



MATERNAL AND PERINATAL FACTORS ASSOCIATED WITH THE CALORIE AND FAT CONTENT OF BREAST MILK

FATORES MATERNO E PERINATAIS ASSOCIADOS AO TEOR DE CALORIAS E GORDURA DO LEITE MATERNO

Myrella Hevellyn Rodrigues Neves^{1*}, Keila Fernandes Dourado², Fabiana Albuquerque Meirelles Villachan³, Maria Izabel Siqueira de Andrade⁴, Deziderio Azevedo da Silva¹, Camyla Vidal Alves¹, Renata Kelly Gomes Oliveira¹

¹Nutritionist Specialist in Clinical Nutrition from the Uniprofessional Residency Program of the Federal University of Pernambuco – UFPE, Recife (PE), Brazil;

²Nutritionist Professor at the Federal University of Pernambuco – Academic Center of Vitória – UFPE/CAV, Vitória de Santo Antão (PE), Brazil; ³Nurse Specialist in Women's Health from the Residency Program of the State Health Department of Pernambuco – Hospital Barão de Lucena – SES/PE-HBL, Recife (PE), Brazil; ⁴Nutritionist Professor at the Federal University of Alagoas – UFAL, Maceió (AL), Brazil.

***Corresponding author:**
Myrella Neves – Email:
myrella.hevellyn@ufpe.br

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ABSTRACT: Objective: To evaluate maternal and perinatal factors associated with the calorie and fat content of donor milk from a Human Milk Bank (HMB). Methods: This study was conducted based on the crematocrit records of breast milk from donors registered with an HMB, at any stage of lactation. Sociodemographic, lifestyle, clinical, gestational, and perinatal variables were associated with the calorie and fat content. Statistical significance was set at $p < 0.05$. Results: The study included 141 donors. It was observed that the more calories, the more fat the milk had. Colostrum was hyperlipidemic in the presence of a partner, normal delivery, and in those born with adequate birth weight (AWG) and large for gestational age (LGA). In the transition phase, milk was hypercaloric in cases of excess pregestational weight (EPG), prematurity, and low birth weight; and was hyperlipidic when EPPG, PAI, and LGA. Conclusion: It is concluded that maternal and perinatal factors were associated with calories and fat in breast milk.

KEYWORDS: Breastfeeding. Associated factors. Human milk. Fat content.

RESUMO: Objetivo: Avaliar fatores maternos e perinatais associados ao teor de calorias e gordura do leite de doadoras de um Banco de Leite Humano em Recife -PE. Métodos: Realizado a partir dos registros do crematócrito do leite materno de doadoras cadastradas. Foram correlacionadas por Pearson, calorias e gordura, e associadas por Qui-quadrado à variáveis sociodemográficas; de estilo de vida e clínicas; gestacionais; e perinatais. Adotou-se significância estatística $p < 0,05$. Resultados: Compuseram o estudo, 141 doadoras. Observou-se que quanto mais calorias, mais gordura possuía o leite. O colostro foi hiperlipídico na presença de companheiro, parto normal, nascidos com peso adequado para idade gestacional (AIG) e grandes para idade gestacional (GIG). Na fase transição, o leite foi hipercalórico quando excesso de peso pré-gestacional (EPPG), prematuridade e baixo peso ao nascer; e foi hiperlipídico quando EPPG, AIG e GIG. Conclusão: Conclui-se que fatores maternos e perinatais se associaram às calorias e gordura no leite materno.

PALAVRAS-CHAVE: Aleitamento materno. Fatores associados. Leite humano. Teor de gordura.

INTRODUCTION

Breast milk is the result of lactation, serving to supply the essential nutrients necessary for safeguarding health, promoting growth, and ensuring proper development following birth¹. It has complete nutrition, with all the essential nutrients for growth and development at this stage². In addition, it comprises unique defensive compounds absent in other types of milk and protects the child's body³.

Human milk undergoes three distinct stages of maturation, with its nutritional composition varying according to the postpartum period and the specific needs of the infant⁴. The first milk is called colostrum (1st to 7th day postpartum), the transitional milk is the intermediate period for milk maturation (8th to 14th day postpartum), and finally, mature milk (from the 15th day postpartum)⁵.

The energy density of breast milk varies according to the stage of lactation and is a gradual and progressive process⁴. The lipid fraction of breast milk is the most variable constituent, meaning that it can be altered by factors such as maternal age, diet, and pre-gestational nutritional status⁶⁻⁷.

The study of the composition of breast milk has become a central area of research due to its vital importance in infant development and the discovery of its biochemical complexity. The composition of breast milk is influenced by genetic, environmental, and nutritional factors, and its variability can directly impact the health and well-being of infants. Globally, breast milk research has also addressed the effects of breastfeeding practices, variations in milk composition across different geographical regions, and the impact of public health policies on breastfeeding promotion. Such studies are essential to better understand variations in milk quality and the best practices to promote maternal and child health⁶⁻⁸⁻⁹.

