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Original Research Paper

Interaction of time and breastfeeding type on maternal postpartum weight and body fat

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Abstract
Postpartum weight retention and excess adiposity increase the risk of long-term maternal obesity and cardiometabolic disease, yet evidence on how time and breastfeeding type affect early postpartum weight and body fat trajectories remains limited. This prospective cohort study examined the effect of time and breastfeeding type on changes in maternal postpartum weight and body fat percentage among 34 postpartum mothers (17 exclusively vs. 17 partially breastfeeding) selected through purposive sampling. Breastfeeding data was collected by interview, body weight was measured using a digital scale, and body fat percentage was assessed using skinfold anthropometry at the first week, 1 month, and 3 months postpartum. Data were analyzed using mixed-design ANOVA. Exclusively breastfeeding mothers showed gradual decreases in body weight and body fat percentage, whereas partially breastfeeding mothers showed increases over the same period (mean body weight 62.58; 61.25; 58.08 kg vs. 66.11; 67.38; 68.66 kg; and mean body fat percentage 31.05%; 29.65%; 27.28% vs. 29.26%; 30.94%; 32.72%). Although there were no significant differences in body weight ($p = 0.076$) or body fat percentage ($p = 0.888$) across time points, a significant interaction between breastfeeding time and type was found for both body weight ($p < 0.001$) and body fat percentage ($p < 0.001$), indicating different change trajectories between the two groups over time. Exclusive breastfeeding is linked to better postpartum weight and fat loss than partial breastfeeding. A larger sample and longer follow-up study including additional factors (maternal diet, physical activity, stress, and nutritional status during breastfeeding) are recommended.

Keywords: body composition; breastfeeding; maternal adiposity; maternal body fat; postpartum

1. Introduction

Breast milk (ASI) is the gold standard for nutritions for babies aged 0-6 months (WHO, 2021), contains nutrients that are useful for the growth and development of babies and increase intelligence optimally, and has various types of antibodies so that babies are not susceptible to disease (Victora et al., 2016). Breastfeeding also improves the health of the mother, reduces risk of bleeding as well as speeds up the recovery after giving birth, reduces the risk of obesity, type 2 diabetes mellitus, and breast and ovarian cancer (AWHONN, 2021). The decline in body weight and body fat percentage in mother reduces obesity.

As preparation, during pregnancy, the woman body experiences significant metabolic and physiological adaptations to support fetal and placental growth. One of the main changes is the need for energy and basal metabolic rate. Weight gain during pregnancy depends on the initial body mass index, and some of this gain is derived from maternal energy reserves in the form of fat (Most et al., 2019).

The early postpartum period, or the first month, is a critical time when the mother's body undergoes significant physiological changes, including weight loss and changes in body fat

composition. One important change is a decrease in body fat, which supports maternal health recovery and breast milk production. Breastfeeding plays a crucial role in mobilizing energy reserves. Breast milk production requires an average of 500-750 kcal of energy per day, depending on the volume and composition of the milk produced (WHO, 2021). If calorie intake is increased by 500 kcal/day, the remaining 250-300 kcal is mobilized from the mother's energy reserves, primarily fat. This means that exclusive breastfeeding can help naturally reduce maternal fat and weight gain after delivery. Fat stores during pregnancy, amounting to 4 kg, approximately equals to 36,000 kcal, can be depleted within 3-4 months if the mother breastfeeds consistently (WHO, 2021). This finding aligns with the theory of maternal metabolic adaptation during lactation, where maternal fat stores are utilized to meet the increased energy requirements for breast milk production (Anhˆe & Bordin, 2022).

If fat reserves are not mobilized and the mother's body fat loss does not occur optimally, the mother is at risk of postpartum weight retention, which can progress to overweight or obesity. Research of Li et al. (2020) indicates a positive association between body fat percentage and maternal weight retention 42 days postpartum. Postpartum weight retention is a significant risk factor for obesity one year postpartum, even in women with normal pre-pregnancy weight (Nagpal et al., 2021).

