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Original Research

The Correlation between Independent Self-Monitoring and Limiting Postpartum Weight Maintenance in Obese Women during Pregnancy: A Prospective Multicenter Observational Study

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Abstract

Background: Obesity during pregnancy has a high incidence rate worldwide. At the same time, postpartum weight of pregnant obese patients can lead to a series of complications. This study aimed to examine the effectiveness of independent self-monitoring (SM) interventions during pregnancy and postpartum on reducing postpartum weight retention in women with obesity during pregnancy. **Methods**: A multicenter observational study was conducted, involving 448 participants diagnosed with obesity during pregnancy, from five medical organizations. Participants were divided into two groups: those with independent SM activities (SM; n = 201) and those without independent self-monitoring activities (no-SM, NSM; n = 247). Independent SM behaviors included dietary and weight measurements. Linear mixed-effects models with repeated measures, and multiple logistic regression models were employed to assess continuous and categorical weight outcomes, respectively. **Results**: Changes in body weight were observed from the prepregnancy period to the 12-month postpartum phase. An observable SM effect was evident, resulting in reduced weight retention in the SM group across various time intervals. Notably, at the 12-month postpartum mark, the SM effect retained a slight but significant impact, with the SM group maintaining 2.4 kg less weight compared to the NSM group (95% confidence interval (CI): –4.5 to –0.3). Furthermore, relative to NSM participants, the SM group exhibited a 2.5-fold increased likelihood (95% CI: 1.2–4.8) of experiencing no weight retention at 3 months postpartum compared to their prepregnancy weight. Additionally, SM was associated with a higher probability of vaginal delivery and a decreased likelihood of cesarean sections (p = 0.046). Importantly, no significant distinctions were observed in neonatal outcomes or among participants with varying gestational weight gain (GWG) levels (p = 0.144 and p = 0.064). **Conclusion**: Independent SM interventions, comprising dietary and weighting, are effective in limiting postpartum weight retention among women with obesity during pregnancy, and enhance delivery method. Healthcare professionals should consider incorporating independent SM strategies into prenatal and postnatal care programs, to support healthy weight management and reduce the risk of adverse pregnancy outcomes and long-term obesity development.

Keywords: independent self-monitoring; postpartum weight retention; obesity during pregnancy; weight management; prenatal care

1. Introduction

Pregnancy and postpartum periods represent critical life stages, predisposing women to obesity development. Excessive gestational weight gain (GWG) is a known predictor of postpartum weight retention [1,2]. Globally, nearly 39 million pregnancies per year are complicated by maternal obesity, with some countries reporting prevalence rates of overweight and obesity in pregnancy exceeding 60% (South Africa 64%, Mexico 65%, USA 55%–63%) [3,4]. In England, overweight and obesity prevalence among women aged 16–24 years is 35%, rising to 61% among those aged 35–44 years, emphasizing the potential risk among women of reproductive age [5].

According to the Pregnancy Risk Assessment Monitoring System, the prevalence of obesity prior to conception in the United States of America (USA) has increased by 69.3% over the past decade, with rates as high as 22% [6,7]. In China, a national nutrition survey conducted in 2002 indicated that the prevalence of overweight and obesity among women aged 18–44 was 21.8% and 6.1%, respectively [8], with an increasing trend observed particularly among women of childbearing age [9]. In the United Kingdom (UK), approximately 1 in 1000 births involve women with a body mass index (BMI) >50 kg/m^2 [10], while Australia reports a super-obesity prevalence of 2.1 per 1000 births [11,12].

In comparison to women of normal weight, those who were diagnosed as obese or overweight at the beginning of pregnancy, are two to three times more likely to exceed the Institute of Medicine's GWG recommendations and are less likely to regain their prepregnancy weight [13]. A higher risk of different unfavorable pregnancy outcomes in subsequent pregnancies is linked to postpartum weight retention, or an increase in BMI between pregnancies [14]. The obesity pandemic among women is fueled in part by excessive prenatal weight gain and postpartum weight retention [2,15–17]. Research has indicated that GWG is linked

to the risk of pregnancy complications, maternal postpartum weight retention, and obesity in offspring [18]. While GWG is necessary for ensuring the health of the fetus, excessive weight gain during pregnancy has been associated with unfavorable outcomes [19–24].