Ensuring successful breastfeeding in the first months of a child's life results in improving the health conditions of the mother-child binomial; optimizing growth and development; reducing mortality; reducing public and private spending on illness, hospitalizations, and infant food supplies; as well as minimizing the incidence of future chronic diseases³. However, challenging circumstances that prevent breastfeeding, including premature birth, the newborn's admission to a neonatal unit, maternal health issues, or insufficient milk supply, can create obstacles in establishing and maintaining breastfeeding⁸.

In this context, the use of milked and donated human milk has become an efficient alternative for providing nutrition to neonates in special conditions and a way of maintaining milk production by the donors⁹. Human Milk Banks (HMB) are institutions responsible for encouraging breastfeeding, supporting, promoting, and protecting breastfeeding. The HMBs process, store, and properly dispose of pasteurized breast milk⁵.

While it serves as a crucial alternative, the process and unique traits of the nursing mother result in the milk's composition being notably distinct. Therefore, it is important to understand the factors that can alter the composition of milk, to ensure it can be distributed while considering its nutritional value and the particular needs of newborns, especially those who are very low birth weight or premature⁹.

Some studies have shown that the nutritional composition of human milk can be modified by certain maternal factors, as well as factors related to birth¹⁰⁻¹¹.

Considering this perspective and the scarcity of studies relating maternal and perinatal aspects to the nutritional composition of human milk, this study aimed to evaluate potential maternal and perinatal factors associated with the calories and fat content of milk from donors at an HMB in a reference hospital in the state of Pernambuco.

2. METHODOLOGY

2.1. STUDY DESIGN

This is a quantitative, retrospective, cross-sectional, exploratory, and analytical study. According to Lakatos and Marconi¹², the quantitative approach allows for the measurement of data and the application of statistical techniques to identify patterns and relations between variables. The retrospective design used secondary data previously collected from the Human Milk Bank and electronic medical records. It was characterized as crosssectional because it analyzed the information at a single point in time, without longitudinal follow-up, and is suitable for investigating associations between variables. It was also exploratory and analytical in nature, aiming to enhance understanding of the topic and employing statistical tests to identify potential associations and correlations¹³.

2.2. STUDY SETTING AND PERIOD

The research was performed at the HMB of a public hospital of reference in maternal and child care, located in the city of Recife, state of Pernambuco. It is certified by the Child-Friendly Hospital Initiative and is a benchmark in the care and humanization of its target population. The hospital has two emergency rooms (obstetrics and pediatrics), where an average of 2,000 visits are recorded each month, and at least 300 deliveries occur each month in the obstetric operating room.

Data collection occurred from September to November 2024, using the records of donors and their respective crematocrits of breast milk donated between January and October 2023.

2.3. SAMPLE, POPULATION, AND SELECTION CRITERIA

The records of all breast milk donors attended by the HMB who had a pasteurization cycle and respective crematocrit analysis with determination of calories and percentage of fat in the milk, from January to October 2023, at any stage of maturation, were selected.

After selecting the nursing mothers, the electronic medical records of the respective newborns were consulted to extract the perinatal data.

Neonates who were not born in the hospital where the research was conducted were excluded from the study, as it was impossible to consult birth data in medical records; twin pregnancies were also excluded, as it was difficult to relate maternal factors and their respective newborns to the calories and fat content of the milk.

2.4. DATA COLLECTION INSTRUMENT AND STUDY VARIABLES

A form was created to transcribe maternal and perinatal data from the HMB records and electronic medical records.

The maternal variables listed were subdivided into sociodemographic, gestational, clinical, and lifestyle.

The sociodemographic data considered included place of origin, determined based on the donor's address and categorized as residing in the Metropolitan Region of Recife-PE (RMR), the interior of the state of Pernambuco, or another Brazilian state; marital status, indicating whether the nursing mother had a partner; and maternal age, presented in absolute values and categorized as under 19 years old, between 20 and 35 years old, and over 35 years old.

The gestational data included the type of delivery, categorized as either vaginal or cesarean. Pre-gestational nutritional status was assessed using the Body Mass Index (BMI), calculated by dividing pre-pregnancy weight by the square of height, and classified according to the World Health Organization (WHO) criteria as follows: BMI < 18.5 kg/m², underweight; BMI between 18.5 and 25 kg/m², normal weight eutrophic; and BMI > 25 kg/m², overweight¹⁴. To check weight gain during pregnancy, the weight at the end of pregnancy was subtracted from the pre-gestational weight and then checked and classified as insufficient, adequate or excessive by the appropriate weight gain interval during pregnancy, considering the gestational age at delivery according to the curves proposed by Kac et al.¹⁵, which consider the following weight gain ranges: 9.7 - 12.2 kg for underweight; 8 - 12 kg when adequate weight; 7 - 9 kg if overweight and 5.0 - 7.2 kg in the case of obesity.

Lifestyle data was also collected, recording whether or not the donor drank coffee, smoked, or drank alcohol. Regarding clinical data, we extracted from the records whether the subject had diabetes mellitus, hypertension, syphilis, and human immunodeficiency virus (HIV).

The variables collected related to the newborn were gender, gestational age at delivery, birth weight, and weight-for-gestational-age adequacy.