Postpartum weight retention, or the mother's inability to return to pre-pregnancy weight, can increase the risk of various long-term health problems. Approximately 25% of women retain at least 4.5 kg of body weight at 6–12 months postpartum, increasing the risk of hypertension, type 2 diabetes mellitus, and cardiovascular disease later in life (ACOG, 2021; Tsai & Nicholson, 2017). Therefore, exclusive breastfeeding not only benefits the baby's health but can also contribute to the mother's future weight management and metabolic health. However, the metabolic benefits for the mother are less explored than those for the baby.

Existing studies have reported inconsistent findings regarding the relationship between breastfeeding and postpartum maternal weight and body composition. Several recent studies reported that exclusive or full breastfeeding was associated with reductions in postpartum weight retention and improvements in maternal body composition indicators (Guzmán-Mercado et al., 2021; Loy et al., 2024; Rabi et al., 2021). However, other longitudinal studies demonstrated that postpartum weight change patterns among breastfeeding mothers varied considerably across the postpartum period (Aktac & Boran, 2022). These variations may be influenced by breastfeeding duration, postpartum observation period, maternal characteristics, and body composition assessment methods (Biddulph et al., 2022; Jayasinghe et al., 2021).

Most previous studies focused on body weight or BMI, while studies specifically examining longitudinal changes in maternal body fat percentage during the early postpartum (1-3 months postpartum) period remain limited. Weight alone cannot accurately reflect changes in body composition, particularly body fat percentage, which plays a crucial role in metabolic health, postpartum recovery, and breast milk production (Biddulph et al., 2022; Dalrymple et al., 2024). Furthermore, postpartum maternal body fat percentage has also not been officially reported as an indicator in global surveys conducted by the WHO or the Ministry of Health of the Republic of Indonesia. Simple indicators such as BMI, weight, and height are still used because they are easier to measure in the field, including at the Prambonwetan Tuban community health center. Preliminary observations there showed variability in postpartum weight changes among breastfeeding mothers, with 6 out of 15 mothers (40%) experiencing continued weight gain during the first month postpartum.

Therefore, the novelty of this study lies in the simultaneous longitudinal assessment of maternal body weight and body fat percentage using skinfold anthropometry among exclusive and partial breastfeeding mothers during the first three months postpartum in a primary healthcare setting. The study aims to analyze the effect of breastfeeding time and type on postpartum maternal weight loss and body fat percentage among mothers at the Prambonwetan Tuban Community Health Center. The

research results are expected to be used as a more effective strategy for promoting breastfeeding by providing a new understanding that the benefits of breastfeeding are not only the best nutrition and maintaining health for babies, but also contribute to weight loss and body fat percentage in mothers as a protective factor against the risk of obesity and metabolic disorders in mothers.

2. Research Methods

This quantitative prospective cohort study was conducted from March to July 2025 at the Prambonwetan community health center in Tuban. This study involved 34 postpartum women (17 women practiced exclusive breastfeeding and 17 women practiced partial breastfeeding) selected using purposive sampling from an initial population of 48 postpartum women who gave birth between March and April 2025. Confinement was achieved through inclusion criteria (mothers 2–7 days postpartum, singleton births, willingness to participate, and informed consent) and exclusion criteria (chronic illnesses and metabolic disorders such as diabetes mellitus, thyroid disorders, chronic kidney or liver disorders, cancer, and tuberculosis; use of weight-loss medications; or withdrawal from the study). The relatively small sample from a single primary healthcare center limits generalizability. All eligible partial breastfeeding mothers were included due to their limited number, while an equal number of exclusive breastfeeding mothers were randomly selected to ensure balanced comparison. Baseline characteristics such as age, parity, education, occupation, gestational age, and infant birth weight were documented to describe participant characteristics that may influence breastfeeding practices and postpartum body composition. However, pre-pregnancy BMI and other potential confounders such as dietary intake, physical activity, stress levels, and sleep duration were not controlled or measured in this study.

