

# Longitudinal Association of Maternal Attempt to Lose Weight During the Postpartum Period and Child Obesity at Age 3 Years

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The effect of maternal attempt to lose weight during the postpartum period on later child weight has not been explored. Among 1,044 mother–infant pairs in Project Viva, we estimated longitudinal associations of maternal attempt to lose weight during the postpartum period with child weight and adiposity at age 3 years and examined differences in associations by type of weight loss strategy used. Using covariate-adjusted linear and logistic regression models, we estimated associations before and after adjusting for maternal weight-related variables including prepregnancy BMI. At 6 months postpartum, 53% mothers were trying to lose weight. At age 3 years, mean (s.d.) child BMI z-score was 0.44 (1.01) and 8.9% of children were obese. Children whose mothers were trying to lose weight at 6 months postpartum had higher BMI z-scores (0.30 (95% confidence interval (CI) 0.18, 0.42)) and were more likely to be obese (3.0 (95% CI 1.6, 5.8)) at 3 years of age. Addition of maternal prepregnancy BMI to the models attenuated but did not eliminate the associations seen for BMI z-score (0.24 (95% CI 0.12, 0.36) and obesity (2.4 (95% CI 1.2, 4.7)). Attempting to lose weight by exercising alone was the only weight loss strategy that consistently predicted higher child BMI z-score (0.36 (95% CI 0.14, 0.58)) and odds of obesity (6.0 (95% CI 2.2, 16.5)) at age 3 years. In conclusion, we observed an association between maternal attempt to lose weight at 6 months postpartum, particularly through exercise alone, measured using a single item and child adiposity at age 3 years. This association should be thoroughly examined in future studies.

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## INTRODUCTION

Gestational weight gain is necessary for fetal growth and development, although excessive gestational weight gain is common (1,2). To reduce complications in subsequent pregnancies (3) and to prevent long-term consequences of excess body weight and obesity, women should lose retained postpartum weight. There is currently no consensus regarding what weight loss strategy postpartum women should be encouraged to adopt. Accordingly, many women may not receive weight loss advice from a health-care providers during the postpartum period (4).

Several studies have examined the effectiveness of particular postpartum weight loss interventions (5–8). However, it is unclear whether a mother's attempt to lose weight during the postpartum period is associated with longer term effects on the child. Limited research suggests that maternal dieting may be associated with offspring overeating. In one longitudinal study of children, maternal restraint and drive for thinness predicted

the emergence of overeating during the first 5 years of life (9). In a retrospective study of young adults, overeating was more common in females who remembered their mother dieting (10).

The objective of the present study was to examine the longitudinal association of maternal attempt to lose weight at 6 months postpartum with measures of child adiposity at age 3 years, while controlling for maternal weight-related variables that could confound the relationship. Furthermore, we sought to assess the extent to which the association differed by type of weight loss strategy used.

## METHODS AND PROCEDURES

### Study design and participants

Study subjects were participants in Project Viva, a prospective cohort study of pre- and perinatal factors, pregnancy outcomes, and offspring health. Details of study design and recruitment are reported elsewhere (11). Participants were recruited at their initial prenatal visit from eight urban and suburban obstetric offices in Massachusetts between 1999

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and 2002. Of the 2,128 women who delivered a live singleton infant, 1,579 were eligible for 3-year follow-up by virtue of having completed a prenatal nutritional assessment and consenting for their children to be followed up. From this group, we excluded 321 participants who had missing measured child height and weight at age 3 years and 214 who had missing data for maternal attempt to lose weight assessed at 6 months postpartum. Thus, our sample size was 1,044 mother–infant pairs. When compared with the 535 who were eligible for but not included in this analysis, mothers in the present study were more likely to be white (77% vs. 53%), have at least a college education (75% vs. 53%), and have an annual household income  $\geq$ \$70 000 (68% vs. 49%); participants did not differ in birth weight or mean maternal prepregnancy BMI.

