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Mariam Girguis

Yale University, girguismariam@gmail.com

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THE INFLUENCE OF BREASTFEEDING ON POSTPARTUM WEIGHT RETENTION

By

Mariam S. Girguis

A Thesis Presented to

The Department of Chronic Disease Epidemiology

Yale University

In Candidacy for the Degree of

Master of Public Health

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Abstract

Background: Weight gained during pregnancy and not lost postpartum has been identified as a contributor to increased obesity risk among women of childbearing age.

Objective: To determine the influence of “any” and exclusive breastfeeding duration on postpartum weight retention (PPWR).

Design: Women were selected from the longitudinal Infant Feeding Practices Study II (IFPS II) . All women who reported both their pre-pregnancy weight and at least one postpartum weight were included in the analyses. Multivariate logistic and linear regression models were used to examine the association between “any” and exclusive breastfeeding duration and PPWR at 3 (n=2254), 6 (n=1966), 9 (n= 1824), and 12 (n=1693) months postpartum. Models were controlled for pre-pregnancy BMI, maternal age, parity, poverty level, education, and prenatal smoking status.

Results: Results indicate that breastfeeding is associated with PPWR. “Any” breastfeeding for between 3-4 and 4-5 months was associated with an increased odds of retaining above median PPWR at 12 months postpartum (OR: 1.99, 95%, CI: 1.21, 3.24; OR: 1.83, 95% CI; 1.01-3.29). By contrast, exclusive breastfeeding was associated with decreased odds of retaining above median PPWR at 6 months (OR: 0.63, 95% CI: 0.41-0.98). Exclusive breastfeeding for at least 6 months was also associated with significantly decreased odds of retaining above median PPWR at 6, 9, and 12 months postpartum.

Conclusion: Exclusive breastfeeding for at least 6 months was associated with decreased odds of retaining above median PPWR.

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Due to a combination of biological, hormonal, environmental, and cultural factors, obesity distinctively affects women's health. Approximately 24.5% of women living in the United States aged 20-44 years of age are overweight (BMI 25.0-29.9 kg/m²) and 23% are obese (BMI > 30 kg/m²). Among those who are obese, 10.3% meet the criteria for class II or III obesity (BMI > 35 kg/m²)[1]. As researchers are trying to understand the multiple influences on obesity, they have concluded that reproductive transitions, such as pregnancy, increase the risk for obesity[2]. As pregnancy is likely to be a significant risk factor for excessive weight gain for most women, this study seeks to understand the influence of breastfeeding duration on postpartum weight retention (PPWR). PPWR at time t is defined as the weight gain from pregnancy which is not lost following childbirth. It is usually calculated by subtracting a mother's pre-pregnant weight from her postpartum weight at time t .

Postpartum Weight Retention

Several studies have concluded that excess weight gain during pregnancy and failure to lose weight after pregnancy are risk factors for long term obesity. Rooney et al (2002) found that pregnancy weight gain accounts for more than half of adult weight gain among overweight women who previously had a normal weight [3]. Pregnancy has frequently been cited as a contributor to overweight. Women experience a wide range of weight gains during pregnancy and PPWR. Although the majority of studies conclude that significant PPWR exists, they report that median PPWR ranges from -0.6 to 7.7 lbs. [4-10]. This wide range of PPWR estimates across studies may be explained by different methods used for estimating PPWR and/or sample characteristics.

One of the first reports demonstrating significant PPWR studied 7,000 women in the United States longitudinally and found that PPWR was 7.7 lbs on average [4]. In this study

PPWR was defined as the weight retained in the time elapsed between births (from one pregnancy to the subsequent pregnancy) in relationship to maternal weight prior to the first pregnancy. Using a similar study design, Harrison et al conducted a study in the United Kingdom. After controlling for age, they found that women lost 0.6 lb. between two subsequent pregnancies. They concluded that pregnancy did not significantly affect weight gain [5]. A subsequent study, conducted by the same authors followed a group of women for 2.5 years postpartum and found a significant yet small influence of pregnancy on PPWR which was 1.1 lbs. on average [6]. Consistent with this study, a Swedish Cohort study [7] found that average PPWR, 12 months after birth, was also 1.1 lbs. Likewise, others have estimated that pre-menopausal and post-menopausal women gain an average of 1 lbs. per year throughout life[47].

Rookus et al [8] followed a cohort of 49 women for 9 months postpartum in the Netherlands and found that there was no significant difference in BMI between women 9 months postpartum and their age matched non-pregnant counterparts[8]. Few studies have been able to investigate the influence of pregnancy on PPWR for longer follow up periods. Two longitudinal studies following women for 10 years postpartum in the United States and Australia found that there was a significant but modest positive association between pregnancy and PPWR[9, 10].

The overall influence of pregnancy on weight gain is difficult to estimate as previous studies have used diverse samples and methods for estimating PPWR. Thus far the literature suggests that there is a significant yet small association between pregnancy and weight gain. While the majority of women may not experience significant PPWR, there may be subgroups of women who do retain substantial weight after delivery. A prospective cohort study in the United States concluded that 15-25.6% of mothers retain at least 10 lbs. postpartum [11, 12].

Gestational weight gain (GWG) has also been associated with PPWR [12, 15, 16]. In general, the more weight that women gain during pregnancy, the more PPWR they experience [16]. Excessive gestational weight gain has been cited as the primary risk factor for retaining excessive weight in the postpartum period [10, 11, 15-18]. Women with a gestational weight gain above the recommendations of the IOM had greater PPWR in a cohort of Brazilian women [15]. The Institute of Medicine (IOM) has issued gestational weight gain guidelines as a function of pre-pregnancy BMI[13]. The most updated 2009 IOM pregnancy weight gain guidelines are similar to its 1990 guidelines, except now there is an upper limit of how much weight obese women should gain while pregnant[13]. These guidelines provide cut off points for investigating gestational weight gain and PPWR. A study conducted in the United States found that for those women who met the recommended gestational weight gain, PPWR at 10 to 18 months for White women was 1.6 lbs. while for Black women it was 7. 2 lb.[14]. Among 18–45 year old Brazilian women living in Rio de Janeiro, each unit increase in pre-pregnancy BMI was associated with a decrease of 0.51 kg in PPWR[15]. Other risk factors associated with PPWR include pre-pregnancy BMI, primiparity, duration of breastfeeding, smoking, high energy intake and low physical activity, although these associations have not been found in all studies[11, 17]. Smoking relapse among prenatal smokers was found to reduce PPWR compared to women who remained abstinent postpartum [19].

Breastfeeding and Postpartum Weight Retention

The relationship between breastfeeding and PPWR remains elusive. A systematic review of 15 observational studies concluded that there may exist a dose-response relationship between breastfeeding duration/intensity and PPWR, and that weight loss differences attributed to breastfeeding were transient, being more evident within 3 to 6 months postpartum[20]. Another systematic review based on similar evidence concluded that the influence of breastfeeding on

PPWR is unclear and if an association is present, the effect size is likely to be small [21]. Based on these reviews, the 2010 Dietary Guidelines for Americans Advisory Committee (DGAC) concluded that although there is some evidence of an association between breastfeeding and maternal weight, “this weight loss is small, transient, and depends on breastfeeding intensity and duration”[22].

Biological Plausibility

The storage of fat has been found to be a normal physiological adaptation of pregnancy. During pregnancy, a gain in adipose tissue is expected among all women. Building body fat reserves during this physiological state is needed for supporting the high energy needs of pregnancy [23]. Fat stored during pregnancy is also assumed to be needed to support the increased energy demands associated with lactation [24, 25]. Because breastfeeding requires a high maternal energy investment it is possible that human lactation (vs. formula feeding) may result in a reduction in PPWR. However this relationship may not exist if appetite adjustments and other factors compensate completely or overcompensate for the increased energy expenditure needed for the human lactation process.

Epidemiology

As indicated above the conclusions of the 2010 DGAC were influenced by two systematic reviews [13, 20]. The Agency for Healthcare Research and Quality (AHRQ)’s systematic review was built on and updated a previous systematic review [26]. With the inclusion of eight prospective cohort studies, AHRQ’s [21] review concluded that the influence of breastfeeding on PPWR are not clear. Dewey’s [20] review was based on 15 studies stratified into those that measured and those that estimated PPWR. The conclusion of this systematic review indicated that weight loss attributed to breastfeeding was most notable within three to six

months postpartum and was a function of breastfeeding intensity. This conclusion was supported only by those studies that had actual measures of PPWR [19].

Various studies have reached inconsistent conclusions which may be attributable to study design, length of follow up period, breastfeeding modality, and study population. As concluded by the 2010 DGAC committee, the relationship between breastfeeding and PPWR is not yet fully understood. Yet several studies have concluded that exclusively breastfeeding for 6 months, as recommended by WHO[28] is associated with a reduction in PPWR compared to women who do not breastfeed exclusively for 6 months[27, 29, 30]. A study found that after controlling for maternal age, marital status, BMI, gestational weight gain, and ethnicity, there was a dose-response association between breastfeeding and PPWR. Even though this relationship was not significant at 3 months postpartum, at 6 months maternal weight retention was lowest among women who exclusively breastfed compared to those who “any” breastfed, and was also lower among those who “any” breastfed compared to those who never breastfed [31]. An analysis of over 26,000 women from the Danish National Birth Cohort study found that if women exclusively breastfed for 6 months, PPWR could be eliminated [29]. Another investigation of 36,030 Danish women found that the relationship between breastfeeding and PPWR is modified by pre-pregnancy BMI. On average women were estimated to have lost only 0.06–0.09 kg for every week of exclusive breastfeeding. However, exclusive breastfeeding was significantly and negatively associated with PPWR only among women with a BMI<35 kg/m² [30]. A study that followed 41 women through their 3rd month postpartum in Northwest Mexico found that a majority of the women who were exclusively breastfeeding did not significantly reduce PPWR compared to women who did not exclusively breastfeed during the first 3 months postpartum [27].

Some studies found a significant relationship between “any” breastfeeding and PPWR. Women who “any” breastfed for 20 weeks or more experienced a reduction in PPWR compared to women who did not breastfeed at all by the beginning of the second pregnancy[32]. The long term influence of breastfeeding and PPWR was examined by retrospectively assessing cumulative breastfeeding history and current maternal body fat 16-20 years after the last pregnancy. Total body fat mass percentage was greatest among women who reported to have breastfed for less than 6 months compared to mothers who breastfed for longer than 6 months[33]. Contrary to the before mentioned results, a multi-country study that followed 1743 mothers at 3, 6, 9 and 12 months postpartum found differences in PPWR as a function of BMI and country (Brazil, Ghana, India, Norway, Oman, and USA), but not as a function of breastfeeding duration[34].

