Factors associated with stunting in children under 5 years of age in Ecuador: A cross-sectional study from the National Survey on Child Malnutrition

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Factors associated with stunting in children under 5 years of age in Ecuador: A cross-sectional study from the National Survey on Child Malnutrition

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DECLARATION

I, Pamela Cecilia Piñeiros Rosas, hereby declare that the research “Factors associated with stunting in children under 5 years of age in Ecuador: A cross-sectional study from the National Survey on Child Malnutrition” is being submitted as part of the requirements for the fulfillment of my Master's Degree in the Department of Global Control of Infectious Diseases, Division of Health Policy and Financing at Yonsei University, Seoul. This article presents a comprehensive account of my investigation, encompassing all ideas, sources, and content with proper acknowledgment. Furthermore, I confirm that the findings of this research have not been previously presented as part of any academic program and are not now being considered for any degree candidacy.

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Pamela Cecilia Piñeiros Rosas December 2023

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ABSTRACT

Background: In Ecuador, as of 2023, the prevalence of stunting in children under 5 years is 17.5%, exceeding the Latin American average (Freire, 2014; INEC, 2023b). Stunting has extensive implications, encompassing limitations in physical growth, diminished educational achievements, cognitive challenges, and decreased productivity in the workforce, all of which have social, human, and economic repercussions. This study aims to acknowledge the risk factors of stunting in children under 5 years in Ecuador to discuss whether current public policies are addressing it or not.

Methods: Secondary data were obtained from a cross-sectional representative survey called as the National Survey on Child Malnutrition (ENDI). A total of 20.758 children under 5 years were included in this study from where dependent variable stunting and independent variables were obtained, analyzing through Chi-square and bivariate logistic regression to examine the factors associated with stunting.

Results: The prevalence of stunting obtained in this study is 18.1%. Children in major proportion are males, delivery in public or private facilities, with vaginal delivery representing represents the majority. The complete rotavirus vaccination scheme is 97% and the pneumococcus complete vaccination scheme is 94.9%. Mothers aged between 27 to 49 years represent 61.3% of the total, while the educational level of mothers who have attended Middle or High School represent 47.6%. During pregnancy, 89.3% of the mothers were supplemented with iron and folic acid and attended 4 to 8 visits (66.9%) during pregnancy. Households participating in this study were located in a major proportion of urban areas and presented poverty with low access to safe water and excreta disposal.

The findings also revealed that children above one year are 1.94 times more likely to be stunted. Children without a complete vaccination scheme for rotavirus and pneumococcus are respectively 1.07 and 1.03 times more likely to be stunted compared to children with a complete vaccination scheme (OR= 1.07, 95% CI: 0.88-1.34), (OR= 1.04, 95% CI:

0.96-1.14). Children with mothers with no or basic education are 1.99 times more likely to be stunted, compared to mothers with higher education (OR= 1.99, 95% CI: 1.76-2.25), and women aged between 12 to 19 years are 1.17 times more likely to have children with stunting (OR= 1.17, 95% CI: 1.01-1.36).

Children born at home or in other places are 1.56 times more likely to be stunted, and having a vaginal birth increases the possibility of stunting by 1.25 times. A lack of supplementation with iron and folic acid during pregnancy increases the possibility of having a stunted child by 1.16 (OR= 1.16, 95% CI: 1.04-1.31), and preterm babies are 2.16 times more likely to be stunted compared to those born on time or post-term (OR= 2.16, 95% CI: 1.91-2.46). Having fewer than 4 prenatal care visits during pregnancy increases the risk of having a stunted child by 1.16 times (OR= 1.61, 95% CI: 1.39-1.87).

Conclusion: Factors like age between one to two years, mothers with no or basic education, less than 4 antenatal care visits, pre-term delivery, and no institutional delivery have shown a strong correlation with stunting. Simultaneously, child gender, having diarrhea in the last two weeks, complete vaccination scheme, mother´s age under 27 years, vaginal delivery, no micronutrient supplementation during pregnancy, safe water access, poverty, and rural area are related also in a minor magnitude in Ecuador.

Keywords: stunting, risk factors, Ecuador.

I. INTRODUCTION

1.1 Background

Globally in 2020, around 144 million children under 5 years suffered from stunting (UNICEF, 2023). In Latin America, the prevalence of stunting in the region showed a reduction of 37% between 2000 and 2020 but still represents 11.3%, which locates the region's average 10 points above the world's percentage; the highest prevalence was in Guatemala, Ecuador, Haiti, and Honduras (FAO et al., 2022). In Ecuador, in the last 35 years, the prevalence of stunting in children under five years has decreased from 40.2% in 1988 to 17.5% in 2023, and for children under 2 years from 24% in 2012 to 20.1.in 2023 but remains above the Latin American average (Freire, 2014; INEC, 2023b).

The Sustainable Development Goals establishes goal 2 "to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture" and by 2030 proposes to end all forms of malnutrition, including stunting. According to the framework developed by UNICEF, stunting is the result of an interaction between environmental, socioeconomic, and political factors, including poverty with a main role in this context; however, prioritizing the alleviation of overall poverty and inequality would lead to significant decreases in stunting, which can be addressed through targeted health and nutrition initiatives on a global scale (Black et al., 2008).

