| RESEARCH ARTICLE

Association between Breastfeeding and Reduced Risk of Obesity in Childhood: A Cross-sectional Study in Ecuadorian Infants under Five Years of Age

Jhon Ponce-Alencastro[1] ✉ Viviana Chilito-Osorio[2], Pamela Ramos-Rivera[3], Amanda Tenorio-Romero[4], Edison Castro-López[5], Karen Viña-Zambrano[6] and Stephanie Cruz-Pierard[7]

[1]*Teaching Researcher, Medical Doctor, Health Faculty, Medical Sciences Department, Universidad Técnica de Manabí, Portoviejo, Ecuador*
[2]*Medical Doctor, Hospital Padre Carollo, Quito, Ecuador.*
[3]*School of Medicine, Faculty of Health Sciences, Pontificia Universidad Católica del Ecuador, Quito, Ecuador*
[4]*Pediatrician, Ministry of Public Health, District 01D03- Technical Office 01D07, Camilo Ponce Enriquez, Ecuador*
[5]*Medical Doctor, Centro de Especialidades Médicas Vital Médica's, Ambato, Ecuador*
[6]*Medical Doctor, Hospital General IESS Santo Domingo, Santo Domingo, Ecuador*
[7]*Master in Human Nutrition, Universidad UTE, Quito, Ecuador*
Corresponding Author: Jhon Ponce-Alencastro, **E-mail**: scienceacrev@gmail.com

| ABSTRACT

Poor eating habits and an increased sedentary lifestyle are responsible for obesity being one of the main public health problems in Ecuador and the world. Several factors can modulate the risk of an infant to be obese, considering genetic, environmental and sociodemographic variables. The aim of this study is to analyze the evidence on the relationship between breastfeeding (BF) and obesity in childhood and thus contribute to the planning of prevention strategies from an early age. A nationally representative sample of children under 5 years of age from the National Health and Nutrition Survey (ENSANUT, 2018) was used. We used heteroscedasticity and autocorrelation tests of the data to rule out possible statistical modeling problems and used multicollinearity tests to avoid redundant information in the models. We also calculated confusion matrices to test the correct specification of the models. In addition, we used a binary logistic linear regression model where the Odds Ratio (OR) with their 95% confidence intervals (95% CI) were estimated for each of the independent variables. Our results show that those children who were breastfed show a greater protective factor against obesity compared to those children who were not breastfed. That is, our results show that exclusive breastfeeding during the first six months of life increased 2 times (OR= 2.01; CI=1.91-2.17) the probability of not suffering from obesity. Other significant protective factors are the mother's age, the mother's educational level and the mother's area of residence. The recommendation derived from this research is that BF should be carried out until the sixth month of life of the infant and complemented with solid (non-milk) food until two years of age and beyond since this could protect against childhood obesity and its associated comorbidities in adulthood, although the benefit that BF can offer against the risk of obesity in the general population is small.

| KEYWORDS

Breastfeeding, Exclusive breastfeeding, Obesity, Overweight, Infants, Protection factor

1. Introduction

Breastfeeding is optimal for the newborn and infant, a situation that has led the World Health Organization to recommend breastfeeding within the first hour after birth and as the only food for the first six months of life and up to two years or more,

complemented by healthy eating (Oyarzún et al., 2018)since breastfeeding is a way of providing ideal nourishment for the healthy growth and development of the infant (Careaga & Acosta, 2017).

The composition of breast milk consists of nutrients and trophic and immuno-modulatory factors that generate protection against obesity, chronic diseases and metabolic syndrome. (Burke et al., 2005). However, despite the above, many infants and children under 2 years of age do not receive optimal nutrition. Globally, less than 40% of infants under 6 months of age receive breast milk as an exclusive form of feeding (Cai et al., 2012).

Research in recent years makes a special emphasis on one of the main benefits of exclusive breastfeeding, which is the protection of the child against obesity in the short, medium and long term. In most large studies, an inverse relationship is found between the duration of breastfeeding and the presence of excess weight (overweight or obesity) in children and young people, although some authors doubt this protective effect (Bammann et al., 2014).

The World Health Organization defines obesity as an abnormal or excessive accumulation of fat that can be harmful to health. Currently, childhood obesity is one of the most serious public health problems of the 21st century; there is a real pandemic of both obesity and overweight throughout the world (Gatica Mandiola et al., 2013). (Gatica Mandiola et al., 2013).. Although obesity is recognized as a manifestation of energy imbalance between intake and expenditure in the individual, its etiology is multifactorial and also encompasses other areas, which in turn interact with each other such as social, cultural and biological characteristics. Thus, the first 1,000 days of life, considering intrauterine and extrauterine life up to 2 years of age, have been identified as a critical developmental period that could shape the susceptibility to metabolic diseases such as obesity (Agosti et al., 2017). In this context, it has been evidenced that childhood overweight and obesity have increased significantly in the pediatric population suffering from overweight and obesity (41 million) reported in 2016 and of them, more than 17 million live in developing countries (Padilla Vinueza et al., 2022).