Sex was categorized as female or male. Gestational age (GA) was recorded in weeks of gestation until delivery and was categorized according to the WHO as extreme premature (<28 weeks), preterm (28 - 37 weeks), and term (> 37 weeks)¹⁶. The classification of newborns in terms of birth weight was based on WHO definitions (2011), so they were considered underweight when <2500g, adequate weight when 2500g - 4000g, and macrosomic when >4000g. To assess the adequacy of birth weight related to GA, term births (GA > 37 weeks) used the WHO (2006) curves, according to weight for age in percentiles (P), with <P3, small for gestational age (SGA), P3 - P97, adequate weight for gestational age (AWG) and >P97, high for gestational age (LGA). For premature newborns (GA < 37 weeks), the INTERGROWTH-21 tables were used, which correct weight by GA in percentiles (P), classifying them as SGA < P10, AWG between P10 and P90, and LGA >P90¹⁴⁻¹⁶⁻¹⁷.

To obtain the calorie content and fat percentage of breast milk, the HMB records of the creatamocrit were used. This technique involves introducing the milk into microcapillary tubes, followed by centrifugation for 15 minutes, resulting in the separation of the cream and whey. The columns are then measured after separation. The values obtained are applied to specific mathematical formulas that determine the approximate value of calories and percentage of fat present in a liter of milk¹⁸.

Breast milk was classified according to its stage of maturation as colostrum (1st to 7th day after delivery), transition (8th to 14th day after delivery), and mature (from the 15th day after delivery). Subsequently, the calorie content and fat percentage were assessed, and the samples were classified according to caloric value as follows: hypocaloric when <650 Kcal/liter; normocaloric when between 650 Kcal/liter and 711 Kcal/liter; and hypercaloric when >711 Kcal/liter¹⁹. Regarding fat percentage, the classification was done by stage of maturation. Colostrum was considered hypolipidic when the fat content was <1.7%, normolipidic when it was between 1.7% and 2.8% and hyperlipidic when it was >2.8%. Transition milk was considered hypolipidic when the fat content was <2.8%, normolipidic when it was between 2.8% and 3.4% and hyperlipidic when >3.4%. Mature milk was considered hypolipidic when the fat content was <2.9%, normolipidic if it was between 3.8% and 3.4% and hyperlipidic when >3.8%²⁰.

2.5. DATA PROCESSING AND ANALYSIS

The database was built in Excel, and all the analyses were carried out using the *Statistical Package for the Social Sciences* (SPSS) software, version 13.0 for Windows (SPSS Inc., Chicago, United States).

The continuous variables were tested for normal distribution using the Kolmogorov-Smirnov test. Data for variables with a normal distribution were expressed as averages and standard deviations (AD). Categorical variables were expressed as absolute and relative frequencies.

The Chi-square test was used to check for associations between proportions. Pearson correlation analyses were used to assess the relationship between the amount of energy and fat in the different presentations of breast milk.

A p-value of <0.05 was used to determine statistical significance.

2.6. ETHICAL ASPECTS

This study complied with the ethical precepts of Resolution 466/12 of the National Health Council. It was approved by the Research Ethics Committee (REC) involving human beings of the "Centro Acadêmico de Vitória da Universidade Federal de Pernambuco" (CAV-UFPE) under CAAE (Certificate of Presentation of Ethical Appreciation) 78443524.2.0000.9430.

3. RESULTS

In the period studied, January to October 2023, 179 donors were registered at the HMB with pasteurization and crematocrit performed, but only 141 were eligible for the study. Of the 141 donors, 93 had colostrum records, 45 had transition records, and 64 had mature milk records. In addition, some forms contained missing data, but were used considering the relevance of the variables analyzed, which is why some of the results presented have different n records.

Maternal and perinatal characteristics are presented in Table 1. The participants were 50.4% from the interior of the state of Pernambuco and 42.8% from the RMR. Regarding marital status, 73.0% lived with a partner. The majority of donors (62.4%) were aged between 20 and 35, with an average age of 25.2 ± 7.1 years.

Regarding gestational data, 50.4% of deliveries were vaginal and 48.2% were cesarean. The majority of the women started pregnancy with EPPG (31.2%), had an average BMI of 27 kg/m^2 ($\pm 10.2 \text{ kg/m}^2$), and 36.2% gained excess weight during pregnancy, compared to 14.2% who gained adequate weight.

The lifestyle data evidenced that 61.0% of the donors drank coffee, 90.1% were non-smokers, and 87.2% did not drink alcohol. Regarding the clinical data surveyed, 12.1% of the nursing mothers were diabetic or had gestational diabetes, 31.2% were hypertensive or had some hypertensive syndrome during pregnancy, 5% had syphilis during pregnancy, and none of the donors had been exposed to HIV.

Regarding the perinatal factors found, male babies were more frequent (58.2%); the majority were born prematurely (66.0%), with an average GA of 33.1 weeks (± 4.0 weeks); 66.6% had a low birth weight ($2138.4 \text{ g} \pm 972.2 \text{ g}$), but 61% were AWG at birth.