Stunting typically initiates in utero and persists during the first two years of life. Hence, this period represents a critical window during which linear growth can be influenced by modifiable environmental factors associated with nutrition, infections, and social care. Stunting is a repetitive pattern where women who experienced childhood stunting are more likely to have stunted children, perpetuating an intergenerational cycle of poverty and diminished human potential that is challenging to break. Therefore, ensuring proper maternal nutrition, health, and physical well-being is essential in preventing child undernutrition (Akseer et al., 2022).

Children suffering from stunting may never attain their full possible height, and their brains may never develop to their full cognitive potential. These children begin their lives at a marked disadvantage. Stunting has extensive implications, encompassing limitations in physical growth, diminished educational achievements, cognitive challenges, and decreased productivity in the workforce, all of which have social, human, and economic repercussions. It has severe short- and long-term effects that impact health and functional consequences, poor educational performance, low adult wages, lost productivity, and they face barriers to participation in their communities (de Onis & Branca, 2016). Studies in the past decade have supported the role of social determinants, including maternal education, paternal education, household assets, and early marriage, in the prevalence of stunting, wasting, and other forms of malnutrition (Victora et al., 2021).

As per the United Nations Population Fund, Ecuador has a population of around 18 million, with 64% residing in urban areas and the remaining 36% in rural areas. Ecuador is a culturally diverse country, with several ethnicities. The majority, 71.9%, identify as mestizo, followed by 7.4% as Montubia, 7.2% as Afro-Ecuadorian, 7% as indigenous, 6.1% as white, and 0.4% as belonging to other ethnic groups (UNFPA, 2022). Despite experiencing a rise in average earnings over the last 20 years and being classified as a Middle-Income Country by the World Bank, Ecuador still faces significant inequality. The country is characterized by ongoing poverty and inequality, which contribute to the prevalence of stunting.

As of 2018, the poverty rate in Latin America and the Caribbean was 30.1%, while the extreme poverty rate was 10.7%. The statistics indicate that around 185 million people are living in poverty and 66 million people living in extreme poverty. Based on the report from Ecuador's National Statistics Institute, the poverty rate in 2019 stood at 25%. Nevertheless, this percentage rose to 33% in 2020 as a result of the pandemic's influence. However, by the end of 2021, the monetary poverty rate had dropped to 27.7%, primarily due to the country's economic revival (Garcia-Velez et al., 2022).

Therefore, taking into consideration that Ecuador continues to have one of the highest

prevalences of stunting in Latin America despite all of the efforts and programs that the government has implemented, Ecuador's current nutrition and policies have not taken adequate notice of the determinants of stunting. Instead, they continue to concentrate on the delivery of health services, without addressing the multi-causal factors that influence this problem. Despite this, no study investigates the factors that determine stunting in Ecuador.

This study aims to acknowledge the determinants and risk factors of stunting in children in Ecuador at the individual, household, and parental levels and to discuss whether current public policies are addressing it or not.

1.2. Purpose

The purpose of this study is to determine the factors associated with stunting in children aged under five years in Ecuador.

- Specific Objectives:

To determine:

- The individual risk factors associated with stunting in children aged under 5 years in Ecuador.
- The maternal risk factors associated with stunting in children aged under 5 years in Ecuador.
- The access to health services risk factors associated with stunting in children aged under 5 years in Ecuador.
- The household risk factors associated with stunting in children aged under 5 years in Ecuador.

1.3. Definitions

1.3.1. Stunting

According to the World Health Organization Growth Standards, stunting is measured

by length/height for age and correlates with z- score of more than 2 standard deviations below the median, which reflects attained growth in length or height at the child's age at a given visit (WHO, 2008).

1.3.2. Excreta Disposal

According to Ecuador´s National Statistics Institute, this indicator is constructed as an approximation that measures the access of a house with minimum sanitation conditions that correlate with a potentially healthy environment. This indicator measures the method of excreta disposal of a household, considering that excreta disposal through a septic tank does not guarantee a healthy environment (INEC, 2023b).

1.3.3. Safe Water:

According to Ecuador´s National Statistics Institute, this indicator is constructed as an approximation that measures households using safe drinking water supplies. The indicator takes into account the supply type, water quality, proximity of supply, and availability of safe water for drinking. Referring to water quality measures whether they drink it as it arrives at home, boil it, or have some other treatment (INEC, 2023a).

II. LITERATURE REVIEW

2.1. Individual Risk Factors Associated with Stunting

Stunting occurs as a consequence of inadequate nutrition during pregnancy and the early stages of childhood. The nutritional status is determined by three primary factors: diet, physical well-being, and level of attention received. Children achieve optimal nutritional status when they have inexpensive access to a wide range of nutrient-dense food, get appropriate maternity and child-care practices, have access to sufficient health services, and live in a healthy environment that includes safe water, sanitation, and excellent hygiene practices. These factors have a direct impact on the consumption of nutrients and the occurrence of disease. The interplay between undernutrition and infection gives rise to a potentially fatal cycle of escalating disease and declining nutritional conditions (UNICEF, 2013).