We conducted in-person study visits with both mothers and children at enrollment, at 6 months postpartum, and at 3 years postpartum. We obtained sociodemographic data and other participant characteristics from study visit interviews, self-administered questionnaires completed at study visits, and through mailed yearly self-administered questionnaires. We measured length and weight at the 6-month study visit and measured height and weight at the 3-year visit. The study was approved by the institutional review boards of Harvard Pilgrim Health Care, Brigham and Women's Hospital, and Beth Israel Deaconess Medical Center.

## Measures

**Main exposure—maternal attempt to lose weight at 6 months postpartum.** We assessed maternal attempt to lose weight based on a yes/no response to the question “are you actively trying to lose weight?” asked via questionnaire at 6 months postpartum. Women who provided a “yes” response to this question were asked to select the types of weight loss strategies they were using from the following options: changing eating habits, exercising, breastfeeding, using diet pills, bottle feeding, purging, smoking, and/or other. We also stratified this variable into categories, which represented the most common types of weight loss strategies used in the sample: (i) trying to lose weight by exercising only, (ii) trying to lose weight by changing eating habits only, and (iii) trying to lose weight by both exercising and changing eating habits.

**Outcome measures—child adiposity at age 3 years.** We measured height and weight of children using a calibrated stadiometer (Shorr Productions, Olney, MD) and scale (Seca model 881; Seca, Hanover, MD). We calculated age- and sex-specific weight-for-length z-scores at 6 months and BMI percentiles and z-scores at 3 years using US reference growth data (12). We defined obesity as BMI for age and sex  $\geq$ 95th percentile and overweight as a BMI for age and sex between the 85th and 95th percentiles for age and sex (12), and used BMI  $<$ 85th percentile as the comparison. Research assistants performing all measurements followed standardized techniques (13), and participated in biannual in-service training to ensure measurement validity (Shorr Productions). Inter- and intrarater measurement error were well within published reference ranges for all measurements (14).

**Other measures.** Mothers reported information about maternal age, height, prepregnancy weight, race/ethnicity, education (some college or less, college graduate or more), annual household income ( $<$ \$70,000,  $\geq$ \$70,000, missing), duration of breastfeeding, and paternal height and weight. We calculated total gestational weight gain by subtracting prepregnancy weight from the last prenatal weight. We report gestational weight gain as a continuous variable and as a categorical variable classified as inadequate, adequate, or excessive weight gain based on 2009 Institute of Medicine (IOM) recommendations (15). IOM gestational weight gain recommendations are 12.5–18 kg for underweight women (BMI  $<$ 18.5), 11.5–16 kg for normal weight women (BMI 18.5–24.9), 7–11.5 kg for overweight women (BMI 25.0–29.9), and 5–9 kg for obese women (BMI  $\geq$ 30.0). Inadequate weight gain and excessive weight gain are defined as gestational weight gain that falls below or above recommended ranges, respectively.

## Statistical analysis

We examined the bivariate associations between maternal attempt to lose weight at 6 months postpartum with our main outcomes (BMI z-score, overweight, and obesity) and other covariates. We used linear and logistic regression to examine the independent association of maternal attempt to lose weight with child BMI z-score, overweight, and obesity at 3 years of age (model 1). Adjusted multivariate models included child characteristics (age, sex, birthweight, breastfeeding duration, weight-for-length z-score at 6 months) and parental and household characteristics (maternal age, race/ethnicity, education; paternal BMI; household income) (model 2).

Maternal obesity before (16) and during (17) pregnancy is associated with offspring obesity in early childhood and excessive gestational weight gain is also associated with higher child obesity at age 3 years (18). Accordingly, we adjusted our models for maternal weight-related variables which may confound the association between maternal attempt to lose weight during the postpartum period and child weight at 3 years of age. We individually added maternal weight-related variables to the adjusted models: prepregnancy BMI (model 3), postpartum weight retention at 6 months (model 4), IOM gestational weight gain category (model 5), maternal BMI at 6 months postpartum (model 6), and change in maternal BMI from 6 months to 3 years postpartum (model 7). To examine whether associations differed by type of weight loss strategy, we ran analogous models using a 4-category exposure variable representing maternal weight loss strategy used.

We report regression estimates ( $\beta$ ) or odds ratios and 95% confidence intervals (CIs) for the main outcomes. We conducted all of the analyses using SAS version 9.1 (SAS Institute, Cary, NC).