This study used breastfeeding type (exclusive, non-exclusive, or partial) as the independent, which were measured using interview guidelines based on the 2022 SSGI Individual Toddler Questionnaire (Kementerian Kesehatan RI, 2022). The dependent variables were maternal weight and body fat percentage. Weight was measured with a digital scale, and maternal body fat percentage was determined by anthropometric measurements with skinfold calipers at the suprailiac site, a strong predictor of postpartum body fat changes and commonly used in lactating women (Biddulph et al., 2022).

Three measurements were taken at the first week (days 2–7), 1 month, and 3 months postpartum to assess changes in weight and body fat percentage and to compare trajectories between exclusively and partially breastfeeding mothers. Data on the characteristics of breastfeeding mothers and infants were obtained from the mother's KIA (Mother's and Child's Health) handbook. Data were analyzed univariately using frequency distributions and percentages, followed by mixed-design ANOVA (α = 0.05, 95% CI) to examine differences in changes in weight and body fat percentage over time and between groups, after a Shapiro–Wilk test confirmed data normality and met ANOVA requirements. This study received ethical approval from the Health Research Ethics Committee of Universitas Muhammadiyah Lamongan (No: 036/EC/KEPK-S2/03/2025).

3. Results and Discussion

3.1. Results

3.1.1. Respondent Characteristics

The results in Table 1 show that the majority of respondents were aged 20–35 years (29; 85.3%). Over half had a high school education (20; 58.8%) and worked as housewives (19; 55.9%). Most were multiparous (22; 64.7%) and delivered at term 37–42 weeks of gestation (33; 97.1%). More than half of infants were male (20; 58.8%), and all newborns weighed between 2,500 and 4,000 g (29; 100%). Some respondents, as many as 17 people (50.0%), 17 mothers (50.0%) practiced exclusive

breastfeeding for the first six months, while 17 (50.0%) provided partial breastfeeding (breast milk plus formula or other foods/drinks).

Table 1. Respondent Characteristics

	Variable	Frequency	Percentage (%)
Age	<20 years old	0	0
	20-35 years old	29	85.3
	>35 years old	5	14.7
Education	Elementary School	1	2.9
	Junior High School/Equivalent	2	5.9
	Senior High School/Equivalent	20	58.8
	Diploma 3/Bachelor's Degree	11	32.4
Occupation	Housewive	19	55.9
	Private Employee	9	26.5
	Teacher	2	5.9
	Civil Servant	1	2.9
	Self–Employed	3	8.8
Parity	Primipara	11	32.4
	Multipara	22	64.7
	Grande Multipara	1	2.9
Gestational Age	< 37 weeks	0	0
	37 - 42 weeks	33	97.1
	>42 weeks	1	2.9
Baby Weight	< 2500 gr	0	0
	2500 - 4000 gr	34	100
	> 4000 gr	0	0
Baby Sex	Male	20	58.8
	Female	14	41.2
Breastfeeding Type	Exclusive Breastfeeding	17	50.0
	Partial Breastfeeding	17	50.0

3.1.2. Changes in Body Weight and Body Fat Percentage of Respondents

The Shapiro–Wilk test showed a significance value of $p > 0.05$ for all time points in both groups, indicating that the data were normally distributed and qualified for a mixed-design ANOVA. However, Mauchly's Test of Sphericity showed $p < 0.05$ for both variables, therefore, the analysis used the Greenhouse–Geisser (G-G) correction.