A child's growth and development begin during its formation in the womb. Numerous factors contribute to determining the nutritional status of the child both before and after birth. Moreover, the child's health is influenced by feeding practices, including breastfeeding, as well as the introduction and accessibility of solid foods (Tello et al., 2022).

Ensuring ideal breastfeeding and complementary feeding practices is essential in preventing child undernutrition. The World Health Organization advises exclusive breastfeeding for the initial 6 months of life, followed by continued breastfeeding for at least 2 years, alongside the timely introduction of safe, suitable, and nutritionally sufficient complementary foods (Walters et al., 2019).

Breastfeeding plays a crucial role in promoting the healthy development of the brain and is indispensable for averting the triple challenge of malnutrition, infectious illnesses, and mortality. It also mitigates the risk of obesity and chronic health issues later in life and protects the mother against chronic diseases such as breast and ovarian cancers, type

2 diabetes, and cardiovascular diseases. The substantial and positive impacts of breastfeeding during early life persist throughout the lifespan, benefiting children, mothers, families, and society at large, with significant economic advantages (Pérez-Escamilla et al., 2023).

Inadequate feeding practices are projected to account for up to 34% of childhood mortality annually. Evidence suggests that exclusively breastfeeding a child is associated with substantial health advantages throughout their life and contributes significantly to enhancing childhood survival (Tamiru et al., 2012). Securing optimal nutrition for infants and toddlers in the initial 1000 days of life is crucial for healthy growth, development, and metabolic programming throughout childhood. This effort is vital for promoting health and preventing diseases across the entire lifespan. Furthermore, inadequate patterns of infant feeding have been linked to heightened severity and frequency of infections, increasing energy needs, while decreasing appetite, and nutrient absorption (Ibrahim et al., 2022).

Pneumonia and diarrhea collectively contribute to millions of child deaths annually, representing nearly one-third of all child fatalities globally. These two conditions have traditionally been associated with an interlinked cycle of malnutrition and infection, particularly affecting vulnerable children in low- and middle-income countries. Consequently, the global impact of these diseases may extend beyond their substantial impact on child survival to encompass enduring adverse effects on child growth and neurodevelopment (Schlaudecker, Steinhoff, & Moore, 2011). Connections between various infectious diseases and stunted growth have been identified, with the most significant impact observed in the case of diarrheal infections (Berendsen et al., 2016).

Vaccination holds an important significance for malnourished children, given their increased vulnerability to infectious diseases due to compromised immunity. By reducing the incidence of infections, vaccination has the potential to enhance the nutritional status of children (Sato, 2021). In addition to the extent of vaccination coverage, the timing of vaccination might be crucial, considering that the child's immune function changes with age; early immunization has more pronounced consequences, especially reducing

morbidity and mortality due to infections (Chissaque et al., 2021).

2.2. Maternal Risk Factors associated with stunting

In low and middle-income countries, where financial resources are limited, maternal employment, income, and education are factors that can be linked to a child's nutritional status and prospects in life. Given that mothers are the primary caregivers of children, they have important control over critical factors to achieve children's well-being, including feeding practices, psychosocial care, hygiene practices, and healthcare of the newborn. The educational level as well as employment, and therefore economic independence, are factors through which mothers can improve parenting practices and consequently the health and nutrition status of their child (Chilinda et al., 2021).

By 2022, 1.5 per 1,000 10-14 adolescent women give birth, with elevated rates observed in the regions of sub-Saharan Africa, Latin America, and the Caribbean (World Health Organization, 2023). Unfortunately, Ecuador has the highest adolescent fertility rate among all LAC countries with 111 per 1000 births among adolescents between 15 to 19 years. These statistics are of great concern due to the notable disparities in healthcare, societal and economic conditions that are intensified by adolescent pregnancies (Herran & Palacios, 2020).

Adolescents are at an increased risk of experiencing pregnancy-related complications, such as unsafe abortions, and have a higher likelihood of experiencing a subsequent pregnancy at a young age. Moreover, infants born to adolescent mothers are more prone to premature birth and a higher risk of perinatal mortality. These babies face significantly elevated mortality rates compared to those born to women aged 20 to 24. Additionally, they are at risk of malnutrition, experiencing lower levels of mental and physical development, and having limited access to quality education. Permanent abandonment or discontinuation in studies; lack of access to formal work; poor social insertion, poverty, as well as non-fulfillment of their life projects, mental problems such as depression, self-inflicted injuries, and suicide have been linked to pregnancy in adolescents.

Moreover, the risk of dying during pregnancy, childbirth, or postpartum is up to 4 times higher in pregnant women under 15 years of age (Yakubu & Salisu, 2018).

