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Greater intrinsic motivation for engaging in healthy lifestyle behaviors is associated with reduced postpartum weight

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Abstract

Objective: Lifestyle behaviors impact postpartum weight, yet intrinsic motivation for them—i.e., what individuals enjoy, value, and do with ease—is poorly understood. The Pregnancy, Lifestyle and Environment Study-2 (PETALS-2) examined whether intrinsic motivations for engaging in healthy eating, physical activity (PA), and weight self-monitoring are each associated with long-term postpartum weight change.

Methods: We assessed behavior-specific intrinsic motivation using validated scales, from pregnancy up to six timepoints through 30 months postpartum, among diverse cohort participants ($N=311$) in a large healthcare system. Weight was prospectively ascertained via electronic health records, remote scales, and study visits.

Results: In adjusted regressions, participants with higher intrinsic motivation experienced significantly reduced postpartum weight. For healthy eating motivation, each one-unit higher score predicted up to -3.43 lbs. (95% CI: -5.34, -1.53) postpartum weight at 24 months; for PA motivation, -2.70 (-4.61, -0.78) at 30 months; for self-weighing motivation, -4.15 (-6.33, -1.97) at 30 months; and for a combined motivation score across all three behaviors, -5.47 (-7.95, -2.99) at 24 months.

Conclusions: Greater intrinsic motivation for healthy lifestyle behaviors predicted reduced long-term postpartum weight, and could be a promising target for innovative behavioral interventions.

Keywords

Motivation; maternal obesity; pregnancy; longitudinal; behavioral science

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Introduction

Postpartum weight retention increases risks for obesity, adverse perinatal outcomes in later pregnancies, and diminished maternal cardiometabolic health (1–6). Long-term increases in postpartum weight have been associated with worse cardiovascular health factors, and being a predictor of pre-diabetes or diabetes, at 5 years after delivery (7). Increased postpartum weight can raise the likelihood of entering a future pregnancy at an elevated body mass index (BMI), which itself has been causally linked to adverse pregnancy outcomes (8, 9).

While healthy lifestyle behaviors are critical to managing postpartum weight, motivation for them in this demanding phase of the life course is inadequately understood. This is a notable gap given that individuals must not only have the opportunity and capability, but the motivation to engage in behaviors for health promotion (10). Several aspects of motivation have descriptively been identified as influencing postpartum lifestyle behaviors, yet intrinsic motivation specifically—that is, what individuals enjoy, value, and do with ease—has garnered comparatively less attention (11). Rooted in self-determination theory, intrinsic motivation is conceptualized as the most autonomous form of self-regulation, and reflects engaging in a behavior for genuine enjoyment or alignment with personal values (12–16). Research in non-pregnant or -postpartum populations suggests that intrinsic motivation is modifiable through persuasive communication, experiential, and evaluative conditioning techniques (17–19). Interventions that increased intrinsic motivation have yielded better physical activity (PA) and weight loss maintenance up to 3 years later (18, 20, 21). However, individuals' positive attitudes toward key behaviors are rarely formally assessed or directly intervened upon in postpartum interventions, or assessed longitudinally; and the potential impact of intrinsic motivation on long-term postpartum weight remains unclear.

The Pregnancy, Lifestyle and Environment Study-2 (PETALS-2) was designed to fill these gaps in knowledge by examining motivational determinants of long-term postpartum weight, using a longitudinal repeated measures design spanning early pregnancy to the postpartum period. We aimed to examine the hypothesis that intrinsic motivation for three lifestyle behaviors—healthy eating, PA, and self-weighing (i.e., self-monitoring of weight, a standard weight management technique)—are each prospectively associated with lower long-term postpartum weight. An expanded understanding of these associations could inform the design of behavioral interventions to improve long-term postpartum weight, an important maternal cardiovascular risk factor.

