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REVIEW ARTICLE

Percentage of birth weight loss as a reference for the well-being of the exclusively breastfed newborn

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Abstract

As health professionals, we have memorized that "newborns can lose up to 10% of their birth weight during the first week of life and should regain it by two weeks of age". However, this statement, which appears so accurate, comes from studies conducted in the 1960s, when medical knowledge and how newborns were fed were utterly different from what it is today. Currently, multiple factors contribute to the percentage of weight loss at birth and the rate at which this weight is regained. There are nomograms for exclusively breastfed and formula-fed newborns and those by vaginal or cesarean delivery. To meet the World Health Organization's goal of exclusively breastfeeding newborns, it is essential to recognize that "loss of more than 10% of birth weight" does not represent the need for formula supplementation. When assessing these cases, we must consider several factors that influence the percentage of weight loss in newborns. Therefore, diagnostic decisions should always be individualized in favor of breastfeeding.

Keywords: *Newborn. Breastfeeding. Weight loss.*

Porcentaje de pérdida de peso al nacimiento como referencia del bienestar del recién nacido alimentado exclusivamente con leche materna

Resumen

Como profesionales de la salud hemos memorizado que "los recién nacidos pueden perder hasta el 10% de su peso al nacimiento durante la primera semana de vida, y deben recuperarlo al cumplir 2 semanas de vida". Sin embargo, esta afirmación, que aparenta ser matemáticamente exacta, proviene de estudios realizados en la década de los 60, cuando el conocimiento médico y la forma de alimentar a los recién nacidos era completamente diferente a lo que es ahora. Actualmente se reconocen múltiples factores que pueden influir en el porcentaje de pérdida de peso al nacimiento y el ritmo con el cual se recupera este peso. Se cuenta con diferentes nomogramas para recién nacidos alimentados exclusivamente con leche materna y aquellos alimentados con fórmula láctea, e incluso aquellos nacidos por cesárea o por vía vaginal. Para que se logre apoyar la meta de la Organización Mundial de la Salud de alimentar exclusivamente con leche materna a los recién nacidos, es imprescindible reconocer que la "pérdida de más del 10% del peso al nacimiento" no representa por sí sola la necesidad de suplementación artificial. Al evaluar estos casos, se deben considerar varios factores que influyen en el porcentaje de peso que pierde un recién nacido. Por ello, las decisiones diagnósticas deben ser siempre individualizadas en favor de la lactancia materna.

Palabras clave: *Recién nacido. Lactancia materna. Pérdida de peso.*

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Introduction

During the 1960s, scientific literature began to document the concern of some physicians about weight loss in newborns during their first days of life due to jaundice[1]. As infant mortality increased, clinicians such as Newman and Gross began to document weight gain in newborns and associated inadequate weight gain with poor human milk intake[1,2]. In 1978, Nelson stated that newborns should regain their birth weight by 10 days of life[3]. In the same year, O'Connor reported a series of cases of newborns who had failed to thrive on exclusive breastfeeding, which was corrected by initiating formula feeding[4].

Concern about weight loss in the first days of life continued until 1983, when case reports of newborns who lost weight critically after birth, especially when exclusively breastfed, became frequent[5]. As a result, different physicians began to quantify, classify, and publish the weight loss percentage in newborns in the literature. At that time, physicians were concerned with diagnosing and treating excessive weight loss, fever due to dehydration, and jaundice, the pathophysiology of which was still a matter of constant debate and research[6].

Since then, Smith et al. recognized that there was little information to conclude the standard percentage of weight loss in newborns. Therefore, the personal experiences of different authors on this subject began to be analyzed[5]. For example, in their book on breastfeeding published in 1980, Lawrence and Lawrence recommended that weight loss > 5% "during the first few days" should be considered a red flag[7]. Later, in 1983, Maisels and Gifford debated Lawrences' statement by demonstrating that the mean weight loss percentage in 100 exclusively breastfed healthy newborns was 5.8% at 3 days of life and concluded that medical management of patients who lost > 5% of their birth weight was unnecessary[6,7].