## RESULTS

The mean age of women was 32.7 (4.7) years. Mean gestational weight gain was 15.6 (5.3) kg, with most women (59%) gaining an amount of weight that is considered excessive according to IOM recommendations. Among the children at age 3 years, the mean (s.d.) BMI z-score was 0.44 (1.02). At 3 years, 275 (26%) of children were either overweight or obese. Other participant characteristics are shown in **Table 1**.

Of the 1,044 women comprising the sample, 557 (53%) indicated they were attempting to lose weight at 6 months postpartum. Weight loss strategies used most frequently by these women included changing eating habits (83%) and exercising (77%). Of the women who were attempting to lose weight, 83 (15%) were trying to lose weight through exercise only, 116 (21%) were trying to lose weight by changing eating habits only, 346 (62%) were trying to lose weight using a combined approach that involved both exercising and changing eating habits. The remaining 12 (2%) women were attempting to lose weight using a strategy other than exercising or changing eating habits. Because of the small number of women who were attempting to lose weight using a strategy other than exercising or changing eating habits, these women were not included analyses stratified by type of weight loss strategy used.

Participant characteristics stratified by whether or not mothers were attempting to lose weight at 6 months postpartum are shown in **Table 1**. Women who were trying to lose weight at 6 months postpartum had higher prepregnancy BMIs, greater gestational weight gain, were more likely to have excessive gestational weight gain, and were heavier at 6 months postpartum than those who were not. Change in BMI from 6 months to 3 years postpartum was similar in women who were trying

**Table 1** Descriptive statistics and bivariate association of maternal attempt to lose weight with parental/household and child characteristics (n = 1,044)

	Entire sample	Maternal attempt to lose weight at 6 months postpartum		
		Yes (n = 557, 53%)	No (n = 487, 47%)	P value <sup>a</sup>
<i>Parental/household characteristics</i>		Mean (s.d.)		
Maternal age (years)	32.7 (4.7)	32.7 (4.7)	32.8 (4.7)	0.62
Prepregnancy BMI (kg/m <sup>2</sup> )	24.4 (5.0)	25.6 (5.1)	23.0 (4.6)	<0.0001
Gestational weight gain (kg)	15.6 (5.3)	16.4 (5.6)	14.8 (4.8)	<0.0001
Postpartum weight retention (kg) at 6 months	3.3 (5.1)	4.0 (5.8)	2.4 (4.1)	<0.0001
BMI (kg/m <sup>2</sup> ) at 6 months postpartum	26.0 (5.4)	27.7 (5.2)	24.0 (4.9)	<0.0001
Change in BMI (kg/m <sup>2</sup> ) from 6 months to 3 years postpartum	-0.04 (2.46)	-0.17 (2.84)	0.10 (1.94)	0.10
Paternal BMI (kg/m <sup>2</sup> )	26.4 (3.8)	26.8 (3.9)	26.0 (3.7)	<0.001
		N (%)		
Maternal race/ethnicity				0.20
White	803 (77%)	433 (78%)	370 (76%)	
Black	96 (9%)	46 (8%)	50 (10%)	
Hispanic	53 (5%)	34 (6%)	19 (4%)	
Other	91 (9%)	44 (8%)	47 (10%)	
Maternal education				<0.01
≤Some college	261 (25%)	159 (29%)	102 (21%)	
College graduate	782 (75%)	398 (71%)	384 (79%)	
Household income				0.20
<\$70,000	316 (30%)	165 (30%)	151 (31%)	
≥\$70,000	676 (65%)	358 (64%)	318 (65%)	
Don't know/missing	52 (5%)	34 (6%)	18 (4%)	
Gestational weight gain category				<0.0001
Inadequate	129 (13%)	44 (8%)	85 (18%)	
Adequate	295 (29%)	125 (23%)	170 (35%)	
Excessive	604 (59%)	378 (69%)	226 (47%)	
<i>Child characteristics</i>		Mean (s.d.)		
Age at 3 year visit (years)	3.2 (0.3)	3.2 (0.3)	3.3 (0.3)	0.20
Birthweight (kg)	3.5 (0.6)	3.5 (0.6)	3.5 (0.5)	0.57
Breastfeeding duration (months)	6.5 (4.5)	5.9 (4.4)	7.3 (4.5)	<0.0001
WFL z-score at 6 months	0.71 (0.96)	0.78 (0.99)	0.64 (0.93)	0.04
		N (%)		
Sex				0.17
Male	521 (50%)	232 (45%)	289 (55%)	
BMI percentile at 3 years				<0.0001
<5th	24 (2%)	10 (2%)	14 (3%)	
5th–<85th	745 (71%)	374 (67%)	371 (76%)	
85th–<95th (overweight)	182 (17%)	104 (19%)	78 (16%)	
≥95th percentile (obese)	93 (9%)	69 (12%)	24 (5%)	