Methods

Study design, setting, and procedure

PETALS-2 is a prospective longitudinal cohort study set in Kaiser Permanente Northern California (KPNC), an integrated healthcare delivery system serving 4.6 million members. The KPNC membership is similar in health and demographic characteristics to the underlying regional population of insured adults, with the exception of the extremes of income (22). Study participants were identified in the parent study, PETALS, a population-based study among healthy pregnant individuals aged 18–45 years with a singleton pregnancy (23). As described previously, participants completed a baseline in-person

clinic visit in early pregnancy (10–13 weeks' gestation) in which assessments of intrinsic motivation were administered from September 2017–December 2018 (24). Participants who responded to this baseline survey, did not decline future contact and data sharing for future studies, and had a confirmed live birth from the index PETALS pregnancy were then potentially eligible for this follow-up study, PETALS-2. All participants provided informed consent. PETALS-2 was approved by the Kaiser Foundation Research Institute human subjects committee (IRB protocol 1295116) and is reported here using the STROBE guidelines (25).

Potentially eligible individuals received letter, email, and telephone invitations to participate in the PETALS-2 postpartum follow-up assessments. Participants were enrolled at 6 months postpartum or, if not reached, were recruited at a later postpartum time point. PETALS-2 exclusion criteria included demise of the index PETALS infant; an intervening (new) pregnancy prior to PETALS-2 enrollment; current hospitalization; history of serious mental illness or eating disorder (given the study's focus on weight and weight management behaviors); and moving out of the geographical area (the latter criterion was dropped in 2020 to maximize participation during the COVID-19 pandemic).

Data assessment

We integrated prior data from PETALS and new follow-up data from PETALS-2 from four sources: electronic health record (EHR), surveys, in-person study clinic visits, and provision of a home-based, digital “smart” scale (BodyTrace) for remote body weight monitoring (Table S1). Postpartum assessments were conducted at 6 weeks (via EHR only, to reduce participant burden in the weeks after delivery) and at 6, 12, 18, and/or 24 months after delivery. Participants received the remote body weight scale at their first study clinic visit in the postpartum period (at 6 or 12 months postpartum). They were instructed to use (or not use) the scale as they normally would, with the exception of being prompted to take a weight measurement at the assessment time points. BodyTrace scales use cellular network connectivity (without the need for broadband internet or WiFi connections) to unobtrusively transmit encrypted, time-stamped weight measurements to the research team. To maximize participation and adjust to research constraints following onset of the COVID-19 pandemic in 2020, in-person clinic visits ceased (including provision of BodyTrace scales to new participants); the study transitioned to fully remote assessments; and the final study time point was extended to 30–36 months postpartum.

Baseline participant characteristics were assessed in PETALS. This included self-reported race and ethnicity, age, education, household income, parity, and marital status assessed via survey. Pre-pregnancy weight was abstracted from the EHR as that measured by clinical staff closest to, and within 6 months prior to the last menstrual period. Self-reported pre-pregnancy weight was used if a measured weight was unavailable ($n = 3$; 1%). Height was measured by PETALS staff using a stadiometer and standard anthropometric protocols (26). Pre-pregnancy BMI was calculated as pre-pregnancy weight (kg) divided by squared height (m^2). Given evidence that excess gestational weight gain is associated with substantial postpartum weight retention [e.g., Krukowski et al. (27)], gestational weight measurements were abstracted from the EHR to calculate total gestational weight gain.

Using the last weight measured within 3 weeks before delivery, total gestational weight gain was categorized as within, below, or exceeding the Institute of Medicine (now National Academy of Medicine) guidelines (28).