Furthermore, Nelson's statement that a newborn should regain its birth weight after 10 days of life[3] contradicted what had been observed by Fomon et al., who described since 1970 that newborns exclusively breastfed could regain their birth weight as late as 14 days of life[8]. Unfortunately, more than four decades after we began to worry about the percentage of weight loss in newborns, there are still few or no studies with sufficient scientific evidence to reach a consensus on each newborn's standard weight loss rate.

Currently, conclusions in the literature are contradictory: each depends on the influence and relationship of several extrinsic and intrinsic factors, both in the mother and the newborn, that directly affect the percentage of weight loss expected individually[9]. For example, the Academy of Breastfeeding Medicine (ABM) considers excessive weight loss to be > 10%[10], while the American Academy of Pediatrics refers to extreme weight loss as > 7%[11]. Moreover, Macdonald et al. conducted a study on 937 patients. They stated that exclusively breastfed newborns regain their birth weight in a median of 8.3 days, while formula-fed infants regain their birth weight in a median of 6.5 days[12]. These examples demonstrate that not only are the recommendations issued in the guidelines controversial but also no scientific basis supports this knowledge. The statement that "newborns normally lose up to 10% of their birth weight during the first week of life and should regain their birth weight by 2 weeks" is arbitrary and should be the subject of further study[4]. However, this statement becomes particularly important when we recognize that its origin lies in the experience and knowledge of more than four decades ago. However, it still defines how pediatricians base their decisions and evaluate the need for artificial feeding, hospital discharge, and follow-up.

Unfortunately, this lack of reliability and evidence-based practices prevent us from achieving the World Health Organization goal of 50% of newborns being exclusively breastfed by 2025[13].

Factors influencing weight loss during the first days of life

Several factors have been described in both the newborn and the mother that influence birth weight, the variability of weight loss, and the rate at which weight is lost. Some of them are mentioned below (Figure 1). First, we should consider that the human body consists of lean mass (fat-free mass composed of proteins, intra-, extracellular water, and bone mineral content) and fat mass (body fat)[14].

Maternal and perinatal factors

Maternal age and body mass index (BMI)

Advanced maternal age and high maternal BMI are inversely associated with the rate of newborn weight gain. This has been related to a possible decrease and delay in lactogenesis II[15-17]. For example, Fonseca et al. described that mothers > 40 years of age had a 3.32-fold increased risk of having newborns with

