics, pregravid BMI, or gestational weight gain between women who completed the three-month interview and those who did not participate (excluded or refused); however, there was a lower mean gestational age and a higher proportion of preterm births among non-participants.

At the 12 month visit, 550 (80%) of the participants completing the 3 month postpartum visit, went on to also complete the 12 month components. Participants who became pregnant between the two postpartum time points (n=45) and those who moved out of the recruitment area (n=73)

were not eligible for the 12-month home visit, thus explaining the majority of the attrition. Women who did not complete the 12 month interview were on average younger, more likely to be non-Hispanic black, and have greater than a college education compared to those who did complete the interview. There were no differences in prepregnancy BMI, adequacy of gestational weight gain, weight at the 3 month visit, or in birth outcome of the index pregnancy (i.e. gestational age, birth weight).

The protocols for this study were approved by the UNC School of Medicine Institutional Review Board and were in accordance with the ethical standards of the responsible committee on human experimentation. The home visit protocols collected information on a wide range of exposures that may influence the mother's postpartum weight status including diet, physical activity, work status, depression symptoms, and social support.

Outcome Assessment

Postpartum weight retention at 3 and 12 months was calculated by subtracting women's self-reported pregravid weight from measured weight during the 3- and 12-month home interviews. The pregravid weight was checked for biologically implausible values by comparing the self-reported weight with the weight measured at the first prenatal visit. Women with implausible or missing values had their pregravid weight imputed following previously published methodology (5% of the sample).[18] Weight retention was categorized using a priori cut points of lost weight/no change, 1 to 10 lbs (0.45 to 4.5 kg, moderate), and >10 lbs (4.5 kg, high) for each of the follow-up time points. Our rational for using these categories were based on data from a previous study demonstrating that a weight retention greater than 10 lbs (4.5kg) at one year postpartum is associated with long-term overweight status[19] as well as reviews on the topic of weight retention that indicate it is important to determine and differentiate risk factors among a subset of high retainers.[5,20]

Predictors

Predictors of postpartum weight retention that were considered in this analysis included sociodemographic, perinatal, behavioral, and psychosocial variables.

Sociodemographic variables—Information on race/ethnicity (non-Hispanic white, non-Hispanic black, and other), maternal age, education (grade 12 or below, grades 13–16, grade 17 or above), work status (yes/no), number of children living in the home including the child from the index pregnancy (1, 2, ≥3), and family income defined by the 2001 poverty level[21] (<185%, 185–350%, >350%) was self-reported during the home interviews. We used the variables that corresponded to each time point in the analysis.

Perinatal variables—Prepregnancy BMI (kg/m^2) was classified following guidelines established by the IOM: underweight <19.8 kg/m^2; normal weight 19.8 to 26.0 kg/m^2; overweight > 26.0 to 29.0 kg/m^2; and obese >29.0 kg/m^2.[6] Maternal height, measured at the first prenatal clinic visit or at the postpartum home visit, and self-reported prepregnancy weight were used for these calculations. Gestational weight gain was defined as the difference between each woman's pregravid weight, and her weight measured near the time of delivery. Gestational weight gain was categorized using the inadequate, adequate, and excessive weight ranges defined by the 1990 IOM recommendations[6] adjusted for gestational age.[22] The 1990 IOM recommendations were employed since they were in effect at the time this study was conducted. Information on cesarean delivery (yes/no), preterm birth status (yes/no), and number of days of hospitalization post-delivery (<4, ≥4 days), was abstracted from medical charts. Subsequent hospitalization for the child (yes/no) was obtained by questionnaire from the mother at the two home interviews.

Behavioral variables—Maternal dietary intake at 3-and 12-months postpartum was collected using a self-administered modified Block 98.2 questionnaire of approximately 110 food items, which solicited information concerning portion sizes using a serving size visual. This questionnaire has been used in the PIN cohort for over 10 years, and has been previously described.[22,23] Dietsys+Plus, version 5.6 was used to analyze the questionnaires.[24] This software produces estimates of usual intake for 34 nutrients. Total energy intake, percent energy from carbohydrates, percent energy from fat, and percent energy from protein were categorized in tertiles for this analysis with the lowest tertile as the reference category.