Obese children are at risk for obesity in adulthood and, as a consequence, disability and premature death (Baur, 2011). In the short term, obesity can affect almost all organs causing serious alterations, including hypertension, dyslipidemia, insulin resistance, fatty liver, and pulmonary and psychological complications(Vander Wal & Mitchell, 2011). Recent studies suggest that early nutrition and maternal weight gain may determine the future disease. The speed of weight gain during the first months of life, the milk pattern during the first semester and the introduction of the first foods could be determinants of this situation (Ruben et al., 2013).

From the perspective of obesity, the relationship between feeding in the first year of life and childhood obesity has been sought. Given this situation, it has been shown that a longer duration of breastfeeding is associated with a decreased risk of obesity, with a 4% reduction for each month of breastfeeding (Sandoval Jurado et al., 2016). In this context, a study conducted in the United States found that children who were exclusively breastfed for 3 to 5 months were 35% less likely to be obese compared to those who did not breastfeed. A meta-analysis showed that breastfeeding reduces the risk of obesity in childhood significantly and appears to have a small but consistent protective effect against childhood obesity (Arenz et al., 2004). Other research has determined that the duration of breastfeeding and the risk of being overweight was inversely associated with the risk of overweight; therefore, research findings strongly support a dose-dependent association between a longer duration of breastfeeding and decreased risk of being overweight in childhood and possibly in adulthood. In contrast, another study compared adiposity between children who were breastfed and those who were not breastfed and found no significant difference (Burdette et al., 2006).

Consequently, breastfeeding has been widely described as a protective factor against childhood obesity, showing a dose-response effect between the duration of breastfeeding and the reduction of the risk of obesity in early childhood. However, the mechanisms through which this effect is exerted are diverse, and due to the complexity of their interaction, it is still necessary to explain the factors that may be related. Taking into account that there are controversies regarding the benefits of exclusive breastfeeding in the protection of the child against obesity in the short, medium and long term, which in our country has not been found in the available literature, The existence of studies reflecting the search for the relationship between excess weight and adiposity with exclusive breastfeeding in infants under 5 years of age, and it is also convenient to consider the existence of an increase in both the incidence and prevalence of overweight and obesity worldwide, together with the early abandonment of exclusive breastfeeding; it was decided to carry out the present investigation. The objective of this study was to determine the possible relationship between overweight and central obesity with the duration of exclusive breastfeeding.

2. Methodology
2.1 Survey and Population
A cross-sectional study was conducted with data obtained from the 2018 National Health and Nutrition Survey of Ecuador (ENSANUT). This is a survey conducted by the National Institute of Statistics and Census (INEC). The ENSANUT 2018 is a survey conducted by the National Institute of Statistics and Census, which uses probability sampling. This survey is applied every 5 years,

and its target population is all household members in the 24 provinces of Ecuador. After cleaning the database, a total of 14356 Ecuadorian children under five years of age were obtained.

2.2 Source of Information
The ENSANUT 2018 includes the HOGAR form, where all the characteristics of the Ecuadorian population are evidenced to make representative estimates at the national level, urban-rural, by geographic domain for the 24 provinces of the country. In addition, the anthropometric measurements of children can also be found.

2.3 Study Variables
Our dependent variable of interest (childhood obesity) was generated from the Body Mass Index (BMI) of the children, and, following Saldaña & Mendoza (2009), we classified as obese children those children with a BMI greater than or equal to the 95th percentile of the distribution; otherwise, they are considered children without obesity. In this way, we generated the dichotomous variable obesity, which takes the value 1 if the child suffers from obesity and 0 if he/she does not suffer from obesity. On the other hand, our independent variable of interest is breastfeeding. For this variable, we used the question "At birth, did you breastfeed your child at birth (breastfed)?" whose answer is if breastfed=1 and not breastfed= 0. In addition, we used other variables as possible predictors of childhood obesity, such as family income, region of origin, age, sugar consumption, healthy child control, ethnicity, marital status of the mother, educational level of the mother, employment status of the mother, urban density, economic development of the province, area of residence. These control variables are detailed in **Table 2**.

2.4 Inclusion and Exclusion Criteria
Data from children aged zero to five years and their mothers were included. Mothers who did not report having children and missing data from the base were excluded.

2.5 Statistical Analysis
The ENSANUT 2018 survey database was analyzed with the statistical package Stata v15 (Stata Corporation, College Station, Texas, USA). A value of p<0.05 was considered to determine the statistical significance between variables. Discrete choice linear models were used to determine the overall correlation between the variables of interest. The association was evaluated using prevalence ratios (OR) with their respective 95% confidence intervals and analysis for each of the variables included in the study. In this study, the independent variable of interest is a variable indicating whether a child was breastfed. While the dependent variable is a variable indicating whether a child suffers from obesity. Specifically, the following equation was used to evaluate predictors of childhood obesity:

$$Childhood\ obesity_i = \beta_0 + \beta_1 X_i + \sum_{j=2}^{12} \beta_j Z_i + \varepsilon_i$$

(1).

Where $Childhood\ obesity_i$ represents whether a child suffers from childhood obesity, X_i represents a set of sociodemographic variables, and Z_i represents a set of territorial control variables. These sociodemographic and territorial variables are listed in Table 2, ε_i represents the stochastic error term.