Because it is still unclear if there is an association between breastfeeding and PPWR, the objective of this study is to determine if there is an association between breastfeeding and PPWR in a major longitudinal US study.

Materials and Methods

Participants

In an effort to better understand dietary practices of pregnant women, The Food and Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC), in collaboration with other federal agencies, conducted a consumer-based research study. The Infant Feeding Practices Survey II (IFPS II) is a longitudinal study focusing on infant feeding practices and maternal dietary intake that follows women from the 3rd trimester of pregnancy to 12 months postpartum. Surveys were administered using monthly mail questionnaires to a national mail panel, with over sampling of African American and Hispanic women. There were

4,902 pregnant women who participated in the study between May and December of 2005.

Women were chosen from a national consumer opinion panel throughout the United States and were sampled for the IFPS II; these women are expected to be more likely to return the numerous questionnaires associated with participation in IFPS II. To qualify for the study, a healthy woman must have given birth to a healthy, full-term or near-term singleton infant weighing at least 5 pounds at birth.

Procedures of IFPS II

During pregnancy, each woman received a Prenatal Questionnaire and demographic surveys. A Birth Screener interview was conducted around the expected date of delivery to determine if the baby had been born. If the family could not be reached by telephone, they were mailed a postcard asking them to dial into an Interactive Voice Response (IVR) questionnaire. If they did not respond to the post card, they were mailed a copy of the Birth Screener questions along with the Neonatal Questionnaire around the time they would have received this questionnaire if the baby had been born on the expected due date.

Neonatal Questionnaires were mailed to each mother two to four weeks after the baby's birth. Following the Neonatal Questionnaires were a series of nine Postnatal Questionnaires mailed approximately monthly throughout the infant's first year of life, each consisting of several modules. A detailed explanation of the IFPS II methods and surveys is reported elsewhere [1]. Surveys mailed prenatally, and at 3, 6, 9, and 12 months postpartum were the sources of data for the analyses presented in this paper.

Analysis Sample

There are 4,902 unique women represented in the IFPS II database. Pre-pregnancy weight was reported by 4,832 women. The mean pre-pregnant weight was 159.10 lbs. with a range from 80-470 lbs. Maternal self-reported follow up weight was reported in response to the survey at 3,

6, 9, and 12 months postpartum. Time after parturition was estimated according to the mothers reported birth date of the child. At each estimated time point, a survey was mailed to the mother. PPWR was calculated at 3, 6, 9, and 12 months for 2304, 2008, 1866, and 1731 women, respectively. Women included in this analysis were those who reported their pre-pregnant weight and their postpartum weight for at least one of the four selected time points. Women were excluded from this analysis if their PPWR fell <1% or >99%ile of the sample distribution at each time point. The final sample size at 3, 6, 9, and 12 months is 2254, 1966, 1824, and 1693 women, respectively. To ensure that maximizing the sample size at each time by including subjects with missing data did not bias the analysis, a sample bias analysis was also conducted for all the below mentioned analyses with only women without any missing data at any time point.

PPWR

Maternal pre-pregnancy weight was self-reported in the prenatal questionnaire during the mother's third trimester of pregnancy. Post-partum weight retention was calculated for each mother at 3, 6, 9, and 12 months postpartum. PPWR was created by using the absolute difference of the mother's self-reported pre-pregnant weight from her self-reported weight at each time point. PPWR is a continuous variable, with approximately normal distribution. After extreme/implausible values were removed from the dataset, PPWR was divided into tertiles and converted into a categorical variable. PPWR values used in these analyses range from -36 to 45, -33 to 53, -38 to 52, and -37 to 49 pounds for 3, 6, 9, and 12 months postpartum, respectively.

Breastfeeding Duration

“Any” and exclusive breastfeeding duration was determined according to the mother's report of using formula at the hospital and her response to the infant abridged food frequency questionnaire at the hospital, and 2,3,4,5,6,7,9,10, and 12 months postpartum. In each

questionnaire, mothers were asked whether they were currently breastfeeding (either exclusively breastfeeding or mixing breastfeeding with formula (“any”); yes/no), and if no longer breastfeeding, when breastfeeding was discontinued. Additionally, each questionnaire included a section called “stopped breastfeeding”. Mothers were asked to complete this section if they indicated that they had stopped breastfeeding since they returned their last survey. Breastfeeding was expressed in total exclusive (giving the infant no food or liquid other than breast milk) and “any” (giving the infant breast milk in addition to other liquid or solid foods) breast-feeding months.

Duration of “any” breastfeeding and exclusive breastfeeding were categorized into groups according to the time point of analysis to account for time dependent relationships. Breastfeeding duration categories at 3 months postpartum groups are: none, 0-1 month, 1-2 months, 2- 3 months, and at least 3 months. Breastfeeding duration categories for 6 months postpartum analyses are: none, 0-1 month, 1-2 months, 2- 3 months, 3-4 months, 4-5 months, 5-6 months, and at least 6 months. Breastfeeding duration categories for 9 months postpartum analyses are: none, 0-1 month, 1-2 months, 2- 3 months, 3-4 months, 4-5 months, 5-6 month, 7-8 months, 8- 9 months, and at least 9 months. Breastfeeding duration categories for 12 months postpartum analyses are : none, 0-1 month, 1-2 months, 2- 3 months, 3-4 months, 4-5 months, 5-6 months, 7-8 months, 8- 9 months, 9-10 months, 10-11 months, 11-12 months, and at least 12 months.

Covariates

Demographic and other possible confounders were included in statistical models. Maternal age (range 18-52) was collected at 3 months postpartum. Race/Ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic-White, Asian/Other), Education (less than high school graduate, high school graduate, and more than high school graduate), poverty level

(<185%, 185-350%, and >350%) , BMI (kg/m²), parity (primiparous vs. multiparous [2 children, 3 or more]) and prenatal smoking status (yes, no) were determined through the demographics questionnaire which was sent to mothers prenatally. To calculate BMI, self-reported height and weight from the prenatal questionnaire was used.

Statistical Analyses

Continuous covariates were categorized at clinically meaningful cut points: pre-pregnancy BMI was categorized according to NHLBI guidelines (National Heart, Lung and Blood Institute, 1998), and exclusive breastfeeding duration was categorized according to American Academy of Pediatrics (AAP) recommendations.

Descriptive statistics were generated to describe the sample. Distributions of each independent variable were compared across PPWR tertiles at each time point. P-values were obtained using Chi squared tests for categorical variables and t-tests for continuous variables at each time point. A bivariate analysis was conducted between breastfeeding variables and PPWR. A general linear p-value was obtained to test for association. Multivariate logistic and linear regression models were run at each time point to examine the association between breastfeeding duration and PPWR. Independent variables were selected for inclusion in the multivariate analysis if they were significantly associated with PPWR in the bivariate analyses.

To determine the most parsimonious model, backward stepwise regression modeling was used. Logistic regression models were run to examine the association between breastfeeding and the risk of retaining above median PPWR. Backward and forward variable elimination was used to determine the best binomial multivariate model. Akaike Information Criterion (AIC) was used to compare the backward and forward selection results to obtain the best fit model. When results were inconsistent, the model with the lowest AIC was chosen as the final model. The primary independent variable was either duration of exclusive breastfeeding or duration of “any”

breastfeeding. The dependent variable was obtaining above median PPWR. Statistical models were adjusted for pre-pregnancy BMI, maternal age, race/ethnicity, parity, maternal education, poverty level, prenatal smoking (Y/N), and gestational weight gain, since these covariates were significantly associated with PPWR in the Bivariate analysis.

Since duration of exclusive breastfeeding and duration of “any” breastfeeding are highly correlated, two separate reduced models were created for each of these key independent variables. Additionally, since linear regression model results were fairly consistent with logistic regression findings (see appendix), only logistic regression results will be presented.

Creation of Composite Variable

Based on the results of the logistic and linear regression models at each time point, a new composite breastfeeding duration variable was created to represent mutually exclusive categories representing the combined duration of “any” and exclusive breastfeeding. Based on the exclusive breastfeeding duration and “any” breastfeeding multivariate analyses results at different time points these breastfeeding category (ies) representing the longest exclusive breastfeeding and “any” breastfeeding durations were expected to have a significant influence on PPWR at 12 months. Using this new composite variable, binomial multivariate logistic regression was used to test the odds of retaining above median PPWR at 12 months postpartum. Understanding the influence of breastfeeding duration on PPWR at 12 months was prioritized, as there have not been many studies that have explored breastfeeding and PPWR at this time point. Additionally, because of the time dependent breastfeeding categories, 12 months was the only time point where the maximum possible breastfeeding duration could be tested. A multivariable linear regression model was also used to test the relationship between the composite variable and PPWR expressed as a continuous variable.

Results

Description of the Sample

There were a total of 2,571 women who reported their postpartum weight for at least one of the four time points. Of these women, 48% of the women reported their postpartum weight at all four time points. There were 87.6%, 76.4%, 70.9%, and 65.8% reported their 3, 6, 9, and 12 month postpartum weights. Sampling bias analysis revealed that there was no sampling bias due to the attrition rates in this study. Women included in each analysis were similar in respect to age, BMI, exclusive and “any” breastfeeding duration, parity, poverty level, prenatal smoking status, education, and weight gain during pregnancy (Table 1). Mean exclusive breastfeeding duration within the analysis sample ranged between 6.1 and 6.8 weeks and mean “any” breastfeeding duration ranged between 33.9 and 34.3 weeks (Table 1). Mean maternal age was 29 years. Average gestational weight gain ranged between 30.8 and 31.4 pounds (Table 1). The great majorities (87.8%) of the women were White, 5.1% were Hispanic, 4.1% were Black and 2.8% were Asian. In this sample 42.5% of the women had some college or more, and 29% were primiparous (Table 2a). Within this sample, only 189 women (8.4%) in the 3 months analysis reported that they smoked prenatally (Table 2a).