Intrinsic motivation—Intrinsic motivation was assessed separately for each lifestyle behavior. As described elsewhere (24), motivation for PA was assessed with the extensively validated 4-item Intrinsic Regulation subscale of the Behavioral Regulation in Exercise Questionnaire-Version 2 (BREQ-2) (29). Motivation for healthy eating and self-weighing were assessed with the 6-item Attitudes Toward Healthy Foods scale and 6-item Attitudes Toward Weighing scale, respectively, both of which were developed in the “Stability Skills First” behavioral weight management randomized controlled trial (items available upon request from Michaela Kiernan, PhD) (18). The Attitudes Toward Healthy Foods scale assesses affective attitudes toward healthy eating (e.g., enjoying the taste of healthy foods). Given that self-weighing can be perceived as unpleasant, the Attitudes Toward Weighing assesses respondents’ endorsement of a *neutral sense of ease* towards self-weighing (rather than “enjoyment” per se). Both 6-item scales demonstrated adequate internal consistency (Cronbach’s $\alpha = .70 - .78$), criterion validity, and discriminant validity in a similarly diverse maternal sample (24). All intrinsic motivation items were on a 5-point Likert scale with consistent response options from 1 (*not at all*) to 5 (*extremely*), with scale scores generated by averaging the relevant item responses for each type of behavior. As such, mean scores directly correspond to response options with higher scores indicating greater intrinsic motivation. Finally, as an exploratory analysis given conceptual similarity across these three types of motivation, we calculated a single variable representing average intrinsic motivation combined across the three types of behaviors; the combined score retained the same 1 to 5 scale, with higher scores reflecting greater intrinsic motivation across lifestyle behaviors.

Postpartum weight change—Postpartum weight change was calculated as postpartum weight minus pre-pregnancy weight. Postpartum weight was assessed throughout the PETALS-2 observation period from a hierarchy of data sources, retaining for analysis only one weight measurement per day per participant: (1) EHR, supplemented by (2) study clinic visits; (3) BodyTrace remote scales; and (4) self-report surveys. This hierarchy mirrored the prioritization of objective (rather than self-reported) data sources, in an effort to reduce measurement error.

To clean data derived from BodyTrace remote scales, we applied the SAS %TPF (TrueProfileFinder) macro designed to identify only the weights belonging to study participants, excluding weights of others who may have used the scale (30). SAS %TPF incorporates supervised clinic visit weights to increase accuracy. We further optimized the %TPF algorithm by identifying macro parameters that improved identification of weights truly belonging to participants (percent true calls) in the PETALS-2 data set (31). This optimization identified parameters providing strong accuracy (97.9% true call), sensitivity (98.5%), and specificity (93.5%). This process was applied to 32,917 weight measurements from 222 participants who were provided with scales, followed by restriction to a single measurement per day and applying the hierarchy of data sources.

We pre-defined six contiguous windows of time since delivery as follows: 6 weeks postpartum (i.e., 1–19 weeks); 6 months postpartum (20–45 weeks); 12 months postpartum (46–71 weeks); 18 months postpartum (72–97 weeks); 24 months postpartum (98–123 weeks); and 30+ months postpartum (124+ weeks). Within each window, a single weight measurement was retained for analysis that a) followed the hierarchy of sources; and b) was closest to, but occurred after and non-concurrent with, the most recent previous survey-based measurement of motivation. As such, motivation was always assessed prior to an associated weight measurement; this ensured the temporal sequence of motivation predicting a subsequent weight. Weight measurements were included for analysis if assessed within 12 months of the most recent previous survey (for the baseline survey in pregnancy, this was operationalized as within 12 months after delivery).

Statistical Analyses

We examined descriptive statistics for each intrinsic motivation scale; Cronbach's α to assess their internal consistency; and Spearman's rank order correlations among the scales. We examined intrinsic motivation for each lifestyle behavior as a predictor of postpartum weight change using linear mixed effects regression with repeated measures. This included examining heterogeneity in the strength of associations over time by including interactions terms for intrinsic motivation by window of time since delivery. This approach accommodates variation in the number of repeated measurements per person and in the spacing of measurements through time. As the approach is appropriate for unequal repeated measures per person, imputation or other approaches to handling missing data are not necessary. Exploratory analyses examined the combined intrinsic motivation score as a predictor of postpartum weight change.

