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Risk Factors for Early Weight Loss in Breastfed Term Infants: Biomedical Perspective

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ABSTRACT

Infants can lose some of their birth weight in the first weeks of life. Identification of the risk factors associated with breastfed infant weight loss in the few weeks following the birth can increase the success of exclusive breastfeeding. The aim of this research was to determine the risk factors in breastfed full-term infants that cause early weight loss at a hospital. This study was retrospective study, which analyzes weight loss in breastfed term infants born between July 1, 2024, and October 31, 2024, at hospital in Boyolali, Central Java. A total of 194 infants were included in the study. The variables studied the maternal age, method of delivery, infant's birth weight, infant's gender, and maternal parity. Pearson Chi-Square test was used to compar categorical data. Logistic Regression with the Backward Stepwise method was used to analyze multivariate data. Caesarean section was statistically significant risk factor for early weight loss in breastfed term infants that increases the chance of weight loss by 1.56 times. We concluded that caesarean section increased the chance of early weight loss in breastfed term infants.

KEYWORDS:
Early Weight Loss, Infants, Risk Factor, Breastfed, Term

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INTRODUCTION

Exclusive breastfeeding has a significant means giving breast milk without additional fluids or other food except medication for medical indications in infants aged 0 - 6 months.[1] Exclusive breastfeeding can give protection to infants from various infections, such as diarrhea, respiratory tract infections, ear infections, pneumonia and urinary tract infections. Breast milk can also be used to prevent the risk of other diseases in the future, such as obesity, allergies, inflammatory bowel disease, diabetes, cancer and stunting.[2,3] Human milk oligosaccharide (HMO) founded in breastmilk, apart from being associated with development food sensitization in the first year of life, it is also related to infant's digestive health. Composition of HMO influenced by maternal diet and other environmental exposures, breastfeeding exclusivity, and genetics including fucosyltransferase-2 secretor, which is a strong determinant of the microbiome. Microbiome in breast milk play an important part in the regulation of the immune system and helps establish a healthy microbiome in infants by influencing gut and respiratory microbiota.[4]

WHO data shows that coverage of exclusive breastfeeding globally during the 2014-2019 period only reached 39%. Meanwhile, data from the United Nations International Children's Emergency Fund (UNICEF) shows that only 3% of mothers provide exclusive breastfeeding for six months, with

exclusive breastfeeding coverage in Indonesia only 55%.[2] The Indonesian Ministry of Health targets exclusive breastfeeding coverage of 60% in 2024, however exclusive breastfeeding coverage in Indonesia in 2020 was 53.9%, which has not met the target. Based on data from the Badan Pusat Statistik (BPS), exclusive breastfeeding coverage per year in Central Java Province for babies under six months reached 78.93% (2020), 78.71% (2021), and 80.20% (2022).[5] However, exclusive breastfeeding coverage in Boyolali Regency in 2022 is 79.1%, with the exclusive breastfeeding target in Boyolali Regency being 65%.[6]

Exclusive breastfeeding affects the increase in infant weight.[7] This is in line with the results of a study conducted by Hardiningsih & Yunita that there is a relationship between exclusive breastfeeding and increased infant weight.[8] Siregar & Ritonga found a relationship between exclusive breastfeeding and weight growth in infants aged 0-6 months.[9] However, almost all infants experience weight loss in the first days of life, which is mainly caused by fluid reduction.[10-12] Infant weight loss is also a consequence of the use of adipose tissue as an energy source by newborns.[13] Excessive weight loss is associated with complications such as jaundice, hypoglycemia, and dehydration, which cause kidney failure, thrombosis, hypovolemic shock, and seizures.[14-18] It is important to determine the risk factors for weight loss to find preventive measures. Cesarean section is known to be a risk factor for weight loss in infants.[19] The presence of other risk factors, such as primiparity, early gestational weeks, older maternal age, and female gender are statistically significant risk factors for early weight loss in newborns.[20] Caesarean section is a potential factor that can cause weight loss in babies.[21] There has been no study in Indonesia that measures the risk factors for early weight loss in breastfed term infants, especially in Boyolali, Central Java. Therefore, the aim of this study was to determine the factors associated with weight loss in term infants who were breastfed in hospital.

METHODS

This research has received ethical approval from the UMS Faculty of Medicine Ethics Commission with the number 5388A/B.2/KEPK-FKUMS/XI/2024. This research was a retrospective observational study without patient contact. The study was conducted in a hospital in Boyolali, Central Java. We included infants born at ≥37 weeks of gestation between July 1, 2024, and October 31, 2024. We excluded cases of multiple births, low birth weight, cases where the infant was admitted to the neonatal intensive care unit (NICU), or referred to other facilities, and cases of exclusive formula feeding. All mothers were educated about breastfeeding after delivery and during hospitalization. After delivery, the newborn undergoes a pediatric assessment. The focus is on direct skin-to-skin contact and initiating

breastfeeding. During hospital stay, nursing and midwifery staff monitor mother and baby closely to minimize potential challenges to breastfeeding. Exclusive breastfeeding and rooming in were prioritized unless there were medical complications related to the mother or infant.