Table 1. Sample Characteristics Across Time

	3 Month Sample Mean (SD)	6 Month Sample Mean (SD)	9 Month Sample Mean (SD)	12 Month Sample Mean (SD)
Age (years)	29.2(5.3)	29.4(5.3)	29.6(5.3)	29.8(5.3)
BMI (kg/m²)	26.4(6.5)	26.4(6.53)	26.5(6.53)	26.4(6.5)
Exclusive Breastfeeding Duration (in weeks)	6.8(12.2)	6.1(9.4)	6.2(9.2)	6.1(9.2)
“any” breastfeeding duration (in weeks)	34.3(30.9)	33.9(30.2)	34.1(29.9)	33.9(29.4)
Parity	1.2(1.2)	1.2(1.1)	1.2(1.2)	1.2(1.1)
% Poverty level	267.9(195.8)	272.4(198.9)	276.5(193.8)	280.4(196.0)
Cigarettes smoked daily prenatally	0.08(.2)	0.07(0.2)	0.07(0.2)	0.07(0.2)
Weight gain during Pregnancy (mean)	30.8(13.8)	31.4(13.8)	31.1(13.8)	31.0(13.5)

^a Mean (Standard Deviation)

To understand the relationship between PPWR and covariates, PPWR was divided into tertiles; low, medium, and high. Variable distribution by PPWR tertiles are presented in table 2a-d. In the 3 month analyses first or low PPWR included all cases with 11lb or less. The second or medium (med) tertile included cases with a PPWR greater than 1 and less than 11lb. The upper or high tertile included cases with PPWR values that were larger than 11 lbs.

There was an association between pre-pregnancy BMI and PPWR tertile (Table 2 a-d). At 3 months, women in the high PPWR had a mean BMI of 24.7 compared with a BMI of 29.6 among women in the low PPWR tertile ($P < .0001$). A similar association was found in the subsequent time points, i.e. at 6, 9, and 12 months post-partum. There was a significant and inverse association between maternal age and PPWR tertile at all-time points ($P < 0.001$). Likewise there was a significant inverse association between parity and PPWR tertile across time points ($P < 0.01$). At 12 months, 37.5 % of primiparous women fell in the low tertile while 26% were in the high PPWR tertile (Table 2d). Among nulliparous women, 32% were in the “low” and 40% fell in the high PPWR tertile. Among multiparous women with only two children prior to this birth, 27.8% were in the low PPWR tertile while 38.4% were in the high PPWR tertile. Among multiparous women with 3 or more children prior to this birth, more women were in the low PPWR tertile than in the high PPWR tertile. 32.7% of these women were in the low PPWR tertile, while only 27.2% were in the high PPWR tertile. Race/Ethnicity was significantly associated with PPWR tertiles at 3, 6, and 9 month postpartum ($P < 0.05$) (table 2a-c) but not at 12 months postpartum (table 2d). At 12 months, while 38% of Black women vs. 32% of White women fell in the upper PPWR tertile, only 22% of Asian women and women of “other” races/ethnicities fell in the upper PPWR tertile. Maternal education was significantly and inversely associated with PPWR tertile across time ($P < 0.05$) (table 2a-d). At 12-months, 38% of

women with less than a high school vs. 28.6% of women who completed high school fell in the high PPWR tertile. Thirty five percent of women who graduated from high school fell in the low PPWR, while 33.4% of women who did not complete high school fell in the low PPWR tertile (Table 2d). Similar findings were documented in the analyses at 3, 6, and 9 months. Prenatal smoking status was negatively associated with PPWR tertile at 3 and 12 months ($P < 0.05$) but this association was not significant at 6 and 9 months (Table 2a-d).

A substantial proportion of women (40%) reported “any” breastfeeding for at least 12 months. “Any” breastfeeding duration was not significantly associated with PPWR tertiles at 3 months, but became significantly and inversely associated with PPWR at 6 ($P = .0368$), as well as at 9, and 12 months postpartum ($P < 0.001$). At 6 months, while 29.7% of women who breastfed for at least 6 months fell in the high PPWR tertile, 40.7% were in the low PPWR tertile. The corresponding percentages for women who breastfed for 3-4 months were 40.9% and 29.5%, respectively at 6 and 9 months (Table 2b).

Only 44.7% of women reported ever exclusively breastfeeding. Among women who reported that they exclusively breastfed, only 13% reported that they exclusively breastfed according to WHO and AAP recommendations of 6 months. Exclusive breastfeeding duration was significantly and inversely associated with PPWR at 9 and 12 months ($P < 0.05$) but this association was not significant at 3 and 6 months (Table 2 a-d). A similar response pattern as the one found for “any” breastfeeding duration was also documented for the association between exclusive breastfeeding and PPWR. At 12 months, 46.2% of the women who exclusively breastfed for at least 6 months fell in the “low” and only 24.9% were in the high PPWR tertile (Table 2d). The corresponding percentages for women who exclusively breastfed for 3-4 months were 44.2% and 27.1%, respectively (Table 2d). These associations were further explored through multivariate logistic and linear regression modeling.

Table 2a. Sample Characteristics by Post-Partum Weight Retention Tertile at 3 months^a

Characteristic	N	Post-Partum Weight Retention			p ^c
		Low(N = 739) ^b	Med(N = 768) ^b	High(N= 745) ^b	
% Weight Change	2256	-3.68±4.0	4.5±2.1	13.62±5.4	<.0001
Pre-Pregnancy BMI	2256	29.6±7.5	25.2±5.8	24.7±5.0	<.0001
Maternal Age (years)					<.0001
18-24	452	130(28.7)	124(27.4)	198(43.8)	
25-29	760	240(31.5)	265(34.8)	255(33.5)	
30-34	648	212(32.7)	252(38.8)	184(28.4)	
35+	393	157(40.0)	127(32.4)	108(27.5)	
Parity					.0016
0	632	192(30.3)	197(31.1)	243(38.4)	
1	890	315(35.3)	317(35.6)	258(28.9)	
2	447	137(30.6)	152(34.0)	158(35.3)	
≥3	241	90(37.3)	87(36.1)	64(26.5)	
“Any” Breastfeeding					.2024
None	307	107(34.8)	106(34.5)	94(30.6)	
0-1 months	236	71(30.0)	74(31.3)	91(38.5)	
1-2 months	178	53(29.7)	54(30.3)	71(39.8)	
2-3 months	119	45(37.8)	35(29.4)	39(32.7)	
At least 3 months	1414	466(32.7)	501(35.4)	450(31.8)	
Exclusive Breastfeeding					.3701
None	1224	420(34.3)	412(33.6)	392(32.0)	
0-1 months	288	95(30.9)	89(30.9)	104(36.1)	
1-2 months	113	32(37.1)	42(37.1)	39(34.5)	
2-3 months	80	25(28.7)	23(28.7)	32(40.0)	
At least 3 months	547	166(37.2)	204(37.2)	177(32.3)	
Race/Ethnicity					.0312
Non-Hispanic White	1893	641(33.8)	633(33.4)	619(32.7)	
Non-Hispanic Black	90	24(26.6)	32(35.5)	34(37.7)	
Hispanic	110	33(30.0)	37(33.6)	40(36.3)	
Asian	62	17(27.4)	33(53.2)	12(19.3)	
Maternal Education					.0025
<12	402	124(30.8)	127(31.5)	151(37.5)	
12	817	295(36.1)	257(31.4)	265(32.4)	
>12	904	282(31.1)	350(38.7)	272(30.0)	
Prenatal Smoking Status					.0129
Non-Smoker	2055	659(32.0)	721(35.0)	675(32.8)	
Smoker	189	75(39.6)	47(24.8)	67(35.4)	

^a Table values are mean ± SD for continuous variables and n (ROW %) for categorical variables.

^b Percentages may not sum to 100% due to rounding.

^c P-value is for t-test (continuous variables) or χ^2 test (categorical variables).

Table 2b. Sample Characteristics by Post-Partum Weight Retention Tertile at Retention **6 months**^a

Characteristic	N	Post-Partum Weight Retention			p ^c
		Low(N = 751) ^b	Med(N = 558) ^b	High(N= 656) ^b	
% Weight Change	1966	-3.6±3.9	3.5±1.9	12.7±6.3	<.0001
Pre-Pregnancy BMI	1966	28.5±7.5	24.5±5.4	25.6±5.3	<.0001
Maternal Age (years)					<.0001
18-24	354	99(27.9)	87(27.5)	168(47.4)	
25-29	667	263(39.4)	193(28.9)	211(31.6)	
30-34	595	228(38.3)	189(37.7)	178(29.9)	
35+	349	161(46.1)	89(25.5)	99(28.3)	
Parity					.0063
0	546	198(36.2)	136(24.9)	212(38.8)	
1	798	324(40.6)	224(30.5)	230(28.8)	
2	383	136(35.5)	113(29.5)	134(34.9)	
≥3	204	85(41.6)	59(28.9)	60(29.4)	
“Any” Breastfeeding					.0368
None	271	103(38.0)	66(24.3)	102(37.6)	
0-1 months	193	70(36.2)	46(23.8)	77(39.9)	
1-2 months	150	47(31.3)	47(31.3)	56(37.3)	
2-3 months	95	41(43.1)	24(25.2)	30(31.5)	
3-4 months	88	26(29.5)	26(29.5)	36(40.9)	
4-5 months	57	15(26.3)	19(33.3)	23(40.3)	
5-6 months	80	29(36.2)	26(32.5)	25(31.2)	
At least 6 months	1032	421(40.79)	304(29.4)	307(29.7)	
Exclusive Breastfeeding					.2901
None	1081	411(38.0)	303(28.0)	367(33.9)	
0-1 months	233	81(34.7)	71(30.4)	81(34.7)	
1-2 months	103	36(34.9)	28(27.1)	39(37.8)	
2-3 months	57	24(42.1)	12(21.0)	21(36.8)	
3-4 months	88	38(43.1)	21(23.8)	29(32.9)	
4-5 months	169	56(33.1)	52(30.7)	61(36.0)	
5-6 months	120	55(45.8)	33(27.5)	32(26.6)	
At least 6 months	115	51(44.3)	38(33.0)	26(22.6)	
Race/Ethnicity					.0100
Non-Hispanic White	1671	650(38.9)	470(28.1)	551(32.9)	
Non-Hispanic Black	60	21(35.0)	16(26.6)	23(38.3)	
Hispanic	99	31(31.3)	26(26.2)	42(42.4)	
Asian	56	19(33.9)	27(48.2)	10(17.8)	
Maternal Education					<.0001
<12	355	115 (32.3)	94(26.4)	146(41.1)	
12	683	268(39.2)	176(25.7)	239(34.9)	
>12	834	344(41.2)	267 (32.0)	223(26.7)	
Prenatal Smoking Status					.4659
Non-Smoker	1807	692(38.3)	518(28.6)	597(33.0)	
Smoker	154	57(37.0)	39(25.3)	58(37.6)	

^a Table values are mean ± SD for continuous variables and n (ROW %) for categorical variables.

^b Percentages may not sum to 100% due to rounding.

