Journal of Medical and Health Studies
ISSN: 2710-1452
DOI: 10.32996/jmhs
Journal Homepage: www.al-kindipublisher.com/index.php/jmhs

JMHS
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

Chronic Child Malnutrition in Ecuador and Associated Risk Factors

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| ABSTRACT

Chronic child malnutrition worldwide is responsible for 45% of deaths in children under 5 years of age. In Ecuador, 27.2% of children suffer from any type of malnutrition. This problem has alarming consequences since it affects the country's productivity and has an impact throughout the individual's life, since at this stage the greatest impact is suffered by the child's brain, in which irreversible metabolic and structural alterations occur. However, child malnutrition is not only a problem of lack of food, it is a deeper social conflict that must be considered when providing solutions. A nationally representative sample of children under 5 years of age from the National Health and Nutrition Survey 2018 (ENSANUT) was used. A binary logistic linear regression model was used where Odds Ratio (OR) with their 95% confidence intervals (95% CI) were estimated for each of the independent variables. Our results reveal that family income reduces the probability of child malnutrition by 2.03 times. In addition, micronutrient intake during 6 months to 2 years of age reduces the probability of child malnutrition by 2.32 times (OR= -1.91 ; -3.02). This result is statistically significant ($p<0.05$). On the other hand, unemployment, being out of the labor force (in the mother) having a greater number of children at home, working more hours and being a migrant mother also positively predicts the probability of suffering from chronic child malnutrition. Malnutrition is one of the main health problems in Ecuador. It affects a significant percentage of the population and, associated with other factors, is responsible for most of the avoidable mortality and considerable damage to children's health. For this reason, strategies should include epidemiological surveillance, promotion.

| KEYWORDS

Chronic malnutrition, Risk factor, Child development.

| ARTICLE INFORMATION

ACCEPTED: 20 March 2024 **PUBLISHED:** 02 April 2024 **DOI:** 10.32996/jmhs.2024.5.2.3

1. Introduction

Childhood is an essential stage in human development, characterized by rapid growth and maturation. For a healthy development, adequate nutrition is vital (Agostoni et al., 2023).. Undernutrition, according to WHO, occurs when a lack of nutrients affects the normal growth of children (John et al., 2024). In Latin America, child undernutrition is a major health and welfare problem. It is a major cause of preventable death and disease among children in the region, often associated with poverty and inadequate health policies in many Latin American countries (Kac & García Alvear, 2024). (Kac & García Alvear, 2010).

The according to WHO data from 2016 indicates that, globally, about 52 million children under 5 years of age were undernourished, 17 million severely undernourished, and 155 million stunted (Agostoni et al., 2023).. Approximately 45% of under-five deaths are associated with undernutrition, being more common in low- and middle-income countries. In Latin America, it is estimated that 25% of children under 5 years of age suffer from undernutrition. Ecuador, as a middle-income country, has recognized the importance of child nutrition for child development(Bradley et al., 2023). Prolonged poor nutrition leads mainly to child stunting. Associated factors include unfavorable socioeconomic conditions, inadequate maternal nutrition and health, and improper infant and young child feeding practices. Severe and prolonged nutrient deficiencies can manifest as short stature and cause irreversible damage to brain development. This hampers children's ability to reach their full physical and cognitive potential (Venter et al., 2024)..

Insufficient intake of vitamins and minerals, known as micronutrients, prevents adequate production of enzymes, hormones, and other substances essential for healthy growth (Scrinis & Castro, 2023).. Micronutrients, indispensable in small amounts, are vital for optimal life initiation and proper development. Specifically, iron and vitamin A play a crucial role in maintaining healthy and productive populations. These nutrients provide children under 5 years of age with the opportunity to grow normally and healthily, preparing them to be productive adults (Gonzalez-Fernandez et al., 2023).. Lack of these micronutrients can limit a person's life potential, increasing the risk of disease and death(Di Vincenzo et al., 2023). . Micronutrient supplementation has shown positive results, with children from three months to five years of age experiencing small increases in weight (0.24 kg per year) and height (0.54 cm per year), as well as moderate increases in hemoglobin levels. Regarding the consumption of micronutrient supplements, the percentage of households consuming them increased from 24% in 2014 to between 41% and 43% during the period 2015-2017 (Fenech et al., 2023)..