WFL, weight-for-length.

<sup>a</sup>P values from t-test or  $\chi^2$ .

to lose weight at 6 months postpartum (mean (s.d.)) (-0.17 (2.84) kg) and those who were not (0.10 (1.94) kg).

As shown in **Table 2**, women who were trying to lose weight at 6 months postpartum by changing eating habits only had a

greater reduction in BMI from 6 months to 3 years postpartum (-0.6 (2.9) kg) than women who were not trying to lose weight by exercising or changing eating habits (0.1 (1.9) kg). BMI from 6 months to 3 years did not differ appreciably between women

**Table 2 Bivariate association of maternal weight loss strategies used at 6 months postpartum with parental/household and child characteristics (n = 1,044)**

	Maternal weight loss strategies				P value <sup>a</sup>
	None <sup>b</sup> (n = 499, 48%)	Exercise <sup>c</sup> (n = 83, 8%)	Eat <sup>d</sup> (n = 116, 11%)	Exercise + Eat <sup>e</sup> (n = 346, 33%)	
<i>Parental/household characteristics</i>					
	Mean (s.d.)				
Prepregnancy BMI (kg/m <sup>2</sup> )	23.1 (4.6)	23.7 (4.5)	26.0 (4.4)	26.0 (5.4)	<0.0001
Gestational weight gain (kg)	14.9 (4.8)	15.8 (4.3)	16.5 (5.4)	16.4 (6.0)	0.0001
Postpartum weight retention (kg) at 6 months	2.3 (4.1)	3.2 (4.4)	5.2 (5.5)	4.0 (6.1)	<0.0001
BMI (kg/m <sup>2</sup> ) at 6 months postpartum	24.0 (4.8)	25.6 (4.5)	29.0 (5.0)	27.9 (5.3)	<0.0001
Change in BMI (kg/m <sup>2</sup> ) from 6 months to 3 years postpartum	0.1 (1.9)	0.2 (1.8)	-0.6 (2.9)	-0.1 (3.0)	<0.05
Paternal BMI (kg/m <sup>2</sup> )	26.0 (3.7)	26.0 (4.0)	26.9 (4.0)	27.0 (3.9)	<0.001
	N (%)				
Maternal race/ethnicity					<0.01
White	380 (76%)	63 (76%)	78 (67%)	282 (82%)	
Black	50 (10%)	4 (4%)	11 (9%)	31 (9%)	
Hispanic	19 (4%)	8 (10%)	11 (9%)	15 (4%)	
Other	49 (10%)	8 (10%)	16 (14%)	18 (5%)	
Maternal education					<0.01
≤Some college	105 (21%)	19 (23%)	42 (36%)	95 (27%)	
College graduate	393 (79%)	64 (77%)	74 (64%)	251 (73%)	
Household income					0.09
<\$70,000	154 (31%)	16 (19%)	44 (38%)	102 (29%)	
≥\$70,000	326 (65%)	62 (75%)	66 (57%)	222 (64%)	
Don't know/missing	19 (4%)	5 (6%)	6 (5%)	22 (6%)	
Gestational weight gain category					<0.0001
Inadequate	86 (17%)	9 (11%)	9 (8%)	25 (7%)	
Adequate	173 (35%)	22 (27%)	20 (18%)	80 (24%)	
Excessive	234 (47%)	51 (62%)	84 (74%)	235 (69%)	
<i>Child characteristics</i>					
	Mean (s.d.)				
Birthweight (kg)	7.3 (4.5)	7.2 (4.4)	5.9 (4.4)	5.5 (4.3)	<0.0001
WFL z-score at 6 months	0.27 (0.95)	0.57 (1.17)	0.56 (1.13)	0.61 (0.99)	<0.0001
	N (%)				
BMI percentile at 3 years					<0.01
<5th	14 (3%)	3 (4%)	2 (2%)	5 (1%)	
5th–<85th	377 (76%)	51 (61%)	79 (68%)	238 (69%)	
85th–<95th (overweight)	82 (16%)	17 (20%)	19 (16%)	64 (19%)	
≥95th percentile (obese)	26 (5%)	12 (14%)	16 (14%)	39 (11%)	