^c P-value is for t-test (continuous variables) or χ^2 test (categorical variables).

Table 2c. Description of the sample according to Post-Partum Weight Retention 9 months^a

Characteristic	N	Post-Partum Weight Retention			p ^c
		Low(N = 586) ^b	Med(N = 618) ^b	High(N= 620) ^b	
% Weight Change	1824	-5.3±4.0	2.1±1.8	11.9±6.6	<.0001
Pre-Pregnancy BMI	1824	28.3±7.5	25.1±6.2	26.1±5.5	<.0001
Maternal Age (years)					.0006
18-24	309	83(26.8)	86(27.8)	140(45.3)	
25-29	617	199(32.2)	214(34.6)	204(33.0)	
30-34	558	186(33.3)	193(34.5)	179(32.0)	
35+	339	117(34.5)	126(37.1)	96(28.3)	
Parity					.0005
0	509	159(31.2)	136(29.8)	198(38.9)	
1	735	259(35.2)	224(35.9)	212(28.8)	
2	356	108(30.3)	113(31.7)	135(37.9)	
≥3	195	58(29.7)	83(42.5)	54(27.6)	
“Any” Breastfeeding					<.0001
None	242	74(30.5)	72(29.7)	96(39.6)	
0-1 months	174	41(23.5)	54(31.0)	79(45.4)	
1-2 months	138	33(23.9)	42(30.4)	63(45.6)	
2-3 months	96	30(31.2)	36(37.5)	30(31.2)	
3-4 months	80	24(30.0)	24(30.0)	32(40.0)	
4-5 months	51	10(19.6)	21(41.1)	20(39.2)	
5-6 months	65	21(32.3)	23(35.3)	21(32.3)	
6-7 months	72	16(22.2)	29(40.2)	27(37.5)	
7-8 months	57	14(24.5)	22(38.6)	21(36.8)	
8-9 months	69	20(28.9)	25(36.2)	24(34.7)	
At least 9 months	781	303(38.8)	271(34.7)	207(26.5)	
Exclusive Breastfeeding					.0161
None	991	299(30.1)	340(34.3)	352(35.5)	
0-1 months	219	70(31.9)	60(27.4)	89(40.6)	
1-2 months	95	25(26.3)	37(38.9)	33(34.7)	
2-3 months	58	18(31.0)	18(31.0)	22(37.9)	
3-4 months	88	33(37.5)	34(38.6)	21(23.8)	
4-5 months	148	47(31.7)	52(35.1)	49(33.1)	
5-6 months	110	47(42.7)	35(31.8)	28(25.4)	
At least 6 months	116	47(40.5)	43(37.0)	26(22.4)	
Race/Ethnicity					.0018
Non-Hispanic White	1553	516(33.2)	516(33.2)	521(33.5)	
Non-Hispanic Black	59	13(22.0)	23(38.9)	23(38.9)	
Hispanic	87	23(26.4)	25(28.7)	39(44.8)	
Asian	52	15(28.8)	29(55.7)	8(15.3)	
Maternal Education					<.0001
<12	307	88(28.6)	96(31.2)	123(40.0)	
12	632	198(31.3)	200(31.6)	234(37.0)	
>12	801	281(35.0)	305(38.0)	215(26.8)	
Prenatal Smoking Status					.2228
Non-Smoker	1686	540(32.0)	580(34.4)	566(33.5)	
Smoker	134	42(31.3)	38(28.3)	54(40.3)	

^a Table values are mean ± SD for continuous variables and n (ROW %) for categorical variables.

^b Percentages may not sum to 100% due to rounding.

^c P-value is for t-test (continuous variables) or χ^2 test (categorical variables).

Table 2d. Description of the sample according to Post-Partum Weight Retention 12 months^a

Characteristic	N	Post-Partum Weight Retention			p ^c
		Low(N = 565) ^b	Med(N = 572) ^b	High(N= 555) ^b	
% Weight Change	1693	-5.8±4.0	1.8±1.7	12.3±6.7	<.0001
Pre-Pregnancy BMI	1693	28.2±7.4	24.7±5.6	26.5±6.0	<.0001
Maternal Age (years)					<.0006
18-24	264	72(27.2)	74(28.0)	118(44.7)	
25-29	566	194(34.2)	189(33.3)	183(32.3)	
30-34	523	173(33.0)	193(36.9)	157(30.0)	
35+	339	127(37.4)	116(34.2)	96(28.3)	
Parity					<.0001
0	472	152(32.2)	132(27.9)	188(39.8)	
1	692	260(37.5)	252(36.4)	180(26.0)	
2	320	89(27.8)	108(33.7)	123(38.4)	
≥3	180	59(32.7)	72(40.0)	49(27.22)	
“Any” Breast feeding					<.0001
None	217	69(31.8)	73(33.6)	75(34.5)	
0-1 months	165	53(32.1)	38(23.0)	74(44.8)	
1-2 months	122	31(25.4)	44(36.0)	47(38.5)	
2-3 months	80	22(27.5)	32(40.0)	26(32.5)	
3-4 months	76	23(30.2)	24(31.5)	29(38.1)	
4-5 months	48	10(20.8)	15(31.2)	23(47.9)	
5-6 months	69	26(37.6)	16(23.1)	27(39.1)	
6-7 months	69	19(27.5)	32(46.3)	18(26.0)	
7-8 months	51	12(23.5)	19(37.2)	20(39.2)	
8-9 months	64	17(26.5)	25(39.0)	22(34.3)	
9-10 months	51	13(25.4)	19(37.2)	19(37.2)	
10-11 months	55	14(25.4)	24(43.6)	17(30.9)	
11-12 months	68	28(41.1)	21(30.8)	19(27.9)	
At least 12 months	558	229(41.0)	190(34.0)	139(24.9)	
Exclusive Breast feeding					.0162
None	921	296(32.1)	307(33.3)	318(34.5)	
0-1 months	212	61(28.7)	72(33.9)	79(37.2)	
1-2 months	85	22(25.8)	31(36.4)	32(37.6)	
2-3 months	53	17(32.0)	18(33.9)	18(33.9)	
3-4 months	70	31(44.2)	20(28.5)	19(27.1)	
4-5 months	145	51(35.1)	47(32.4)	47(32.4)	
5-6 months	101	39(38.6)	38(37.6)	24(23.7)	
At least 6 months	106	49(46.2)	39(36.7)	18(16.9)	
Race/Ethnicity					.1157
Non-Hispanic White	1442	497(34.4)	480(33.2)	465(32.2)	
Non-Hispanic Black	52	12(23.0)	20(38.4)	20(38.4)	
Hispanic	79	20(25.3)	25(31.6)	34(43.0)	
Asian	50	18(36.0)	21(42.0)	11(22.0)	
Maternal Education					.0278
<12	372	91(33.4)	77(28.3)	104(38.2)	
12	573	186(32.4)	195(34.0)	192(33.5)	
>12	772	271(35.1)	280(36.2)	221(28.6)	
Prenatal Smoking Status					.0313
Non-Smoker	1561	518(33.1)	541(34.6)	502(32.1)	
Smoker	127	43(33.8)	31(24.4)	53(41.7)	

^a Table values are mean ± SD for continuous variables and n (ROW %) for categorical variables. ^b Percentages may not sum to 100% due to rounding. ^c P-value is for t-test (continuous variables) or χ^2 test (categorical variables)

PPWR and breastfeeding duration

The unadjusted means and standard deviations of PPWR at each time point by breastfeeding duration are reported in table 3. At 3 months there was no significant association between “any” breastfeeding ($P=.325$) or exclusive breastfeeding ($P=.632$) and PPWR. At 6 months, “any” breastfeeding duration was significantly and positively associated with PPWR ($P=0.006$). At this time point there was no association between exclusive breastfeeding duration and PPWR (Table 3).

At 9 months, both “any” breastfeeding and exclusive breastfeeding ($P=0.001$) duration were inversely associated ($P<0.001$) with PPWR. The mean PPWR for women who “any” breastfed for at least 9 months was 2.0 lbs. and the unadjusted mean PPWR for women who exclusively breastfed for at least six months is 1.2 lbs.

At 12 months, “any” breastfeeding ($P=0.018$) and duration of exclusive breastfeeding ($P=0.015$) were significantly associated with PPWR. The mean PPWR for women who “any” breastfed for 0-1, 6-7, and at least 12 months were 7.9, 2.9, and 1.6 lbs., respectively (see table). The mean PPWR at this time point amongst women who exclusively breastfed for at least 6 months was 0.42 lbs. and 4.0 lbs. among women who did not exclusively breastfeed for any duration.

In sum, these bivariate analyses suggest that amongst women who exclusively breastfed, a non-linear downward trend was found between duration of exclusive breastfeeding and PPWR at 9 and 12 months (Figure B). From these analyses, the relationship between PPWR and “any” breastfeeding duration is not clear, although there looks like there is an overall decline as duration of breastfeeding increases, this relationship seems to dramatically fluctuate and will be further explored (Figure A).