3. Results and Discussion
First, to highlight the case study, **Figure 1** shows the spatial distribution of child malnutrition. In general, the provinces with a more intense color are those with a higher percentage of childhood obesity. This fact shows that childhood obesity mainly affects the provinces of the Ecuadorian Coast and Highlands.

Figure 1. Spatial distribution of childhood obesity in Ecuador.
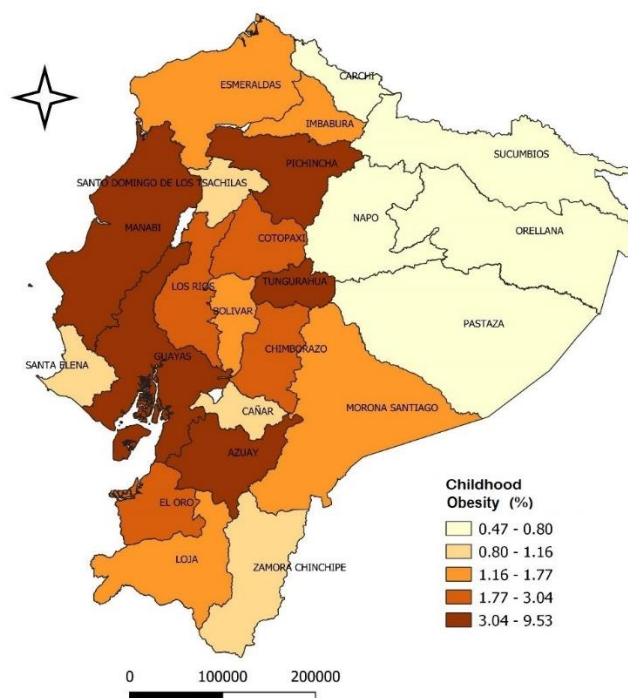
Next, we performed exploratory statistics of the key variables of this study. **Table 1** shows the percentage of children who report that they suffer from obesity, which is 28.55%. This means that a large number of children suffer from childhood obesity in Ecuador. That is, more than a quarter of Ecuadorian children report being obese. In addition, 95.27% of mothers reported that their child was breastfed, while 4.43% of mothers reported that they did not breastfeed their child. This fact is of great importance since we observed that a large percentage of mothers do not breastfeed their children, and at the same time, a large percentage of children with obesity problems are reported. A significant relationship could be occurring in this sense. On the other hand, we observed that obesity is more frequent in boys (54.34%), the same who report more cases of not breastfeeding (57.29%) compared to girls (42.79%). This fact leads to infer patterns that assume that breastfeeding does have a significant relationship with childhood obesity.

Table 1. Percentage of children with childhood obesity and reported breastfeeding.

Variable and response	Children	Girls	Total	Total percentage
Childhood obesity				
Yes	2227	1870	4098	28.55%
No	6060	4197	10257	71.45%
Breastfeeding				
Yes	7898	5778	13676	95.27%
No	389	291	680	4.43%

Table 2 shows the descriptive statistics of the sociodemographic variables used for the linear regression model. Here we observe that the average family labor income is $422 USD, 42.7% of the children are from the highland region, the average age is 2.34 years, and 81.03% of the children are mestizo. In addition, 40.7% of their mothers are single, and 38.1% are married. We also note that 43.4% of the mothers have a high school education, and 64.57% of the women are employed. Regarding territorial characteristics, we observed that on average, there are 151 inhabitants per square kilometer, the provincial gross value added (economic development) is, on average, $1297.65 USD, and 59.33% of the women live in the urban area. Regarding some variables related to children's nutrition, 61.22% consume sugar, and the average age at which children were taken to their first well-child check-up is 2.36 years old.

Table 2. Descriptive statistics of the variables used in this study.

Variable	Mean-Percent	Min	Max	95% CI		
Childhood obesity						
Yes	28.55%	0	1	25.55%	-	30.55
No	71.45%	0	1	68.45%	-	73.45
Breastfeeding						
Yes	95.27%	0	1	90.32		99.36
No	4.43%	0	1	3.12		5.74
Family labor income						
Income in dollars	422.12	0	1500	403.27	-	415.45
Region of origin of the child						
Sierra	38.5%	0	1	38	-	39
Costa	42.7%	0	1	41.21	-	43.09
Amazon	16.3%	0	1	15.98	-	17.01
Galapagos	2%	0	1	1.96	-	2.51
Child's age						
Age in years	2.34	1	5	2.12	-	2.54
Sugar consumption						
Yes	61.22%	0	1	57.97	-	69.53
No	35.43%	0	1	29.55	-	42.54
Well-child checkup						
Years of age at which the child was taken to control	2.36	0	5	2.17	-	2.45
Child's ethnicity						
Indigenous	7.1%	0	1	6.6	-	7.28
Afro-Ecuadorian	5.3%	0	1	4.90	-	5.98
Mongrel	81.03%	0	1	80.22	-	81.86
White	1.4%	0	1	1.2	-	1.9
Montubio or Others	4.6%	0	1	4	-	5.1
Mother's marital status						
Married	38.1%	0	1	38	-	39
Single	40.7%	0	1	41.21	-	43.09
Widow	18.3%	0	1	15.98	-	19.01
Divorced	2%	0	1	1.96	-	2.51
Mother's educational level						
None	0.7%	0	1	0.3	-	1.1
Basic Education	27.3%	0	1	27.1	-	28.3
Middle/High School Education	43.4%	0	1	43.41	-	44.12
Higher Education	27.1%	0	1	26.87	-	27.98
Mother's employment status						
Employee	64.57%	0	1	58.97	-	69.12
Unemployed	35.43%	0	1	30.05	-	40,66
Urban density						
Inhabitants per square kilometer	151.01	1152.5	321	146.32	-	160.33
Economic development of the province						
Provincial GVA per capita	1297.65	540.5	321	836.43	-	1456.67
Area						
Urbana	59.33%	0.54	0	55.51	-	61.51
Rural	44.49%	0.36	0	41.49	-	46.49