Considering the strong connection between a mother and her child, which implies that maternal characteristics can influence the health of children, existing research has indicated that a mothers level of education has a beneficial impact on child health and contributes to a reduction in the global prevalence of child malnutrition (Lawal et al., 2023). Although a mother's education plays a pivotal role that may not directly influence nutritional status, its impact is primarily observed through its influence on parenting practices for children; however, a low level of maternal education can lead to child undernutrition, manifested as wasting, stunting, and imbalances in weight (Laksono et al., 2022).

Children born to educated women experience reduced instances of malnutrition, as evidenced by reduced rates of underweight, wasting, and stunting. Several mechanisms contribute to this phenomenon: 1) a mother's formal education directly imparts valuable health knowledge to prospective mothers; 2) the literacy and numeracy skills acquired through schooling enhance women's ability to identify illnesses and seek appropriate treatment for their children. Furthermore, their improved capacity to comprehend medical instructions for childhood illness treatment results in more effective care, and 3) an extended duration of schooling renders women more receptive to modern medical practices. Moreover, other studies have identified a robust connection between maternal education, socioeconomic status, and the nutritional status of children (Abuya, Ciera, & Kimani-Murage, 2012).

Educated women are more likely to secure stable, higher-paying employment, marry individuals with greater educational and income levels, and reside in improved neighborhoods. These factors collectively exert a positive influence on child health and overall survival (Ickes, Hurst, & Flax, 2015).

2.3. Risk Factors Associated with Access to Health Services

Intrauterine growth restriction (IUGR) is characterized by the fetus's inability to achieve its expected growth potential at any gestational age. Pregnancies affected by IUGR are influenced by conditions that impede normal fetal growth. Early detection during antenatal care, selecting the most suitable time and method for delivery, and implementing treatment when necessary can substantially reduce associated risks (Ernst et al., 2017).

Undetected infections during pregnancy along with pre-existing health conditions like high blood pressure and diabetes, frequently add complexity and increased risk to both the pregnant mother and the child. Antenatal care (ANC), encompassing services provided to expectant mothers and their unborn children during pregnancy, constitutes a fundamental component of primary healthcare. ANC programs extend beyond pregnancy-related care to encompass additional aspects that can mitigate potential maternal risk factors; moreover, ANC has demonstrated a decrease in rates of newborn mortality, occurrences of stillbirth, preterm labor, and low birth weight. These services also involve promoting healthy lifestyles, addressing malnutrition, and raising awareness about issues like gender-based violence (Kuhnt & Vollmer, 2017).

The mode of birth has ramifications for the child's health. Cesarean section (CS) is associated with early complications including hypoxia, respiratory disruptions, soft tissue injuries, as well as neurological and psychiatric issues. Significant long-term problems for children delivered via cesarean section (CS) include adverse impacts on the immune system, such as systemic connective tissue disorders, juvenile arthritis, inflammatory bowel disease, immunological deficiencies, asthma, sepsis, type 1 diabetes, celiac disease, and autoimmune illnesses. Cesarean section (CS) deliveries are thought to impact the immediate immune response in newborns by changing the bacterial colonization in the digestive system. This is because CS babies do not come into contact with the vaginal and anal microbiota during birth, unlike infants delivered vaginally(Kiilerich et al, 2021),

and have been associated with excess Weight gain in infancy and the development of childhood overweight and obesity (Babu et al., 2021).

2.4. Household Risk Factors associated with stunting

Stunting is linked with water, hygiene, and sanitation practices (WASH) due to various factors, including recurrent episodes of diarrhea, the transmission of infections, and the development of environmental enteric dysfunction. In rural areas where access to safe water is limited, the daily consumption of untreated and contaminated water poses a significant risk. Inadequate water, sanitation, and hygiene (WASH) conditions exert a substantial negative impact on children's growth and development. This occurs not only because of prolonged exposure to enteric pathogens but also due to broader social and economic factors (Woldesenbet, Tolcha, & Tsegaye, 2023).

Inadequate water and sanitation practices amplify the transmission of pathogens through the fecal-oral route, resulting in diarrheal episodes, defined as the occurrence of more than three liquid stools per day. Repeated bouts of diarrhea lead to the depletion of nutrients and fluids, causing a general state of weakness and dehydration. Furthermore, the ingestion of fecal bacteria in significant quantities contributes to the development of environmental enteric dysfunction (EED), an underlying condition of the small intestine marked by intestinal inflammation, heightened intestinal permeability, and consequently reduced nutrient absorption. This elevates the risk of undernutrition and impedes both physical and cognitive growth and development. (Girma et al., 2021).

Water, sanitation, and hygiene (WASH) interventions primarily focus on preventing the ingestion of harmful microorganisms by disrupting the transmission of fecal-oral pathogens. It's important to recognize that various routes of transmission are associated with excreta-related pathways, including direct transmission through contaminated hands and indirect transmission via the contamination of drinking water, soil, utensils, food, and flies. It's also essential to acknowledge that the significance of each transmission route varies depending on the pathogens and specific settings, and different populations may

have varying pathogen prevalence. Therefore, effective interventions should be tailored to address the predominant transmission routes relevant to the target population and specific context. In the case of WASH interventions aiming to prevent environmental enteric dysfunction (EED), it is crucial to target and mitigate the specific pathways through which fecal-oral transmission occurs during the first two years of a child's life (Mbuya & Humphrey, 2016).