Table 3. Unadjusted Mean (SD) Postpartum Weight Retention by Breastfeeding

Characteristic	3 Months ^a	P-value ^b	6 Months ^a	P-value ^b	9 Months ^a	P-value ^b	12 Months ^a	P-value ^b
“Any” Breastfeeding		.324		0.005		<.0001		0.018
None	6.7(17.4)		6.0(18.5)		4.7(17.8)		3.6(18.7)	
0-1 months	8.1(20.8)		8.3(19.6)		8.7(21.3)		7.9(21.5)	
1-2 months	7.4(15.6)		6.8(14.5)		7.5(15.6)		5.1(15.7)	
2-3 months	5.85(16.3)		5.8(17.6)		5.7(18.0)		4.6(18.3)	
3-4 months	6.10(14.14)		7.7(13.9)		5.2(14.0)		3.6(16.9)	
4-5 months	-		9.7(20.13)		7.6(17.3)		6.3(15.3)	
5-6 months	-		4.0(13.5)		3.4(12.7)		4.9(16.6)	
6-7 months	-		4.3(14.1)		6.1(12.8)		2.9(17.4)	
7-8 months	-		-		6.4(17.5)		6.1(11.1)	
8-9 months	-		-		4.5(11.9)		4.4(13.4)	
9-10 months	-		-		2.0(14.4)		5.7(13.4)	
10-11 months	-		-		-		4.1(11.8)	
11-12 months	-		-		-		1.7(13.2)	
At least 12 months	-		-		-		1.6(15.8)	
Exclusive Breastfeeding		.632		.245		0.001		0.015
None	6.0(16.9)		5.5(17.08)		5.0(17.7)		4.0(18.4)	
0-1 months	7.3(15.9)		6.6(16.19)		5.5(15.6)		5.2(15.0)	
1-2 months	7.36(12.3)		6.5(12.8)		5.5(12.9)		6.7(14.1)	
2-3 months	6.2(15.1)		5.3(14.4)		4.1(14.9)		4.0(16.8)	
3-4 months	6.9(13.2)		6.3(15.5)		1.9(13.4)		1.5(15.8)	
4-5 months	-		6.3(14.6)		4.1(14.3)		3.2(14.0)	
5-6 months	-		3.1(11.03)		1.2(11.2)		1.7(14.1)	
At least 6 months			2.53(9.9)		1.2(10.9)		0.42(11.5)	

^a Table values are mean (SD)

^b P-value is for t-test using General Linear Modeling (PROC GLM)

Figure A. "Any" Breastfeeding Duration by Unadjusted Mean PPWR at 12 months

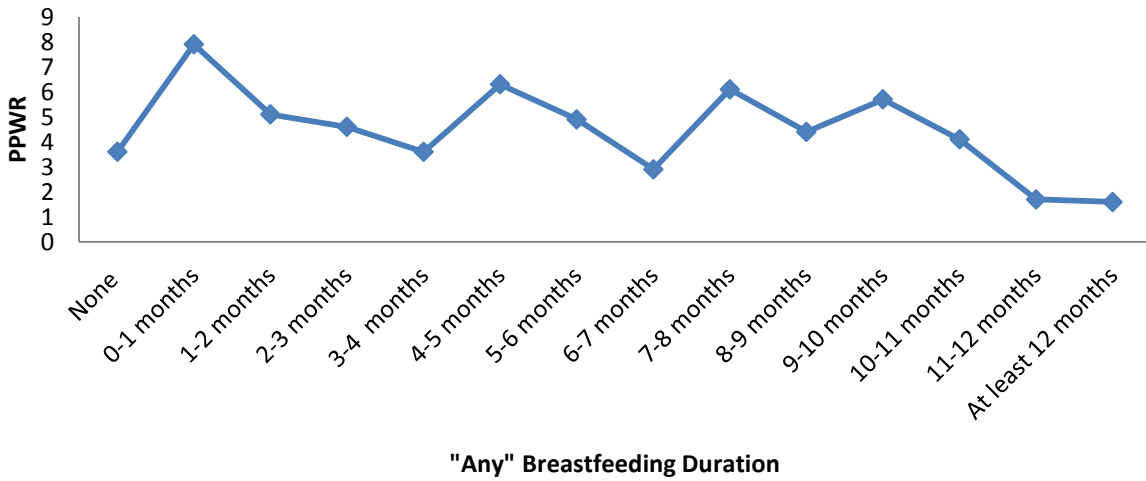
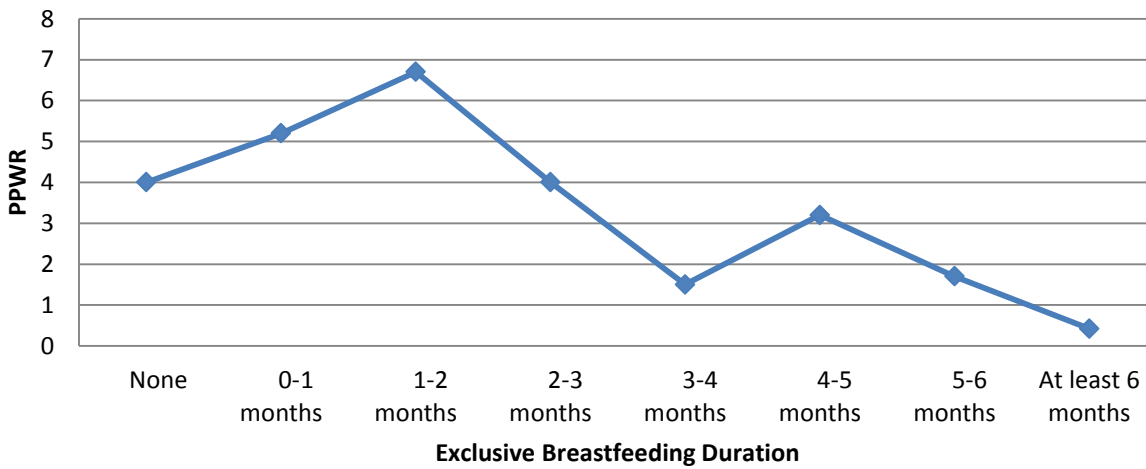


Figure D. Exclusive Breastfeeding Duration by Unadjusted Mean PPWR at 12 Months



Multivariate Logistic Regression

After adjusting for maternal age, pre-pregnancy BMI, and maternal race/ethnicity the duration of “any” breastfeeding significantly increased the odds of retaining above median PPWR at 6,9, and 12 months while the duration of exclusively breastfeeding significantly decreased the odds of retaining above median PPWR at 6, 9, and 12 months (Table 4a-d). At 6 months, women who “any” breastfed for 3-4 and 4-5 months had a 99% and 83% increased odds of retaining above median PPWR, respectively, compared to women who did not breastfeed at all (Table 4b). At 9 months, women who “any” breastfed for 0-1, 1-2 ,3-4, 4-5, and at least 6 months had a 57%, 103%, 71%, 94%, and 68% increased odds of having above median PPWR (Table 4c). At 12 months breastfeeding for 1-2 months and for at least 6 months remained significantly associated with increased odds of having above median postpartum weight compared to women who did not “any” breastfeed at all (Table 4d).

Exclusive breastfeeding duration was associated with significantly decreased odds of having above median PPWR postpartum weight at 6, 9, and 12 months among women who exclusively breastfed for at least 6 months compared to women who did not exclusively breastfeed at all. Indeed the odds of retaining above median PPWR among women who exclusively breastfed for at least 6 months decreased by 37% at 6 months, 37% at 9 months , and 46% at 12 months (Table 4b-d).

Table 4a. Factors associated with above median (vs. <= median) postpartum weight retention at **3 months: Multivariate binomial logistic regression analyses.**

Characteristic	N	% above median PPWR	Unadjusted OR (95% CI)	Adjusted "any" breastfeeding OR (95% CI)	Adjusted exclusive breastfeeding OR (95% CI)
"Any" Breast Feeding					
None	307	44.63	1.00	1.00	---
0-1 months	236	55.08	1.46(.99-2.14)	1.46(.99-2.17)	---
1-2 months	178	52.81	1.06 (0.95-2.01)	1.06(.69-1.64)	---
2-3 months	119	46.22	0.99 (0.69-1.64)	.99(.60-1.62)	---
At least 3 months	1414	48.09	0.97(0.89-1.47)	.97(.73-1.29)	---
Exclusive Breast Feeding					
None	1224	46.98	1.00	---	1.00
0-1 months	288	51.74	1.21(0.93-1.56)	---	1.34 (1.01-1.79)
1-2 months	113	48.67	1.07(0.72-1.57)	---	0.98 (0.64-1.49)
2-3 months	80	55.40	1.37(0.87-2.17)	---	1.29 (0.78-2.14)
At least 3 months	547	49.73	1.11(.91-1.36)	----	1.03 (.82-1.30)

*Controlled pre-pregnancy BMI, maternal age, race/ethnicity, parity, maternal education, poverty level, prenatal smoking (Y/N), and gestational weight gain

** Backward Model Selection used

*** "Any" Breast Feeding and Exclusive Breastfeeding OR were generated using separate models.

Table 4b. Factors associated with above median (vs. <= median) postpartum weight retention at **6 months: Multivariate binomial logistic regression analyses.**

Characteristic	N	% above median PPWR	Adjusted OR (95% CI)	Adjusted "Any" Breastfeeding OR (95% CI)	Adjusted Exclusive Breastfeeding OR (95%CI)
"Any" Breast Feeding					
None	271	45.76	1.00	1.00	---
0-1 months	193	50.78	1.27(0.76-1.64)	1.19(.88-1.60)	---
1-2 months	150	46.67	1.22(0.61-1.45)	1.21(0.83-1.78)	---
2-3 months	95	35.79	0.82(0.36-1.01)	0.89(.50-1.35)	--
3-4 months	88	54.55	1.95(0.79-2.30)	1.99(1.21-3.24)	---
4-5 months	57	50.88	1.74(.67-2.33)	1.83(1.01-3.29)	---
5-6 months	80	40.00	1.00(0.49-1.44)	1.05(.63-1.76)	---
At least 6 months	1032	38.76	1.34(0.52-0.99)	1.34(0.94-1.90)	---
Exclusive Breast Feeding					
None	1081	42.92	1.00	---	1.00
0-1 months	233	45.92	1.23(0.89-1.70)	---	1.21(.88-1.65)
1-2 months	103	45.63	1.22(0.77-1.91)	---	1.17(.76-1.82)
2-3 months	57	45.61	1.20(0.65-2.2)	---	1.19(.67-2.13)
3-4 months	88	44.32	1.30(0.79-2.12)	---	1.16(.72-1.86)
4-5 months	169	47.34	1.45(.99-2.11)	---	1.26(.89-1.78)
5-6 months	120	31.67	0.82(0.52-1.2)	---	0.71(.46-1.08)
At least 6 months	115	29.57	0.73(0.46-1.16)	---	.63(.41-.98)

*Controlled pre-pregnancy BMI, maternal age, race/ethnicity, parity, maternal education, poverty level, prenatal smoking (Y/N), and gestational weight gain

** Backward Model Selection used

*** "Any" Breast Feeding and Exclusive Breastfeeding OR were generated using separate models.

Table 4c. Factors associated with above median (vs. <= median) postpartum weight retention at **9 months: Multivariate binomial logistic regression analyses.**