The nutritional status of expectant mothers is widely regarded as a valuable prognostic indicator for perinatal and long-term adverse outcomes in both the infant and the mother [25]. Preexisting overweight or obesity before conception constitutes a significant risk factor for gestational diabetes mellitus, hypertensive syndrome, and fetal growth disorders [26,27]. Postpartum weight retention is also more common among mothers with excessive weight gain. In terms of fetal and neonatal risks, excessive weight gain can lead to macrosomia, neonatal hypoglycemia, and an elevated risk of childhood obesity for the offspring [28–33]. Additionally, excessive weight gain is associated with an increased risk of developing gestational diabetes mellitus [34], gestational hypertension [35], preeclampsia [30], and the need for cesarean sections [36].

This study aimed to examine the effectiveness of pregnancy and postpartum self-monitoring (SM) on postpartum weight retention in patients with obesity during pregnancy. We hypothesized that women receiving higher-term SM activities would retain less weight during postpartum than women receiving fewer-term independent SM activities, or no independent SM (no-SM, NSM) activities.

2. Methods

2.1 Participants and Procedure

This multicenter observational study involved participants diagnosed with obesity during pregnancy from five medical organizations. We followed the Preferred Reporting Items for Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) standardized reporting requirements for this study (**Supplementary Table 1**) [37].

In a prospective observational study, we have enrolled 3675 pregnant patients with obesity at the hospital between June 2017 and May 2022, and have linked them to the hospital's database. A total of 2515 patients were excluded from the postpartum weight retention analysis due to outlier data. This exclusion comprised 1872 patients with missing database records, 578 patients diagnosed with severe complications, and 65 patients who experienced adverse pregnancy outcomes.

All participants provided informed consent either through written consent forms or verbal consent. A cohort of 1160 patients completed the 12-month postpartum follow-up, with 516 of them engaging in independent SM, and 644 not participating in independent SM activities (NSM). The final analysis was based on 448 patients, which included 201 individuals who continued independent SM activities from baseline to 12 months postpartum, and 247 individuals who did not engage in independent (No-SM, NSM) activities throughout the postpartum period, or who had abandoned these activities. The participants in the SM group had SM behaviors in the postpartum 12-month period. Participants were matched into the NSM group based on their weight, postpartum complications, and gestational age in the SM group.

During the postpartum follow-up period, 288 patients were excluded due to loss of contact, low-reliability data provision, or severe postpartum complications. The study's flowchart is presented in Fig. 1 for reference. The sample size was calculated by performing a power analysis, which was conducted based on the most rigorous planned analysis for the data (multivariate analysis of variance, MANOVA), and estimated a minimum of 183 participants. According to the results of sensitivity analysis, the sample goal was inflated to a minimum of 201 to account for any invalid or missing data.

The inclusion criteria comprised the following: (1) Singleton pregnancy status; (2) Gestational age $\leq$12 weeks; (3) Documentation of maternity records established within the hospital; (4) Consistent attendance for routine prenatal examinations; (5) Completion of the survey through an online platform; (6) Provision of informed consent through signature. The exclusion criteria encompassed: (1) Gestational age exceeding 12 weeks; (2) Individuals unable to adhere to regular prenatal care appointments; (3) Transient or itinerant residents lacking long-term residency in the local area; (4) Those presenting contraindications to pregnancy, such as gynecological malignancies.

Obesity was defined as a prepregnancy BMI of 30 kg/m^2 or higher. BMI values prior to pregnancy were computed by assessing the height and weight of pregnant women during their initial prenatal evaluation, which took place during the early stages of pregnancy (i.e., within the first 12 gestational weeks).

2.2 Independent Self Supervision

In this study, participants demonstrated their engagement in independent SM by supplying various forms of evidence, such as mobile phone software data screenshots, daily check-in group chat logs, and photographs of paper-based independent SM records. The collected data encompassed daily food intake quantity, daily food type, and monthly body weight measurements. Researchers gathered data from the participants every three months through phone and internet communication.