Next, we performed a formal test to rule out the presence of multicollinearity among our independent variables. In **Table 3,** we present a multicollinearity analysis. We use the Variance Inflator Factor (VIF) to perform this test. Previous literature indicates that a VIF greater than 5 can demonstrate that there is multicollinearity in our data. As we can see, no variable presents a VIF greater than 5; therefore, we discard multicollinearity problems in our independent variables. This analysis is important since

multicollinearity problems cause instability of the parameters of a regression, incorrect signs and higher standard errors, which translates into statistical insignificance of the parameters.

Multicollinearity test of the estimated model.

Variable	VIF	SQRT VIF	Tolerance	R-Squared
Exclusive breastfeeding	1.16	1.90	0.5634	0.6532
Labor income	1.88	1.75	0.8872	0.0227
Region of origin	1.25	1.22	0.2221	0.1188
Age	1.88	1.75	0.8872	0.0227
Sugar consumption	1.88	1.75	0.8872	0.0227
Well-child checkup	1.32	1.11	0.7853	0.6781
Ethnicity	1.77	1.22	0.2212	0.1122
Marital status	1.22	1.85	0.7210	0.2780
Educational level	1.12	1.27	0.8127	0.0252
Employment status	1.22	1.74	0.8827	0.2252
Urban density	1.57	1.85	0.7210	0.2780
Economic development of the province	1.44	1.75	0.8752	0.0252
Area	1.72	1.11	0.8875	0.2087
Mean VIF	1.82			

Next, to further explore the pattern found in **Table 1,** we performed a linear regression analysis to observe and analyze the influence of various sociodemographic factors on the probability of childhood obesity. For this, we use a logit model, as shown in **Table 4.** In the table, the dependent variable is the dichotomous variable that takes the value of 1 if a child is obese and 0 otherwise. Here we observe that there are negative odd ratios of some variables. For example, income has a negative influence on the probability of childhood obesity. This occurs because families with higher incomes have better possibilities of attending or paying for a doctor, in addition to increasing the probability of having a more balanced diet. Specifically, an increase in income decreases 2 times the probability of suffering from obesity (OR= -2.078, CI= -2.035; -2.086). We found that breastfeeding decreases the probability of childhood obesity by 2.45 times (OR:-2.078), this correlation being statistically significant. Other variables with positive odd ratios are age, married, widowed and divorced marital status. We also observed that a higher educational level decreases the probability that the child will suffer from obesity. This is because more educated women are aware of the risks of a lack of breastfeeding for the child. On the other hand, being unemployed increases the probability of obesity in children, while living in a denser urban area increases the probability of an obese child, while a higher level of economic development decreases the probability of childhood obesity.

Table 4. Logistic regression analysis between childhood obesity and breastfeeding.

	OR		P-value		95% CI
Dep. Var: If childhood obesity=1, 0 otherwise					
Breastfeeding					
No	Ref.				
Yes	-2.465*		0.035		-2.125--2.764
Labor income					
Income in dollars	-2.078*		0.035		-2.035--2.086
Region of origin					
Sierra	Ref.				
Costa	-1.083*		0.030		-1.010--1.369
Amazon	1.511		0.149		1.002-1.824
Galapagos	2.402		0.152		2.322-2.575
Child's age					
Age in years	0.822*		0.035		0.521-1.128
Sugar consumption					
No	Ref.				
Yes	1.567*		0.032		1.321-1.875
Well-child checkup					

Years of age at which the child was taken to control	2.001*	0.089	1.821-2.281
Child's ethnicity			
Indigenous	Ref.		
Afro-Ecuadorian	1.035	0.932	1.003-1.056
Mongrel	0.933**	0.006	0.626-2.086
White	0.903	0.864	0.276-1.071
Montubio or Others	0.818	0.620	0.692-0.991
Marital status			
Married	Ref.		
Widow	0.693	0.799	0.593-1.770
Divorced	0.976	0.981	0.083-2.034
Educational level			
None	Ref.		
Basic Education	2.262	0.125	2.221-2.860
Middle/High School Education	2.337	0.109	2.191-2.889
Higher Education	-2.783*	0.060	-2.042- -2.889
Employment status			
Employee	Ref.		
Unemployed	1.099	0.634	1.0093-1.482
Urban density			
Inhabitants per square kilometer	1.654**	0.023	1.570-1.687
Economic development of the province			
Provincial GVA per capita	-1.092**		-1.017--2.097
Area			
Urbana	Ref.		
Rural	1.456	0.123	1.570 - 1.242
Constant	5.790***	0.007	5.472-5.940
Observations	14356		
AIC	1848.35		
BIC	2011.41		
Chi²	152.4		
Chi² p-value	0.000		
Log-likehood	-898.174		

Notes: Asterisks mean: *p < 0.10,**p < 0.05, ***p < 0.01.