Characteristic	N	% above median PPWR	Adjusted OR (95% CI)	Adjusted "Any" Breastfeeding OR (95% CI)	Adjusted Exclusive Breastfeeding OR (95%CI)
"Any" Breast Feeding					
None	242	51.24	1.00	1.00	--
0-1 months	174	53.45	1.59(1.14-2.20)	1.57(1.17-2.10)	--
1-2 months	138	52.99	1.95(1.32-2.89)	2.03(1.40-2.96)	--
2-3 months	96	54.19	1.15(0.73-1.79)	1.20(0.78-1.84)	--
3-4 months	80	40.33	1.64(1.01-2.66)	1.71(1.07-2.74)	--
4-5 months	51	56.86	1.89(1.05-3.41)	1.94(1.09-3.48)	--
5-6 months	66	42.42	1.05(0.62-1.78)	1.08(.64-1.81)	--
At least 6 months	978	40.18	0.60(1.11-2.29)	1.68(1.19-2.35)	--
Exclusive Breast Feeding					
None	991	47.12	1.00	---	1.00
0-1 months	219	50.68	1.21(0.88-1.65)	---	1.16(.88-1.57)
1-2 months	95	49.47	1.27(0.82-1.98)	---	1.11(.68-1.71)
2-3 months	58	44.83	1.00(0.57-1.75)	---	.87(.53-1.50)
3-4 months	88	36.36	0.79(0.49-1.27)	---	.62(.42-.99)
4-5 months	148	45.27	1.24(0.84-1.81)	---	.94(.65-1.34)
5-6 months	110	36.36	0.83(.54-1.30)	---	.63(.44-.96)
At least 6 months	116	37.07	0.83(0.54-1.28)	---	.63(.42-.95)

*Controlled pre-pregnancy BMI, maternal age, race/ethnicity, parity, maternal education, poverty level, prenatal smoking (Y/N), and gestational weight gain

** Backward Model Selection used

*** "Any" Breast Feeding and Exclusive Breastfeeding OR were generated using separate models.

Table 4d. Factors associated with above median (vs. <= median) postpartum weight retention at **12 months: Multivariate binomial logistic regression analyses.**

Characteristic	N	% above median PPWR	Adjusted OR (95% CI)	Adjusted "Any" Breastfeeding OR (95% CI)	Adjusted Exclusive Breastfeeding OR (95%CI)
"Any" Breast Feeding					
None	217	45.62	1.00	1.00	---
0-1 months	165	54.55	1.09(0.77-1.55)	1.14(.83-1.56)	---
1-2 months	122	55.74	1.60(0.04-2.44)	1.78(1.19-2.68)	---
2-3 months	80	46.25	1.01(0.60-1.68)	1.14(.69-1.87)	---
3-4 months	76	51.32	1.11(0.66-1.88)	1.29(.78-2.14)	---
4-5 months	48	58.33	1.53(0.80-2.92)	1.68(.89-3.16)	---
5-6 months	70	45.71	1.07(0.63-1.81)	1.16(.69-1.95)	---
At least 6 months	915	41.20	1.46(1.00-2.13)	1.65(1.16-2.35)	---
Exclusive Breast Feeding					
None	921	46.47	1.00	---	1.00
0-1 months	212	52.36	1.26(.91-1.74)	---	1.31(0.96-1.79)
1-2 months	85	55.29	1.38(.85-2.22)	---	1.31(0.83-2.09)
2-3 months	53	52.83	1.31 (.73-2.37)	---	1.23(0.69-2.19)
3-4 months	70	32.86	0.63 (.36-1.11)	---	.58(0.34-0.99)
4-5 months	145	42.76	0.97 (0.65-1.44)	---	.86(0.59-1.24)
5-6 months	101	37.62	0.87(.55-1.38)	---	.76(0.49-1.19)
At least 6 months	106	31.13	0.61(0.38-0.98)	---	.54(0.34-0.85)

*Controlled pre-pregnancy BMI, maternal age, race/ethnicity, parity, maternal education, poverty level, prenatal smoking (Y/N), and gestational weight gain

** Backward Model Selection used

*** "Any" Breast Feeding and Exclusive Breastfeeding OR were generated using separate models.

In sum, the main multivariate findings indicate that exclusive breastfeeding was significantly and negatively associated with PPWR at 6, 9 and 12 months among women who exclusively breastfed for at least 6 months. Unexpectedly “any” breastfeeding was positively associated with PPWR at 6, 9, and 12 months, interestingly, neither exclusive nor “any” breastfeeding were associated with PPWR at 3 months.

Discussion

The results suggest that breastfeeding may influence PPWR and that the direction for this association is modified by the type of breastfeeding practiced, i.e., exclusive vs. “any” breastfeeding. Specifically, these analyses show that exclusive breastfeeding for at least six months is associated with a decreased risk of retaining above median PPWR while “any” breastfeeding duration is associated with an increased risk of retaining above median PPWR.

The findings from this study are inconsistent with those previously reported by Krause et al [31], Ostbye [32], and Rooney and Schauburger [3]. In Krause et al, researchers found that PPWR at 6 months was significantly lower among women who “any” breastfed, compared with their counterparts who never breastfed. Studies with longer follow up periods such as those conducted by Ostbye [32] and Rooney and Schauburger [3] found that “any” breastfeeding was associated with lower PPWR at 5 and 10 years postpartum respectively, compared to women who never breastfed. Ostbye’s study used data from the North Carolina Special Supplemental Nutrition Program for Woman Infants and Children (WIC). Participants of the WIC program vary significantly from the IFPS II cohort. Rooney and Schauburger [3] found that breastfeeding reduced long term weight retention at both 10 and 15 years of follow up. Additionally another prospective study conducted in Sweden [36] found that women who had breastfed for longer were less likely to become overweight 15 years later. On the other hand, Gigante et al [37] did not find a significant association between “any” breastfeeding duration and PPWR or

anthropometry 5 years after delivery. However they did find that waist circumference and body fat were smaller 5 years after delivery among women who exclusively breastfed. Because none of the previous studies discussed found a positively significant relationship between “any” breastfeeding duration and PPWR, as it was found in this study, clearly this is an important area for future research. These findings were unexpected and additional analysis was conducted to ensure that the reference category for this analysis was not significantly different from the rest of the sample. There was no significant difference between women who reported that they did not “any” breastfeed and women who did breastfeed in terms of BMI, parity, education, race, poverty level. However, there was a significant difference in age among women who did not “any” breastfeed at all. These women were on average younger than women who reported that they did breastfeed.

After adjustment for covariates, there was a statistically significant relationship between exclusive breastfeeding for at least 6 months and PPWR at 6, 9 and 12 months. Exclusive breastfeeding was not associated with PPWR at 3 months. This finding is consistent with other studies [31, 27, 38] that did not find a significant association between breastfeeding and PPWR at 3 months. As previously concluded by AHRQ [21] and Dewey [20] this finding suggests that PPWR from breastfeeding may only happen when it is practiced intensively (i.e., exclusively) and sustained beyond the early months postpartum.

Our findings that exclusive breastfeeding for at least 6 months were inversely associated with PPWR are consistent with previous studies [31, 29]. Baker et al [29] concluded that PPWR could be eliminated if exclusive breastfeeding is practiced for 6 months. The 12 months finding indicate that exclusive breastfeeding for at least 6 months significantly reduce the risk of retaining more than 2 lbs. postpartum. Linear regression results (data not shown) from this analysis indicate that compared with women who did not exclusively breastfeed women who

exclusively breastfed for at least 6 months reduced PPWR by 3.5 lbs. at 6 months, 4.3 lbs. at 9 months, and 3.9 lbs. at 12 months (see appendix).

The role of breastfeeding on PPWR has been controversial and study results have been inconsistent for the US population. Several previous studies have focused on populations where breastfeeding is less common, preventing them from being able to analyze separately “any” vs. exclusive breastfeeding durations. The IFPS II cohort data used for the analyses, presented in this thesis, has significantly higher rates of both “any” and exclusive breastfeeding compared to the American population. Thus, this thesis is unique and contributes much to the literature as it provides a separate analysis for “any” breastfeeding duration and exclusive breastfeeding duration.

Findings from this thesis suggest that health professionals should differentiate between “any” and exclusive breastfeeding when discussing PPWR with mothers. Specifically they need to be aware that benefits to PPWR may result only if exclusive breastfeeding is practiced for 6 months which is consistent with the WHO and AAP recommendation for the duration of this infant feeding behavior. The differences in findings between “any” and exclusive breastfeeding are difficult to explain but could be due to the different energy demands of lactation. In lactating women, energy needs are increased by about 30% over those of non-pregnant, non-lactating women [39]. Gradual weight loss during lactation (about 0.5 kg/mo.) is common in populations with a relatively high BMI [40]. The RDA of 2500-2600 kcal for lactating women represents the increased energy intake needed for lactation and is generally based on an average daily milk volume of 750-850 mL (67-77 kcal/100 mL) produced at an estimated 80-90% rate of efficiency [41]. Because women who are “any” breastfeeding are producing a lower volume of milk, their energy requirements are also lower. Despite the lower energy requirements, the increased risk of retaining above median PPWR for mothers who are “any” breastfeeding may be due to their increased energy consumption that overcompensates for their energy requirements. In women

who exclusively breastfeed, their energy intake may undercompensate for their increased energy requirements. Due to its relevance, this hypothesis deserves to be tested through future longitudinal studies that carefully measure both energy intake as well as energy expenditure through dietary intake and physical activity measurement. Dietary intake is available for 1,200 IFPS II participants. Thus, this data set may provide useful energy intake information that will be useful in understanding the energy balance among women practicing various breastfeeding modes and durations.

Because “any” breastfeeding duration findings were unexpected, it is important to focus on the needs of future studies. Based on these findings, I suggest that all future studies include exercise and dietary data. Additional strengths of this study include the use of data drawn from a sample where breastfeeding was commonly practiced and the availability of important covariates including maternal demographics and PPWR confounders such as race, pre-pregnancy BMI, parity, education, prenatal smoking status, and poverty level. Additionally, the longitudinal nature of these data helps to provide a time dependent ‘lagged’ analyses at different time points. Indeed, the nature of the study design allowed for examining the influence of breastfeeding duration (both exclusive and “any”) on PPWR.

Most of the women in this study were middle class, White women perhaps limiting the external validity of the findings. Further studies are needed to determine if these findings also apply to low income women with diverse ethnic/racial backgrounds. Such studies may be difficult to conduct since at the moment a small proportion of US women are able to exclusively breastfeed, practice “any” breastfeeding for long periods of time, or even initiate breastfeeding at all [42]. Since low income women are at highest risk of obesity, it is imperative that exclusive breastfeeding promotion strategies continue to be developed for this high risk group. Studies designed to test these strategies can then be used as an opportunity to test the association between exclusive breastfeeding and PPWR among low-income women.

A possible limitation of this study is the use of self-reported pre-pregnancy and postpartum weight. However, several authors have shown a high correlation between reported and measured weight [43-46] . Despite this high correlation between self-reported weight and measured weight there may be social desirability bias and women may not have weighed themselves at the time they received the questionnaire. Also, of special concern is that self-reported weight bias is a function of the degree of overweight/obesity of individuals (the higher the real weight the more likely it is to be underreported [48]).