Physical activity was collected using an interviewer administered questionnaire that was designed to capture moderate and vigorous activity in the previous seven days.[25] The questionnaire assessed frequency, intensity, and duration of all moderate to vigorous activities including: work, recreation, transportation, child and adult care, and both indoor and outdoor household activities. Intensity of activity is assessed (i) using a modified Borg scale[26] to capture the participant's perception of intensity (measured in hours/week), and (ii) classified using published metabolic equivalent (MET) tables to represent absolute intensity (measured in MET hours/week).[27] Validity of this tool was conducted in a pregnancy population and reliability in the PIN population; results indicated moderate to substantial validity when the questionnaire was compared to a structured diary (correlation coefficients ranging from 0.4 to 0.7) but poor to fair validity when compared to accelerometer (0.1 to 0.3) and substantial reliability (correlation coefficients > than 0.8).[28] Both perceived and absolute intensity measures were examined in this analysis. For both physical activity measures, we created a three-level variable with those reporting no activity (absolute intensity) or zero hours/week (perceived intensity) as one category and then splitting the remaining women into a dichotomous variable using the median as the cut point.

Sleep duration was assessed at 3- and 12-months postpartum using the following question, "How many hours of sleep do you usually get each 24 hours (be sure to include time you spend napping)?" The number of hours reported by the women was categorized as ≤ 5, 6 to 7, and ≥ 8 hours/24 hours, to be consistent with previous literature.[14] Smoking status (yes/no) was determined by whether or not the woman stated that she had smoked since the previous interview (during pregnancy or at delivery for the 3 month interview and since 3 months postpartum at the 12 month interview). The in-home questionnaire collected information on infant feeding including duration of exclusive and any breastfeeding. Breastfeeding was categorized as never breastfed, started but stopped breastfeeding, and still breastfeeding at 3-months postpartum. At 12-months postpartum, breastfeeding was categorized as never breastfed, breastfed for less than 6 months, and breastfed for 6 months or longer.

Psychosocial Variables—Women's eating disorder symptomatology were assessed using the Eating Attitudes Test (EAT-26).[29] This instrument is a 26-item screening questionnaire that is used to determine women with possible eating disorders. Questions address eating, dieting, and food control behaviors; a score of 20 or above indicates further clinical evaluation for an eating disorder. In this study, we used a cut point of 8 and 7, which designated a score at or above the 75th percentile at 3 and 12 months postpartum respectively.

Postpartum depression was evaluated using the Edinburgh Postnatal Depression Scale (EPDS).[30] The EPDS is a ten item screening questionnaire that assesses the woman's mood during the past week. This questionnaire has been previously validated against the Research Diagnostic Criteria for depression with a sensitivity of 86% and a specificity of 78%.[31] Total scores were dichotomized using a cut point of 12; a score of 13 or higher indicated postpartum depressive symptoms.[32]

Statistical Analysis

The final analyses were conducted with the information from 688 and 550 women at the 3- and 12-months postpartum visit using SAS version 9.1.33 Analysis included generation of study population descriptive statistics; means, standard deviations and frequencies were calculated at 3 and 12 months and by weight retention categories at each time point. Statistical testing of univariate associations between the predictors and weight retention categories was done using a chi square test for categorical variables and analysis of variance for continuous variables. We built models for the predictors of postpartum weight retention at each time point (e.g., 3 and 12 months postpartum) by starting with a full model of all predictors (p value <0.2) and then eliminating the least significant predictor one at a time until we reached our final models. Due to the high prevalence of postpartum weight retention, log-binomial models were used to estimate relative risks for the probability of postpartum weight retention. Models were fit in WinBUGS 1.4 [34] with normal prior distributions centered at 0 with variance 1, which reflected our prior thinking that relative risks greater than exp(2)=7.4 or less than exp(−2)=0.14 were highly unlikely. These priors functioned to stabilize inferences, as convergence problems with log-binomial models are well-known.35 Spearman correlation coefficients for the variables in the final model were computed; for the 3 month model the coefficients ranged from −0.53 to 0.16 and for the 12 month model they ranged from −0.55 to 0.24.