We retrospectively obtained demographic and perinatal data from patient medical records. The study included 194 infants, with several exclusion criteria applied. Specifically, the study excluded babies who: were not breastfed, were born before 37 weeks' gestation or after 42 weeks' gestation, had a birth weight below 2500 grams, were diagnosed with a metabolic or congenital condition, were admitted to the Neonatal Intensive Care Unit (NICU), have an APGAR score below 7, or multiple births (e.g. twins or triplets). Figure 1 illustrates the process of selecting research participants.

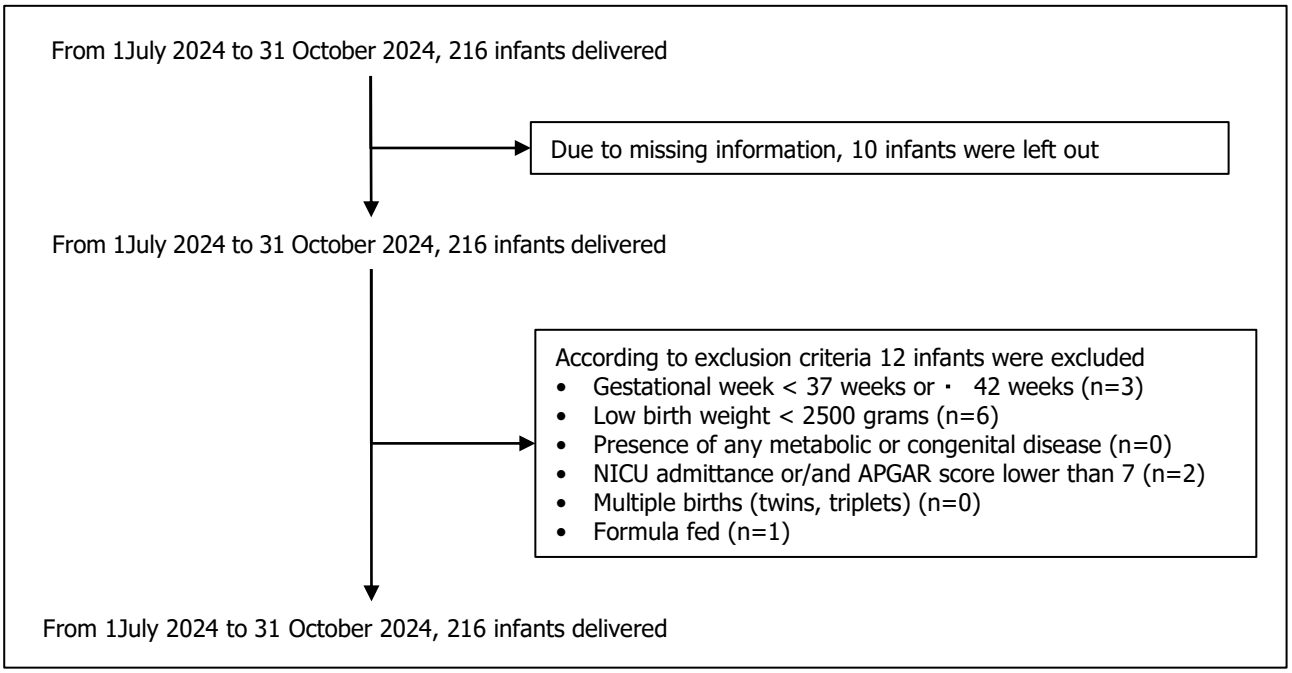

Figure 1. Flowchart of the study

This study involved a retrospective review of medical records to collect demographic and perinatal information. The researchers studied various characteristics of mothers and babies, including the maternal age, method of delivery (categorized as standard vaginal delivery, vacuum-assisted delivery, or cesarean section), infant's birth weight, infant's gender, and maternal parity. Maternal age was grouped into two groups: women over 35 years and women aged 35 years and under, using classification criteria established by Badan Koordinasi Keluarga Berencana Nasional (BKKBN).[22] Parity was classified into primiparous and multiparous. Infant weight was then measured during the postpartum period (7-14 days after delivery) at the outpatient clinic. Infant weight was compared with birth weight and classified into weight gain and weight loss.

This study received ethical clearance from the local ethics committee. Because this was a retrospective study, individual informed consent was

not required. This research adhered to the ethical standards outlined in the Declaration of Helsinki.

Statistical analysis was carried out using STATA 17 software. To compare categorical data, the Pearson Chi-Square test was used. Logistic Regression with the Backward Stepwise method is used to analyze multivariate data. Statistical significance was determined at a 95% confidence interval, with a p value of less than 0.05 considered statistically significant.