Motivation scores were treated as time-varying in regression models, with updating of the covariate with the measurement at the last assessment—that is, weight modeled as a function of the most recent, but non-concurrent measurement of motivation. This ensured the temporal sequencing between a given motivation measurement in relation to a subsequent weight measurement. Regression models included time since delivery (i.e., time window) as a categorical fixed effect, providing point and interval estimates of differences in the population mean change at each pre-specified time point, with a random intercept and unstructured covariance matrix (which evidenced the most favorable model fit statistics) to account for the within-person non-independence among repeated measurements for valid estimation of regression coefficients and associated standard errors. In addition to time since delivery, models adjusted for variables previously shown to be associated with postpartum weight change and sociodemographics: maternal age at delivery, race/ethnicity, education, parity, pre-pregnancy BMI, source of weight data (EHR vs. non-EHR), and gestational weight gain category. Similar models without adjusting for gestational weight gain category were not substantively different (data not shown). Model fit statistics were consistently slightly better, and results were not substantively different, for the fully adjusted models presented here vs. unadjusted base models (which included only postpartum time point and the time point x motivation interaction; data not shown). Analyses were conducted using SAS version 9.4 (SAS Institute).

Results

Of 472 individuals who completed the baseline assessment of intrinsic motivation in PETALS (24), 450 were identified as potentially eligible for PETALS-2 and received a recruitment contact; 32 subsequently did not meet eligibility criteria. Of the 418 eligible individuals, 107 declined or could not be reached whereas 311 enrolled, yielding a recruitment rate of 74.4%. All 311 participants completed the baseline survey in pregnancy; contributed data on pre-pregnancy weight; and contributed at least one postpartum survey and weight measurement. Participant characteristics are shown in Table 1. Approximately 70% of participants self-identified with a racial or ethnic background other than White; 36% did not have a college degree; and 49% had an annual household income of \$99,000 or less (similar to Census data indicating 56% of households were at that income level in the expensive San Francisco Bay Area (32)). Of note, 23 of the 311 participants (7.4%) were recruited to PETALS-2 after onset of the COVID-19 pandemic (i.e., after the shelter-in-place mandate took effect in California on March 19, 2020). This small number precluded sensitivity analyses that might have compared participants who joined before vs. after the pandemic.

The study collected a total of 1,088 completed surveys across time points (Table S2). Across time points, each intrinsic motivation scale demonstrated adequate internal consistency ($\alpha = .73-.94$, Table S2). The scales were either uncorrelated or modestly correlated with one another, suggesting that they assess related but non-overlapping constructs (Table S3). Overall, intrinsic motivation for self-weighing (mean [SD] = 2.5 [0.9]) was descriptively lower than intrinsic motivation for healthy eating (3.8 [0.8]) and for PA (3.4 [1.1]) across time points. Applying the criteria that survey measurements be linked to a subsequent and non-concurrent weight measurement yielded a total of 925 surveys available for analysis (Table 2).

The study collected a total of 17,482 postpartum weight measurements across time points and sources, of which 15,639 were valid after excluding weights measured during or after an intervening pregnancy. For the present outcome of postpartum weight, analyses excluded participants who provided no postpartum weight measurements prior to an intervening pregnancy ($n=1$, 0.6%); and those whose only postpartum weight measurement occurred prior to a survey response (violating the intended temporal sequence), or occurred more than 12 months after their most recent previous survey ($n=4$, 1.3%). This yielded an analytic sample of 306 for the postpartum weight outcome. Of those, participants who experienced an intervening pregnancy during the study period contributed data until pregnancy onset ($n=60$, 19.6%). Characteristics of participants in the analytic sample did not differ between those with and without an intervening pregnancy during the observation period, except for parity (Table S4).

Applying the hierarchy of data sources and retaining one weight measurement per assessment window yielded 914 weight measurements in the postpartum observation period for analysis. Overall, most measurements were derived from the EHR (577 measurements, 63.1%) followed by remote scales (188, 20.6%), study clinic visits at 6–12 months postpartum (122, 13.3%), and self-report survey (27, 3%). Descriptively, postpartum weight

change ranged from a mean [SD] of 9.1 lbs. [12.3] weight retention at 6 weeks to 5.3 lbs. [12.5] at 6 months, 4.0 lbs. [13.5] at 12 months, 4.8 lbs. [13.8] at 18 months, 6.1 lbs. [14.1] at 24 months, and 7.6 lbs. [18.0] at 30+ months postpartum (Table 2).