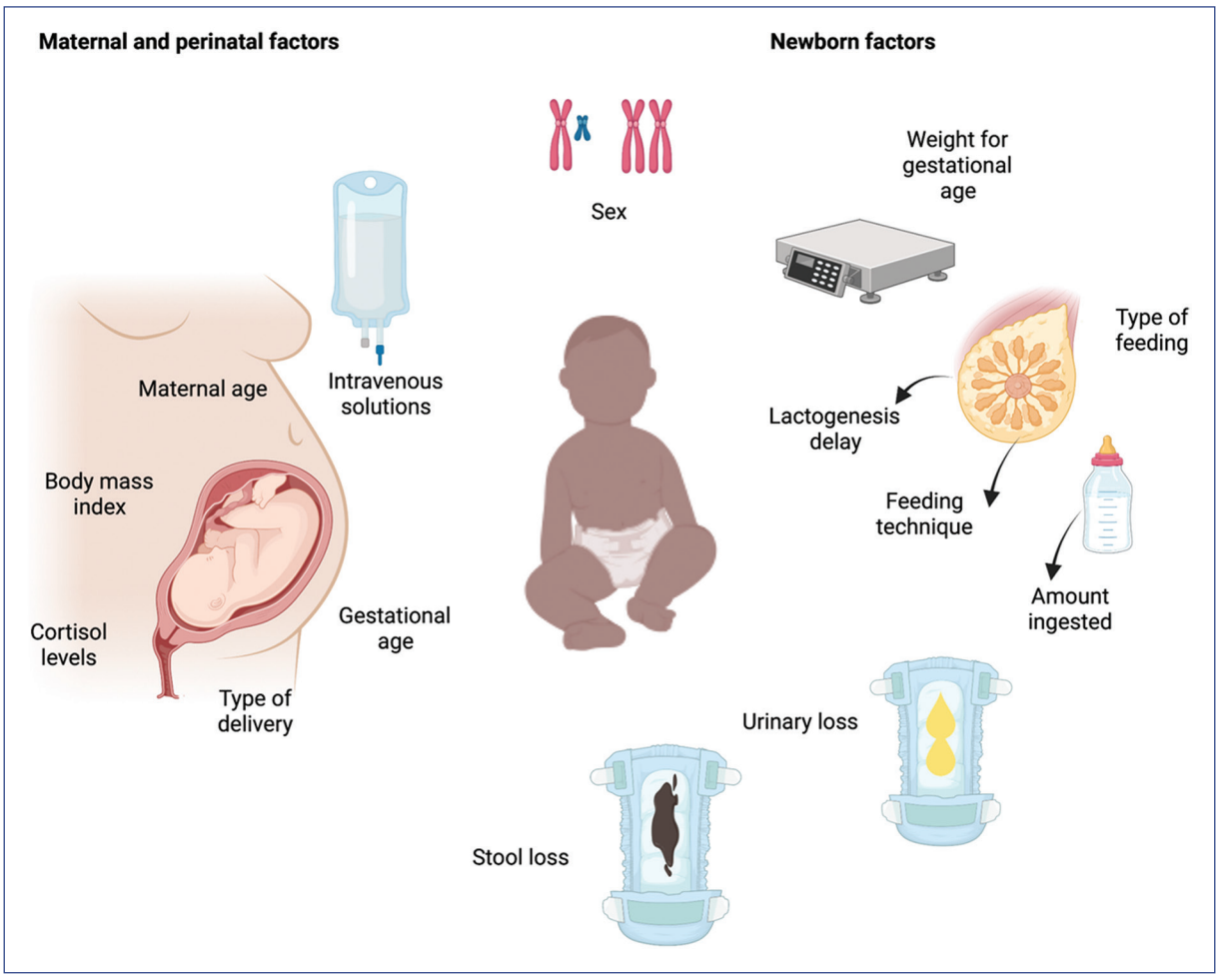

Figure 1. Factors that influence weight loss in a newborn. Created with Biorender.com.

excessive weight loss[18]. In the words of Regnault et al., for every 10 years increase in maternal age after 30 years, weight loss increases by 0.46%[18,19].

Type of birth

Infants born by cesarean section are more likely to lose weight than those delivered vaginally[19-21]. History of cesarean section has also been reported to be associated with delayed lactogenesis II[22] and even related to difficulty initiating breastfeeding[16]. Particularly stressful deliveries, such as an emergency cesarean section[22] or more than 14 hours in labor, may represent a 2.4-fold risk of excessive weight loss due to high cortisol levels in the mother and the infant[16,23]. Fonseca et al. described that cesarean section delivery implies 2.4 times more risk of having excessive newborn weight loss since this type of delivery has important implications in eliminating pulmonary fluid[18].

Intravenous solutions

Chantry et al. described in great detail how excessive weight loss in newborns during their first days of life is significantly and independently associated with maternal intrapartum fluid balance. These authors found that weight loss tripled in newborns whose mothers had a fluid balance > 200 ml/h compared to those mothers with a fluid balance < 100 ml/h, which was very similar to the weight loss presented in newborns whose mothers had delayed lactogenesis II[24]. This finding is a consequence of using intravenous solutions before birth and is influenced by the amount of solution infused and the duration of the infusion before birth[21,25,26]. The suggested reason is excessive fluid loss, as shown by the fact that infants who lose > 7% of their birth weight record more urination episodes in the first 48 hours of life[24,27]. It could also be related to meconium loss and the consequent weight loss it produces[18]. Mulder et al.

suggested that total diuresis significantly predicts weight loss > 7%. The authors also proposed that a possible cause of newborns losing > 7% of their weight despite adequate breastfeeding could be physiological diuresis[27], in many cases related to the mother's positive intrapartum fluid balance[24]. Another theory is that the mother's positive water balance may influence the newborn's interest in breastfeeding by suppressing thirst. However, further studies are needed to confirm this hypothesis[24].