Table 2. Descriptive Statistics of Mean Body Weight and Body Fat Percentage of Postpartum Mothers

Observation Period	Body Weight(kg)		Body Fat Percentage (%)	
	Exclusive Breastfeeding	Partial Breastfeeding	Exclusive Breastfeeding	Partial Breastfeeding
First Week	62.58 ± 1.35	66.11 ± 1.35	31.05 ± 0.94	29.26 ± 0.94
1 Month	61.25 ± 1.47	67.38 ± 1.47	29.65 ± 0.95	30.94 ± 0.95
3 Moths	58.08 ± 1.85	68.66 ± 1.85	27.28 ± 1.20	32.72 ± 1.20

The analysis results in Table 2 show the average weight and body fat percentage of postpartum mothers based on breastfeeding type and observation period. Mothers who exclusively breastfed experienced a gradual decrease in both weight and body fat from the first week to three months postpartum. In contrast, mothers who partially breastfed showed increases in both variables during the same period. This difference can be clearly seen in Figure 1A and IB. Among exclusively

breastfeeding mothers, the majority demonstrated a decrease in body fat percentage. However, 6 of 17 (35.29%) participants exhibited an increase, indicating variability in postpartum body composition changes.

There was no significant overall difference in maternal weight across observation periods ($p = 0.076$). However, a significant difference was observed between breastfeeding groups ($p = 0.003$), and the interaction between time and breastfeeding type was also significant ($p < 0.001$) (see Table 3), indicating different weight change trajectories between exclusive and partial breastfeeding mothers during the postpartum period. Mothers who exclusively breastfed tended to show a downward weight trend, whereas mothers who partially breastfed showed relatively stable or increasing weight patterns over time.

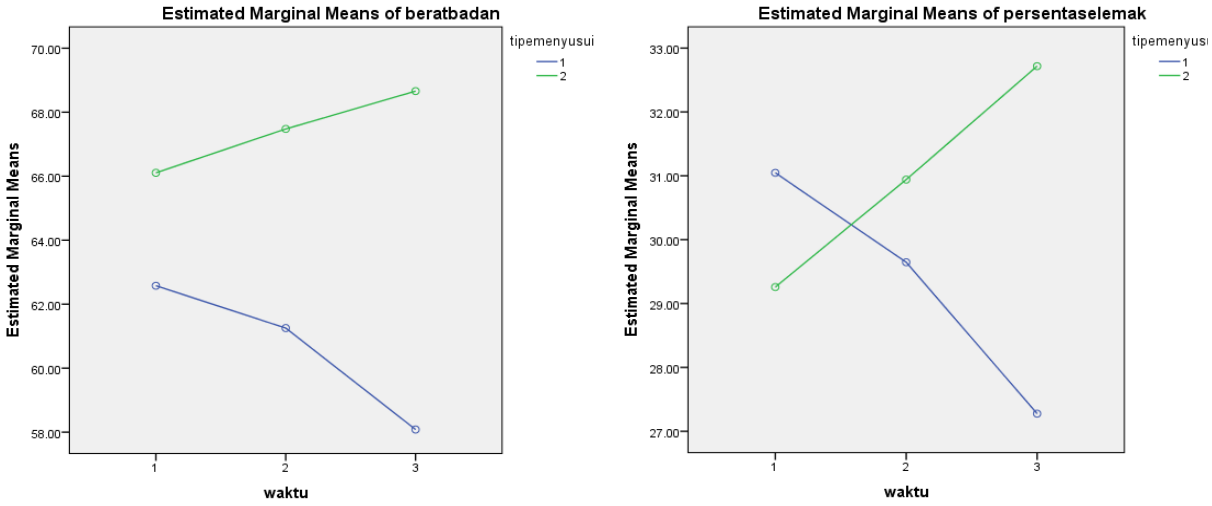

Figure 1A. Changes in Maternal Body Weight **Figure 1B.** Changes in Maternal Body Fat

Regarding body fat percentage, no significant overall differences were observed across time ($p = 0.888$) or between breastfeeding groups ($p = 0.209$). Nevertheless, the significant interaction between time and breastfeeding type ($p < 0.001$) suggests that body fat percentage trajectories differed between exclusive and partial breastfeeding mothers during the postpartum period. The findings suggest different longitudinal patterns of maternal weight and body fat changes between exclusive and partial breastfeeding mothers during the first three months postpartum.