The characterization of the breast milk studied in terms of calories and fat content is presented in Table 2. The results established that colostrum had an average of 648.3 Kcal (± 127.9 Kcal) and was mostly hypocaloric (38.3%); transition milk had an average of 687.4 Kcal (± 81.3 Kcal), 13.5% of which was normocaloric and 13.5% hypercaloric; and mature milk had an average of 680.2 Kcal (± 110.8 Kcal), with 18.4% hypocaloric. When the percentage of fat was assessed, 43.3% of colostrum ($3.38 \pm 1.76\%$), 24.8% of transitional milk ($3.67 \pm 0.83\%$), and 17.7% of mature milk ($3.59 \pm 1.12\%$) were mostly hyperlipidemic.

Table 1. Sociodemographic, gestational, lifestyle, clinical, and perinatal characteristics of breast milk donors at a Human Milk Bank and their respective newborns at a public hospital in Recife-PE in 2023.

Variables	n	Frequency (%)	Variables	n	Frequency (%)
Sociodemographic data			Gestational Data		
Place of Birth	141		Type of Delivery	139	
Interior of the State	71	50.4	Vaginal	71	50.4
Metropolitan Region	68	48.2	Caesarean	68	48.2
Other States	2	1.4	DI (Dystocia)*	2	1.4
Marital status	141		Pre-gestational BMI	93	
With Partner	103	73.0	Underweight	7	5.0
Without a Partner	38	27.0	Eutrophic	39	27.7
Maternal Age	138		Excess Weight	44	31.2
<19 years old	35	24.8	DI*	50	35.5
20 - 35 years old	88	62.4	Pregnancy Weight Gain	85	
>35 years old	15	10.6	Insufficient	12	8.5
DI*	3	2.1	Appropriate	20	14.2
Lifestyle and Clinical Data			Excessive	51	36.2
Coffee Consumption	140		DI*	58	41.1
No	54	38.3	Perinatal Data		
Yes	86	61.0	Sex	133	
DI*	1	0.7	Male	82	58.2
Tobacco Use	141		Female	51	36.2
No	127	90.1	DI*	8	5.7
Yes	14	9.9	Gestational age (weeks)	141	
Alcohol Use	141		Extreme Premature	15	10.6
No	123	87.2	Pre-term	93	66.0
Yes	18	12.8	Term	33	23.4
Diabetes Mellitus	141		Birth Weight	141	
No	124	87.9	<2500g	94	66.6
Yes	17	12.1	2500 - 4000g	43	30.5
Hypertension	141		>4000g	4	2.8
No	97	68.8	Weight for Gestational Age**	141	
Yes	44	31.2	SGA	12	8.5
Syphilis	141		AWG	86	61.0
No	134	95.0	LGA	43	30.5
Yes	7	5.0			
HIV positive	141				
No	141	100			

DI*: Data not available. **SGA: Small for Gestational Age; AWG: Adequate for Gestational Age; LGA: Large for Gestational Age. Source: The authors.

Calorie content and fat percentage were correlated, and the results demonstrated a strong correlation between these variables across all stages of lactation ($p < 0.01$), colostrum ($r = 0.95$), transitional milk ($r = 1.0$), and mature milk ($r = 1.0$), as illustrated in Graph 1. These findings suggest that higher fat percentages in the analyzed breast milk samples are associated with higher caloric content.

Table 2. Frequency of classification of calories and fat in the milk of breast milk donors at different stages of maturation, from a Human Milk Bank in a public hospital in Recife-PE in 2023.

Variables	Colostrum (n 93)	Transition (n 45)	Mature (n 64)
	N (%)	N (%)	N (%)
Calories (Kcal)			
Hypocaloric	54 (38.3)	7 (5.0)	26 (18.4)
Normocaloric	17 (12.1)	19 (13.5)	15 (10.6)
Hypercaloric	22 (15.6)	19 (13.5)	23 (16.3)
DI*	48 (34.0)	96 (68.1)	77 (54.6)
% Fat			
Hypolipid	4 (2.8)	7 (5.0)	17 (12.1)
Normolipid	28 (19.9)	3 (2.1)	22 (15.6)
Hyperlipid	61 (43.3)	35 (24.8)	25 (17.7)
DI*	48 (34.0)	96 (68.1)	77 (54.6)

DI* Data not available. Source: The authors.

Associations were tested between the calorie content of breast milk at the different stages of maturation and factors intrinsic to the donor (Table 3) and the newborn (Table 4). Milk in the transition phase showed a significant association with pre-pregnancy BMI ($p=0.011$), suggesting that excess weight before pregnancy results in hypercaloric milk in the transition phase. When calories were associated with perinatal factors, transitional milk presented a significant relation with GA ($p=0.049$) and low birth weight ($p=0.03$), i.e., premature births and births weighing less than 2.500g had breast milk in the transitional phase with a higher calorie content. The other factors in the different stages of breast milk maturation were not significantly associated with calories.



Figure 1. Correlation between calories and fat percentage of breast milk from donors of a Human Milk Bank of a public hospital in Recife-PE at different stages of maturation in 2023. Source: The authors.

Table 3. Correlation between maternal factors and calories in the milk of breast milk donors at different stages of maturation, from a Human Milk Bank in a public hospital in Recife-PE in 2023.