Children who experience malnutrition and lack vitamins and minerals during the early years of life face an increased risk of mortality in infancy, as well as illness and malnutrition throughout their lives, which limits their physical and intellectual development and restricts their ability to learn and work in adulthood (Allen & Saunders, 2023). This, in turn, reduces opportunities for professional and economic advancement, thus contributing to perpetuating the cycle of poverty (Łuszczki et al., 2023).. Hunger and undernutrition represent obstacles to achieving all the Millennium Development Goals, not only because of their effects on poverty, but also because of their impact on health, education and mortality. Numerous studies and research have shown the causal and associative relationships between hunger, undernutrition and poverty, as well as how these phenomena affect school attendance and performance, hinder access to markets and resources, affect maternal and child health, weaken the immune system, and limit educational and employment opportunities for women and girls (Mertens et al., 2023).. These data underscore the crucial importance of nutrition in population health, a responsibility that falls on the health sector and, given its relevance, implies the implementation of programs aimed at addressing these problems.

In this context, the country faces a historical challenge represented by chronic malnutrition, which is closely related to the deep social inequality and economic problems that often affect the poorest populations with unfavorable living conditions.(Katoch, 2024). To address this situation, the development of the Intersectoral Food and Nutrition Plan of Ecuador (2018-2025) has been proposed, with the objective of identifying the main nutrition problems and their possible solutions. As part of this plan, the delivery of micronutrient supplements to children between 6 and 24 months of age has been implemented. The administration of sixty sachets of Chis Paz for sixty days, with a daily dose, has been shown to be sufficient to rapidly improve hemoglobin levels and iron stores in a large proportion of young children. In addition, the hematological benefits are maintained for a period of six months after the intake of the 60 sachets (Ministry of Public Health, 2018).

Micronutrient interventions have gained international recognition because they are considered cost-effective strategies in terms of costs and benefits. Based on these considerations, the Ecuadorian State, through the Ministry of Public Health, has implemented in recent years several supplementation programs for children through the distribution of micronutrient sachets known as "Chis Paz". Therefore, the purpose of this research is to address the following question: What impact do the micronutrient sachet programs have on the reduction of chronic child malnutrition?

Therefore, the objective of this study is to analyze the impact of different determinants of chronic child undernutrition in the Ecuadorian context. The contribution of this work is twofold. First, we analyze the context of a developing country where evidence is scarcer. Second, we quantitatively estimate the impact of different risk factors mentioned in the literature. Our results are of great relevance as they help to better highlight the significant risk factors that influence chronic child undernutrition and the public policies needed to address this persistent public health problem in less developed countries.

The remainder of the paper is organized as follows: Section 2 describes the methodology and data used; Section 3 presents the results of the analyses.; Section 4 provides the discussion of the results obtained; and the final section summarizes the conclusions.

2. Methodology

2.1 Survey and Population

Cross-sectional data obtained from the 2019 National Health and Nutrition Survey (ENSANUT), whose data were obtained and presented by the National Institute of Statistics and Census (INEC), were used for this study. After cleaning the database, a total of 9211 children were obtained.

2.2 Source of Information

The ENSANUT 2019, is a survey that employs probability sampling, A nationally representative sample of children under 5 years of age from the 24 provinces of Ecuador was used. ENSANUT 2019 includes the Household form, in section 7: Anthropometry for all persons in the household. The ENSANUT basket is nationally representative, urban-rural, by geographic domain for the 24 provinces of the country.

2.3 Study Variables

Our dependent variable of interest is chronic child malnutrition. The information for this variable was obtained through section 7: Anthropometry for all persons in the household, of the Hogar form. In addition, our variables are the risk factors associated with chronic child undernutrition that have been found in the literature, such as: the age and sex of the infant, a variable indicating whether the child consumes micronutrients, the number of children of the mother (siblings of the child), household income, years of schooling of the mother, form of work and hours of work of the mother, a variable indicating whether the mother is a migrant, as well as ethnicity, urban density and area of residence. The variables used to construct this index are shown in **Table 1**.