WFL, weight-for-length.

<sup>a</sup>P values from t-test or  $\chi^2$ . <sup>b</sup>Not trying to lose weight by changing eating habits or exercising. <sup>c</sup>Trying to lose weight by exercising only. <sup>d</sup>Trying to lose weight by changing eating habits only. <sup>e</sup>Trying to lose weight by exercising and changing eating habits.

who were trying to lose weight by exercising (0.2 (1.8) kg) and those who were not trying to lose weight by exercising or changing eating habits (-0.1 (3.0) kg).

As shown in **Table 3**, maternal attempt to lose weight at 6 months postpartum was associated with higher BMI z-score at child age 3 years ( $\beta = 0.30$  (95% CI 0.18, 0.42)) and with elevated odds of obesity (3.0 (95% CI 1.6, 5.8)) in covariate-

adjusted models. Because both maternal attempt to lose weight and child weight status are related to mother's own weight status, we ran additional models that included several maternal weight-related variables. Adding prepregnancy BMI (model 3) attenuated the covariate-adjusted associations of maternal attempt to lose weight with BMI z-score ( $\beta = 0.24$  (95% CI 0.12, 0.36)) by ~10% and with odds of obesity (2.4 (95% CI 1.2, 4.7))



**Table 3 Associations of maternal attempt to lose weight at 6 months postpartum with child adiposity (n = 1,044)**

Model	Child adiposity outcomes at age 3 years		
	BMI z-score	Overweight (BMI 85th–94th percentile)	Obesity (BMI ≥95th percentile)
	$\beta$ (95% CI)	OR (95% CI)	
Model 1. Unadjusted	0.35 (0.22, 0.47)	1.3 (1.0, 1.9)	2.9 (1.8, 4.7)
Model 2. Adjusted <sup>a</sup>	0.30 (0.18, 0.42)	1.5 (1.0, 2.3)	3.0 (1.6, 5.8)
Model 3. M2 + prepregnancy BMI	0.24 (0.12, 0.36)	1.5 (1.0, 2.3)	2.4 (1.2, 4.7)
Model 4. M2 + postpartum weight retention at 6 months	0.31 (0.19, 0.43)	1.6 (1.1, 2.5)	3.1 (1.6, 6.0)
Model 5. M2 + IOM gestational weight gain category	0.30 (0.18, 0.42)	1.5 (1.0, 2.4)	3.1 (1.5, 6.0)
Model 6. M2 + maternal BMI at 6 months postpartum	0.22 (0.09, 0.35)	1.5 (1.0, 2.4)	2.3 (1.2, 4.6)
Model 7. M2 + change in maternal BMI from 6 months to 3 years postpartum	0.32 (0.20, 0.44)	1.6 (1.1, 2.5)	3.1 (1.6, 6.1)

CI, confidence interval; IOM, Institute of Medicine; OR, odds ratio.

<sup>a</sup>Adjusted for child characteristics (age, sex, birthweight, breastfeeding duration, WFL z-score at 6 months) and parental/household characteristics (maternal age, race/ethnicity, education; paternal BMI; household income).