Variables	Colostrum (n=93)			Transition (n=45)			Mature (n=64)		
	hypo ²	normo ²	hyper ²	hypo ²	normo ²	hyper ²	hypo ²	normo ²	hyper ²
Sociodemographic data									
Place of Birth	n = 93			n = 45			n = 64		
Interior of the State	28	8	12	2	11	14	15	7	13
Metropolitan Region	26	9	10	4	7	5	11	8	8
Other States	0	0	0	1	1	0	0	0	2
			$p=0.899$				$p=0.514$		$p=0.322$
Marital status	n = 93			n = 45			n = 64		
With Partner	37	9	18	7	14	14	20	10	19
Without a Partner	17	8	4	0	5	5	6	5	4
			$p=0.421$				$p=0.245$		$p=0.664$
Maternal Age	n = 93			n = 45			n = 61		
<19 years old	16	7	4	1	6	4	4	4	3
20 - 35 years old	31	9	14	4	11	12	18	10	15
>35 years old	7	1	4	2	2	3	2	1	4
			$p=0.421$				$p=0.758$		$p=0.436$
Gestational Data									
Type of Delivery	n = 93			n = 45			n = 62		
Vaginal	27	9	16	2	2	10	10	6	13
Caesarean	27	8	6	5	5	9	15	9	9
			$p=0.662$				$p=0.135$		$p=0.201$
Pre-gestational BMI	n = 53			n = 28			n = 48		
Underweight	2	1	1	1	1	0	2	0	2
Eutrophic	15	3	4	3	3	2	10	2	6
Excess Weight	15	5	7	1	6	11*	11	6	9
			$p=0.662$				$p=0.011$		$p=0.572$
GP¹ in Pregnancy	n = 51			n = 28			n = 42		
Insufficient	4	1	1	1	1	3	4	1	2
Appropriate	9	2	3	2	2	3	6	1	3
Excessive	18	6	7	1	9	6	10	5	10
			$p=0.661$				$p=0.961$		$p=0.359$
Lifestyle and Clinical Data									
Coffee Consumption	n = 92			n = 45			n = 64		
No	20	6	5	3	6	8	12	7	7
Yes	33	11	17	4	13	11	14	8	16
			$p=0.164$				$p=0.842$		$p=0.274$

Variables	Colostrum (n=93)				Transition (n=45)				Mature (n=64)			
	hypo ²	normo ²	hyper ²		hypo ²	normo ²	hyper ²		hypo ²	normo ²	hyper ²	
Tobacco Use	n = 93				n = 45				n = 64			
No	47	14	20		6	17	18		26	14	20	
Yes	7	3	2	$p=0.749$	1	2	1	$p=0.438$	0	1	3	$p=0.062$
Alcohol Use	n = 93				n = 45				n = 64			
No	44	12	20		7	16	18		26	12	23	
Yes	10	5	2	$p=0.492$	0	3	1	$p=0.961$	0	3	0	$p=0.925$
Diabetes Mellitus	n = 93				n = 45				n = 64			
No	48	16	19		5	17	17		15	28	12	
Yes	6	1	3	$p=0.861$	2	2	2	$p=0.330$	2	4	3	$p=0.863$
Hypertension	n = 93				n = 45				n = 64			
No	39	10	18		4	16	14		18	8	15	
Yes	15	7	4	$p=0.572$	3	3	5	$p=0.653$	8	7	8	$p=0.750$
Syphilis	n = 93				n = 45				n = 64			
No	51	16	20		7	17	18		25	14	22	
Yes	3	1	2	$p=0.593$	0	2	1	$p=0.868$	1	1	1	$p=0.925$

1. WG - Weight gain; 2. hypo: hypocaloric; normo: normocaloric; hyper: hypercaloric. *Statistical significance $p<0.05$. Source: The authors.

Table 4. Correlation between perinatal factors and the calorie and fat content of milk from breast milk donors at different stages of maturation, from a Human Milk Bank in a public hospital in Recife-PE in 2023.

Variables	Colostrum (n=93)				Transition (n=45)				Mature (n=64)			
	hypo ³	normo ³	hype ^{r3}		hypo ³	normo ³	hype ^{r3}		hypo ³	normo ³	hype ^{r3}	
Calories												
<i>Perinatal Data</i>												
Sex	n = 93				n = 44				n = 56			
Male	36	7	11		3	12	12		15	6	14	
Female	18	10	11	<i>p</i> =0.108	4	6	7	<i>p</i> =0.486	6	9	6	<i>p</i> =0.905
Gestational age	n = 93				n = 45				n = 64			
Extreme Premature	4	0	5		0	1	5		3	3	6	
Pre-term	39	16	13		7	14*	14*		14	8	12	
Term	11	1	4	<i>p</i> =0.179	0	4	0	<i>p</i>=0.049	9	4	5	<i>p</i> =0.160
Birth Weight	n = 93				n = 45				n = 64			
<2500g	39	14	16		3	13	19*		14	11	15	
2500 - 4000g	14	3	5		4	5	0		11	3	8	
>4000g	1	0	1	<i>p</i> =0.989	0	1	0	<i>p</i>=0.003	1	1	0	<i>p</i> =0.330
Weight GA¹	n = 93				n = 45				n = 64			
SGA ²	4	1	1		2	0	1		2	2	2	
AWG ²	34	10	12		3	9	10		17	7	3	
LGA ²	16	6	9	<i>p</i> =0.320	2	10	8	<i>p</i> =0.400	7	6	8	<i>p</i> =0.690
Fats												
<i>Perinatal Data</i>												
Sex	n = 93				n = 45				n = 56			
Male	3	19	32		3	2	22		12	7	16	
Female	1	9	29	<i>p</i> =0.132	4	1	12	<i>p</i> =0.318	4	11	6	<i>p</i> =0.933
Gestational age	n = 93				n = 45				n = 56			
Extreme Premature	0	3	6		0	0	6		3	2	7	
Pre-term	2	22	44		7	3	25		10	12	12	
Term	2	3	11	<i>p</i> =0.648	0	0	4	<i>p</i> =0.748	4	8	6	<i>p</i> =0.530
Birth Weight	n = 93				n = 45				n = 56			
<2500g	2	24	43		3	3	29		11	13	16	
2500 - 4000g	2	4	16		4	0	5		6	7	9	
>4000g	0	0	2	<i>p</i> =0.449	0	0	1	<i>p</i> =0.109	0	2	0	<i>p</i> =0.944
Weight GA¹	n = 93				n = 45				n = 56			
SGA ²	0	3	3		2	0	1		2	2	2	
AWG ²	4	19	33*		3	3	16		10	12	15	
LGA ²	0	6	25	<i>p</i>=0.034	2	0	18*	<i>p</i>=0.035	5	8	8	<i>p</i> =0.774