Then, the confusion matrix of the model is shown. In **Table 5,** we can see that the estimated model is correctly specified. In the model, we use as a dependent variable denoting whether a child suffers from obesity, which is 75.12% specified by the independent variables. That is, the independent variables predict that a child is obese in 75.12% of the cases. It is worth mentioning that this percentage is relatively high, being an acceptable level higher than 60%.

Table 5. Confusion matrix of the estimated model.

Obesity Model						
True						
Classified		D		~D		Total
		3281		1423		1689
		2451		2231		6987
Total		4288		2966		5785
Correctly classified						75.12%

Finally, to determine the fit and explanation of the independent variables, the ROC curve was applied with the probabilities estimated by applying logistic regression. The ROC curve in **Figure 2** coincides with the probability of correctly distinguishing a case of a child suffering from obesity from one that does not, through the significant predictor variables, the worst scenario being when the area is equal to 0.50. In our case, the significant variables, such as family income, female schooling, being employed and urban density, represented an area under the curve of 0.80880 (95% CI: 0.752-0.854), considering that they adequately predict (positively or negatively) cases of childhood obesity ($p < 0.001$).

Figure 2. ROC curve of the estimated model.

Area under ROC curve = 0.8008
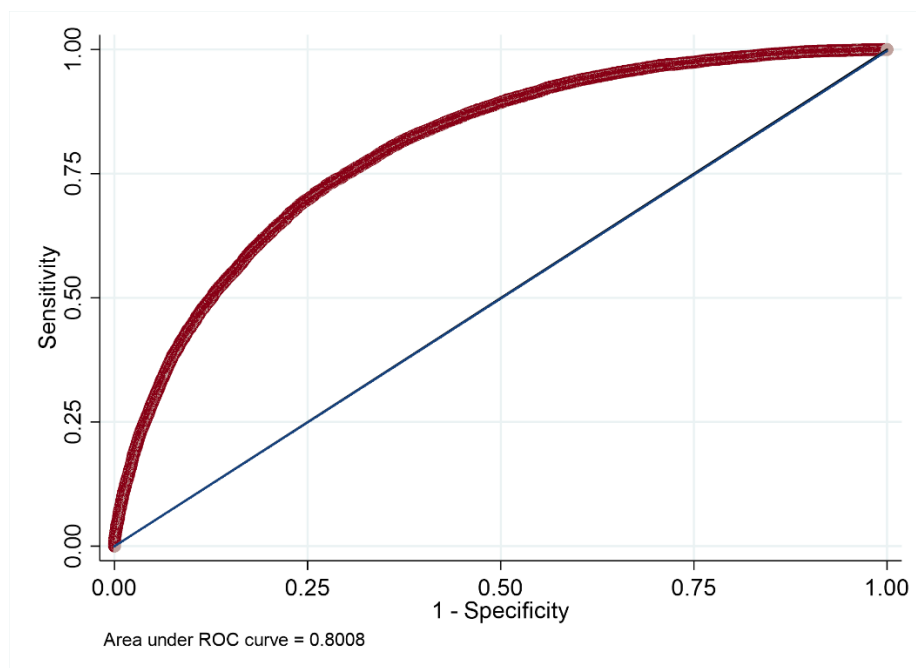
4. Discussion

Childhood obesity has been associated with a wide range of health complications in adulthood (Owen et al., 2005)and epidemiological evidence points to the influence of nutrition in early life on the growth pattern, body composition and subsequent risk of developing chronic noncommunicable diseases.

In the results of our study, it can be verified that 28.55% of children under 5 years of age suffer from obesity; that is, more than a quarter of Ecuadorian children report being obese. In addition, 95.27% of mothers reported that their child was breastfed, while 4.43% of mothers reported that they did not breastfeed their child. We observed that obesity is more frequent in boys (54.34%), the same who report more cases of not being breastfed (57.29%) compared to girls (42.79%). This fact leads to infer patterns that assume that breastfeeding does have a significant relationship with childhood obesity. Therefore, the protective effect of predominant breastfeeding in the first years of life on malnutrition due to excess weight in children under 5 years of age can be inferred.

Therefore, our results are consistent with those reported in multiple studies worldwide. A study conducted in the United States by the Centers for Disease Control and Prevention showed that breastfeeding between the first 6 and 12 weeks of life was associated with a lower risk of overweight and obesity among children compared to not breastfeeding (adjusted OR of 0.70; 95% CI, 0.50-0.99).