Three biological mechanisms have established a direct connection between inadequate water, hygiene, and sanitation practices and undernutrition. These mechanisms include (1) frequent episodes of diarrhea, (2) infections caused by soil-transmitted helminths, and (3) a subclinical gut condition known as environmental enteric dysfunction. The frequency of diarrheal illnesses, as a syndrome, is closely associated with impaired growth in children. Establishing a direct causal link between diarrhea and malnutrition, however, presents a challenge, as undernutrition can elevate both the probability and severity of diarrhea. Proper sanitation practices can serve as a preventive measure against soil-transmitted helminth infections, also known as helminthiasis; notably, more severe cases of ascariasis and trichuriasis are linked to stunted children. Environmental enteric dysfunction (EED) is a condition that typically doesn't exhibit symptoms but results in chronic inflammation, diminished nutrient absorption within the intestinal tract, and a compromised barrier function of the small intestine. These irregularities in both the function and structure of the gut can have significant implications for affected children, including growth deficiencies, developmental delays in early childhood, and compromised immune function (Cumming & Cairncross, 2016).

Diarrhea continues to be a significant contributor to the mortality rates among children under the age of 5, ranking as the second leading infectious cause of death in this demographic, following lower respiratory infections. Moreover, diarrheal illness significantly contributes to the burden of disability-adjusted life years (DALYs), particularly playing a substantial role in the prevalence of stunted growth in low-income regions. Predictably, research indicates that communities with limited access to healthcare,

clean water, sanitation facilities, and economically marginalized populations bear a disproportionate burden of diarrheal diseases (Mudadu Silva et al., 2023).

Children from low socioeconomic backgrounds face a higher probability of encountering inadequate nutrition, potentially resulting in stunted growth when contrasted with their peers from wealthier households. This phenomenon can be attributed to the adverse impact of lower socioeconomic status on their ability to access quality food or nutrition, resulting in a decreased intake of essential nutrients. Conversely, individuals with a higher socioeconomic status have the means to afford nutritious food, promoting healthier lifestyles and enhanced childcare. Importantly, this contributes to a decline in the prevalence of malnutrition. (Ekholuenetale et al., 2022). Examining the evolving disparities in child health outcomes related to socioeconomic factors and identifying the primary factors driving these changes continue to be vital aspects of policy formulation aimed at enhancing child well-being (Nwosu & Ataguba, 2020).

III. CONCEPTUAL FRAMEWORK

3.1. UNICEF Conceptual Framework

The conceptual framework was based on the one developed by UNICEF, which recognizes the determinants of stunting on a multidimensional interaction of household, environmental, socio-economic, and cultural influences. This framework explains that Nutritional well-being is determined by three factors: food, health, and care. Achieving an ideal nutritional state for children requires their ability to obtain reasonably priced, varied, and nutritionally rich foods, as well as the adoption of suitable maternal and childcare practices.

Additionally, it involves access to adequate healthcare services and a healthy environment, encompassing safe water, sanitation facilities, and proper hygiene practices.

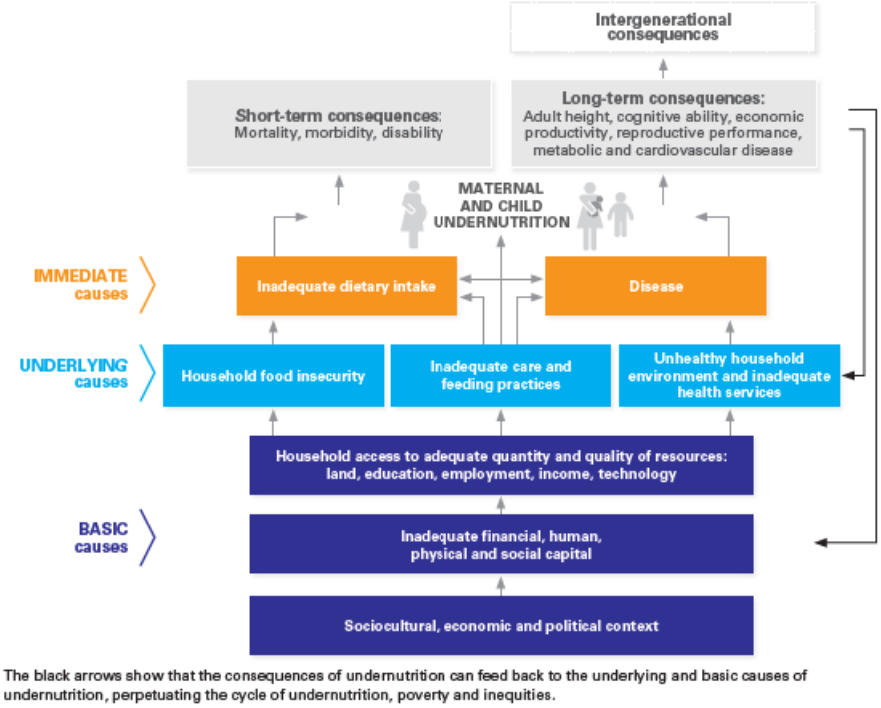

Figure 1. Conceptual Framework of the determinants of child undernutrition

These elements play a direct role in determining nutrient intake and the occurrence of diseases. The interplay between malnutrition and infections can lead to a dangerous cycle where illness worsens and nutrition and health deteriorates (UNICEF, 2013).