RESULTS

The mean age of women in the PIN postpartum cohort at the 3 month interview was 31.0 years (SD ±5.5) with the majority (59%) between 25 and 35 years of age. Eighty percent of the women were married, 76.4 % were non-Hispanic white, 14.5% non-Hispanic black and 8.7% other. Forty-six percent had some college education, 36% had beyond a post-graduate degree and only 17.2% had a high school education or less. Approximately a quarter of the women were considered to be of low income (<185% of poverty line). Slightly more than half of the women had a normal BMI at the start of pregnancy while a third had a BMI >26 kg/m^2 and 14% were of underweight status. Forty-six percent of the women were first time mothers while 37% had two children at home, and 16.8% had at least 3 children. The majority of women gained excessively (63%), 14% gained inadequately, and less than a quarter of the women gained within the recommended gestational weight gain range. The percent of preterm birth in the population was 12.6 and the mean birth weight was 3311 gm (SD ± 574.3).

Table 1 shows the distribution of selected maternal characteristics of the population at 3- and 12-months postpartum. Breastfeeding was the normative in this population with less than 10% never initiating and 26% still breastfeeding at the 12 month interview; the mean duration of breastfeeding was 34.1 (SD ± 20.5; median, 38.7) weeks. The average weight retained at 3 and 12 months was 9.4 (SD±11.4; median, 9.0) and 5.7 (SD±13.2; median, 3.6) lbs, respectively. At the 3 month visit, 21% of women had either lost or were at their prepregnancy weight, while 34% had retained 1 to 10 lbs and 44% retained >10 lbs. By 12 months postpartum, 37% of women had lost below or attained their prepregnancy weight, 35% had retained 1–10 lbs and 27% had retained at least 10 lbs or more.

The weight retained at 12 months resulted in women moving into different weight status groupings. Among those who began the pregnancy as underweight (BMI <19.8 kg/m^2), 45% of them moved into the normal weight category and 2.8% into the overweight. For women who started normal weight (BMI 19.8 to 26.0 kg/m^2), 14.2% became overweight and 3.9% obese. Among women who were overweight (BMI >26 to 29 kg/m^2), 40% became obese while 15% moved into the normal weight category. Among those who were obese class I (BMI 30–35 kg/m^2), 13.8% moved into the obese class II (BMI 35 to 40 kg/m^2) and 11.8% moved into the obese class III (BMI >40 kg/m^2), category while 6.9% moved down into the overweight category.

Significant differences for several of the predictors examined were seen across the categories at both time points (data available as supplementary materials on-line (Table 1)). At 3 months postpartum, a higher proportion of women who were younger (<=24 yrs of age), less educated, not married, low income, underweight, not recreationally active, had a score in the upper 75th percentile of the eating attitudes test, and had excessive gestational weight gain retained greater than 10 lbs compared to the other weight retention groups. While in the women who retained 1 to 10 lbs, there was a lower proportion of women who never breastfed and smoked compared to those who gained greater than 10 lbs or who lost weight or had no weight change. At 12-months postpartum, similar significant bivariate associations as those at 3-months were observed for maternal age, education, marital status, income, prepregnancy weight status, smoking status, and gestational weight gain. The significant association for breastfeeding status remained but a longer duration of breastfeeding (>=6 months) was associated with having returned to prepregnancy weight or weight loss. New associations emerged for race/ethnicity, infant hospitalizations, % energy from protein, perceived intensity of work related physical activity, and absolute intensity of time spent in care giving activities. Higher proportions of women who were non-Hispanic black, not working, had a hospitalized infant (either at delivery or after being brought home), were in the lowest category of protein intake (expressed as % of total energy), the lowest category of absolute intensity of care-related activity, and the highest category of perceived intensity of work-related physical activity retained greater than 10 lbs compared to the other weight retention groups.