Table 3. Mixed-Design ANOVA Results on Body Weight and Body Fat Percentage

Variable	Source of Variations	df (G-G)	F calculated	Sig. (p)
Body Weight (kg)	Period	1.154	2.686	0.105
	Breastfeeding Type	1.32	9.951	0.003
	Period × Breastfeeding Type	1.154	26.380	0.000
Body Fat Percentage (%)	Period	1.130	0.120	0.763
	Breastfeeding Type	1.32	1.643	0.209
	Period × Breastfeeding Type	1.130	17.808	0.000

Table 4 shows the Estimated Marginal Means (EMMs) values, indicating that the average weight and body fat of exclusively breastfeeding mothers were lower than those of partially breastfeeding mothers. These results indicate that exclusive breastfeeding plays a role in reducing postpartum maternal weight and body fat.

Table 4. Estimated Marginal Means (EMMs) of Postpartum Maternal Body Weight and Body Fat

Variable	Factor	Mean ± Std. Error	95% Confidence Interval
Body Weight (kg)	Exclusive	60.64 ± 1.52	57.54 – 63.73
	Partial	67.41 ± 1.52	64.32 – 70.51
	Overal mean	64.03 ± 1.07	61.84 – 66.21
Body Fat Percentage (%)	Exclusive	29.32 ± 0.91	27.47 – 31.18
	Partial	30.97 ± 0.91	29.12 – 32.83
	Overal mean	30.15 ± 0.66	28.80 – 31.51

3.2.Discussion

The WHO and the Indonesian Ministry of Health recommend exclusive breastfeeding for the first six months of a baby's life without additional food or drink, including water, except for specific medical indications (Kementerian Kesehatan RI, 2023). The study found that 17 mothers were still not exclusively breastfeeding or partially breastfeeding. While, providing supplementary food or formula before 6 months of age can disrupt the baby's immature digestive system and increase the risk of gastrointestinal infections and allergies (WHO, 2021). Furthermore, giving other foods too early can make the baby feel full, leading baby to breastfeed less, which ultimately reduces breast milk production due to the lack of stimulation from the baby's sucking.

Maternal demographic characteristics such as age, education level, occupation, and parity are predisposing factors that can influence the success of exclusive breastfeeding (Ren et al., 2024). In this study, the majority of mothers were aged 26–30 years (85.3%), a mature reproductive age range often associated with better physiological and psychological readiness for breastfeeding and higher exclusive-breastfeeding rates compared with too young or older mothers (Efriani & Astuti, 2020). However, other studies report no mother age effect on exclusive breastfeeding (Ummah et al., 2025), and mother age (under 20 or over 35 years) related challenges in breast milk production or postpartum recovery can be modified by education and social support (Akse et al., 2023; Dalrymple et al., 2024).

Most mothers had a high school education (58.8%). Education plays a significant role in shaping mothers' understanding and behavior regarding breastfeeding practices. Research indicates that the higher a mother's education, the greater her understanding of the importance of exclusive breastfeeding, including awareness of the long-term health benefits for the baby (Ummah et al., 2025). Perceived insufficient milk supply was a common reason for supplementing with formula, reflecting gaps in maternal knowledge, perceptions of adequate milk supply correlate with continued exclusive breastfeeding (Agustina et al., 2020; Sandhi et al., 2020). whereas perceived insufficiency is a major barrier (Nguyen et al., 2021). Maternal knowledge is the dominant factor of exclusive breastfeeding behavior (Kapti et al., 2023) and aggressive formula marketing via digital media can undermine breastfeeding among mothers and families with limited information (Ratnasari et al., 2017).