In adjusted regression analyses, the association between each type of motivation and postpartum weight change across the observation period varied by time since delivery. The motivation x time interaction terms were statistically significant for healthy eating ($p = .0016$), PA ($p = .0002$), and self-weighing ($p < .0001$). Therefore, we present point estimates and 95% CIs for motivation as a predictor of postpartum weight change at individual time points (Table 3). Higher intrinsic motivation for healthy eating significantly predicted lower postpartum weight at 12, 18, and 24 months postpartum. Specifically, each one-unit higher score for intrinsic motivation for healthy eating was prospectively associated with up to -3.43 lbs. (95% CI: -5.34 to -1.53; $p = .0005$) at 24 months postpartum. Similarly, intrinsic motivation for PA predicted lower long-term postpartum weight at 12, 18, 24, and 30+ months. Each one-unit higher score for intrinsic motivation for PA was prospectively associated with up to -2.70 lbs. (-4.61 to -0.78; $p = .006$) at 30+ months postpartum. Higher intrinsic motivation for self-weighing was associated with higher weight retention at 6 weeks postpartum (1.79 lbs.; 0.66 to 2.92; $p = .002$); but subsequently predicted lower long-term postpartum weight at 18, 24, and 30+ months. The latter estimates increased in magnitude, with each one-unit higher score for intrinsic motivation for self-weighing prospectively associated with up to -4.15 lbs. (-6.33 to -1.97; $p = .0002$) at 30+ months postpartum. Estimates at other time points were not statistically significant.

In exploratory analyses, internal consistency was strong for a combination of all 16 intrinsic motivation survey items, i.e., across the three types of lifestyle behaviors (Cronbach's $\alpha = .80$). In adjusted regression analyses, the combined intrinsic motivation score was significantly associated with long-term postpartum weight. Each one-unit higher score for combined intrinsic motivation predicted higher weight retention at 6 weeks postpartum (2.65 lbs.; 95% CI: 0.96 to 4.34; $p = .002$); but subsequently predicted lower long-term postpartum weight: -3.40 lbs. (-5.60 to -1.19; $p = .003$) at 12 months, -4.23 lbs. (-6.30 to -2.15; $p < .0001$) at 18 months, -5.47 lbs. (-7.95 to -2.99; $p < .0001$) at 24 months, and -5.15 lbs. (-8.01 to -2.29; $p = .0005$) at 30+ months. The estimate at 6 months was in a similar direction but non-significant (-1.70 lbs.; -4.27 to 0.87; $p = .19$).

Discussion

In this longitudinal study in a diverse cohort of pregnant adults, intrinsic motivation for engaging in healthy eating, PA, and self-weighing lifestyle behaviors predicted reduced postpartum weight at long-term follow-up, from 12 to approximately 30 months postpartum, in a diverse sample. In the case of intrinsic motivation for self-weighing, and a combined score representing intrinsic motivation across the three lifestyle behaviors, the magnitude of these effects increased from 12 to 24 months postpartum. Results suggest that intrinsic motivation in the perinatal and postpartum period has a measurable impact on subsequent long-term postpartum weight.

The effect of intrinsic motivation on long-term postpartum weight change may be clinically meaningful. Indeed, the absolute magnitude of these effects represent substantial portions of the average postpartum weight retained in this sample. For example, greater intrinsic motivation for PA was associated with 2.70 lbs. less weight at 30+ months postpartum; this is considerable given the average weight increase of 7.6 lbs. at that time point, and the 4.12 lbs. observed in other samples with similar follow-up duration (33). Of note, intrinsic motivation for self-weighing and the combined intrinsic motivation score also predicted greater postpartum weight at 6 weeks postpartum; however, these findings soon after delivery may be less clinically relevant than longer-term findings at 12 months and beyond (e.g., when individuals are more likely to enter a subsequent pregnancy).