2.3 Statistical Analyses

We use linear mixed-effects models with repeated measures assess the weight retention outcomes. The time effect incorporated six levels: prepregnancy, baseline ($\leq$18 weeks' gestation), delivery, and 3, 6, and 12 months postpartum. In addition, each model encompassed an intervention group variable. Adjusted odds ratios (AOR) and the 95% confidence interval (CI) for the treatment were presented. The level of statistical significance was established

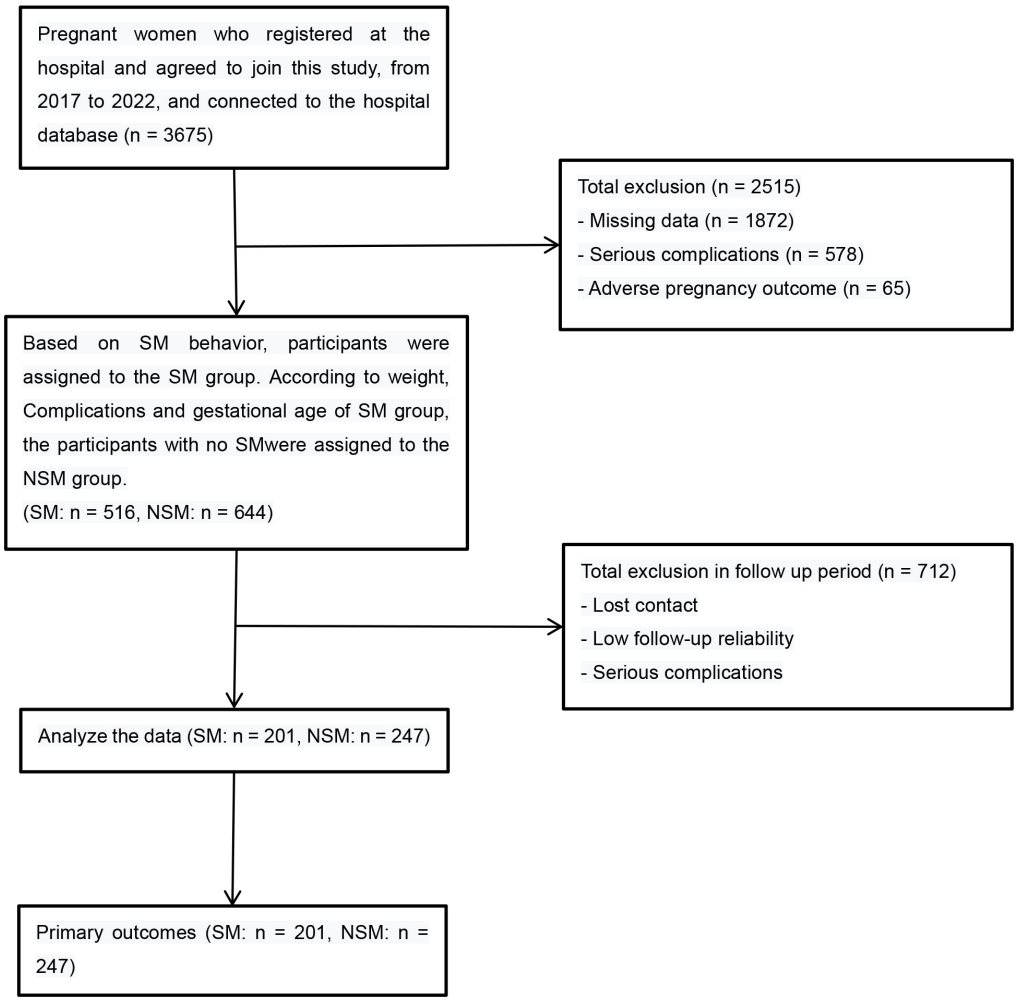

Fig. 1. Study flow. SM, self-monitoring; NSM, no-self-monitoring.

at $p < 0.05$. Multiple logistic regression models were employed to investigate the intervention's effect on categorical weight outcomes. All statistical analyses were conducted using SPSS version 23.0 (SPSS Inc., Chicago, IL, USA).

3. Results

The baseline characteristics of the 448 participants revealed a mean age of 32.6 years (standard deviation (SD): 12.1) at recruitment. The average BMI of the cohort was 34.8 kg/m^2 (SD = 6.4) in prepregnancy. For different time points, the mean prepregnancy weight was 86.6 kg (SD: 18.5), the mean baseline weight was 89.2 kg (SD: 16.9), and the mean weight at delivery was 103.8 kg (SD: 18.7). In terms of family income, 28.8% earned less than \$20,000, 15.0% had income between \$20,000 and \$40,000, 18.5% had income between \$40,000 and \$60,000, and 36.4% had income higher than \$60,000. A portion (38.2%) held a lower or 12th-grade education or were high school graduates, while 61.8% had a better educational background, including 1 to 3 years of college or higher education, as displayed in Table 1.