More than half of mothers in this study (55.9%) are housewives, meaning they have more time to breastfeed their babies and thus support exclusive breastfeeding, as they are not interrupted by work schedules outside the home. Conversely, maternal employment status has been shown to be the most significant risk factor preventing mothers from exclusively breastfeeding (Mastan & Achadi, 2021). Most of breastfeeding mothers are multiparous (64.7%), who already have previous experience in parenting. Susanti & Maha (2025) found that parity is significantly associated with exclusive breastfeeding. Mothers with higher parity tend to have a better breastfeeding experience, longer breastfeeding duration, higher rates of exclusive breastfeeding and lower weight retention than primiparous mothers (Rosenbaum et al., 2022; Sandhi et al., 2020). Previous experience provides greater confidence and ability to carry out the breastfeeding process. Mothers with high breastfeeding confidence scores are less likely to provide expressed breast milk and are more likely to sustain exclusive breastfeeding for longer (Fan et al., 2022).

Meanwhile, the majority of mature gestational ages (37–42 weeks) and normal birth weights (2500–4000 grams) indicate a healthy initial condition, supporting the initiation and continuation of effective breastfeeding practices (Agyekum et al., 2022), as physiologically, babies have mature sucking and swallowing reflexes, enabling them to accept breast milk well. Low birth weight and preterm infants frequently experience immature feeding coordination, which may interfere with effective breastfeeding (Giannì et al., 2021).

The findings of this study showed that changes in maternal body weight and body fat percentage during the postpartum period were influenced by both breastfeeding type and duration of follow-up. Mothers who exclusively breastfed generally experienced gradual reductions in body weight and body fat percentage throughout the first three months after delivery. In contrast, mothers who partially breastfed tended to show increasing anthropometric measurements over the same period. These results suggest that postpartum body composition may change differently depending on breastfeeding practices over time.

The interaction effect identified in this study indicates that the pattern of postpartum body composition changes cannot be explained solely by breastfeeding type or duration, but rather by their interaction. Although no overall significant difference in body fat percentage was observed between groups, repeated measurements revealed distinct trajectories of change throughout the postpartum period. This emphasizes the importance of longitudinal monitoring when assessing maternal body composition during lactation.

These findings align with Rosenbaum et al. (2022), who found that exclusively breastfed mother had a lower body mass index (BMI) than those who did not exclusively breastfed. This demonstrates the protective role of exclusive breastfeeding in postpartum weight retention. Mothers who exclusively breastfeed have lower postpartum weight retention than mothers who partially breastfeed or do not breastfeed at all (Dalrymple et al., 2024). Longer breastfeeding duration is associated with lower postpartum weight retention and reduced maternal adiposity indicators (Tahir et al., 2019; Waits et al., 2020). This suggests that exclusive breastfeeding interventions have a differential impact on postpartum maternal body composition over time, compared to mothers who do not exclusively breastfeed, either partially or not (Blanco et al., 2023).

The mechanisms underlying significant physiological changes in maternal weight and body fat levels of postpartum mothers likely involve higher energy expenditure during breast milk production and hormonal changes that support the mobilization of maternal body fat reserves. The energy used to produce breast milk comes largely from the mother's body fat reserves developed during pregnancy. This decrease in fat percentage indicates that exclusive breastfeeding can have a physiological effect on body fat mobilization during the postpartum period. The breastfeeding process requires approximately 500 kcal of energy per day, most of which is obtained from the mother's body fat reserves (Anhê & Bordin, 2022; Calcaterra et al., 2025). Therefore, breastfeeding mothers generally experience a gradual decrease in body weight and fat percentage, especially if breastfeeding is done regularly and exclusively. Thus, exclusive breastfeeding can accelerate the process of body fat mobilization and aid postpartum weight loss. It is contrary to the mothers who partially breastfeed and tend to experience less energy expenditure than mothers who exclusively breastfeed, due to the lower frequency and intensity of breastfeeding.

Exclusive breastfeeding can also influence the regulation of metabolic hormones such as oxytocin and prolactin, which help increase the mother's metabolism (Victora et al., 2016). Decreased progesterone levels and increased oxytocin and prolactin levels contribute to accelerated fat metabolism. Oxytocin released during breastfeeding also stimulates uterine contractions and increases energy expenditure. Therefore, if a breastfeeding mother consumes a balanced, nutritious diet and remains active, even light exercise, the process of body fat loss will be more optimal. Furthermore,

breast milk contains various bioactive components that can influence maternal metabolism and support gradual, sustainable weight loss after delivery (Marshall et al., 2022).