1. GA: Gestational age. 2. SGA: Small for Gestational Age; AWG: Adequate for Gestational Age; LGA: Large for Gestational Age. 3. hypo: hypocaloric/hyperlipidemic; normo: normocaloric/normolipidemic; hyper: hypercaloric/hyperlipidemic. * Statistical significance $p<0.05$. Source: The authors.

Correlations were made considering maternal and perinatal factors (Table 5) and relating them to the milk fat content of the donors at the different stages of lactation. The results showed statistical significance in the colostrum phase for marital status ($p=0.024$), type of delivery ($p=0.025$), and weight for GA ($p=0.034$), where nursing mothers who had a partner, who had a vaginal delivery, and newborns who were AWG, obtained hyperlipidic colostrum. The transition phase also showed high-fat milk, with statistically significant results for the variables pre-pregnancy BMI ($p=0.015$) and weight for GA ($p=0.035$), demonstrating that the greater the excess weight before pregnancy, in addition to children who were born AWG and LGA, the higher the fat content in the transition milk assessed. The other maternal and perinatal factors investigated had no statistically significant relationship with the fat content of breast milk.

Table 5. Correlation between maternal factors and milk fat percentage of breast milk donors at different stages of maturation, from a Human Milk Bank in a public hospital in Recife-PE in 2023.

Variables	Colostrum (n=93)				Transition (n=45)				Mature (n=64)			
	hypo ²	normo ²	hyper ²		hypo ²	normo ²	hyper ²		hypo ²	normo ²	hyper ²	
Sociodemographic data												
Place of Birth	n = 93				n = 45				n = 64			
Interior of the State	1	15	32		2	2	23		12	9	14	
Metropolitan Region	3	13	29		4	1	11		5	13	9	
Other States	0	0	0	<i>p</i> =0.566	1	0	1	<i>p</i> =0.535	0	0	2	<i>p</i> =0.751
Marital status	n = 93				n = 45				n = 64			
With Partner	0	19	45*		7	3	25		13	16	20	
Without a Partner	4	9	16	<i>p</i>=0.024	0	0	10	<i>p</i> =0.070	4	6	5	<i>p</i> =0.749
Maternal Age	n = 93				n = 45				n = 61			
<19 years old	2	6	19		1	0	10		2	4	5	
20 - 35 years old	2	16	36		4	2	21		12	16	15	
>35 years old	0	6	6	<i>p</i> =0.601	2	1	4	<i>p</i> =0.535	2	1	4	<i>p</i> =0.889
Gestational Data												
Type of Delivery	n = 93				n = 45				n = 62			
Vaginal	1	12	39*		2	1	21		6	8	15	
Caesarean	3	16	22	<i>p</i>=0.025	5	2	14	<i>p</i> =0.104	11	13	9	<i>p</i> =0.749
Pre-gestational BMI	n = 53				n = 28				n = 48			
Underweight	0	2	2		1	0	1		2	0	2	
Eutrophic	1	6	15		3	1	4		6	5	7	
Excess Weight	0	10	17	<i>p</i> =0.779	1	0	17*	<i>p</i>=0.015	6	11	9	<i>p</i> =0.511
GP¹ in Pregnancy	n = 51				n = 28				n = 42			
Insufficient	0	3	3		1	0	4		2	2	3	
Appropriate	0	6	8		2	0	5		3	3	4	
Excessive	2	8	21	<i>p</i> =0.649	1	1	14	<i>p</i> =0.390	6	9	10	<i>p</i> =0.915
Lifestyle and Clinical Data												
Coffee Consumption	n = 92				n = 45				n = 64			
No	2	10	19		3	0	14		7	10	9	
Yes	2	17	42	<i>p</i> =0.242	4	3	21	<i>p</i> =0.862	10	12	16	<i>p</i> =0.693
Tobacco Use	n = 93				n = 45				n = 64			
No	4	22	55		6	2	33		17	21	22	
Yes	0	6	6	<i>p</i> =0.463	1	1	2	<i>p</i> =0.297	0	1	3	<i>p</i> =0.110
Alcohol Use	n = 93				n = 45				n = 64			
No	3	24	49		7	1	33		17	19	25	
Yes	1	4	12	<i>p</i> =0.785	0	2	2	<i>p</i> =0.732	0	3	0	<i>p</i> =0.783
Diabetes Mellitus	n = 93				n = 45				n = 64			
No	4	24	55		5	3	31		17	19	25	
Yes	0	4	6	<i>p</i> =0.940	2	0	4	<i>p</i> =0.309	0	3	0	<i>p</i> =0.956
Hypertension	n = 93				n = 45				n = 64			
No	4	19	44		4	2	28		10	14	17	
Yes	0	9	17	<i>p</i> =0.667	3	1	7	<i>p</i> =0.187	7	8	8	<i>p</i> =0.545
Syphilis	n = 93				n = 45				n = 64			
No	3	27	57		7	3	32		16	21	24	
Yes	1	1	4	<i>p</i> = 0.617	0	0	3	<i>p</i> =0.365	1	1	1	<i>p</i> =0.783