Increased postpartum weight raises long-term risks for obesity, suboptimal cardiometabolic health, and adverse pregnancy outcomes in subsequent pregnancies. Reaching one's pre-pregnancy weight may reduce these risks. The present study suggests that intrinsic motivation could be a promising target for novel interventions to reduce long-term postpartum weight and improve maternal health. Similar approaches have been tested in non-maternal samples of women engaged in behavioral weight management trials. For example, the "Stability Skills First" intervention aimed to increase intrinsic motivation for engaging in healthy lifestyle behaviors by maximizing adults' immediate, day-to-day satisfaction with them; those randomized to the intervention maintained significantly greater weight loss 1 year after the intervention ended (18). Likewise in other intervention trial settings, increases in intrinsic motivation have been associated with significantly improved long-term maintenance of weight loss (34); and autonomous motivation has been shown to mediate greater weight loss effects among adults with overweight or obesity (35). Building on these trials, postpartum interventions could be designed to enhance enjoyment of healthy lifestyle behaviors, reduce feelings of deprivation when engaging in healthy behaviors, and address notable uneasiness with self-weighing. Uneasiness with self-weighing deserves a particularly empathic approach given pervasive weight stigma, including during pregnancy and the postpartum period (36). Interventions could be developed to help reduce emotional reactivity to the scale, re-framing it as a neutral tool to support adaptive and sustainable health practices (18, 37). The present study emphasizes the potential utility of addressing intrinsic motivation in novel interventions, and demonstrates validated approaches to measure it efficiently in large research samples.

In light of this study's novel findings regarding long-term weight, future research is warranted to determine whether intrinsic motivation also predicts engagement in these behaviors themselves—i.e., the more proximal outcomes of meeting national guidelines for healthy eating and moderate- to vigorous-intensity physical activity, and regular (e.g., weekly) self-weighing. Emerging research has suggested that intrinsic motivation is a distal determinant of PA in pregnancy (38). Higher autonomous motivation has also been associated cross-sectionally with greater PA among underserved mothers with overweight or obesity (39). Still, scant research has examined this construct in the postpartum period. The relationship between motivation and self-weighing is particularly understudied.

Importantly, motivation is but one determinant of health behaviors and health outcomes (10). *Opportunities* to engage in health behaviors (e.g., access to healthy foods and activity-

promoting physical environments), and *capabilities* to do so (e.g., health-related knowledge and skills) are also essential determinants of downstream long-term postpartum weight (40). Rather than replacing the focus on these essential determinants, postpartum weight management interventions that explicitly address motivation could enhance the potency of multilevel interventions to impact maternal health.

Study strengths include the racially and ethnically diverse cohort, particularly given that individuals from minority groups experience increases in postpartum weight more often (41). Continued research in diverse samples is needed to identify promising targets for future postpartum weight management interventions. Additional study strengths include the validated measures of intrinsic motivation; the prospective, longitudinal design that maintained the temporal sequencing between measurements of motivation and subsequent measurements of weight; and the lengthy follow-up, examining postpartum weight change beyond 12 months after delivery, in contrast to much prior research (41). The robust assessment of postpartum weight is an important strength, with multiple data sources increasing confidence in the validity of weight measurements. In addition, the present study demonstrates the efficient measurement of intrinsic motivation in large samples using novel and validated measures. Indeed, the non-significant or modest correlations observed here confirm prior findings that the three measures of intrinsic motivation assess related, but non-overlapping constructs (24).

This study has important limitations. Among these is the interruption of data collection activities caused by the COVID-19 pandemic, which disrupted follow-up assessments and the ability to deploy BodyTrace scales to all participants. However, we mitigated this limitation through data collection from multiple sources, including the EHR; and statistical models that accommodate variation in the number of repeated measurements per person and in the spacing of those measurements through time. We note that missing data are expected. Using the mixed model approach, which made maximal use of all data collected, imputation or other missing data approaches were not necessary. This statistical approach also helped mitigate the important limitation of reduced study retention—particularly at 30+ months, a time point that was added mid-way through the study to allow for extended data collection during the pandemic. It is notable that despite the limited precision evidenced by wide CIs at 30+ months, significant associations were observed between intrinsic motivation and postpartum weight change even during this extended follow-up. Additional study limitations are the setting within a single health system and the high educational level of the sample. Future research in additional populations is needed to bolster generalizability.