**Table 4 Associations of type of maternal weight loss strategy used at 6 month postpartum with child adiposity (n = 1,032)**

Model	Model 1	Model 2	Model 3
	Unadjusted	Adjusted <sup>a</sup>	M2 + prepregnancy BMI
<i>BMI z-score (<math>\beta</math> (95% CI))</i>			
None <sup>b</sup>		(ref.)	
Exercise <sup>c</sup>	0.32 (0.08, 0.55)	0.39 (0.16, 0.61)	0.36 (0.14, 0.58)
Eat <sup>d</sup>	0.30 (0.10, 0.50)	0.27 (0.06, 0.47)	0.19 (−0.02, 0.39)
Exercise + eat <sup>e</sup>	0.36 (0.22, 0.50)	0.27 (0.14, 0.41)	0.21 (0.08, 0.35)
<i>Overweight (OR (95% CI))</i>			
None		(ref.)	
Exercise	1.6 (0.9, 2.8)	1.9 (0.9, 4.4)	1.9 (0.8, 4.5)
Eat	1.2 (0.7, 2.0)	1.5 (0.8, 3.1)	1.5 (0.7, 3.0)
Exercise + eat	1.3 (0.9, 1.9)	1.4 (0.9, 2.2)	1.4 (0.8, 2.2)
<i>Obesity (OR (95% CI))</i>			
None		(ref.)	
Exercise	3.6 (1.7, 7.5)	6.5 (2.4, 17.5)	6.0 (2.2, 16.5)
Eat	3.2 (1.6, 6.2)	2.2 (0.8, 6.0)	1.5 (0.5, 4.4)
Exercise + eat	2.6 (1.5, 4.4)	2.5 (1.2, 5.1)	1.9 (0.9, 4.0)

CI, confidence interval; OR, odds ratio; WFL, weight-for-length.

<sup>a</sup>Adjusted for child characteristics (age, sex, birthweight, breastfeeding duration, WFL z-score at 6 months) and parental/household characteristics (maternal age, race/ethnicity, education; paternal BMI; household income). <sup>b</sup>Not trying to lose weight by changing eating habits or exercising. <sup>c</sup>Trying to lose weight by exercising only. <sup>d</sup>Trying to lose weight by changing eating habits only. <sup>e</sup>Trying to lose weight by exercising and changing eating habits.

by 20%. Similarly, adding maternal BMI at 6 months (model 6) attenuated the covariate-adjusted association between maternal attempt to lose weight and BMI z-score ( $\beta = 0.22$  (95% CI 0.09, 0.35)) and odds of obesity (2.3 (95% CI 1.2, 4.6)). Similarities in the associations seen in models 3 and 6 were expected to given

the high correlation between maternal BMI before pregnancy and at 6 months postpartum ( $r = 0.93$ ). Adding postpartum weight retention (model 4), IOM gestational weight gain category (model 5), or change in maternal BMI from 6 months to 3 years postpartum (model 7) as a covariate did not substantially attenuate the association between maternal attempt to lose weight and any of the measures of adiposity at child age 3 years.

The association between the type of weight loss strategy used by mothers at 6 months postpartum and measures of child adiposity at 3 years of age in unadjusted models (model 1), covariate-adjusted models (model 2), and covariate-adjusted models including maternal prepregnancy BMI (model 3) are shown in **Table 4**. In model 3, women who were trying to lose weight by exercising only, compared with women who were not trying to lose weight, had children with higher BMI z-scores (0.36 (95% CI 0.14, 0.58)) and odds of obesity (6.0 (95% CI 2.2, 16.5)) at age 3 years. In model 3, maternal attempt to lose weight by changing eating habits only was not significantly associated with BMI z-score (0.19 (95% CI −0.02, 0.39)), odds of overweight or odds of obesity (1.5 (95% CI 0.5, 4.4)) in children at age 3 years. Also in model 3, maternal attempt to lose weight by both exercising and changing eating habits predicted higher BMI z-score (0.21 (95% CI 0.08, 0.35)), but not higher odds of obesity (1.9 (95% CI 0.9, 4.0)). Models adjusted for postpartum weight retention at 6 months (model 4), IOM gestational weight gain category (model 5), maternal BMI at 6 months postpartum (model 6), and change in maternal BMI from 6 months to 3 years postpartum (model 7) produced similar trends such that only attempting to lose weight through exercise alone consistently predicted higher BMI z-score and odds of overweight and obesity in children at age 3 years.