RESULT AND DISCUSSION

Hospital records of 194 healthy term infants were evaluated. All infants were initially exclusively breastfed after birth. Most mothers were under 35 years of age (89.7%). Most mothers were primiparous (82.5%). Infants were mostly born through normal delivery or vacuum-assisted delivery (VAD) (55.7%). Male infants accounted for 54.6% of the total infants. Maternal and infant characteristics are presented in Table 1.

Table 1. Characteristics of mothers and infants (n=194)

		n	%
Maternal Age	≤35	174	89.7
	>35	20	10.3
Parity	Primipara	160	82.5
	Multipara	34	17.5
Delivery Mode	Caesarean	86	44.3
	Vaginal birth/VAD	108	55.7
Gender	Boy	106	54.6
	Girl	88	45.4
Infant's weight	Gain	130	67
	Loss	64	33

Risk factors were then analyzed, which showed statistically significant results for infant weight after bivariate analysis were maternal age, parity and mode of delivery (Table 2). Older maternal age, higher parity and cesarean section were significant risk factors for infant weight. We also analyzed excessive weight loss, defined as a weight loss of ≥10% in postnatal life, especially in the first 5 days of life in relation to birth weight.[17] Excessive weight loss was identified and evaluated as one group (Table 3). Two of the four infants had high total bilirubin levels on day 5, so light therapy was performed according to the threshold of light therapy for infants.[23]

Table 2. Evaluated Risk Factors for Infant's Weight in Bivariate Analysis (n=194)

		Infant's Weight Loss		Infant's Weight Gain		RR	95% CI		*p*
		n	%	n	%		Lower	Upper	
Maternal Age	**>35**	11	55.0	9	45.0%	1.81	1.14	2.85	0.027
	≤35	53	30.5	121	69.5				
Parity	**Multipara**	17	50.0	17	50.0	1.70	1.13	2.57	0.020
	Primipara	47	29.4	113	70.6				
Delivery Mode	**Caesarean**	39	45.3	47	54.7	1.96	1.29	2.97	0.001
	Vaginal birth/VAD	25	23.1	83	76.9				
Gender	**Boy**	38	35.8	68	64.2	1.21	0.80	1.83	0.353
	Girl	26	29.5	62	70.5				

Table 3. Characteristics of Infant's Excessive Weight Loss (n=4)

Maternal Age	Parity	Gestational Age (weeks)	Infant's Weight Loss per Day (g)	% Weight Reduction in First 5 Days	Total Bilirubin (mg/dl)
≤35	Multipara	38	60	10.3	14.2
≤35	Primipara	37	100	14.7	21.5
≤35	Multipara	37	74	12.3	21.03
>35	Multipara	37	86	10.75	16.2

Only one of the risk factors was proven to be statistically significant after logistic regression analysis (Table 4), namely cesarean section. Cesarean section is the most prominent risk factor that increases the odds of early weight loss by 1.56 times.

Table 4. Multivariate Analysis of Risk Factors for Early Weight Loss in Infants

Birthweight (g)	Adjusted RR	95% CI		*p*
		Lower	Upper	
Maternal Age >35	1.40	0.98	1.64	0.059
Multipara	1.26	0.85	1.59	0.219
Caesarean section	1.56	1.23	1.81	0.001

This is the first study in Boyolali, Central Java, Indonesia to investigate risk factors for early weight loss in breastfed term infants. Cesarean section is a significant risk factor found in our study.

According to research conducted by Eren et al, several factors were identified as statistically significant contributors to early weight loss in newborns. These risk factors include delivery via caesarean section, first time motherhood (primiparous), birth at an early gestational age, maternal age over 35 years, and the gender of the baby girl. Among these factors, cesarean delivery is the greatest risk factor, which dramatically increases the probability of premature weight loss by almost 8 times.[20] Kurai et al showed that infants born via caesarean section and exclusively breastfed experienced much greater early weight loss in the early postpartum period compared to babies born vaginally. Developing weight loss percentile charts specific to different delivery methods can provide two main benefits: they enable more accurate predictions of expected baby weight loss and help reassure mothers, potentially encouraging continued commitment to exclusive breastfeeding.[24]

Our findings align with the systematic review by Kelly et al, which confirmed that cesarean delivery is correlated with higher neonatal weight loss in the early days of life compared with vaginal delivery.[19] Mechanisms underlying increased weight loss in newborns undergoing cesarean section include delayed skin-to-skin contact, postoperative maternal discomfort, and intravenous fluid administration. These factors collectively contribute to reduced success rates in exclusive breastfeeding.[20]