Table 2 and Fig. 2 illustrate the changes in weight from prepregnancy, baseline, and delivery room BMI to 3, 6, and 12 months postpartum. The results showed an increase in weight from prepregnancy to delivery, followed by a rapid decline from delivery to 3 months postpartum. However, the weight began to gradually rebound after 3 months postpartum, with a significant SM effect observed at different time points ($p < 0.001$). Specifically, from prepregnancy to 3 months postpartum, SM participants retained less weight than the NSM group participants (1.1 kg *vs*. 5.9 kg). At 12 months postpartum, the SM effect remained slightly significant, with the SM group retaining 2.4 kg less weight than the NSM group (95% CI: –4.5∼–0.3).

Compared to NSM participants, the SM group had 2.5 times higher odds (95% CI: 1.2–4.8) of experiencing no weight retention at 3 months postpartum from their prepregnancy weight. And the SM group had 3.9 times higher odds (95% CI: 2.2–7.8) of experiencing no weight retention at 3 months postpartum from baseline. However, at 6 months postpartum, both groups showed similar trends in weight retention outcomes. In terms of the percentage

Table 1. Baseline characteristics of participants.

	Total (n = 448)	SM group (n = 201)	NSM group (n = 247)	*p*-value
Age (year), mean ± SD	32.6 ± 12.1	34.7 ± 13.6	30.5 ± 11.8	0.144
Prepregnancy BMI (kg/m^2), mean ± SD	34.8 ± 6.4	33.6 ± 5.8	34.9 ± 6.7	0.271
Baseline weight (kg), mean ± SD	89.2 ± 16.9	88.2 ± 16.1	93.1 ± 17.2	0.414
Weight at delivery (kg), mean ± SD	103.8 ± 18.7	102.9 ± 18.6	105.5 ± 19.5	0.084
Prepregnancy weight (kg), mean ± SD	86.6 ± 18.5	85.8 ± 17.2	87.4 ± 18.1	0.059
Obese before pregnancy (BMI ≥30), n (%)	240 (53.6)	106 (52.7)	134 (54.2)	0.142
Total GWG (kg), mean ± SD	13.8 ± 7.8	14.6 ± 8.1	13.6 ± 7.7	0.274
Hypertensive disorder during pregnancy, n (%)	141 (31.5%)	64 (31.8%)	77 (31.2%)	0.414
Gestational diabetes, n (%)	94 (21.0%)	43 (21.4%)	51 (20.6%)	0.076
History of diabetes, n (%)	40 (8.9%)	18 (9.0%)	22 (8.9%)	0.952
History of smoking, n (%)	238 (53.1%)	107 (53.2%)	131 (53.0%)	0.095
History of drink alcohol, n (%)	188 (42.0%)	84 (41.8%)	104 (42.1%)	0.068
Marital status (married), n (%)	422 (94.2%)	191 (95.0%)	231 (93.5%)	0.197
Parity (primipara), n (%)	363 (81.0%)	166 (82.6%)	197 (79.8%)	0.095
Pregnancy rate (%)	66.8%	65.4%	67.7%	0.062
Family income, n (%)				0.091
<$20,000	129 (28.8)	48 (23.9)	81 (32.8)	
$20,000–$40,000	73 (15.0)	31 (15.4)	42 (17.0)	
$40,000–$60,000	83 (18.5)	36 (17.9)	47 (19.0)	
>$60,000	163 (36.4)	86 (42.8)	77 (31.2)	
Education, n (%)				0.088
≤12th grade or high school graduate	171 (38.2)	75 (37.3)	96 (38.9)	
College 1–3 years or more	277 (61.8)	126 (62.7)	151 (61.1)	

SM, self-monitoring; NSM, no-self-monitoring; SD, standard deviation; BMI, body mass index; GWG, gestational weight gain.

Table 2. Changes in weight from prepregnancy, baseline, and delivery room BMI to 6 and 12 months postpartum.