3.2. Hypothetical Model

The present study's hypothetical model was based on the UNICEF conceptual framework. The possible risk factors were organized into four groups:

(i) Individual characteristics: including child's disease occurrence (episodes of diarrhea and fever in the last two weeks), age, rotavirus and pneumococcus complete vaccination scheme, and birth order.

(ii) Mother's characteristics: such as age, marital status, and level of education.

(iii) Health Services: regarding institutional delivery (private or public facility), delivery by cesarean section, number of antenatal care visits, iron and folic acid supplementation during pregnancy, and time of delivery.

(iv) Household: such as poverty due to unmet needs index, excreta disposal access, safe water access, and area.

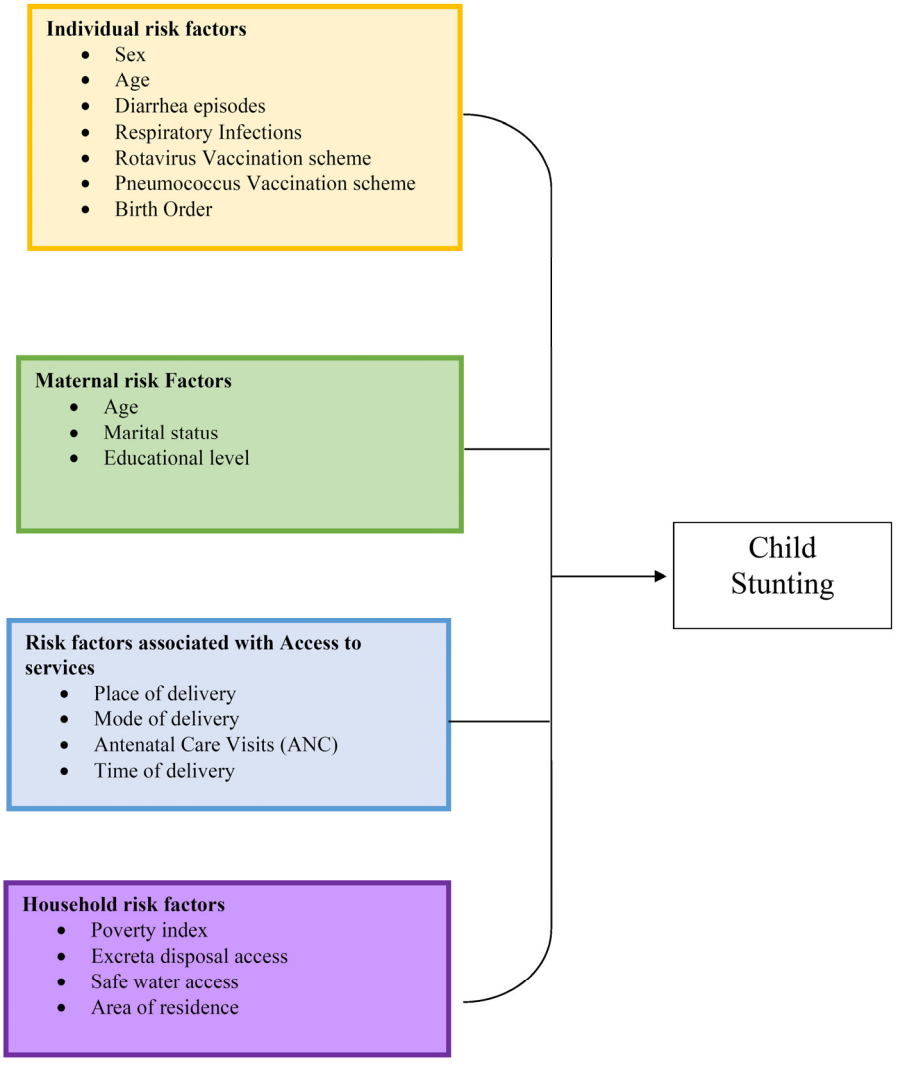

Figure 2. Hypothetical model

IV. METHODS

4.1. Design

To explain the factors associated with stunting in children under 5 years in Ecuador, the secondary data was obtained from a cross-sectional nationally representative survey called the National Survey on Child Malnutrition (ENDI). This is a statistical operation using probabilistic sampling, whose target population is children under 5 years of age, investigating 22.334 homes, obtaining 19.149 effective homes, with geographic coverage throughout the national territory.

4.2. Participants

The target population of this study is all children under 5 years of age (20758); however, the information collected from their mothers will be considered as well.