Number of pregnancies

It has been described that those newborns of multiparous mothers have a higher birth weight because the uterus has a greater uteroplacental flow[28]. Similarly, it has been reported that being primiparous is a risk factor for delayed lactogenesis II[16]. Together with the lack of breastfeeding experience, this could increase the risk of excessive weight loss in newborns[18].

Newborn factors

Sex

Some studies have documented that females present more significant weight loss than males. Although this has been consistently confirmed in the literature, the cause is unclear[20,29].

Weight for gestational age

Birth weight is a significant determinant of weight loss in the immediate neonatal period[29]. More precisely, the lower the newborn's weight, the lower the weight loss experienced during the first days of life[18,20]. For example, Fonseca et al. described that newborns weighing < 2,500 g are 2.68 times more likely to lose less weight than newborns with higher weights[18]. Gallardo et al. proposed that newborns with a small birth weight tend to compensate for it with accelerated growth during their first months[20].

Newborn feeding

The type of newborn feeding, formula or human milk, is a determinant factor when studying weight loss. Martens and Romphf[29] showed that formula-fed newborns lose up to 2.4% of their weight, while breastfed newborns can lose up to 5.5%. The cause of this difference lies not only in the caloric composition of colostrum compared with formula[30] but also in the significant difference between the volume of colostrum physiologically ingested and the volumes of formula routinely prescribed by physicians in the first week of life. Figure 2 shows that the exclusively breastfed infant physiologically ingests only tiny amounts of colostrum during the first 2 days of life, which coincides with the nadir of expected weight loss for this day. However, from day 3, when the mammary gland undergoes secretory activation and lactogenesis II, newborns begin to gain weight steadily[9]. Flaherman et al. demonstrated these data in their study[21]. Thus, the moment when milk intake exceeds the water and fat loss of the newborn is the beginning of physiological weight gain[15].

The ABM considers in protocol number 3 the evolution of human milk production and recognizes the physiological factors that influence newborns and how gastric size evolves. Following this, the volume recommendations of artificial feeding should be closer to the colostrum intake. For example, in the first 24 hours, intake would be every 3 hours with a volume from 2 to 10 ml; in the following 24 hours, 5 to 15 ml; and at 72 hours, 15 to 30 ml until reaching a volume of 30 to 60 ml from the third day of birth[10]. However, a common scenario would be to prescribe the volume of formula milk according to the *gastric capacity* (formula = [(weight in grams – 3)]/100)[31,32] or according to intravenous fluid requirements depending on hours of life[33,34]. This modifies the physiology and, in many cases, the relationship of newborns with their parents, distancing the mother's expectations of milk production from reality[32].

This fact may explain much of the controversy in the literature since there is no consensus on the correct formula milk intake. For example, according to *gastric capacity*, a 3 kg newborn would consume 80 ml/kg/day orally (P.O.) on the first day of life; that is, 30 ml every 3 hours from the first feeding. However, the physiological volume of colostrum intake per feeding for that same newborn would be between 2 and 10 ml (Table 1). It is important to emphasize that the formula for calculating *gastric capacity* originated from studies carried out in 1920 on cadavers, where Scammon and Doyle verified the maximum gastric distention[31,35]. Today, we know that maximum gastric capacity does not correspond to what a person should drink. Feeding this way can lead to more frequent spit-ups, vomiting, and abdominal distention during the hospital stay[28,36], and even the need for anti-reflux treatment at discharge.