	SM group (n = 201)	NSM group (n = 247)	Difference	*p*-value
Weight change from prepregnancy weight to postpartum weight, kg				
6 months postpartum	1.3 (0.1, 2.5)	5.4 (4.0, 6.8)	–4.1 (–5.7, –2.5)	<0.001
12 months postpartum	1.7 (0.2, 3.2)	4.1 (2.4, 5.8)	–2.4 (–4.5, –0.3)	0.024
Weight change from baseline weight to postpartum weight, kg				
6 months postpartum	–0.9 (–2.6, 0.7)	2.7 (1.2, 4.2)	–2.5 (–4.5, –0.4)	<0.001
12 months postpartum	–0.6 (–1.9, 0.8)	1.3 (0.2, 2.3)	–1.8 (–3.9, –0.3)	0.036
Weight change from delivery room weight to postpartum, kg				
6 months postpartum	–12.8 (–14.1, –11.4)	–7.1 (–9.1, –5.0)	–5.6 (–7.1, –4.1)	<0.001
12 months postpartum	–12.4 (–13.8, –11.0)	–8.8 (–10.5, –7.1)	–4.6 (–6.8, –2.4)	0.009

SM, self-monitoring; NSM, no-self-monitoring; BMI, body mass index.

of participants who retained ≥5% of weight from prepregnancy, SM participants had lower odds than the NSM group (3 months: 0.3 (0.1–0.4); 6 months: 0.3 (0.2–0.6); 12 months: 0.3 (0.3–0.7)) (Table 3). In participants with adequate (5–9 kg) or excessive (>9 kg) GWG, the participants with excessive GWG had higher postpartum weight retention, 58.9% (112/190) of participants with excessive GWG retained ≥5% of weight, and 31.2% (58/186) of participants with adequate GWG had records of retained ≥5% of weight.

Table 4 presents the associations between independent SM and delivery methods. Compared with NSM group, the participants in SM group report more vaginal delivery (57.2% *vs.* 31.6%) and less caesarean section deliveries (42.8% *vs.* 68.4%) from delivery room (p = 0.046). Regarding neonatal outcome, both survival (94.0% *vs.* 93.5%) and death (6.0% *vs.* 6.5%) were evaluated, and there are no significant differences observed between the two groups (p = 0.144). In participants with adequate or excessive GWG, there are no significant differences observed between the groups (p = 0.064).

4. Discussion

This study aimed to investigate the effectiveness of pregnancy and postpartum SM interventions on postpartum weight retention, among women with obesity during pregnancy. The results support our hypothesis that