## DISCUSSION

In this prospective cohort, maternal attempt to lose weight at 6 months postpartum was associated with a higher child BMI z-score, and elevated odds of overweight and obesity at child age 3 years. Although heavier women had heavier children and

were also more likely to be trying to lose weight at 6 months postpartum, confounding by mother's weight status does not entirely explain the observed relationship. Adjusting for maternal prepregnancy BMI or BMI at 6 months postpartum attenuated the associations by 10–20%, suggesting that some, but not all, of the observed associations are due to mother's own weight status.

Women with excessive gestational weight gain and those with more postpartum weight retention were more likely to attempt to lose weight at 6 months postpartum. However, controlling for these variables did not substantially attenuate the observed associations between maternal attempt to lose weight at 6 months postpartum and child adiposity at age 3 years. We observed higher offspring adiposity at age 3 years among women who exercised to lose weight at 6 months postpartum. Children of mothers in the "exercise only" and "diet plus exercise" groups had a higher BMI z-score and greater odds of overweight at age 3 years. Maternal weight loss strategies that involved changing diet alone did not predict higher child adiposity.

To our knowledge, this is the first study to investigate and report an association between maternal attempt to lose weight during the postpartum period and offspring weight outcomes. The pathway through which a mother's attempt to lose weight during the postpartum period could influence her child's weight remains to be established. Although previous studies have observed an association between maternal dieting and child overeating (9,10), we did not find that maternal attempt to lose weight by changing eating habits was associated with elevated child weight. Rather maternal attempts that included exercise were most predictive of child adiposity, making alternative explanations more likely. Ongoing research is needed to explore mechanisms which could explain this association. Future studies should examine how the home food environment, dietary intake, eating styles, and feeding habits of women differ based on the type of weight loss strategy they choose to adopt. Furthermore, additional research should examine how exercise type, duration, and frequency impacts energy balance among postpartum women.

Because of the known adverse consequences of postpartum weight retention, additional research is needed to determine the best weight loss strategies to recommend. Past research indicates that advice should be family centered (19), encourage breastfeeding (20,21), promote a change in food intake (20), exercise frequency (20), or both (22), or should address maternal self-efficacy (23). Our findings suggest that postpartum weight loss strategies that include changing eating habits may be most beneficial to both mother and offspring. We observed that women who reported trying to lose weight at 6 months postpartum by changing eating habits were most successful in reducing weight at 3 years postpartum and that women who reported trying to lose weight by exercising only did not reduce their BMI from 6 months to 3 years postpartum. This observation supports recent findings, which suggest that, in the absence of caloric restriction, exercise is not an effective weight loss strategy, particularly among overweight women

(24). Experimental studies are needed to examine the impact of various types of postpartum weight loss strategies on both maternal and child weight.

Our study has several strengths, including a relatively large sample size, use of longitudinal data, and ability to adjust for a large number of covariates including maternal weight-related variables which could confound the relationship between maternal attempt to lose weight and child adiposity. Our study is subject to limitations. First, unmeasured confounding may bias our findings. We were not able to control for past eating and exercise habits or long-term weight loss attempts by the mother, although we expect that a mother's weight control behaviors at 6 months postpartum are highly correlated with these behaviors both prepregnancy and throughout the offspring's first 3 years of life. The use of mostly self-reported measures, including prepregnancy weight, could also have introduced bias. Furthermore, we assessed maternal attempt to lose weight at 6 months postpartum using a single item. Multi-item scales of dieting may be more predictive of behaviors than general single-item questions (25). We asked women to indicate the general types of weight loss strategies they were using, but did not obtain a detailed assessment of weight control behaviors used by the women in our sample. It is likely that substantial individual variability in behaviors exists within each weight loss strategy category and could vary by maternal characteristics such as socioeconomic background and weight status (25). Accordingly, future studies should collect detailed information about the weight loss strategies and behaviors used by postpartum mothers. Future studies could also explore pathways through which maternal weight loss strategies influence behaviors and weight status of children.

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#### DISCLOSURE

The authors declared no conflict of interest.

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