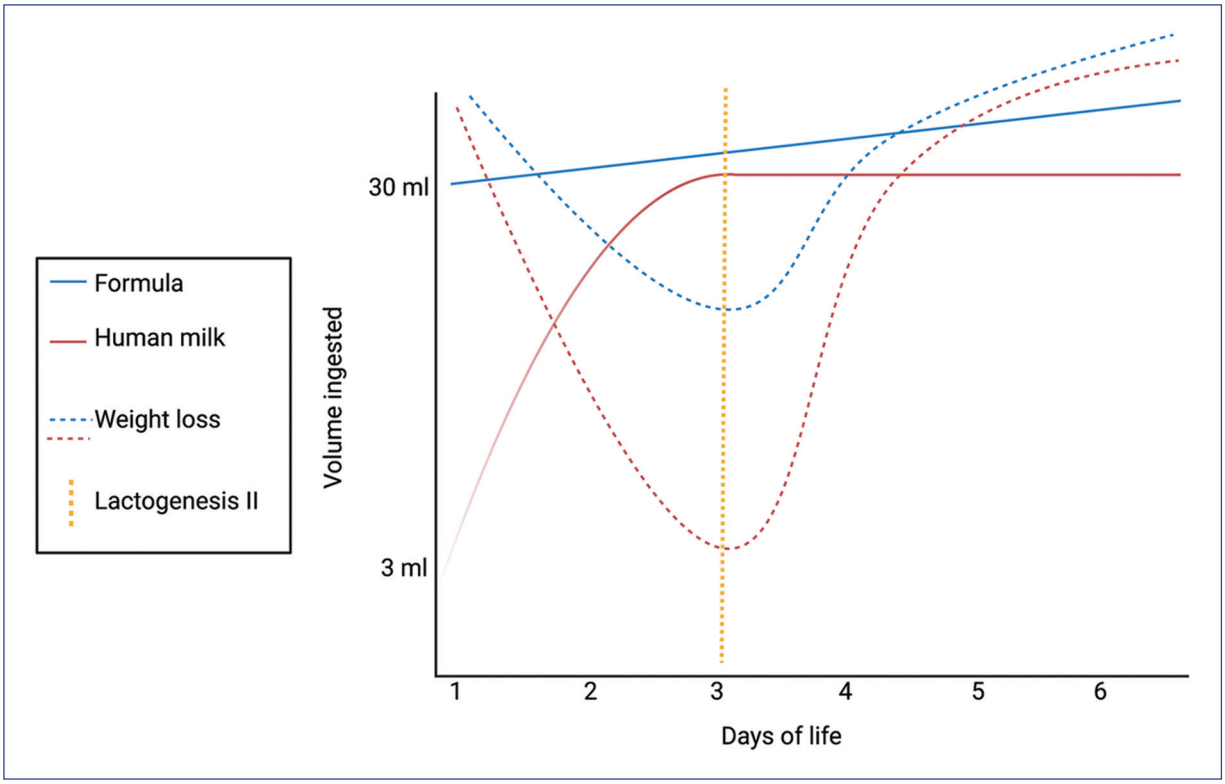

Figure 2. Volume ingested and weight loss according to the type of feeding during the first days of life. Created with Biorender.com.

Table 1. Feeding volume of a newborn according to different methods

	Type of feeding (examples using three different birth weights)		
Days of life	1 (3000 g)	2 (2970 g)	3 (2940 g)
National guidelines[33]	80 ml/kg/day 30 ml every 3 hours	90 ml/kg/day 34 ml every 3 hours	100 ml/kg/day 37 ml every 3 hours
Gastric capacity: [(weight in grams –3)]/100)[29,30]	30 ml every 3 hours	30 ml every 3 hours	29 ml every 3 hours
Physiologic volume according to the expected colostrum volume[10]	2-10 ml per feed on demand	5-15 ml per feed on demand	15-30 ml per feed on demand

The most common cause of loss of more than 10% of birth weight (in up to 74% of newborns) may be incorrect breastfeeding technique or poor latch[37]. Problems with poor infant latch-on are common in the postpartum period. Therefore, counseling before hospital discharge may prevent breastfeeding abandonment and excessive weight loss[38].

In addition, the method of feeding early in life and the different compositions of breastmilk and formula also affect the development of body composition, apparently showing a progressive increase in lean mass due to higher protein intake in formula-fed infants[14,39,40]. Consequently, the different volumes ingested and milk compositions significantly influence body composition and weight loss during the first days of life (Table 2).