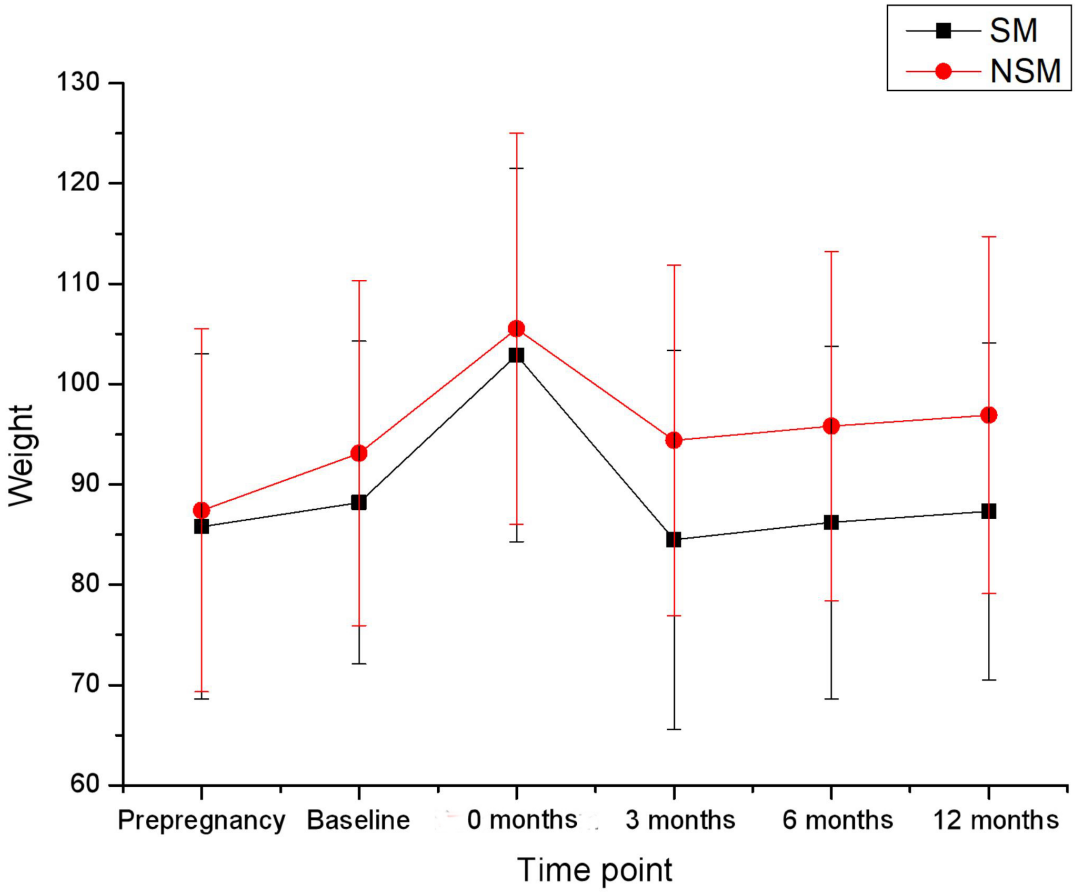

Fig. 2. Weight at different time points. SM, self-monitoring; NSM, no-self-monitoring. Prepregnancy: before pregnancy; Baseline: ≤18 weeks' gestation; 0 month: delivery room; 3, 6, 12 months: 3rd, 6th, and 12th month postpartum.

Table 3. Categorical weight retention outcomes.

	SM group (n = 201)	NSM group (n = 247)	Confidence interval	AOR
Percentage with no weight retention				
From prepregnancy to 3 months postpartum	48.3 (29.6, 66.2)	26.1 (16.5, 36.9)	95%	2.5 (1.2, 4.8)
From baseline to 3 months postpartum	77.3 (63.5, 90.8)	34.4 (21.7, 46.1)	95%	3.9 (2.2, 7.8)
From prepregnancy to 6 months postpartum	45.1 (26.8, 64.2)	32.4 (19.8, 44.5)	95%	2.1 (1.0, 4.1)
From baseline to 6 months postpartum	70.4 (55.8, 84.6)	38.2 (24.4, 51.7)	95%	3.8 (2.0, 7.4)
From prepregnancy to 12 months postpartum	41.9 (22.3, 61.6)	36.5 (22.7, 50.8)	95%	1.5 (0.6, 3.3)
From baseline to 12 months postpartum	60.1 (44.2, 75.4)	52.6 (38.8, 66.3)	95%	1.1 (0.5, 2.1)
Percentage who retained ≥5% of weight				
From prepregnancy to 3 months postpartum	25.4 (17.7, 33.0)	60.9 (48.1, 68.7)	95%	0.3 (0.1, 0.4)
From baseline to 3 months postpartum	20.2 (12.0, 27.6)	38.1 (27.9, 49.4)	95%	0.5 (0.2, 0.9)
From prepregnancy to 6 months postpartum	22.7 (15.7, 29.1)	51.7 (39.6, 63.8)	95%	0.3 (0.2, 0.6)
From baseline to 6 months postpartum	16.2 (8.5, 24.8)	30.4 (18.6, 31.6)	95%	0.6 (0.2, 1.2)
From prepregnancy to 12 months postpartum	19.2 (11.1, 27.6)	42.7 (29.0, 54.4)	95%	0.3 (0.3, 0.7)
From baseline to 12 months postpartum	14.7 (8.6, 20.4)	23.9 (14.4, 32.0)	95%	0.6 (0.3, 1.0)

AOR, adjusted odds ratios; SM, self-monitoring; NSM, no-self-monitoring.

women receiving higher-term independent SM activities retain less weight during postpartum compared to those receiving fewer, or no independent SM activities.

Our findings revealed a significant reduction in weight retention among women in the SM group compared to the NSM group. The intervention participants experienced less weight retention at 3 months postpartum and maintained this advantage up to 12 months postpartum. These results align with previous studies demonstrating the benefits of independent SM in weight management during, and af-

Table 4. Associations between independent SM and delivery methods, neonatal outcome, and GWG.