In summary, we found that intrinsic motivation for engaging in healthy eating, PA, and self-weighing lifestyle behaviors is prospectively associated with reduced long-term postpartum weight in a diverse sample. Future behavioral interventions may be warranted that target intrinsic motivation as a modifiable determinant of long-term postpartum weight management, in concert with other multilevel determinants, as a pathway towards improving maternal cardiometabolic health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What is already known about this subject?

- Postpartum weight retention increases long-term risks for obesity and poor maternal cardiometabolic health.
- Healthy lifestyle behaviors are critical to managing postpartum weight, yet motivation for them in this demanding period is poorly understood.

What are the new findings in your manuscript?

- Intrinsic motivation for engaging in healthy lifestyle behaviors predicted reduced long-term postpartum weight within a diverse population.
- The magnitude of intrinsic motivation's effects represents a substantial proportion of the average postpartum weight gain observed in long-term studies.

How might your results change the direction of research or the focus of clinical practice?

- Innovative behavioral interventions could target intrinsic motivation to foster long-term reductions in postpartum weight.

Table 1.

Baseline participant characteristics: The Pregnancy and Environment Lifestyle Study-2 (PETALS-2) cohort

	<i>n</i> (%) or mean $\pm$ SD
Age at delivery of index pregnancy (years)	
18–24	27 (8.7)
25–29	70 (22.5)
30–34	125 (40.2)
35–39	72 (23.2)
40–44	17 (5.5)
Race or ethnicity	
Asian/Pacific Islander	67 (21.5)
Black/African American	22 (7.1)
Hispanic	84 (27.0)
More than one race/ethnicity	44 (14.1)
Non-Hispanic White	94 (30.2)
Education	
High school or less	34 (10.9)
Some college	78 (25.1)
College graduate	101 (32.5)
Post-graduate	98 (31.5)
Marital status	
Married/civil union	228 (73.3)
Not married, but living with a partner	43 (13.8)
Divorced/separated	3 (1.0)
Single	37 (11.9)
Household income (\$)	
< 50,000	63 (20.5)
50,000–99,000	89 (28.9)
100,000–149,999	60 (19.5)
$\geq$ 150,000	96 (31.2)
Unknown	3 (1.0)
Parity	
0	160 (51.5)
1	106 (34.1)
$\geq$ 2	41 (13.2)
Pre-pregnancy BMI, kg/m ²	
< 18.5	4 (1.3)
18.5–24.9	140 (45.0)
25.0–29.9	93 (29.9)
$\geq$ 30.0	74 (23.8)

	<i>n</i> (%) or mean $\pm$ SD
Gestational weight gain category ^a	
Inadequate	51 (16.4)
Adequate	107 (34.4)
Excess	134 (43.1)
Unknown	19 (6.1)
Gestational age at delivery of index pregnancy (weeks)	38.9 $\pm$ 2.1

Note: PETALS-2 cohort $N=311$. Race/ethnicity, education, marital status, parity, gestational age at delivery, and total gestational weight gain missing for $n=4$ participants. Household income unknown for $n=7$ participants.

^aPer Institute of Medicine guidelines (28) for total gestational weight gain.

Abbreviations: BMI, body mass index.

Table 2. Assessments and postpartum weight change in the Pregnancy and Environment Lifestyle Study-2 (PETALS-2)

Time point	Window	No. surveys ^a	GA or postpartum weeks at survey	No. weight measurements	Postpartum weeks at weight measurement	Source of weight measurements within time points, N (%)				Postpartum weight change (lbs.)
	Weeks	N (%)	M (SD)	N (%)	M (SD)	EHR	CV	BT	Survey	M (SD)
Pregnancy	10–13	306 (100)	13.7 (2.8)	306 (100) ^b	N/A	303 (99.0)	N/A	N/A	3 (1.0)	N/A
Postpartum										
6 weeks	1–19	N/A	N/A	295 (96.4)	4.9 (2.1)	295 (100)	N/A	N/A	N/A	9.1 (12.3)
6 months	20–45	128 (41.8)	29.0 (9.1)	128 (41.8)	33.7 (5.4)	53 (41.4)	67 (52.3)	7 (5.5)	1 (0.8)	5.3 (12.5)
12 months	46–71	135 (44.1)	51.5 (10.7)	135 (44.1)	58.6 (6.2)	54 (40.0)	52 (38.5)	26 (19.3)	3 (2.2)	4.0 (13.5)
18 months	72–97	139 (45.4)	76.7 (7.2)	139 (45.4)	82.6 (5.8)	52 (37.4) ^c	N/A	82 (59.0)	5 (3.6)	4.8 (13.8)
24 months	98–123	125 (40.8)	98.2 (11.7)	125 (40.8)	107.9 (6.7)	39 (31.2)	N/A	68 (54.4)	18 (14.4)	6.1 (14.1)
30+ months	124+	92 (30.1)	114.5 (14.9)	92 (30.1)	143.4 (14.2)	87 (94.6)	N/A	5 (5.4)	0 (0)	7.6 (18.0)