A review by the Agency for Healthcare Research and Quality (AHRQ), which evaluated three systematic reviews and one meta-analysis of good to moderate methodological quality, found an association between breastfeeding and a reduction in the risk of overweight and obesity. In this analysis, the adjusted OR for overweight, comparing the presence versus absence of breastfeeding, was 0.76 (95% CI, 0.67-0.86), and for obesity was 0.93 (95% CI 0.88-0.99). The AHRQ report also mentions an earlier WHO meta-analysis that found that an increased duration of breastfeeding was associated with a 4% decrease in the risk of being overweight (Ip et al., 2009). Another cohort study conducted in Spain of children and adolescents with obesity, where 126 obese patients with a mean age of 11.94 ± 3.12 years were studied, reported that receiving BF for at least 3 months led to a lower rate of obesity, lower waist circumference and fewer complications related to metabolic syndrome during childhood and adolescence.

Another study in Iceland evaluated the association between infant feeding and body mass index in early infancy and at 6 years of age. It assessed 154 children who were followed prospectively from birth to 12 months and again at 6 years of age. And it was shown that the introduction of complementary feeding before 6 months increases the risk of high BMI in formula-fed infants compared to breastfed infants.

In our study, we were also able to observe that; specifically, an increase in income decreases 2 times the probability of suffering from obesity (OR= -2.078, CI= -2.035; -2.086). Other variables with positive odd ratios are age, married, widowed and divorced marital status. We also observed that a higher level of education decreases the probability that the child will suffer from obesity. This is because more educated women are aware of the risks of a lack of breastfeeding for the child. On the other hand, being unemployed increases the probability of obesity in children, while living in a denser urban area increases the probability of an obese child, while a higher level of economic development decreases the probability of childhood obesity. Although these factors analyzed do not show a significant association with the other confounding factors analyzed, it has been observed in several studies. Socioeconomic level (Armstrong et al., 2002), low birth weight (von Kries et al., 1999), low birth weight (von Kries et al., 1999)prenatal education (Bartok & Ventura (Bartok & Ventura, 2009), maternal smoking (Huus et al., 2008), parental age (Bartok & Ventura, 2009) and ethnicity (Grummer-Strawn et al., 2004b) have been considered important confounding factors, which should be taken into account when assessing the association between breastfeeding and obesity.

In conclusion, the majority of this population sample of children under 5 years of age received breastfeeding and had a lower prevalence of obesity than those who did not. Regarding the duration of breastfeeding, there is a protective effect during the first semester if it is received for more than 3 months. This information is useful for further studies.

5. Conclusion

Predominant breastfeeding for the first 6 months of life is a protective factor against overweight malnutrition in children under 2 years of age. Our main objective was to determine the possible relationship between excess weight and central obesity with the duration of breastfeeding. In our study, we were able to verify that 28.55% of children under 5 years of age suffer from obesity; that is, more than a quarter of Ecuadorian children report being obese. In addition, 95.27% of mothers reported that their child was breastfed, while 4.43% of mothers reported that they did not breastfeed their child. We observed that obesity is more frequent in boys (54.34%), the same who report more cases of not being breastfed (57.29%) compared to girls (42.79%). This fact leads to infer patterns that assume that breastfeeding does have a significant relationship with childhood obesity. Therefore, the protective effect of predominant breastfeeding in the first years of life on malnutrition due to excess weight in children under 5 years of age can be inferred. Specifically, we found that breastfeeding decreases the probability of childhood obesity by 2.45 times (OR:-2.078); this correlation is statistically significant. We hope that our work will serve as motivation for prospective studies to be carried out in our country and in the world to evaluate in a controlled manner the protective effect that breastfeeding has on overweight and obesity in the future pediatric population. The main limitations of our study were that in the ENSANUT survey, it was not possible to assess individually for each child until the exact age at which they reported breastfeeding. Given the magnitude and population risks of the obesity epidemic, and given the probable protective effect of breastfeeding against excess malnutrition, it is important to continue investigating different aspects related to the insufficient use of exclusive breastfeeding during the first six months of life in order to develop and apply public policies to reduce the early abandonment of exclusive breastfeeding and, thus, improve the results achieved in the present investigation.

Conflicts of Interest: The authors declare that they have no conflicts of interest.
Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers.
Ethical approval: In the present research, it was not necessary to request approval by the bioethics committee since the data were obtained from a database of the National Health and Nutrition Survey, ENSANUT of the Ecuadorian Institute of Statistics and Census (INEC).
Informed consent: It was not necessary to apply informed consent to the participants since the data were obtained through a database available from the National Institute of Statistics and the Census of Ecuador.