Breastfeeding during the postpartum period can help the mother's body return to its pre-pregnancy body composition, especially when combined with a healthy lifestyle. Mothers who exclusively breastfeed have a 6.8% lower body fat percentage compared to mothers who breastfeed non-exclusively (Khasanah et al, 2019). Exclusive breastfeeding practices not only impact postpartum maternal body composition but also have longer-term effects. Within one year after giving birth, breastfeeding mothers had a lower BMI ($p=0.0014$), lower subcutaneous adipose tissue thickness ($p<0.001$), and a lower risk of obesity ($p=0.016$) (Ćwiek et al., 2023).

However, the results of this study also showed that not all exclusively breastfeeding mothers experienced a decrease in body fat. Six mothers who exclusively breastfed experienced an increase in body fat percentage, and 4 mothers who did not exclusively breastfeed or who only partially breastfed experienced a decrease. These results indicate individual variability. Other factors may contribute, such as food intake, physical activity, and stress. A balanced diet supports normal metabolic processes; conversely, an unbalanced diet will disrupt them. Light to moderate physical activity, such as walking, postpartum exercises, and baby-carrying, helps increase energy expenditure, thereby accelerating the mobilization of fat reserves. Calorie-restricted exercise is associated with weight loss in breastfeeding women (Meyers & Hong, 2020).

Previous studies found that depression and life stress were significantly associated with higher postpartum weight retention (Goldstein et al., 2016; Straub et al., 2016). When stressed, the body increases cortisol levels, which can disrupt fat metabolism, making the body more likely to store fat rather than mobilize it. As a result, fat percentage reduction can be slower. Excessive stress can inhibit milk production, reducing the energy used for milk production. This also slows down the mother's fat reserves. Mothers with high levels of stress are also more likely to experience emotional eating or, conversely, a decreased appetite, both of which can disrupt normal metabolic processes.

This study's strengths include its prospective design and repeated skinfold measurement of body fat to evaluate maternal body fat percentage during the early postpartum period, together with the analysis of interaction effects between breastfeeding type and postpartum time. However, the sample size was limited, follow-up was short (three months), and body fat was assessed using a single method. Several potentially important covariates such as daily energy intake, physical activity, stress level, and individual metabolic variation were not measured. Nevertheless, the study's findings support the hypothesis that exclusive breastfeeding is associated with greater weight loss and body fat percentage. Intensive lactation increases energy needs and accelerates the breakdown of body fat reserves for breast milk production, thus supporting physiological weight loss. These findings confirm the dual benefits of exclusive breastfeeding for maternal health recovery and infant growth. Exclusive breastfeeding not only provides optimal nutritional benefits for infants but also serves as a natural and cost-effective strategy to support maternal health and metabolic recovery of the postpartum mothers.

4. Conclusion

This study demonstrates that breastfeeding type influences changes in maternal weight and body fat percentage postpartum, primarily through a significant interaction between time and breastfeeding type. Mothers who exclusively breastfeed experience a gradual decrease in weight and body fat percentage from the first week to three months postpartum, while mothers who partially breastfeed tend to experience an increase in both parameters. These findings add further evidence regarding postpartum body composition changes among breastfeeding mothers in community-based populations. Exclusive breastfeeding has dual benefits for maternal and infant health and has the potential to reduce the risk of postpartum obesity. Health workers, especially midwives and nutritionists should

actively promote and support exclusive breastfeeding, emphasize the potential physiological benefits to boost maternal motivation, and offer postpartum nutritional counseling with routine monitoring of weight and body fat to identify those at risk of adverse weight retention. Future research should involve a larger sample, extend follow-up, include multiple repeated body-composition assessments and also be expanded by considering additional factors such as maternal diet, physical activity, stress level and nutritional status during breastfeeding.

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