While there were many bivariate associations of these characteristics with weight retention only a few predictors were significant in our multivariable models (Table 2). At 3 months postpartum, significant predictors of retaining 1 to 10 lbs included pre-pregnancy weight status, gestational weight gain, and the number of hours slept during the night. Predictors of retaining greater than 10 lbs at 3 months postpartum included prepregnancy weight status, gestational weight gain, having an infant hospitalized after returning home, the number of hours slept during the night, and having a high score on the eating disorders scale. Compared to normal weight women, underweight women had an increased risk (RR: 1.7; 95% CI: 1.4–2.1) while overweight and obese women had a decreased risk (RR:0.6; 95%CI: 0.4–0.8 and RR: 0.4; 95% CI: 0.3–0.6, respectively) of retaining 1 to 10 lbs. Compared to normal and underweight women, overweight and obese women had a 40% decreased risk of retaining greater than 10 lbs. Compared to women with adequate gestational weight gains, women with excessive gains had an increased risk of weight retention (RR, 1.6; 95%CI, 1.3–2.0 for retaining 1–10lbs and RR, 1.9; 95%CI, 1.6–2.6 for retaining >10 lbs) and women with inadequate gains had a decreased risk of weight retention (RR, 0.8; 95%CI, 0.6–0.9 for retaining 1–10 lbs and RR, 0.3; 95%CI, 0.2–0.6 for retaining >10 lbs). Women who reported sleeping 5 hours or less or had an infant hospitalized after coming home had a nearly two-fold increased risk of retaining >10 lbs (RR, 1.9; 95%CI, 1.5–2.4 and RR, 1.8; 95%CI, 1.4–2.3, respectively).

At 12 months postpartum significant predictors for retaining 1 to 10 lbs included maternal education level, prepregnancy weight status, and gestational weight gain while the predictors for retaining greater than 10 lbs were maternal age, race, employment status, gestational weight gain, total energy intake, and having had the infant hospitalized at birth. In general, women 25 years and older had an approximate 50% decreased risk of retaining >10lbs compared to younger women (the relative risk estimate for women ages 30–34 did not reach statistical significance). Non-Hispanic blacks and women of other races/ethnicities, women who did not work, and those with an infant hospitalized at birth were at increased risk of retaining greater than 10 lbs, with relative risks ranging from 1.6 to 2.0. Women in the highest tertile of energy intake were at 40% increased risk of retaining greater than 10 lbs compared to those in the lowest tertile of intake.

Similar to the results at 3 months postpartum, underweight women had a two-fold increased risk of retaining 1 to 10 lbs (RR, 2.0; 95%CI, 1.6–2.7) and women with excessive gestational weight gains had a 1.5 (95%CI,1.2–2.0) times increased risk of retaining 1 to 10 lbs and a 2.2 (95%CI, 1.4–3.5) times increased risk of retaining >10 lbs.

DISCUSSION

This study examined many variables representing the preconceptional, prenatal and postnatal periods as potential predictors of weight retention at 3-and 12- months postpartum. Predictors of weight retention varied between the two time points with the exception of two maternal characteristics, prepregnancy weight status and gestational weight gain. At 3- months postpartum, an additional predictor of any weight retention included hours slept during the night for any weight retention while having an infant hospitalized after going home and scoring in the upper 75th percentile of the eating attitudes test were associated with retaining >10 lbs. At 12-months postpartum, additional predictors of weight retention included maternal age, race, employment status, total energy intake, and having an infant hospitalized at birth for retaining >10 lbs and only maternal education for retaining 1–10 lbs.