Gestational age

As pregnancy progresses, the body composition of the fetus changes, with the proportion of water gradually decreasing until it reaches approximately 80% at

Table 2. Results of weight loss from the different studies

Author	Year	n	Exclusively breastfed		Formula-fed	
			Weight loss (%)	Days	Weight loss (%)	Days
Wilbaux et al.[15]	2018	2,425	6.3%	1.8 (nadir)	5.2%	2.3 (nadir)
Tavera et al.[41]	2012	865	24 hours: 4.6% 48 hours: 4.9% 72 hours: 5.4%	3	24 hours: 2.8% 48 hours: 3.9% 72 hours: 4%	3
Regnault et al.[19]	2011	1557	5.3%	2-3	3.1%	2-3
Matías et al.[17]	2010	767	3.6%	3	3.9%	3
Martens et al.[29]	2007	812	5.49%	3	2.43%	3
Macdonald et al.[12]	2003	937	6.6%	2.7 (nadir)	3.5%	2.7 (nadir)
Maisels et al.[6]	1983	100	2,501-3,000 g: 5.4% 3,001-3,500 g: 5.9% 3,501-4,000 g: 6% > 4,000 g: 6%	3	Not included in the sample	

Table 3. Risk factors associated with newborn weight-loss

Risk factor	Author (year)	Patients included	Description	Statistics
Maternal age	Regnault et al. (2011)[19]	1,557	A ten-year increase in maternal age was associated with 0.46% higher weight loss by day 3	p = 0.004
	Fonseca et al. (2014)[18]	1,288	Mothers aged over 40 years were positively associated with a loss of more than 9.4% of birth weight	OR = 3.32, 95%CI 1.19–9.25
Maternal BMI	Matias et al. (2009)[17]	171	> 27 kg/m^2 BMI was associated with more than 10% loss of birth weight by day 3	p ≤ 0.05 AOR = 3.8, 95%CI 1.3–11.7
	Dewey et al. (2003)[16]	280	20% of newborns born to mothers with a BMI > 27 kg/m^2 lost more than 10% of birth weight by day 3 vs. 9% in newborns of mothers with a BMI < 27 kg/m^2	p ≤ 0.05
Weight at birth	Matias et al. (2009)[17]	171	> 3,300 g: 13.5% of patients lost more than 10% of their birth weight by day > 3,300 g: 6.4%	p > 0.05
	Regnault et al. (2011)[19]	1,557	Weight loss by day 3 increased by 1.07% for each 1 kg difference	β = 1.07 p ≤ 0.001
Female sex	Gallardo-López et al. (2018)[20]	2,960	Females lost more weight than males	p = 0.000 β = 0.024
	Matias et al. (2009)[17]	171	11.1% of females lost more than 10% of birthweight by day 3 vs. 8.8% of males	p > 0.05
Cesarean delivery	Matias et al. (2009)[17]	171	22.9% of the patients born by cesarean section lost more than 10% of birthweight by day 3 vs. 6% of vaginally delivered	AOR = 3.6 95% CI 1.1–11.7 p = 0.033
	Dewey et al. (2003)[16]	280	Of the babies who lost more than 10% of birth weight by day 3, 54% were born by cesarean section (25% scheduled and 29% urgent)	RR: 2.18 95%CI 0.85–4.56 p = 0.1
	Fonseca et al. (2014)[18]	1,288	History of cesarean section was positively associated with a loss of more than 9.4% of birth weight	OR: 2.42 95%CI 1.12–5.23 p < 0.001

(*Continues*)