2.4 Inclusion and Exclusion Criteria

The working universe was considered to be children under 5 years of age, whose anthropometric measurements were reported in the Home form of the 2019 ENSANUT survey. All children with normal and high weight were excluded, that is, all children above the 5th percentile.

2.5 Ethical considerations

The present study did not require the approval of an institutional ethics committee for its execution, since it is an analysis of data freely available to the public and it was not necessary to use informed consent.

2.6 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 statistical significance between variables. The Chi-square test was used to determine the overall correlation between the variables of interest. The association was evaluated by prevalence ratios with their respective 95% confidence intervals with an analysis for each of the variables included in the study, being the independent variable.

In this context, considering the models used in previous works, this study uses a logit model to define how different risk factors impact on chronic child undernutrition. Thus, the model would have the following general form:

$$\Pr(Y = 1|X) = F(\alpha + X_i + e_i) \quad (1).$$

$$\Pr(Y = 0|X) = 1 - F(\alpha + X_i + e_i) \quad (2).$$

Where we study the probability of a child being malnourished or not (Y = 1 if malnourished and Y = 0 otherwise), according to a series of determinant variables (X: explanatory variables), which are specified in **Table 1.**
Therefore, in order to estimate a discrete choice model that estimates the probability of suffering chronic malnutrition:

$$UN_i = \beta_0 + \beta_1 X_i + \sum_{j=2}^{12} \beta_j Z_i + \varepsilon_i \quad (3).$$

Where UN_i represents undernutrition (measured by asking whether or not a child is undernourished), X_i represents the micronutrient consumption variable, and Z_i represents a set of control variables of the linear regression model. Finally, ε_i represents the stochastic error term.

3. Results

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

Figure 1. Spatial distribution of chronic child malnutrition in Ecuador.