4.2.1. Sampling

According to the Ecuador National Statistics Institute, the sampling design implemented in the ENDI is a stratified two-stage probabilistic sampling of elements. In the first stage, a stratified sample of Primary Sample Unit (PSU) is selected with probability proportional to size (PPT), where the size measure of each PSU is given by the total number of occupied private homes. Then, the entirety of each selected PSU is listed, to correct existing errors in the framework and identify those households with children under five years of age.

In the second sampling stage, a fixed number of homes is randomly selected, with 8 being the number of homes per PSU chosen after operational and budgetary considerations.

There is a third sampling stage only for the Breastfeeding and Child Development sections. In the first, one child under 3 years of age is chosen per woman of effective childbearing age, while in the second, one child over 5 years of age is chosen per

effective household in the second semester of information gathering. In both cases, the selection is made using the closest birthday criterion (INEC, 2023a).

4.3. Measures

The survey collected the information through 3 questionnaires. Questionnaire 1 Household collects information on household members, general characteristics, economic activities, household data, food security, anthropometry, anemia test, E. coli, and chlorine test. Form 2 (Women of childbearing age with children under 5 years of age) collects information regarding the history of pregnancies and births, breastfeeding, childhood health, and early childhood programs; and form 3 (Child Development) obtains information related to child discipline, language development, and vocabulary test.

Given the variables collected through the questionnaires and according to the theoretical framework chosen, the variables included in the present study are presented in Table 1.

Table 1. Description of variables

Variables	Categories	Classification	Definition
Dependent Variable	Stunting	Yes=1, No = 0	Length/height for age and correlates with z-score of more than 2 standard deviations below the median
		Individual Risk Factors	
Independent Variable	Age	0 1 2 3 4	Children under 5 years of age
	Sex	Male=1, Female= 2	Sex of the child (Male and Female)
	Diarrhea	Yes=1, No = 0	Presence of diarrhea in the last two weeks

Variables	Categories	Classification	Definition
	Respiratory symptoms	Yes=1, No = 0	Presence of cough, runny nose, difficulty breathing, sore throat, and/or flu?
	Complete Rotavirus scheme	No=1, Yes = 0	Complete rotavirus vaccination scheme encompasses 2 doses at 2 and 4 months of age
	Complete Neumococo scheme	No=1, Yes = 0	Complete rotavirus vaccination scheme encompasses 3 doses at 2, 4, and 6 months of age
	Birth Order	1, 2	Birth order considering that in Ecuador the fertility rate is 2
		Maternal Risk Factors	
Independent Variable	Age	12 - 19 = 1 20 - 26 = 2 27 – 49 = 3	Mother´s age from 12 and above
	Marital Status	Cohabitation = 1 Separated =2 Divorced/Widow=3 Married=4 Single=5	Current marital status
	Level of Education	None = 1 Primary/Secondary= 2 Higher education = 3	Highest level of education
		Access to Health Services Risk Factors	
Independent Variable	Institutional Delivery	No= 0, Yes= 1	Delivery within a public or private facility
	Cesarea	No= 0, Yes= 1	Cesarea as a mode of delivery
	Number of Antenatal Care Visits	< 4 = 1 5-8 =2 >8 =3	Number of antenatal care visits during the pregnancy
	Iron and folic acid supplementation	No= 0, Yes= 1	Supplementation to pregnant women with iron and folic acid
	Time of delivery	On time = 1 Premature = 2 Postmature = 3	Whether the delivery was on time or before time

Variables	Categories	Classification	Definition
		Household Risk Factors	
Independent Variable	Poverty due to unmet basic needs (UBN)	No poverty due to UBN = 1 Poverty due to UBN = 2	Poverty measured due to unmet basic needs
	Safe Water Access	No= 0, Yes= 1	Households using safe drinking water supplies
	Excreta Disposal	No= 0, Yes= 1	Household with method of excreta disposal
	Area	Urban = 1, Rural = 2	Place of residence

4.4. Data Analysis

To construct the indicators for stunting, vaccination, excrete disposal, and safe water access R Studio was used, following the syntaxis provided by the Ecuador National Statistics Institute.

Statistical software Jamovi 2.3.21 was used to perform the analysis.

- To describe the general characteristics of the study participants, descriptive frequency tables will be performed.
- The stunting comparison will be calculated by Chi-square analysis. To determine the significance between stunting and the risk factors, p-values (<0.05) were taken under consideration for logistic regression.
- The associations between stunting and its risk factors will be examined by multivariate logistic regression with 95% confidence intervals.

Considering that the data set was obtained from the Ecuador National Institute of Statistics, the data was treated, and missing values found were excluded from the analysis.

V. RESULTS

5.1. Characteristics of Participants

A total of 20.758 children under five years old were included in this study. General characteristics and distribution of demographic and health status of the study population were presented in Table 2.