Table 3. Risk factors associated with newborn weight-loss *(Continued)*

Risk factor	Author (year)	Patients included	Description	Statistics
	Regnault et al. (2011)[19]	1,557	Weight loss by day 3 was higher after an emergency cesarean section compared to vaginal delivery Babies born after a planned cesarean section lost even more weight	β = 0.72 p = 0.004 β = –1.53 p < 0.0001
	Gallardo-López et al. (2018)[20]	2,960	Newborns from cesarean section lose more weight than those born vaginally	p ≤ 0.05
Length of labor	Dewey et al. (2003)[16]	280	22% of the patients with labor longer than 14 hours lost more than 10% of their birth weight by day 3, compared to 10% with labor of fewer than 6 hours	RR: 2.41 95%CI 1.14-4.57 p = 0.02
	Chen et al. (1998)[23]	40	Longer labor was associated with greater maternal exhaustion and lower breastfeeding frequency on day 2	β =- 0.35 p ≤ 0.05
Jaundice	Fonseca et al. (2014)[18]	1,288	Phototherapy-treated jaundice was positively associated with a loss of more than 9.4% of birth weight	OR: 1.69 95%CI 1.00-2.87 p = 0.206
Gestational age	Matias et al. (2009)[17]	171	< 39 GW: 11.1% lost more than 10% of birth weight by day 3 > 39 GW: 9.8% lost more than 10% of birth weight by day 3	p > 0.05
	Regnault et al. (2011)[19]	1,557	Weight loss by day 3 decreased by 0.4% for each additional week of gestation	β = –0.4 p < 0.0001
	Gallardo-López et al. (2018)[20]	2,960	As gestational age increases, less weight loss for each newborn	p = 0.006 β = 0.02
Intravenous fluids	Chantry et al. (2011)[24]	448	Infants with excessive weight loss had a greater net hourly intrapartum fluid balance compared with infants without excessive weight loss (> 200 ml/h vs < 100 ml/h net fluid balance)	p = 0.013 RR: 3.18 95%CI 1.35–13.29

AOR: adjusted odds ratio; BMI: body mass index; GW: gestational weeks; OR: odds ratio.

birth[41]. Therefore, the lower the gestational age, the higher the water ratio and, thus, the greater the excess extracellular fluid. A premature newborn can lose up to 15% of body weight because the body surface area is more significant. Even newborns of < 750 g can lose up to 20% of body weight[41].

What tools do we currently have to guide clinical decisions?

In 2014, Flaherman et al. published two nomograms to guide the follow-up of weight loss in exclusively breastfed newborns, one for those born vaginally and the other by cesarean section. The study included 8,457 newborns born vaginally, of whom 5% had lost > 10% of their weight in the first 48 hours, and 8,414 newborns born by cesarean section, of whom almost 10% had lost > 10% of their weight at 48 hours of life. Subsequently, weight gain was initiated in both cases[21]. In 2015, the same group of researchers performed nomograms for infants with exclusive formula feeding, including 4,525 born vaginally and 2,550 by cesarean section. In this case, < 5% of infants born vaginally had lost at least 7% of their weight in the first 48 hours, and < 5% of those born by cesarean section lost > 8% of their weight[42]. To date, these studies are recommended by the American Academy of Pediatrics to guide clinical decisions regarding newborn weight loss in the first days of life. However, individualized predictive models are being developed; for example, those by Wilbaux et al., who considered the different factors that influence birth weight loss[15].

Conclusions

Basing clinical decisions on the percentage of birth weight lost at the end of the first week of life is an arbitrary practice without consistent scientific evidence. Loss of more than 10% of birth weight in "the first days of life" is not an absolute indication of artificial feeding. Therefore, this consideration can lead to unnecessary supplementation and may reduce the chances that any newborn can be exclusively breastfed for at least the first 6 months of life[42].

Weight loss during a newborn's first days is a physiological process that depends on different circumstances[27]. Therefore, we must remember that a weight loss of more than 10% is not an indication for prescribing supplements but a signal for further evaluation of the infant and the mother as a dyad[10]. However, the success of exclusive breastfeeding involves much more than just the intention to breastfeed. Many women also stop breastfeeding due to work stressors[43], demographic characteristics, or lack of family and social support, all of which can significantly influence breastfeeding outcomes[44].

Different factors should be considered and evaluated when addressing newborn weight loss (Table 3). For example, overhydration in the immediate neonatal period, amount of meconium and urinary losses, and low fluid intake in the first days of life can cause different amounts of weight loss, as well as whether the infant was born vaginally or by cesarean section. Therefore, maternal, perinatal, and newborn factors are essential to consider always in favor of breastfeeding[45].

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Conflicts of interest

The authors declare no conflict of interest.

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