	SM group (n = 201)	NSM group (n = 247)	*p*-value
Delivery methods			0.046
Caesarean section	86 (42.8%)	169 (68.4%)	
Vaginal delivery	115 (57.2%)	78 (31.6%)	
Neonatal outcome			0.144
Survival	189 (94.0%)	231 (93.5%)	
Death	12 (6.0%)	16 (6.5%)	
GWG			0.064
5–9 kg	107 (53.2%)	79 (32.0%)	
>9 kg	69 (34.3%)	121 (49.0%)	

SM, self-monitoring; NSM, no-self-monitoring; GWG, gestational weight gain.

ter pregnancy [38–40]. Our study extends these findings by specifically targeting women with obesity during pregnancy, who are at higher risk for adverse pregnancy outcomes and long-term obesity development.

We also observed that SM participants had higher odds of experiencing no weight retention at 3 months postpartum from their prepregnancy weight or baseline weight, as well as lower odds of retaining ≥5% of their prepregnancy weight after delivery. However, the advantage of SM participants having no weight retention was no longer significant at 6 months postpartum. This finding suggests the importance of continued independent SM and support during the postpartum period in order to maintain weight management benefits. Further research could explore the optimal duration and intensity of independent SM interventions for sustained weight management in this population. Furthermore, participants who experienced excessive GWG exhibited a greater likelihood of retaining at least 5% of their prepregnancy weight following childbirth in comparison to those who had appropriate GWG. As elucidated in the study by Martínez-Hortelano [41], the noteworthy prevalence of GWG surpassing the guidelines established by the Institute of Medicine in 2009, particularly among women with overweight or obesity, coupled with its persistent upward trajectory in most geographical regions, underscores the imperative for clinicians to recommend lifestyle interventions aimed at enhancing weight management in women of reproductive age. Our findings suggest that SM represents a suitable lifestyle intervention for women with overweight or obesity.

Our results show that independent SM behavior can indeed improve delivery methods to a certain extent. The possible reason is that individuals with obesity change their BMI through independent SM behavior, leading to changes in their delivery methods. Pettersen-Dahl's report indicate that the delivery method will be affected by the pregnant women's BMI of [42]. Additionally, independent SM behavior is secure as independent SM behavior, and cannot affect survival rate of infants. Furthermore, our findings indicate that independent SM behavior can, to some extent, enhance delivery methods. This improvement may be attributed to individuals with obesity altering their BMI through independent SM behavior, which in turn leads to changes in their delivery methods. Pettersen-Dahl's study [42] supports this notion, as it demonstrates that the BMI of pregnant women influences their delivery method. Furthermore, independent SM behavior is considered safe, as it does not impact the survival rate of infants.

The strengths of our study include the multicenter prospective cohort design, the large sample size, and the use of mobile software for independent SM data collection, which allowed for real-time monitoring and feedback. However, there are several limitations to consider. First, we had a high exclusion rate due to missing data and lost follow-up, which may have introduced selection bias. Second, our study population was limited to women with obesity during pregnancy, and the results may not be generalizable to women with normal or overweight BMIs. Third, we did not assess the potential impact of other factors, such as physical activity, mental health, or social support, which could influence postpartum weight retention.

Despite these limitations, our study provides valuable insights into the potential benefits of pregnancy and postpartum independent SM interventions for weight management among women with obesity during pregnancy. Healthcare professionals should consider incorporating independent SM strategies into prenatal and postnatal care programs, in order to support healthy weight management and reduce the risk of adverse pregnancy outcomes and long-term obesity development. Future research should explore the mechanisms underlying the effectiveness of independent SM interventions, as well as the optimal duration, intensity, and format of such interventions to maximize their impact on postpartum weight management.

5. Conclusion

This multicenter observational study demonstrated the effectiveness of independent SM interventions, including dietary and weight measurements, in limiting postpartum weight retention among women with obesity during pregnancy, and enhancing delivery methods. Our findings suggest that healthcare professionals should integrate indepen-

dent SM strategies into prenatal and postnatal care programs to promote healthy weight management and decrease the risk of adverse pregnancy outcomes and long-term obesity development. Further research is warranted to explore the optimal duration, intensity, and format of independent SM interventions to maximize their impact on postpartum weight management.

Availability of Data and Materials

The data sets generated and/or analyzed during the current study are not publicly available due to ruler of hospital but are available from the corresponding author on reasonable request.

Author Contributions

HT and ZL conceived and designed the experiments. HT and ZL performed the experiments. HT and ZL analyzed the data. HT and ZL contributed reagents/materials/analysis tools. HT and ZL wrote the manuscript. HT and ZL revised the manuscript. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Jinan University (approval number: KY-2023-189).

Acknowledgment

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/j.ceog5101012.

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