References

[1]   Agosti, M., Tandoi, F., Morlacchi, L., & Bossi, A. (2017). Nutritional and metabolic programming during the first thousand days of life. *La Pediatria Medica E Chirurgica: Medical and Surgical Pediatrics*, *39*(2), 157. https://doi.org/10.4081/pmc.2017.157

[2]   Arenz, S., Rückerl, R., Koletzko, B., & von Kries, R. (2004). Breast-feeding and childhood obesity-A systematic review. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity*, *28*(10), 1247-1256. https://doi.org/10.1038/sj.ijo.0802758

[3] Armstrong, J., Reilly, J. J., & Child Health Information Team (2002). Breastfeeding and lowering the risk of childhood obesity. *Lancet (London, England)*, *359*(9322), 2003-2004. https://doi.org/10.1016/S0140-6736(02)08837-2

[4] Bammann, K., Peplies, J., De Henauw, S., Hunsberger, M., Molnar, D., Moreno, L. A., Tornaritis, M., Veidebaum, T., Ahrens, W., Siani, A., & IDEFICS Consortium (2014). Early life course risk factors for childhood obesity: The IDEFICS case-control study. *PloS One*, *9*(2), e86914. https://doi.org/10.1371/journal.pone.0086914.

[5] Bartok, C. J., & Ventura, A. K. (2009). Mechanisms underlying the association between breastfeeding and obesity. *International Journal of Pediatric Obesity: IJPO: An Official Journal of the International Association for the Study of Obesity*, *4*(4), 196-204. https://doi.org/10.3109/17477160902763309

[6] Basain Valdés, J. M., Valdés Alonso, M. del C., Álvarez Viltres, M., Miyar Pieiga, E., Tase Pelegrin, T. S., Basain Valdés, J. M., Valdés Alonso, M. del C., Álvarez Viltres, M., Miyar Pieiga, E., & Tase Pelegrin, T. S. (2018). Excess weight and central obesity and its relationship with the duration of exclusive breastfeeding. *Revista Cubana de Pediatría*, *90*(4). http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S0034-75312018000400007&lng=es&nrm=iso&tlng=en. http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S0034-75312018000400007&lng=es&nrm=iso&tlng=en

[7] Baur, L. A. (2011). Changing perceptions of obesity-Recollections of a paediatrician. *Lancet (London, England)*, *378*(9793), 762-763. https://doi.org/10.1016/s0140-6736(11)61365-2.

[8] Burdette, H. L., Whitaker, R. C., Hall, W. C., & Daniels, S. R. (2006). Breastfeeding, the introduction of complementary foods, and adiposity at 5 y of age. *The American Journal of Clinical Nutrition*, *83*(3), 550-558. https://doi.org/10.1093/ajcn.83.3.550.

[9] Burke, V., Beilin, L. J., Simmer, K., Oddy, W. H., Blake, K. V., Doherty, D., Kendall, G. E., Newnham, J. P., Landau, L. I., & Stanley, F. J. (2005). Breastfeeding and overweight: Longitudinal analysis in an Australian birth cohort. *The Journal of Pediatrics*, *147*(1), 56-61. https://doi.org/10.1016/j.jpeds.2005.03.038

[10] Cai, X., Wardlaw, T., & Brown, D. W. (2012). Global trends in exclusive breastfeeding. *International Breastfeeding Journal*, *7*(1), 12. https://doi.org/10.1186/1746-4358-7-12

[11] Careaga, S. B. A., & Acosta, S. M. J. (2017). Status of feeding practices of children under 2 years of age in the Artemisian community of San Cristóbal. *Cuban Journal of Food and Nutrition*, *27*(1), 112-130.

[12] De Armas, M. G. G. G., Megías, S. M., Modino, S. C., Bolaños, P. I., Guardiola, P. D., & Alvarez, T. M. (2009). [Importance of breastfeeding in the prevalence of metabolic syndrome and degree of childhood obesity]. *Endocrinologia Y Nutricion: Organo De La Sociedad Espanola De Endocrinologia Y Nutricion*, *56*(8), 400-403. https://doi.org/10.1016/S1575-0922(09)72709-3

[13] Gatica Mandiola, P., Vargas Vitoria, C. R., Jirón Amaro, O., Herrera Blanco, M., Duarte Farfán, C., Gómez Campos, R., Martínez Salazar, C., Vargas Valdés, D. I., Luna Seguel, D. P., & Cossio Bolaños, M. A. (2013). Changes in body adiposity in school adolescents (1997-2007). *Clinical nutrition and hospital dietetics*, *33*(3), 23-29.

[14] Grummer-Strawn, L. M., Mei, Z., & Centers for Disease Control and Prevention Pediatric Nutrition Surveillance System (2004a). Does breastfeeding protect against pediatric overweight? Analysis of longitudinal data from the Centers for Disease Control and Prevention Pediatric Nutrition Surveillance System. *Pediatrics*, *113*(2), e81-86. https://doi.org/10.1542/peds.113.2.e81

[15] Grummer-Strawn, L. M., Mei, Z., & Centers for Disease Control and Prevention Pediatric Nutrition Surveillance System (2004b). Does breastfeeding protect against pediatric overweight? Analysis of longitudinal data from the Centers for Disease Control and Prevention Pediatric Nutrition Surveillance System. *Pediatrics*, *113*(2), e81-86. https://doi.org/10.1542/peds.113.2.e81

[16] Huus, K., Ludvigsson, J. F., Enskär, K., & Ludvigsson, J. (2008). Exclusive breastfeeding of Swedish children and its possible influence on the development of obesity: A prospective cohort study. *BMC Pediatrics*, *8*, 42. https://doi.org/10.1186/1471-2431-8-42. https://doi.org/10.1186/1471-2431-8-42

[17] Imai, C. M., Gunnarsdottir, I., Thorisdottir, B., Halldorsson, T. I., & Thorsdottir, I. (2014). Associations between Infant Feeding Practice Prior to Six Months and Body Mass Index at Six Years of Age. *Nutrients*, *6*(4), 1608-1617. https://doi.org/10.3390/nu6041608.