Another limitation of the study is the increased attrition as a function of follow-up duration. This may have resulted in sample attrition bias as women who dropped out at different time points may have had different socio-economic, demographic and biomedical characteristics than those who remained in the study.

Finally, women who exclusively breastfed at 6 months may have been different from the women who breastfed less than 6 months. Although the models attempted to control for known confounders, there may be residual confounding that was not adjusted for in the models.

Conclusion

In a large, middle class, white sample of women participating in IFPS II, exclusive breastfeeding was associated with a reduced risk for retaining above median PPWR for mothers who exclusively breastfed for at least 6 months. This effect persisted over a 12 month period and after adjusting for important covariates. Thus, exclusive breastfeeding for at least 6 months needs to be practiced for PPWR benefit to be seen by mothers.

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Appendix

Multiple linear regression models predicting Postpartum Weight Retention at **3 months** Postpartum (N = 2,241)

Characteristic	Full Model		Reduced Any Breastfeeding Model*		Reduced Exclusive Breastfeeding Model*	
	Beta (SE)	P	Beta (SE)	p	Beta (SE)	p
Maternal Age (years)						
18-24	Reference	---	Reference	---	Reference	---
25-29	-1.99(0.96)	0.040	-2.103(0.92)	0.023	-2.36(0.92)	0.010
30-34	-0.77(1.05)	0.461	-1.20(1.01)	0.233	-1.38(1.00)	0.171
35+	-2.06(1.19)	0.083	-2.4(1.1)	0.035	-2.69(1.14)	0.018
Pre Pregnancy BMI						
Underweight (<18.5)	1.6(1.6)	0.328	1.16(1.5)	0.4451	1.32(1.53)	0.387
Normal (18.5-24.9)	Reference	---	Reference	--	---	---
Overweight(30-34.9)	-3.17(.8)	<.0001	-3.4(0.76)	<.0001	-3.38(0.77)	<.0001
Obese Class1 (30-34.9)	-8.79(1.0)	<.0001	-9.3(0.97)	<.0001	-9.40(0.98)	<.0001
Obese Class2 (35-39.9)	-13.18(1.2)	<.0001	-13.7(1.25)	<.0001	-13.69(1.25)	<.0001
Obese Class3 (>40)	-22.39(1.5)	<.0001	-22.1(1.52)	<.0001	-21.64(1.52)	<.0001
Parity						
0	Reference	----	Reference	---	Reference	---
1	-1.71(.82)	.036	-1.36(0.80)	0.090	-1.509(0.805)	0.061
2	-0.94(1.0)	.344	-1.03(0.98)	0.294	-1.14(0.98)	.246
≥3	-3.3(1.26)	.008	-2.30(1.23)	0.062	-2.48(1.24)	.045
Any Breast Feeding						
None	Reference	---	Reference	---	---	---
0-1 months	.76(1.3)	0.56	0.519(1.27)	0.682	---	---
1-2 months	-.478(1.5)	.074	-0.50(1.38)	0.718	---	---
2-3 months	-2.00(1.7)	0.23	-2.48(1.59)	0.118	---	---
At least 3 months	-2.24(1.1)	.033	-2.34(0.94)	0.013	---	---
Exclusive Breast Feeding						
None	Reference	---	----	----	Reference	---
0-1 months	1.63(1.1)	0.103	----	----	1.24(0.96)	0.198
1-2 months	1.4(1.47)	0.334	----	----	0.13(1.44)	0.927
2-3 months	-.42(.82)	0.278	----	----	-1.22(1.68)	0.467
At least 3 months	1.10(0.87)	0.203	----	----	-0.60(0.77)	0.431
Race/Ethnicity						
White	Reference	----	----	----	---	---
Black	4.5(1.6)	.0046	----	----	---	---
Hispanic	-3.52(1.4)	.018	----	----	---	----
Asian	-1.70(1.9)	.368	----	----	---	----
Maternal Education						
<12	Reference	---	----	----	---	---
12	.38(8.2)	.962	----	----	---	---
>12	3.96(2.2)	.070	----	----	---	---
Prenatal Smoking Status						
Non-Smoker	Reference	---	Reference	----	Reference	---
Smoker	-2.59(1.2)	.037	-3.23(1.16)	0.005	-2.67(1.15)	0.020
% Poverty Level						
<185%	1.62(0.95)	.086	1.870(0.93)	0.044	2.060(0.93)	0.027
185-350%	0.79(0.86)	.359	0.67(0.86)	0.431	0.67(0.86)	0.435
>350%	Reference	---	Reference	----	Reference	---

* Backward stepwise elimination strategy used

Multiple linear regression models predicting Postpartum Weight Retention at **6 months** Postpartum (N = 1,965)

Characteristic	Full Model		Reduced Any Breastfeeding Model*		Reduced Exclusive Breastfeeding Model*	
	Beta (SE)	p	Beta (SE)	p	Beta (SE)	p
Maternal Age (years)						
18-24	Reference	---	Reference	---	Reference	---
25-29	-3.32(0.08)	0.002	-4.70(1.05)	<.0001	-4.88(1.05)	<.0001
30-34	-0.79(1.16)	0.494	-2.409(1.14)	0.0350	-2.73(1.13)	0.0163
35+	-1.24(1.31)	0.342	-3.20(1.28)	0.0129	-3.41(1.28)	0.0078
Pre Pregnancy BMI						
Underweight (<18.5)	.43(1.85)	0.813	1.55(1.82)	.394	1.72(1.82)	0.3456
Normal (18.5-24.9)	Reference	---	Reference	---	Reference	---
Overweight(30-34.9)	-1.7(.84)	0.036	-1.75(0.84)	0.038	-1.76(0.84)	.0373
Obese Class1 (30-34.9)	-4.63(1.1)	<.0001	-5.05(1.106)	<.0001	-5.08(1.10)	<.0001
Obese Class2 (35-39.9)	-10.04(1.37)	<.0001	-10.14(1.42)	<.0001	-10.41(1.4)	<.0001
Obese Class3 (>40)	-13.37(1.68)	<.0001	-13.59(1.69)	<.0001	-13.34(1.69)	<.0001
Parity						
0	Reference	----	Reference	----	Reference	----
1	-2.77(.896)	.002	-2.37(0.89)	0.008	-2.54(0.895)	.0046
2	-2.62(1.10)	.017	-2.07(1.09)	.059	-2.19(1.100)	.0464
≥3	-3.17(1.40)	.023	-2.01(1.39)	.149	-2.26(1.400)	.1061
Any Breast Feeding						
None	Reference	---	Reference	---	---	---
0-1 months	1.7(1.47)	0.1453	1.79(1.06)	0.092	---	---
1-2 months	2.7(1.59)	.0529	2.32(1.36)	.087	---	---
2-3 months	1.2(1.87)	0.478	1.30(1.64)	.426	---	---
3-4 months	2.7(1.97)	.1285	3.18(1.71)	.0631	---	---
4-5 months	4.7(2.29)	0.025	4.89(2.12)	.0211	---	---
5-6 months	-0.36(1.16)	0.841	-.62(1.811)	.730	---	---
At least 6 months	3.37(1.30)	0.0096	3.68(1.21)	.0025	---	---
Exclusive Breast Feeding						
None	Reference	---	---	---	Reference	---
0-1 months	1.38(1.13)	0.222	---	---	1.39(1.10)	0.209
1-2 months	2.09(1.60)	0.1921	---	---	1.31(1.59)	0.4114
2-3 months	0.83(2.12)	0.6968	---	---	-0.68(2.06)	0.7393
3-4 months	2.89(1.72)	.0934	---	---	0.57(1.69)	.7343
4-5 months	2.47(1.33)	.0635	---	---	0.86(1.26)	.4969
5-6 months	-0.27(1.53)	.8560	---	---	-2.37(1.48)	.1105
At least 6 months	-1.26(1.56)	0.417	---	---	-3.55(1.52)	.0200
Race/Ethnicity						
White	Reference	----	---	---	---	---
Black	3.20(1.95)	.101	---	---	---	---
Hispanic	-1.49(1.59)	.350	---	---	---	---
Asian	-2.71(2.10)	.196	---	---	---	---
Maternal Education						
<12	Reference	---	---	--	---	---
12	-9.61(10.3)	.3521	---	--	---	---
>12	10.44(2.32)	<.0001	---	--	---	---
Prenatal Smoking Status						
Non-Smoker	Reference	---	Reference	---	Reference	---
Smoker	-1.92(1.35)	.155	-1.91(1.32)	0.147	-1.45(1.30)	0.2658
% Poverty Level						
<185%	3.4(1.03)	.001	3.79(1.03)	.0003	3.90(1.03)	0.0002
185-350%	1.7(0.93)	.079	1.35(.94)	.1542	1.20(0.95)	0.2054
>350%	Reference	---	Reference	---	Reference	----

* Backward stepwise elimination strategy used

Multiple linear regression models predicting Postpartum Weight Retention at **9 months** Postpartum (N = 1,827)