Two predictors of postpartum weight retention that have received little attention in the literature were identified: having a high score on the eating attitudes test and having a hospitalized infant (both at delivery and after being brought home). To our knowledge there are no other published studies examining the association between non-clinical eating disorder symptomatology and postpartum weight retention. Infant hospitalization has been shown to be associated with weight retention at 9 months in a cohort of Brazilian women; however, it was not statistically significant in multivariable models.[36] We explored the extent to which the infant's hospitalization may increase stress and interfere with a routine schedule for sleeping, eating, and exercise. The average numbers of hours of sleep did not substantially differ across the various weight retention subgroups. At 3 months, lower METs of total physical activity were reported by high retainers with hospitalized infants (after coming home) compared to non-retainers with healthy infants. At 12 months, higher energy intakes and lower METs of total physical activity were reported by high retainers with hospitalized infants (at birth) compared to non-retainers with healthy infants. This suggests that physical activity and eating habits may be altered among women with hospitalized infants, resulting in weight retention.

An emerging behavior associated with weight status is the number of hours of sleep. [37] In the current study, sleep duration of 5 hours or less was associated with weight retention only at 3 months postpartum, suggesting that the lack of sleep associated with having a young infant may contribute to a woman's inability to lose weight in the short-term postpartum. As the infant gets older and mothers' are able to return to their usual sleeping patterns (as evidenced by the decrease in number of women reporting <=5 hours of sleep, Supplementary Table 1), the impact of sleep on weight retention may lessen so that it is no longer a significant predictor of weight retention at 12 months postpartum. This is similar to the results found by Gunderson et al.,[14] which showed that women with 5 or fewer hours of sleep were over 3 times more likely to have >5kg (11 lbs) weight retention at 6 months postpartum compared to women with 7 hours of sleep.

Perhaps the least surprising, but an important finding, was that gestational weight gain emerged in each of the models as a significant predictor of weight retention at 3 and 12 months postpartum. This finding is consistent with those of previous studies that assessed weight retention at 6 months postpartum [7–9,11] and 10 –18 months postpartum[7,17,38] ; in all of these studies women who gained weight above the IOM recommendations retained more weight than those who gained within the recommendations. Prepregnancy weight status has also been consistently associated with weight retention[5]

At 12 months, the proportion of overweight and obese women who have moved up a category in their weight status was substantial. This is less so for normal weight and not really an issue for underweight women since they may benefit from the weight gain. These results while they have been shown by others [11,39], underscore the importance of a weight loss intervention in the postpartum period to prevent women from beginning their next pregnancy at a higher weight status and thus be at greater risk of adverse pregnancy outcomes such as gestational diabetes, preclampsia, macrosomia, and cesarean section.[5]

The predictors of race/ethnicity, younger maternal age, unemployment during the postpartum period, and low education level have been reported previously with varying levels of consistency. Several studies report that black women tend to retain more weight compared to their white counterparts independent of gestational weight gain.[11,17,40,41] It has been suggested that black women may experience greater difficulty in losing weight.[42] Maternal ages of less than 20 years and greater than 30 or 40 years[10,36] are found to be associated with higher weight retention, while other studies have not found such a relationship.[43,44] Greater weight losses within 6 months postpartum are seen the sooner a woman returns to work[44] but this may differ by race. In a study of parity and body weight, the amount of weight associated with parity was less in employed versus unemployed white women but greater in employed versus unemployed black women.[45] Level of education, when used as a measure of socioeconomic status has been inversely associated with weight retention.[41,46]

Lastly, we found that women reporting total energy intakes in the highest tertile were more likely to retain >10 lbs at 12 months postpartum; all other associations between high total energy intake and weight retention were not significant. In a study by Olson et.al., (2003) women who reported eating more food during 6–12 months postpartum compared to the first 6 months postpartum were 3.5 times more likely to retain >=10 lbs at 12 months postpartum. [10] Women who reported eating less food at 6–12 months postpartum also reported that they were doing so for the purpose of losing weight, suggesting that women who do not make dietary changes may be less concerned with weight loss.