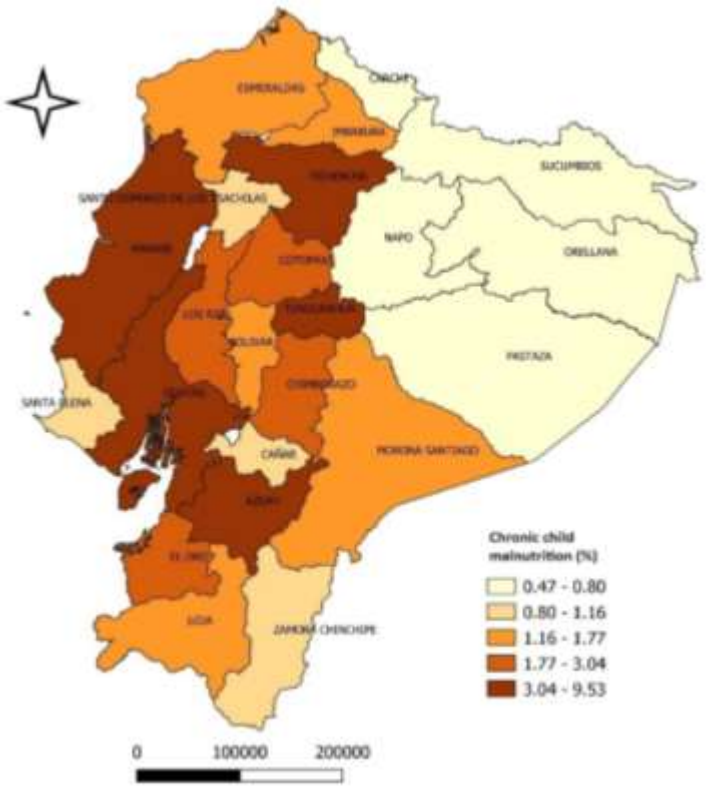


Table 1 shows the descriptive statistics of the variables. Here we analyze all the variables used in this study and we see that the sample is 9211 infants. We observe that 9.89% (CI=8.02% - 10.77%) of the sample suffers from child malnutrition, which highlights the importance of prioritizing policies to address this problem in developing countries such as Ecuador. The mean age of the infants in the sample is 15 months and 53.33% of infants are male. In addition, we observed that 71.45% (68.45% - 73.45%) consume micronutrients. Also, the average number of children of Ecuadorian women is 4. On the other hand, the average household income of Ecuadorian households is $444.01 USD. The average years of schooling of mothers is 7 years of schooling. This shows that the level of schooling of mothers is relatively low in Ecuador. Unemployment among mothers is reported at 30.55% and the average number of hours of work for mothers is 42.78. In addition, 82.52% of mothers reported that they had migrated at some point. This fact is evidence that Ecuador is a country of high internal migration. In terms of ethnicity, 75.61% of the mothers are mestizo, the average urban density is 157 people per square kilometer, while we observe that 55.51% of people are from the urban area.

Table N°1: Descriptive statistics of the variables used in this study

Variable	Mean-Percent	SD	Min	Max	95% CI		
Chronic malnutrition in children							
Yes (Body Mass Index < 5th percentile)	9.89%	0.44	0	1	8.02%	-	10.77%
No (Body Mass Index ≥ 5th percentile	90.11%	0.89	0	1	88.17%	-	92.43%
Age of infant							
Age in months	15	0.12	6	24	14.13	-	16.22
Sex of infant							
Woman	46.67%	0.14	0	1	43.67%	-	48.67%
Man	53.33%	0.33	0	1	50.33%	-	55.33%
Micronutrient intake							
Yes	71.45%	0.12	0	1	68.45%	-	73.45%
No	28.55%	0.43	0	1	25.55%	-	30.55%
Number of children							
Number of children at home	4.12	0.25	0	8	4.01	-	4.98
Household income							

Income in dollars	444.01	100	0	2033	441.68	-	448.49
Mother's years of schooling							
Years of schooling	7.08	1.77	0	22	2.97	-	3.96
Mother's way of working							
Employee	69.45%	0.66	0	1	66.45%	-	71.45%
Unemployed	30.55%	0.26	0	1	27.55%	-	32.55%
Out of the workforce	3.55%	0.26	0	1	2.67%	-	3.77%
Mother's working hours							
Number of working hours	42.78	0.55	4	52	41.54	-	46.86
Are you a migrant?							
No	17.48	0.89	0	1	14.48%	-	19.48%
Yes	82.52%	0.67	0	1	79.52%	-	84.52%
Ethnicity of infant							
Indigenous	14.73%	0.35	0	1	14.26%	-	15.20%
Afro-Ecuadorian	4.03%	0.20	0	1	3.77%	-	4.29%
Mongrel	75.61%	0.43	0	1	75.04%	-	76.18%
White	1.32%	0.11	0	1	1.17%	-	1.47%
Montubio	4.31%	0.20	0	1	4.04%	-	4.58%
Urban density							
Inhabitants per square kilometer	157.01	1152.5	321	2653.12	146.32	-	160.33
Area							
Urbana	55.51%	0.54	0	1	52.51%	-	57.51%
Rural	44.49%	0.36	0	1	41.49%	-	46.49%

Subsequently, we performed a correlation matrix to perform a detailed analysis of the correlation between the variables and to be able to identify possible multicollinearity problems. **Table 2** shows significant correlations between our variables of interest, i.e. between child malnutrition and different determinants of malnutrition, showing a negative coefficient of -0.4505 for example between infant age, micronutrient intake, household income and mother's schooling, and positive correlations with infant sex, number of children at home, working hours and being a migrant. In addition, we observed some other variables with significant correlations urban density. All these variables have an expected sign that is correct. In addition, we observe that some correlations between the independent variables are not greater than 50%. This shows that there are probably no multicollinearity problems among the variables. Below we perform a formal test to test for multicollinearity among the variables.