1.WG - Weight gain; 2. hypo: hypolipidemic; normo: normolipidemic; hyper: hyperlipidemic; *Statistical significance $p<0.05$. Source: The authors.

4. DISCUSSION

The importance of breast milk for children's health, growth, and development, as well as for the mother's health, is well established. The fat contained in milk accounts for 45% to 55% of the calorie content, depending on the time of maturation, and represents the greatest energy content necessary for the baby's nutrition⁷. However, few studies have linked the nutritional content of breast milk, especially the fat content, with maternal and perinatal factors. Furthermore, the methods used to obtain the nutrient composition and the stage of lactation studied differ¹⁰⁻¹⁹⁻²⁰.

The results of the study reflect important sociodemographic, gestational, lifestyle, and health characteristics of breast milk donors at the HMB of a public hospital in Recife-PE, during the period analyzed.

The breast milk donors were predominantly young (20 to 35 years old), lived with a partner, and more than half lived in the interior of the state of Pernambuco, aspects that align with the profile generally observed in studies with women of childbearing age¹¹⁻²¹⁻²². A recent prospective study performed at the same institution described the socioeconomic determinants of the nutritional status of pregnant women and observed similar sociodemographic and gestational characteristics²³.

It is observed that even after so many years of implementation of the regionalization process of the Unified Health System (SUS) by the Operational Assistance Standard (NOAS) in 2001/2002²⁴, it is limited, particularly in inland cities that lack specialized services, requiring patients to seek care in the capital. This situation leads to several challenges, including long travel distances, waiting lists, reduced family support, and increased personal and public expenditures related to healthcare and transportation. Investments in specialized care networks in the countryside and coordination between municipalities would possibly minimize these impasses and optimize care²⁴.

Analyzing the pregnancy characteristics of the donors in the study, the high proportion of vaginal deliveries among donors is consistent with national policies to encourage vaginal delivery, although the number of cesarean sections is still significant²⁵. This variable is relevant because the type of birth can influence the onset and effectiveness of lactogenesis II - the phase responsible for the sudden increase in milk production, which occurs around 48 to 72 hours after birth. Studies indicate that cesarean delivery, especially without previous labor, is associated with delayed lactogenesis and lower initial colostrum volume, which can temporarily compromise production and alter the macronutrient profile of breast milk in the first few days postpartum²⁶⁻²⁷. Thus, the higher prevalence of normal births observed may have favored the production of colostrum in greater volume and with different characteristics, such as higher fat content, as identified in this study.

Pre-gestational BMI showed that a significant proportion of the nursing mothers started pregnancy with EPPG and that excessive weight gain was prevalent. This data is consistent with the growing prevalence of obesity in women of reproductive age in Brazil, where aspects of the nutritional transition can be observed, i.e., changes in eating patterns due to economic, social, demographic, and health changes. This has changed the nutritional profile of the population from malnutrition, not only in Brazil, but in several countries around the world, to an increase in the prevalence of health problems related to excess weight²¹⁻²⁸.

Marano et al.⁷, evaluating the nutritional composition of the milk of 181 HMB donors in Rio de Janeiro and the association with maternal and perinatal factors, found that pre-gestational obesity and excessive weight gain during pregnancy were associated with lower protein content in mature milk. Although the protein content of the milk was not assessed in this study, it is important to emphasize that monitoring nutritional status by a trained professional before and during pregnancy is essential to

minimizing risks to both mother and child and to promoting a lactation process that meets the infant's nutritional needs.

The analysis of calorie composition and fat percentage in the different stages of breast milk maturation is one of the most important points of the study. Colostrum was predominantly hypocaloric but hyperlipidic, indicating a composition rich in essential lipids for the newborn, even in cases of prematurity. Transition milk evidenced significant variations and was associated with pre-gestational BMI, GA at birth, and birth weight. These findings corroborate evidence that maternal and perinatal factors influence the adaptation of milk to the needs of newborns²².