Interestingly, although several significant bivariate associations were found for postpartum depressive symptoms and behavioral characteristics, such as breastfeeding duration, macronutrient composition of the diet, and physical activity, they were not significant predictors of weight retention in the multivariable models. This may suggest a lack of association for these factors once more influential factors, such as total energy intake, are included in the model, a lack of variation within the study population, measurement error, or a consequence of using the data in a cross-sectional manner as was shown for breastfeeding in Janney, et.al.38. Herring et.al.[13] reported an association between postpartum depressive symptoms and weight retention of >5kg (11 lbs) at 1 year postpartum; however, when models were fully adjusted, the association was no longer significant, which is consistent with the present findings. Despite the fact that the behavioral characteristics were not found to be predictors of postpartum weight retention in our analyses, breastfeeding is shown to have beneficial effects on weight loss [10,38] and a few targeted diet and physical activity interventions in women during the postpartum period have proven successful for weight loss.47

There are several limitations of the current analysis. First, no causal relationships can be determined from our present analysis as variables were assessed as predictors of postpartum weight retention in a cross-sectional manner and the study was observational in its design. Second, we had 20% attrition between the 3 month and 12 month follow-up; while differences were noted for age, race/ethnicity and education between those who remained and those who dropped out of the study it is unlikely that predictors of postpartum weight retention would be different. Generalizability of this study may be limited to white, married and moderate to high income women. Lastly, the majority of the data related to behaviors was self-reported and is

thus subject to the errors inherent with this mode of data collection. However, a major strength of this study is the measured weights during pregnancy and in the postpartum period as well as the wealth of information collected of various predictors that allowed for comprehensive modeling.

The results from this study suggest that predictors of weight retention differ during the first year postpartum with the exception of pregravid weight and gestational weight gain. Given that gestational weight gain is a potentially modifiable risk factor our finding emphasizes the importance of having interventions that are successful in achieving weight gains in the recommended ranges. Unfortunately there are only a few intervention studies which have been proven to be effective in having women gain within the targeted ranges[48,49] or that have been successful in reducing postpartum weight retention.[47] The results of this study may help to inform intervention studies aimed in the postpartum period by illustrating the importance of dealing with other factors such as hours of sleep, having had a hospitalized child and attitudes related to eating depending on when the intervention begins.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Descriptive Statistics for the Women in the Pregnancy, Infection and Nutrition Postpartum Study at 3 and 12 Months Postpartum

Characteristic	3 Months		12 Months	
	n[1]	Median; Mean (SD)	n[1]	Median; Mean (SD)
Current BMI	687	25.47; 27.4 (7.1)	535	24.27; 26.6 (7.6)
Absolute Intensity of Total Physical Activity (MET hours/week)[1]	673	0; 7.0 (17.7)	541	0; 8.4 (18.8)
Absolute Intensity of Work-Related Activity (MET hours/week)	673	0; 0.9 (6.8)	541	0; 0.6 (3.2)
Absolute Intensity of Recreational-Related Activity (MET hours/week)	673	0; 4.6 (14.9)	541	0; 6.0 (16.9)
Absolute Intensity of Care-giving-Related Activity (MET hours/week)	673	0; 0.3 (1.4)	541	0; 0.2 (1.8)
Total Energy Intake (kcals)	582	1979.3; 2088.1 (806.8)	446	1817.8; 1935.5 (666.8)
% Energy from Carbohydrates	582	52.6; 52.4 (8.1)	446	51.0; 51.0 (7.8)
% Energy from Fat	582	33.0; 33.3 (6.7)	446	33.3; 33.5 (6.1)
% Energy from Protein	582	14.3; 14.3 (2.8)	446	14.6; 14.5 (2.6)
Eating Attitudes Test Score	684	3.0; 5.0 (5.4)	550	3.0; 4.9 (5.0)
	Frequencies			
Married (yes)	688	81.5	550	84.9
Income (% Poverty Index)	682		545	
>350%		49.4		54.5
185–350%		23.7		23.7
<185%		26.8		21.8
Working (yes)	688	51.7	550	62.4
Smoking (yes)	688	10.0	550	8.9
Edinburgh Postpartum Depression Scale (≥13)	688	7.3	550	6.4
Breastfeeding Status	688		550	
Still breastfeeding		64.8		26.5
Started but stopped		26.2		66.0
Never		9.1		7.5

[1] A total of 688 and 550 home visits were conducted at 3 and 12 months respectively. The samples sizes indicate that some women did not have complete data for all the variables.