Table N°2: Correlation matrix of the variables

	Var 1	Var 2	Var 3	Var 4	Var 5	Var 6	Var 7	Var 8	Var 9	Var 10	Var 11	Var 12	Var 13
Var 1	1												
Var 2	-0.85*	1											
Var 3	-0.004	0.004	1										
Var 4	0.082*	0.073*	-0.002	1									
Var 5	0.150*	0.059*	-0.004	-0.011	1								
Var 6	-0.634*	0.010*	0.004	-0.011	0.621*	1							
Var 7	-0.011	0.039*	-0.004	0.001	0.022*	0.025*	1						
Var 8	-0.027*	0.221*	0.006	0.021*	0.068*	0.078*	0.049*	1					
Var 9	0.056*	0.005	0.007	0.000	0.011	0.014*	0.057*	-0.069*	1				
Var 10	0.071*	0.473*	0.002	0.052*	-0.068*	-0.044*	-0.041*	0.170*	-0.184*	1			
Var 11	-0.033	-0.097*	0.008	0.007	-0.020*	-0.027*	-0.071*	-0.028*	-0.202*	0.123*	1		
Var 12	0.009*	0.053*	0.009	-0.040*	0.021*	0.017*	0.125*	0.113*	0.141*	-0.304*	-0.196*	1	
Var 13	-0.0087	0.0432*	-0.007	0.0015	-0.0123	-0.021	0.059*	0.006	0.222*	-0.159*	-0.199*	0.308*	1

Note: Var 1: Child undernutrition. Var 2: Age of infant. Var 3: Micronutrient intake. Var 4: Sex of infant. Var 5: Number of children at home. Var 6: Household income. Var 7: Mother's years of schooling. Var 8: Mother's form of work. Var 9: Mother's hours of work. Var 10: Is she a migrant? Var 11: Mother's ethnicity. Var 12: Urban density. Var 13: Urban area. Asterisks mean: *p < 0.05.

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 multicollinearity exists in our data. As we can see, no variable has a VIF greater than 5, thus we rule out 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.

Table N° 3: Multicollinearity test of the variables

Variable	**VIF**	**SQRT VIF**	**Tolerance**	**R-Squared**
Age of infant	1.44	2.71	0.9918	0.0082
Sex of infant	2.89	1.09	0.6101	0.3899
Micronutrient intake	2.88	1.33	0.9966	0.0004
Number of children	1.88	1.76	0.6145	0.3855
Household income	1.97	1.65	0.9764	0.0236
Mother's years of schooling	1.45	1.88	0.8821	0.1179
Mother's way of working	1.66	1.43	0.8812	0.1188
Mother's working hours	1.44	1.75	0.6310	0.3690
Are you a migrant?	1.12	1.86	0.9146	0.0854
Ethnicity of infant	1.88	1.67	0.7746	0.2254
Urban density	1.67	1.09	0.8583	0.1417
Urban area	1.05	1.32	0.9537	0.0463
Mean VIF	1.90			

The confusion matrix of the model is shown below. **Table 4** shows that the model is correctly specified in 73.06% of the cases. That is, the independent variables predict chronic child malnutrition in 73.06% of the cases. It is worth mentioning that this percentage is relatively high, being an acceptable level higher than 60%.

Table N° 4: Confusion matrix of the estimated model

Classified	True D	True ~D	Total
+	7948	3569	11517
-	5192	15812	21004
Total	13140	19381	32521

Classified + if predicted Pr(D) >= .5
True D defined as sectores != 0

Sensitivity	Pr(+| D)	60.49%
Specificity	Pr(-|~D)	81.59%
Positive predictive value	Pr(D| +)	69.01%
Negative predictive value	Pr(~D| -)	75.28%
False + rate for true ~D	Pr(+|~D)	18.41%
False - rate for true D	Pr(-| D)	39.51%
False + rate for classified +	Pr(~D| +)	30.99%
False - rate for classified -	Pr(D| -)	24.72%
Correctly classified		73.06%