[18] Ip, S., Chung, M., Raman, G., Trikalinos, T. A., & Lau, J. (2009). A summary of the Agency for Healthcare Research and Quality's evidence report on breastfeeding in developed countries. *Breastfeeding Medicine: The Official Journal of the Academy of Breastfeeding Medicine*, *4 Suppl 1*, S17-30. https://doi.org/10.1089/bfm.2009.0050

[19] Lama More, R. A., Alonso Franch, A., Gil-Campos, M., Leis Trabazo, R., Martínez Suárez, V., Moráis López, A., Moreno Villares, J. M., Pedrón Giner, M. C., & de la AEP, C. de N. (2006). Childhood obesity. Recommendations of the Nutrition Committee of the Spanish Association of Pediatrics. Part I. Prevention. Early detection. Role of the pediatrician. *Anales de Pediatría*, *65*(6), 607-615. https://doi.org/10.1157/13095854

[20] Martínez-Sanguinetti, M. A., Petermann-Rocha, F., Villagrán, M., Ulloa, N., Nazar, G., Troncoso-Pantoja, C., Garrido-Méndez, A., Mardones, L., Lanuza, F., Leiva, A. M., Lasserre-Laso, N., Martorell, M., Celis-Morales, C., Martínez-Sanguinetti, M. A., Petermann-Rocha, F., Villagrán, M., Ulloa, N., Nazar, G., Troncoso-Pantoja, C., … Celis-Morales, C. (2020). From a global view to the Chilean context: What factors have had an impact on the development of obesity in Chile (Part 2). *Revista chilena de nutrición*, *47*(2), 307-316. https://doi.org/10.4067/S0717-75182020000200307.

[21] *Obesity and overweight* (n. d.). Retrieved April 4, 2023, from https://www.who.int/es/news-room/fact-sheets/detail/obesity-and-overweight

[22] Owen, C. G., Martin, R. M., Whincup, P. H., Smith, G. D., & Cook, D. G. (2005). Effect of infant feeding on the risk of obesity across the life course: A quantitative review of published evidence. *Pediatrics*, *115*(5), 1367-1377. https://doi.org/10.1542/peds.2004-1176.

[23] Oyarzún, M. F., Barja, S., Domínguez, M. A., Villarroel, L., Arnaiz, P., Mardones, F., Oyarzún, M. F., Barja, S., Domínguez, M. A., Villarroel, L., Arnaiz, P., & Mardones, F. (2018). Breastfeeding, obesity and metabolic syndrome at school age. *Revista chilena de pediatría*, *89*(2), 173-181. https://doi.org/10.4067/s0370-41062018000100173.

[24] Padilla Vinueza, V. E., Tisalema, H., Acosta Gavilanez, R. I., Jerez Cunalata, E. I., Moreno Carrión, A. A., & Salvador Aguilar, A. D. (2022). Childhood Obesity and Intervention Methods. *Science Domain*, *8*(1), 14.

[25] Ruben, M. M., Cabreriso, M. S., Rolando, C., Torassa, E., Zagaglia, S., Kovalskys, I., & Molinas, J. (2013). Frequency of childhood obesity and determination of associated factors. *Invenio*, *17*(31-32), 191-202.

[26] Saldaña, B. F., & Mendoza, J. M. G. (2009). Childhood obesity and school achievement: Is there a relationship between obesity and school achievement? *Revista del Hospital Juárez de México*, *76*(3), 137-143.

[27]   Sandoval Jurado, L., Jiménez Báez, M. V., Olivares Juárez, S., & de la Cruz Olvera, T. (2016). Breastfeeding, complementary feeding and the risk of childhood obesity. *Atención Primaria*, *48*(9), 572-578. https://doi.org/10.1016/j.aprim.2015.10.004

[28]   Uauy, R., Kain, J., & Corvalan, C. (2011). How can the Developmental Origins of Health and Disease (DOHaD) hypothesis contribute to improving health in developing countries? *The American Journal of Clinical Nutrition*, *94*(6 Suppl), 1759S-1764S. https://doi.org/10.3945/ajcn.110.000562.

[29]   Vander Wal, J. S., & Mitchell, E. R. (2011). Psychological complications of pediatric obesity. *Pediatric Clinics of North America*, *58*(6), 1393-1401, x. https://doi.org/10.1016/j.pcl.2011.09.008

[30]   von Kries, R., Koletzko, B., Sauerwald, T., von Mutius, E., Barnert, D., Grunert, V., & von Voss, H. (1999). Breast feeding and obesity: Cross sectional study. *BMJ (Clinical Research Ed.)*, *319*(7203), 147-150. https://doi.org/10.1136/bmj.319.7203.147.