The positive correlation between fat and caloric content across all stages of lactation reinforces the central role of lipids in determining the energy density of breast milk. This is particularly relevant for premature or low birth weight newborns, who require a higher calorie intake for proper growth and development²⁹.

Marital status showed a significant association with the percentage of fat in colostrum, suggesting that psychosocial factors can directly influence milk quality. In a qualitative study performed by Rizzi and Loureiro³⁰ with 24 puerperal women in a maternity hospital in Vitória, Espírito Santo, on the factors, resources, and psychosocial consequences of breastfeeding, having a family and professional support network was associated with prolonged duration of breastfeeding. In addition, the presence of family support is generally linked to a higher income and, consequently, better living conditions, such as housing and access to food. This finding suggests that the presence of a partner can lead to greater financial and emotional support and stress reduction, which has a positive impact on lactation.

The type of vaginal birth was also significantly associated with the percentage of fat in the colostrum. This result differs from the study by Campos et al.³¹, who, when analyzing the influence of the route of delivery on the lipid content of colostrum by the crematocrit method, of 214 nursing mothers from a maternity hospital in Presidente Prudente (SP), found no statistically significant relationship. This divergence in results may be linked to factors intrinsic to the sample, such as the geographical region studied, maternal diet, and different gestational factors.

Transition milk showed an association with pre-gestational BMI, indicating that women with EPPG tend to produce more caloric milk. In a systematic review performed by Oliveira et al.¹⁰, most of the articles selected showed that obesity changed the total concentration of lipids and their fractions in breast milk. Furthermore, this finding reinforces the importance of nutritional interventions during prenatal care, aimed at maternal and child health, especially weight gain control and monitoring by a specialized professional.

A study conducted by Chen et al.³², with 19.052 women in Taiwan, evaluated the perinatal risks related to pre-pregnancy BMI and weight gain during pregnancy, and found that an overweight or obese BMI before pregnancy leads to maternal risks such as pregnancy-specific hypertension, gestational diabetes mellitus, cesarean delivery, postpartum infections, and prolonged labor. The literature also indicates that overweight women who gain inadequate weight during pregnancy are at increased risk of delivering infants with low birth weight, experiencing spontaneous preterm birth, and facing a higher likelihood of adverse neonatal outcomes³³.

Although the presence of maternal comorbidities was not significantly associated with calories and milk fat in this study, diabetes mellitus and hypertension during pregnancy are important risk factors for premature birth³⁰. A descriptive study performed by Gomes et al.³⁴, with 526 pregnant women divided into age groups, in which the babies were born before 37 weeks, found that the prevalence of diabetes mellitus and hypertension was significant in all groups and increased with increasing maternal age, suggesting that the occurrence of these conditions during pregnancy may be related to early births. It

should be noted that in this study, prematurity changed the lipid composition of breast milk in the transition phase.

Regarding perinatal factors, in addition to GI, birth weight also influenced milk composition. Preterm and low birth weight were associated with higher-calorie transitional milk. In a study conducted by Moreira et al.²², although not statistically significant, it was found that the macronutrients in the breast milk of very low birth weight premature infants had an upward curve for calories, proteins, fats, and carbohydrates. These findings possibly reflect the adaptive capacity of breast milk to meet the increased metabolic demands of these newborns.

The evidence found in this research has important implications for clinical practice and for the management of HMBs, especially in the care of premature and low birth weight newborns. The identification that maternal factors, such as pre-gestational BMI, and perinatal factors, such as gestational age and birth weight, directly influence the caloric and lipid composition of donated milk, allows for targeted screening and selection strategies for milk with a nutritional profile more suited to the specific needs of at-risk newborns. Hypercaloric and high-fat milks, for example, can be prioritized for feeding extreme preterm infants and newborns with intrauterine growth restriction. This helps to optimize weight recovery and reduce complications associated with inadequate nutrient supply during post-birth hospitalization periods. In addition, the study reinforces the importance of considering maternal variables in nutritional counseling during prenatal care and during the lactation period, with a view not only to maternal health, but also to the nutritional quality of the milk offered to newborns. This information can support the development of care protocols and public policies aimed at qualifying the donation and use of human milk, promoting greater effectiveness in neonatal care in public health services.

Although robust, the study's data faced limitations. To begin with, the type of study was retrospective, based on existing records, which limited the refined exploration of the variables used. The sample size and the presence of records in only one of the lactation phases made the presentation of some results vulnerable, especially in the analysis of variables such as calories and milk fat. Furthermore, some of the data comprising the variables were missing or incomplete in the Human Milk Bank (HMB) registration forms, either due to transcription errors or reliance on maternal recall. To address these limitations, future studies should focus on larger, more complete, and prospective samples.

5. CONCLUSION

In view of the results presented in this study, it can be concluded that some maternal and perinatal factors are associated with the amount of calories and fat present in breast milk. Excess weight before pregnancy, premature births, and low birth weight were positively associated with the calories in breast milk during the transition phase, which tended to be more caloric. Concerning fat content, the presence of a partner, vaginal delivery, and adequate birth weight resulted in high-fat colostrum. And finally, starting the pregnancy overweight and giving birth to large-for-gestational-age babies has shown that there is a high amount of fat in transitional milk.

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