[2] MET-metabolic equivalents.

Table 2

Relative Risk and 95% Confidence Intervals of Significant Predictors of Postpartum Weight Retention at 3 and 12 Months[1]

	3 months		12 months	
	1–10 lbs[2]	>10 lbs[3]	1–10 lbs[4]	>10 lbs[5]
Age				
<25			Reference	Reference
25–29			0.7 (0.5, 1.0)	0.5 (0.3, 0.9)
30–34			1.2 (0.9, 1.8)	0.7 (0.4, 1.1)
35+			0.9 (0.7, 1.3)	0.5 (0.3, 0.7)
Race/Ethnicity				
Non-Hispanic white			Reference	Reference
Non-Hispanic black			1.3 (0.9, 1.9)	1.8 (1.1, 2.7)
Other			0.7 (0.4, 1.1)	1.6 (1.1, 2.3)
Education				
>16 years			Reference	
13–16 years			1.4 (1.1, 1.8)	
<=12 years			2.2 (1.5, 3.0)	
Working				
Yes				Reference
No				1.6 (1.2, 2.3)
Pregravid BMI				
Normal	Reference		Reference	
Underweight	1.7 (1.4, 2.1)		2.0 (1.6, 2.7)	
Overweight	0.6 (0.4, 0.8)		0.9 (0.6, 1.2)	
Obese	0.4 (0.3, 0.6)		0.7 (0.4, 1.0)	
Underweight/ Normal		Reference		
Overweight/ Obese		0.6 (0.5, 0.8)		
Gestational Weight Gain				
Adequate	Reference	Reference	Reference	Reference
Inadequate	0.8 (0.6, 0.9)	0.3 (0.2, 0.6)	0.9 (0.6, 1.2)	1.0 (0.5, 2.0)
Excessive	1.6 (1.3, 2.0)	1.9 (1.6, 2.6)	1.5 (1.2, 2.0)	2.2 (1.4, 3.5)
Energy intake				
Lowest tertile				--
Middle tertile				0.6 (0.4, 0.8)
Highest tertile				1.4 (1.0, 2.0)
Hospitalized at Delivery ≥ 4 days				
No				Reference

	3 months		12 months	
	1–10 lbs[2]	>10 lbs[3]	1–10 lbs[4]	>10 lbs[5]
Yes				2.0 (1.3, 2.9)
Hospitalized after coming home				
No		Reference		
Yes		1.8 (1.4, 2.3)		
Sleep (hours/night)				
8+ hours	Reference	Reference		
6–7 hours	1.0 (0.9, 1.2)	1.0 (0.9, 1.1)		
<=5 hours	1.6 (1.2, 2.1)	1.9 (1.5, 2.4)		
Eating Attitudes Test Score				
<=75th % ile		Reference		
>75th %ile		1.2 (1.1, 1.4)		

[1] Results are from log-binomial models fitted using WinBUGS.[32] The reference category for the models are women in the lost weight/no change group.

[2] This model also adjusted for marital status, number of children, and score on the Edinburgh Postpartum Depression scale.

[3] BMI categories had to be combined for this model due to instability in parameter estimates; model was also adjusted for income, delivery mode, and Edinburgh Postpartum Depression scale.

[4] This model also adjusted for maternal height, total physical activity in MET hours, and Edinburgh Postpartum Depression scale.

[5] This model was also adjusted for income.