A multivariate logistic regression analysis to analyze the impact of risk factors associated with childhood chronic malnutrition is shown below in **Table 5.** Our logistic regression involves 9211 infants. Here we note that the dependent variable is a dichotomous variable that takes the value of 1 if an infant suffers from childhood undernutrition. We found that there are several variables that influence child malnutrition, such as the number of children at home, positively affecting the probability of suffering from chronic child malnutrition. In addition, we found that, as expected, the odd ratio (OR) of having consumed micronutrients is significant and negatively greater than 1. Our results show that those children who consumed micronutrients have a lower risk of suffering from child malnutrition. That is, our results specifically show that the consumption of micronutrients reduces by 2.32 times (OR= -1.91 - - -3.02) the probability of suffering from child malnutrition. This result is statistically significant. Likewise, family income reduces the probability of suffering from child malnutrition by 2.03 times. A similar result is observed for the variable of the mother's years of schooling. Unemployment and being out of the labor force (in the mother) also positively predict the probability of suffering from child malnutrition. An interesting variable is migration, as we find that migrant mothers are more likely to have children with child malnutrition. Finally, we also observed that living in a more densely populated city increases the risk of child malnutrition.

In **Table 5** we observe that the chi-square (X^2) and log-likelihood statistics are stable and statistically correct. The chi-square statistic is significant suggesting that, as a whole, the independent variables together explain the variability of the dependent variable. On the other hand, the log-likelihood statistic is negative and is observed to collect as much information as possible.

Table N° 5: Logistic regression analysis between childhood chronic malnutrition and associated risk factors

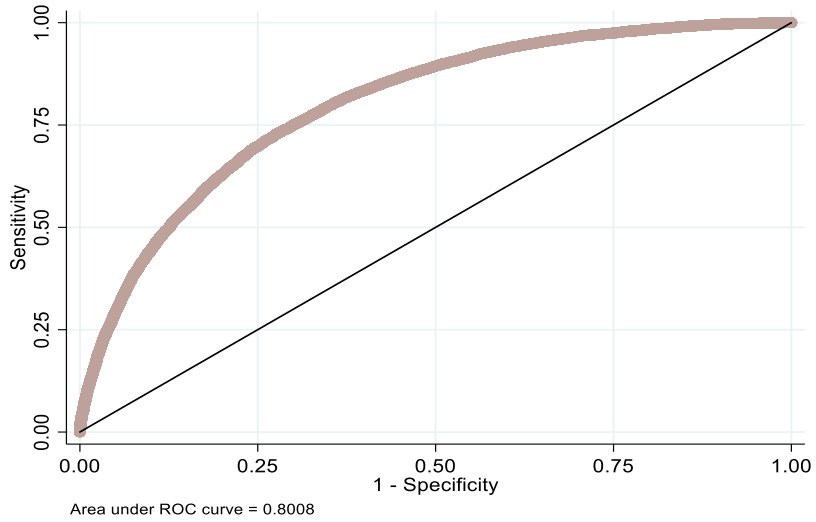
Variable	**OR**	**Std.Err.**	**P>z**	**95% CI**		
Age of infant						
Age	1.001	0.863	0.057	0.872	-	1.321
Sex of infant						
Man	Ref.					
Woman	1.342**	0.723	0.034	0.872	-	1.621
Micronutrient intake						
No	Ref.					
Yes	-2.32**	0.982	0.002	-1.91	-	-3.02
Number of children						
Number of children at home	1.032**	0.054	0.004	1.012	-	1.453
Household income						
Income in dollars	-2.981**	0.687	0.872	-2.001	-	-1.321

Mother's years of schooling										
Years of schooling		-1.686***		0.542		0.001		-1.543	-	-1.754
Mother's way of working										
Employee		Ref.								
Unemployed		1.455*		0.216		0.032		1.321	-	1.765
Out of the workforce		1.032*		0.321		0.021		1.321	-	1.765
Mother's working hours										
Number of working hours		1.653		0.654		0.035		1.345	-	1.897
Are you a migrant?										
No		Ref.								
Yes		1.567*		0.535		0.045		1.354	-	1.853
Ethnicity of infant										
Indigenous		Ref.								
Afro-Ecuadorian		-1.043		0.312		0.067		-1.012	-	-1.231
Mongrel		-1.065		0.432		0.655		1.001	-	1.198
White		-1.986		0.563		0.192		-1.452	-	-2.004
Montubio		1.654		0.643		0.431		1.594	-	1.865
Urban density										
Inhabitants per square kilometer		1.654**		0.543		0.031		1.493	-	1.985
Area										
Urbana		Ref.								
Rural		1.456		0.753		0.912		1.321	-	1.764
Observations		9211								
AIC		23975.03								
BIC		23138.09								
R^2		0.025								
X^2		3.956***								
Log-likehood		-31461.5								