Perinatal stress causes increased production of catecholamines and cortisol in infants, which is important for the adaptation of the circulatory system to extrauterine life and development of pulmonary maturity.[25] Infants born by caesarean section show a lower expression of pain and lower level of cortisol, adrenaline and noradrenaline in the umbilical cord blood compared to vaginal birth, which cause a decline TLR1-2 triggered TNF-α and IL-6 responses at birth.[26] Delivery by caesarean section may reduce the activity of various cytokines and this process may have impact on developing immune system. Lower level of cortisol might result in the increased percentage of adaptation complications in neonates, such as respiratory

disorder, transient tachypnea, or postpartum hypoglycemia, which can result weight loss in infants and increased risk of developing immune disease, including asthma and allergic rhinitis.[21,27]

Delivery by caesarean section cause disturbing colonization with bacterial microflora within the skin and digestive tract, because possibility transfer of *Lactobacillus*, *Bifidobacterium* and *Bacteroides* to the infant digestive tract is higher during vaginal delivery. The bacteria play an important part in the regulation of the immune system, so that ultimately affects the amount NK cells, T lymphocytes, IgA secretion, and proinflammatory cytokine synthesis. In infants born by caesarean section, meconium is found in smaller quantities of *Lactobacillus*, *Bifidobacterium*, *Bacteroides* and *Prevotella* bacteria compared with neonates born vaginally.[28] The dominant bacteria found in meconium in infants born by caesarean section include iatrogenic bacterial species such as *Staphylococcus*, *Streptococcus*, *Klebsiella*, *Enterococcus* and *Clostridium*. *Bifidobacterium* bacteria function in synthesis short chain fatty acids (SCFA), but these bacteria undergo rapid elimination from the digestive tract's infants born by caesarean section.[29] SCFA link early gut colonization with immune maturation and contributes to the balance between pro- and anti-inflammatory reactions, including transferring signals with a group of G protein-coupled receptors (GPR), which is found not only in digestive system cells, but also in immune cells and nervous system. SCFA can modulate weights and reduce counts food is consumed through stimulation of enteroendocrine L cells responsible for releasing peptide YY (PYY) and glucagon-like peptide 1 (GLP-1), so SCFAs can influence neonate's body weight. Lower concentration of SCFA has been linked to an increased risk of subsequent atopic eczema, asthma and food allergy, which can result weight loss in infants.[21,30]

Maternal smoking, maternal malnutrition, and prolonged stress on the mother during pregnancy and delivery such as caesarean section can cause the cessation of several gene expressions in infants. Caesarean section is possible altering global DNA methylation and individual gene methylation. Słabuszewska et al. showed a significant decrease global methylation of DNA in the maternal placenta after caesarean section.[31] Meanwhile Franz et al. found no difference in global DNA methylation between vaginal delivery and cesarean section, although methylation of individual genes was significantly higher in infants born via caesarean section.[32] Several authors reported a relationship between methylation of DNA and birthweight. But specific environmental factors, such as diet, stress and physical activity may influence methylation of DNA. Methylation of DNA involved in energy and glucose metabolism, in fetal and placental growth, possibly affecting fetal growth and development.[21]

DNA methylation may serve as biomarker of macrosomia. Infants with macrosomia may experience a catch-down growth period in the first three months of life.[33]

In our study, all infants who received light therapy were born to mothers under 35 years of age and were delivered by cesarean section. Specifically, we observed an interconnected relationship between neonatal jaundice and weight loss, and weight loss potentially contributes to the occurrence of jaundice. Based on research by Miyoshi et al, several factors were identified as potentially associated with excessive newborn weight loss, including maternal age, first-time motherhood (primiparity), fertility treatment, antepartum cesarean delivery, postpartum hemorrhage, and postpartum hemoglobin levels.[17]

Our study acknowledges several limitations, including the absence of a detailed classification of cesarean section types and limited sample size. To address this gap, future studies should use larger sample sizes and longer follow-up periods. The primary aim is to comprehensively assess patterns of weight loss and gain in babies born via different delivery methods, thereby potentially establishing different weight loss thresholds for babies born via cesarean section. Future research should dig deeper to understand the reasons underlying increased weight loss in babies born by cesarean delivery. Potential areas of investigation may include breastfeeding challenges, pregnancy-related complications, delayed milk production, insufficient family support, and other contributing factors. Researchers are encouraged to develop standard reporting methodologies for neonatal weight loss, such as categorizing infants by type of feeding (exclusive breast-feeding, formula-feeding, mixed-feeding) and caesarean section classification (emergency or elective). The goal is to generate strong scientific evidence that can inform the development of policies, clinical guidelines and feeding strategies tailored specifically for babies born by caesarean section.

CONCLUSION

Cesarean section is a risk factor that increases the odds of early weight loss in breastfed term infants by 1.56 times. Further studies focusing on weight loss in infants born by cesarean section then categorized by type of feeding and potentially by emergency or elective cesarean section with a larger sample size are needed.

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