Note: Analytic sample N=306.

^aNumber of available observations.

^bRefers to baseline assessment of pre-pregnancy weight.

^cIncludes 3 weights measured at a clinic visit that occurred within the 18-month postpartum window.

Abbreviations: GA, gestational age (weeks). CV, study clinic visit. BT, remote BodyTrace scales.

Table 3. Longitudinal associations between intrinsic motivation for engaging in healthy lifestyle behaviors and subsequent postpartum weight change: The Pregnancy and Environment Lifestyle Study-2 (PETALS-2)

Postpartum time point	Intrinsic motivation for healthy eating ^a		Intrinsic motivation for physical activity ^b		Intrinsic motivation for self-weighting ^c		Intrinsic motivation combined ^d	
	No. ^e	β (95% CI) of PPW change, lbs.	No. ^e	β (95% CI) of PPW change, lbs.	No. ^e	β (95% CI) of PPW change, lbs.	No. ^e	β (95% CI) of PPW change, lbs.
6 weeks	294	1.11 (−0.30, 2.52)	295	0.86 (−0.13, 1.85)	295	1.79 (0.66, 2.92)	295	2.65 (0.96, 4.34)
6 months	128	−0.17 (−2.25, 1.93)	128	−1.38 (−2.87, 0.11)	128	0.06 (−1.65, 1.78)	128	−1.70 (−4.27, 0.87)
12 months	135	−1.95 (−3.75, −0.15)	134	−1.90 (−3.29, −0.51)	135	−0.98 (−2.52, 0.56)	135	−3.40 (−5.60, −1.19)
18 months	139	−1.99 (−3.64, −0.33)	139	−2.22 (−3.61, −0.82)	139	−2.11 (−3.54, −0.69)	139	−4.23 (−6.30, −2.15)
24 months	125	−3.43 (−5.34, −1.53)	125	−1.87 (−3.43, −0.31)	125	−3.21 (−5.03, −1.40)	125	−5.47 (−7.95, −2.99)
30+ months	91	−1.16 (−3.47, 1.15)	92	−2.70 (−4.61, −0.78)	91	−4.15 (−6.33, −1.97)	92	−5.15 (−8.01, −2.29)

Note: Analytic sample N=306. Estimates derived from linear mixed-effects regression analyses of longitudinal associations between intrinsic motivation for engaging in healthy lifestyle behaviors and subsequent postpartum weight change. Bold text indicates significance at $p \leq 0.01$. Models adjusted for age at delivery, education, race/ethnicity, pre-pregnancy BMI, parity, gestational weight gain category, postpartum time point, source of weight data (EHR vs. non-EHR), and time point x motivation interaction.

^a Attitudes Toward Healthy Foods scale (total weight observations analyzed = 912)

^b *BREQ-2* (Behavioral Regulation in Exercise Questionnaire-2) intrinsic motivation subscale (total weight observations analyzed = 913)

^c Attitudes Toward Weighing scale (total weight observations analyzed = 913)

^d Intrinsic motivation combined (average score; total weight observations analyzed = 914). Data for intrinsic motivation combined were imputed if missing one or more motivation scales ($n=1$ at 6 weeks, 12 months, and 30+ months).

^e Number of postpartum weight observations analyzed per time point.

Abbreviations: PPW, postpartum weight; CI, confidence interval.