Notes: Asterisks mean: *p < 0.10,**p < 0.05, ***p < 0.01. In the table, the dependent variable is the dichotomous variable of chronic child malnutrition that takes a value of 1=Yes and 0=No.

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 chronic child malnutrition from one that is not, through the significant predictor variables, with the worst scenario being when the area is equal to 0.50. the age and sex of the infant together with other significant variables, micronutrient intake, family income, mother's schooling, number of children at home, having been a migrant, the mother being unemployed or out of the labor force, 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 child undernutrition (p < 0.001).

Figure 2. ROC curve of the estimated model.



4. Discussion

Child malnutrition represents a complex challenge that generates short-, medium- and long-term impacts. It not only affects the individual who experiences it, but also has consequences for society as a whole, given that childhood is a crucial stage in the physical and mental development of people (Hammond et al., 2016). For this reason, international health organizations have established global objectives aimed at combating this problem. Ecuador is no stranger to the reality of other countries in terms of nutritional deficiencies, with an iron deficiency anemia rate in children under 5 years of age exceeding 50% (Brito et al., 2019). These data highlight the importance of nutrition in Ecuador's child population.

The present study evaluated the nutritional status of Ecuadorian children who participated in a governmental micronutrient supplementation program. The findings revealed that, out of a sample of 9211 children under 5 years of age, 9.89% (with a confidence interval of 8.02% to 10.77%) were undernourished. This result highlights the need to prioritize policies aimed at mitigating child malnutrition in a developing country like Ecuador. In addition, it was observed that 71.45% (CI: 68.45% to 73.45%) of the children had consumed micronutrients. It was identified that the odds ratio (OR) of having consumed micronutrients was significantly greater than 1, indicating a lower risk of child undernutrition among those who consumed micronutrients. Specifically, it was found that micronutrient consumption reduced the probability of child undernutrition by 2.32 times (OR= -1.91 to -3.02), this result being statistically significant. It was also observed that family income and the mother's educational level also reduced the probability of child malnutrition, while maternal unemployment and labor inactivity increased this probability.

Our results are in line with several previous studies supporting the efficacy of Chispaz supplementation in improving hemoglobin levels and treating anemia in children. For example, a study conducted in Tena, which included 74 children under 4 years of age, showed that Chispaz supplementation had a positive impact on hemoglobin levels, which contributed to an improvement in the cases of anemia presented at baseline (Ewusie et al., 2014).. In addition, another study conducted on a sample of 337 children aged 0-59 months also found an improvement in hemoglobin levels with Chispaz supplementation. This study revealed a significant relationship between anemia and lack of micronutrient supplementation. (Svarch Guerchicoff, E, 2015). Similarly Ocaña (2014) was able to evidence that supplementation with Chispaz had a positive impact on improving hemoglobin levels in infants with anemia. These studies support the effectiveness of supplementation with Chispaz to combat anemia and improve children's health.

It is important to note that our results diverge from several previous studies that have evaluated the effectiveness of Chispaz supplementation in relation to children's nutritional status. For example, a study conducted in Centros Infantiles del Buen Vivir (CIVB) and Centros Infantiles Creciendo con nuestros Hijos (CNH) did not find statistical significance in terms of micronutrient use in maintaining adequate nutritional status (Petry et al., 2016). Likewise, a meta-analysis revealed that while micronutrients had no effect on growth or psychomotor development, they did show a positive effect in relation to child weight-for-age $p<0.05$ (Warthon-Medina et al., 2015).. A Peruvian study in children aged 6 to 17 months also found that micronutrient supplementation had no additional long-term effects on nutritional status (Francke et al., 2020).