Characteristic	Full Model		Reduced Any Breast Feeding Model*		Reduced Exclusive Breast Feeding Model*		p
	Beta (SE)	P	Beta (SE)	P	Beta (SE)		
Maternal Age (years)							
18-24	Reference	---	Reference	---	Reference		---
25-29	-3.00(1.20)	0.0129	-3.098(1.14)	0.0068	-3.31(1.14)		.0039
30-34	-1.49(1.29)	0.2499	-1.56(1.23)	0.2044	-2.24(1.23)		.0689
35+	-2.05(1.43)	0.1494	-2.13(1.37)	0.1195	-2.67(1.36)		.0504
Pre Pregnancy BMI							
	-						
Underweight (<18.5)	0.42(2.017)	0.8348	-1.18(1.96)	0.5453	-1.18(1.98)		0.5487
Normal (18.5-24.9)	Reference	---	Reference	---	Reference		---
Overweight(30-34.9)	-1.25(.919)	0.1737	-1.33(0.89)	0.1369	-1.18(.899)		.1891
Obese Class1 (30-34.9)	-4.63(1.15)	<.0001	-5.06(1.14)	<.0001	-4.86(1.15)		<.0001
Obese Class2 (35-39.9)	-8.35(1.50)	<.0001	-8.52(1.50)	<.0001	-8.71(1.51)		<.0001
	-						<.0001
Obese Class3 (>40)	14.24(1.82)	<.0001	-15.32(1.78)	<.0001	-14.69(1.79)		1
Parity							
0	Reference	----	Reference	---	Reference		---
1	-2.64(.97)	.0060	-2.77(.95)	0.0036	-2.86(1.16)		.0026
2	-1.79(1.19)	.1343	-2.33(1.16)	0.0440	-2.52(1.47)		.0303
≥3	-2.28(1.50)	.1297	-3.03(1.46)	0.0387	-3.205(1.44)		.0301
Any Breast Feeding							
None	Reference	---	Reference	---	---		---
0-1 months	3.07(1.62)	0.059	3.11(1.53)	.0427	---		---
1-2 months	1.19(1.74)	0.4931	1.88(1.66)	.2566	---		---
2-3 months	-0.58(1.97)	0.7667	0.06(1.87)	.9738	---		---
3-4 months	-0.50(2.12)	.8141	.46(2.01)	.8186	---		---
4-5 months	2.28(2.53)	.3667	1.27(2.44)	.6035	---		---
5-6 months	-2.48(2.27)	.2749	-2.63(2.18)	.2295	---		----
6-7 months	1.41(2.11)	.5016	1.46(2.09)	.4822	---		---
7-8 months	-0.71(2.37)	.7622	1.02(2.28)	.6538	---		---
8-9 months	-0.85(2.22)	.7006	-0.93(2.13)	.6606	---		---
At least 9 months	-3.53(1.33)	.0081	-3.49(1.17)	.0030	---		---
Exclusive Breast Feeding							
None	Reference	---	---	---	Reference		---
0-1 months	.417(1.21)	0.7310	---	---	0.527(1.17)		.6522
1-2 months	1.06(1.70)	0.5320	---	---	0.28(1.67)		.8667
2-3 months	0.307(2.19)	0.8887	---	---	-1.36(2.10)		.5179
3-4 months	-0.39(1.81)	.8298	---	---	-3.18(1.74)		.0670
4-5 months	1.50(1.48)	.3120	---	---	-1.01(1.38)		.4647
5- 6 months	-0.98(1.67)	.5564	---	---	-3.90(1.58)		.0138
	-						
At least 6 months	1.102(1.65)	0.504	---	---	-4.34(1.55)		.0054
Race/Ethnicity							
White	Reference	----	---	---	---		---
Black	2.27(2.06)	.2717	---	---	---		---
Hispanic	-0.49(1.80)	.7848	----	---	---		---
Asian	-0.49(2.19)	.8198	---	---	---		---
Maternal Education							
<12	Reference	---	---	---	---		---
	-						
12	8.88(15.13)	.5455	---	---	---		---
>12	9.77(2.67)	.0003	---	---	---		---
Prenatal Smoking Status							
Non-Smoker	Reference	---	Reference	---	Reference		---
Smoker	-1.99(1.54)	.1956	-1.69(1.45)	.2447	-.99(1.44)		.4932
% Poverty Level							
<185%	2.56(1.11)	.021	3.84(1.09)	.0004	3.72(1.096)		.0007
185-350%	1.43(0.99)	.149	1.52(.98)	.1232	1.31(.991)		.1834
>350%	Reference	---	Reference	---	---		---

* Backward stepwise elimination strategy used

Multiple linear regression models predicting Postpartum Weight Retention at 12 months Postpartum (N =1693)

Characteristic	Full Model		Reduced Any Breastfeeding Model*		Reduced Exclusive Breastfeeding Model*	
	Beta (SE)	P	Beta (SE)	p	Beta (SE)	P
Maternal Age (years)						
18-24	Reference	---	Reference	---	Reference	---
25-29	-2.98(1.34)	0.0266	-4.783(1.28)	.0002	-4.98(1.27)	.0001
30-34	-1.26(1.43)	0.3774	-2.72(1.36)	.0470	-3.02(1.35)	.0264
35+	-2.51(1.56)	0.1079	-4.46(1.49)	.0029	-4.75(1.48)	.0014
Pre Pregnancy BMI						
Underweight (<18.5)	-1.45(2.10)	0.4880	.803(2.06)	.6977	.67(2.06)	.7421
Normal (18.5-24.9)	Reference	---	Reference	---	Reference	---
Overweight(30-34.9)	-1.53(.98)	0.1177	-1.03(.97)	.2878	.98(.97)	.3137
Obese Class1 (30-34.9)	-4.25(1.24)	.0006	-4.41(1.24)	.0004	-4.42(1.25)	.0004
Obese Class2 (35-39.9)	-8.84(1.57)	<.0001	-9.062(1.61)	<.0001	-9.30(1.61)	<.0001
Obese Class3 (>40)	-12.05(2.05)	<.0001	-12.63(2.04)	<.0001	12.35(2.04)	<.0001
Parity						
0	Reference	----	Reference	---	Reference	---
1	-2.59(1.04)	.0129	-2.61(1.03)	.0118	-2.81(1.03)	.0066
2	-1.30(1.29)	.3136	-.09(1.27)	.4465	-1.29(1.27)	.3082
≥3	-2.32(1.60)	.1477	-2.19(1.57)	.1648	-2.40(1.57)	.1284
Any Breast Feeding						
None	Reference	---	Reference	---	---	----
0-1 months	3.25(1.73)	0.0614	3.48(1.68)	.0387	---	---
1-2 months	1.29(1.90)	0.4968	0.71(1.85)	.7006	---	----
2-3 months	.789(2.20)	0.7174	1.21(2.12)	.5664	---	---
3-4 months	-0.77(2.27)	.7346	.503(2.19)	.8187	---	---
4-5 months	1.67(2.75)	.5432	.88(2.68)	.7431	---	---
5-6 months	0.46(2.30)	.8386	1.55(2.27)	.9456	---	---
6-7 months	-.35(2.23)	.8725	-.27(2.24)	.9021	---	----
7-8 months	1.80(2.55)	.4894	1.29(2.58)	.6169	---	---
8-9 months	0.87(2.36)	.7125	.601(2.33)	.7968	---	---
9-10 months	1.59(2.54)	.5312	1.29(2.55)	.6131	---	---
10-11 months	0.133(2.55)	.9585	-.49(2.47)	.8430	---	----
11-12 months	-0.703(2.29)	.7597	-1.58(2.28)	.4888	---	---
At least 12 months	-2.087(1.505)	0.1656	-2.36(1.33)	.0776	---	---
Exclusive Breast Feeding						
None	Reference	---	---	---	Reference	---
0-1 months	.64(1.29)	0.6161	---	---	0.88(1.25)	.4799
1-2 months	3.01(1.85)	0.1055	---	---	2.21(1.87)	.2355
2-3 months	0.17(2.32)	0.9397	---	---	-.74(2.30)	.7466
3-4 months	-0.56(2.05)	.7841	---	---	-2.53(2.01)	.2073
4-5 months	.594(1.55)	.7017	---	---	-1.21(1.46)	.4051
5-6 months	-1.18(1.81)	.9192	---	---	-2.41(1.72)	.1620
At least 6 months	-1.42(1.18)	.4289	---	---	-3.98(1.70)	.0193
Race/Ethnicity						
White	Reference	----	---	---	---	---
Black	2.22(2.23)	0.3187	---	---	---	----
Hispanic	-2.10(1.91)	.2723	---	---	---	---
Asian	-2.97(2.40)	.2158	---	---	---	---
Maternal Education						
<12	Reference	---	---	---	---	---
12	-8.96(11.06)	.4179	---	---	---	---
>12	3.32(2.70)	.2190	---	---	---	---
Prenatal Smoking Status						

Non-Smoker	Reference	---	Reference	---	Reference	---
Smoker	-2.71(1.61)	.0927	-1.65(1.55)	.2870	-1.14(1.52)	.4526
% Poverty Level						
<185%	3.24(1.18)	.0062	3.69(1.18)	.0018	3.75(1.17)	.0015
185-350%	2.56(1.05)	.0151	2.51(1.06)	0.186	2.34(1.06)	.0279
>350%	Reference	---	Reference	---	Reference	---

Multiple linear regression models predicting Postpartum Weight Retention at **12 months** Postpartum Using Composite Variable (N = 2,241)

Characteristic	Full Model		Reduced Model*	
	Beta (SE)	P	Beta (SE)	p
Maternal Age (years)				
18-24	Reference	---	Reference	---
25-29	-3.33(0.33)	0.012	-4.94(1.27)	0.0001
30-34	-1.06(1.41)	0.2566	-2.94(1.34)	0.0291
35+	-2.99(1.54)	0.0524	-4.79(1.47)	0.0012
Pre Pregnancy BMI				
Underweight (<18.5)	-1.3(2.08)	0.5103	0.69(2.05)	0.7373
Normal (18.5-24.9)	Reference	---	Reference	--
Overweight(30-34.9)	-1.46(.97)	0.1337	-1.04(0.97)	0.2829
Obese Class1 (30-34.9)	-4.26(1.23)	.0006	-4.57(0.24)	0.0002
Obese Class2 (35-39.9)	-8.92(1.56)	<.0001	-9.21(1.61)	<.0001
Obese Class3 (>40)	-11.89(2.04)	<.0001	-12.33(2.04)	<.0001
Parity				
0	Reference	----	Reference	---
1	-2.77(1.03)	.0077	-2.76(1.03)	0.0075
2	-1.41(1.28)	.2709	-1.23(1.27)	0.3331
≥3	-2.8(1.58)	.0766	-2.45(1.57)	0.1174
Breast Feeding				
No Breastfeeding	Reference	---	Reference	---
Exclusive≤2 months AND partial ≥0	.087(1.24)	0.485	0.86(1.22)	0.4819
Exclusive 3-4 months AND partial ≥0	-.75(1.83)	0.6818	-1.26(1.84)	0.4939
Exclusive≥ 5 months AND partial ≤ 9 months	0.91(2.69)	.7347	-0.71(2.75)	0.7954
Exclusive≥5 AND partial >9 months	-1.86(1.46)	0.2029	-2.198(1.45)	0.1315
Race/Ethnicity				
White	Reference	----	---	----
Black	2.21(2.22)	.3210	----	---
Hispanic	-2.18(1.86)	.2488	---	----
Asian	-3.50(2.39)	.1424	---	----
Maternal Education				
<12	Reference	---	----	---
12	-11.25(11.04)	.3081	----	----
>12	4.01(2.69)	.1357	----	---
Prenatal Smoking Status				
Non-Smoker	Reference	---	----	----
Smoker	-2.22(1.59)	.1638	---	---
% Poverty Level				
<185%	3.14(1.18)	.007	3.67(1.16)	0.0017
185-350%	2.44(1.04)	.019	2.37(1.06)	0.0254
>350%	Reference	---	Reference	----

*Backwards stepwise model selection used to create reduced model