In addition, a Japanese study found insufficient evidence to quantitatively assess the efficacy of multiple micronutrient supplementation in improving infant health outcomes (Sarah K Abe et al., 2016), these findings suggest that the relationship

between micronutrient supplementation and infant nutritional status may vary depending on the context and factors specific to each population studied.

The data show that the average level of schooling of mothers in Ecuador is 7 years, which indicates a relatively low level of education. In addition, the unemployment rate among mothers is 30.55%, and they work an average of 42.78 hours per week. Our results revealed that family income and the mother's level of schooling are negatively correlated with the probability of child malnutrition, while maternal unemployment and labor inactivity increase the probability of child malnutrition. These findings are consistent with previous studies that have highlighted the role of sociodemographic factors, such as the mother's level of education, as a protective factor against child malnutrition (OR=0.08; CI= 0.009-0.71; p= 0.0049). (Pally Callisaya & Mejía Salas, 2012).. For example, a study in China found that maternal higher education and breastfeeding were positive factors for the nutrition of infants younger than 6 months, highlighting the influence of family factors on the nutritional status of infants(Dang & Yan, 2007). In addition, a relationship between the low educational level of mothers and the nutritional status of their children was observed in an Argentine study, where it was found that the children of mothers with incomplete primary education had a higher prevalence of malnutrition compared to those whose mothers had a higher level of education (De-Regil et al., 2011).. These results underscore the importance of the mother's educational level as a key determinant of children's nutritional status.

In conclusion, the results of this study suggest a significant relationship between micronutrient intake and improvement in the nutritional status of children, as evidenced mainly by the anthropometric assessment performed. The preservation of body weight in relation to height indicates a recently achieved nutritional balance, suggesting an improvement in the nutritional vulnerability status of the children or the resolution of diseases that affected the absorption, distribution and utilization of nutrients. These findings reflect the positive impact of the nutritional supplementation programs implemented by the Government of Ecuador in the most nutritionally vulnerable areas. Therefore, it is expected that government authorities and health regulatory agencies, such as the Ministry of Public Health, work in collaboration with other ministries to develop educational and nutritional programs aimed at the maternal and child population. These programs should include adequate monitoring, control and evaluation of both the people in charge of the management and distribution of supplements and the caregivers in general. In addition, it is crucial to implement updated training to strengthen the administration of micronutrients, such as Chispaz, especially in the most vulnerable areas of the country.

5. Conclusion

Finally, we can conclude that child malnutrition is a complex problem that results from a combination of biopsychosocial, economic and intersectoral planning factors that are not adequately focused on addressing common needs. This situation affects the growth and development of children, with consequences such as the appearance of malnutrition-related diseases and low productivity, which increases public health spending. To combat this problem, it is crucial to ensure adequate access to basic and health services, as well as to have a multidisciplinary team of professionals focused on providing comprehensive care for children.

Child malnutrition not only represents a threat to the health and well-being of the population, but also has significant social and economic implications. In Ecuador, despite the progress achieved through the "Plan Nacional del Buen Vivir", child malnutrition remains a major challenge, with an alarming prevalence of chronic malnutrition among children under five years of age. This negatively affects the school performance and future development of these children. To effectively address this problem, it is critical to implement food supplementation strategies and provide food sovereignty training, especially in rural communities where the prevalence of child malnutrition is highest. In addition, it is necessary to translate political commitment into concrete actions that reduce inequities and actively involve the most vulnerable communities from the outset of programs and policies designed to address this problem.

Funding: This research did not receive external funding.
Conflicts of interest: The authors declare that they have no conflicts of interest.
Editor's note: All statements expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, nor those of the publisher, editors, and reviewers.
Ethical approval: The authors should indicate whether or not ethical approval has been requested for the present study, especially if it is a clinical trial or an animal experiment.
Informed consent: It was not necessary to apply informed consent to the participants since the data were obtained through a database available at the National Institute of Statistics and Census of Ecuador.

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