Among the study population, the proportion between the two genders is approximately equal (50.5% for males and 49.5% for females); and children born as first child represent 89.3%. In terms of age distribution, children under one year represent 17.2%, children between one and two years are similar with 20.7% and 20.1% respectively, while children under three and four years represent 21%. The proportion of children who presented diarrhea in the previous two weeks is 19.5% and for respiratory infections is 54.8%. Children with stunting represent 18.1%, the proportion of children with rotavirus complete vaccination scheme is 97% and pneumococcus complete vaccination scheme is 94.9%.

Regarding maternal characteristics, 61.3% of the mothers are aged between 27 to 49 years, 32.7% are between 20 to 26 years, and 6% are represented by adolescent mothers aged between 12 to 19 years. The proportion of mothers with no education or basic education is 29.1%, mothers who have attended Middle or High School represent 47.6%, while superior educational level counts for 23.2%. The majority of mothers have a common union or cohabitate (44.9%), followed by married (27.6%), single (15%), separated (10.9%), and divorced/widow (1.7%).

Children who were born in public or private facilities represent 93.9%, cesarean section accounts for 43% while vaginal delivery represents 57%, and the majority of the deliveries were declared to be on time (91.7%) while prematurity represents 7% and post maturity 1.3%. During pregnancy, 89.2% of the mothers were supplemented with iron and folic acid; 7.3% attended less than 4 antenatal care visits, 66.9% had 4 to 8 visits, and

25.8% more than 8 visits.

60.8% of the population is located in the urban area while 39.2% correspond to rural areas, only 17.3% have access to safe water; and 19.1% have access to excrete disposal facilities, correlated with the 64.3% of the study population has poverty due to unmet needs.

Table 2. Characteristics of participants

Variables	**Categories**	**Sample Size (20758)**	**Percentage %**
Stunting	No	16993	81.9
	Yes	3765	18.1
Sex	Male	10493	50.5
	Female	10265	49.5
Age	0	3579	17.2
	1	4291	20.7
	2	4177	20.1
	3	4362	21.0
	4	4349	21.0
Diarrhea	No	16741	80.5
	Yes	4044	19.5
Respiratory Infections	No	9381	45.2
	Yes	11377	54.8
Complete Rotavirus Vaccination Scheme	No	617	3.0
	Yes	20141	97.0
Complete Pneumococcus Vaccination Scheme	No	1066	5.1
	Yes	19692	94.9
Birth Order	First	18541	89.3
	Second	2217	10.7
Mother's Age	12 to 19	1255	6.0
	20 to 26	6784	32.7
	27 to 49	12719	61.3
Educational Level	None/Basic Education	6046	29.1

Variables	Categories	Sample Size (20758)	Percentage %
	Middle/High School	9891	47.6
	Superior	4821	23.2
Marital Status	Common Union	9312	44.9
	Separated	2258	10.9
	Divorced/Widow	351	1.7
	Married	5723	27.6
	Single	3114	15.0
Institutional Delivery	No	1270	6.1
	Yes	19489	93.9
Cesarean section	No	11827	57.0
	Yes	8931	43.0
Antenatal Care Visits	< 4	1519	7.3
	5 to 8	13881	66.9
	> 8	5358	25.8
Iron and Acid Folic Suplementation	No	2241	10.8
	Yes	18517	89.2
Time of Delivery	On-Time	19034	91.7
	Pre-term	1456	7.0
	Post-term	268	1.3
Excrete Disposal access	No	16803	80.9
	Yes	3955	19.1
Safe Water Access	No	17174	82.7
	Yes	3584	17.3
Poverty Due to Unmet Needs	No	7401	35.7
	Yes	13358	64.3
Area of residence	Urban	12630	60.8
	Rural	8128	39.2

5.2. Prevalence of Stunting in children under 5 years by risk factors

The comparison between stunted and not stunted children under five years and their risk factors, with p-value (<0.05) taken under consideration, is shown in Table 3. According to the analysis, with values (p=<0.001), we can observe that sex, age, diarrhea, rotavirus vaccination scheme, pneumococcus vaccination scheme, mother's age, and educational level; as well as institutional delivery, cesarean section, antenatal care visits, supplementation, time of delivery, excrete disposal, safe water access, poverty indicator, and area are significantly associated with stunting. On the other hand, respiratory infections, birth order, and mother's marital status are not significant, as shown in Table 3.

Table 3. Prevalence of Stunting of children under 5 years by risk factors

Variables	Stunting				p-value
	No		Yes		
	n	%	n	%	
	16693	**(81.10)**	**3765**	**(18.10)**	
Sex					**<0.001**
Male	8746	(80.80)	2017	(19.20)	
Female	8517	(83.00)	1748	(17.00)	
Age					**<0.001**
0	3051	(85.20)	528	(14.80)	
1	3234	(75.40)	1057	(24.60)	
2	3333	(79.80)	844	(20.20)	
3	3652	(83.70)	710	(16.30)	
4	3723	(85.60)	626	(14.40)	
Diarrhea					**<0.001**
No	13788	(82.50)	2926	(17.50)	
Yes	3205	(79.30)	839	(20.70)	
Respiratory Infections					0.395
No	7703	(82.10)	1678	(17.90)	

Variables	Stunting				p-value
	No		Yes		
	n	%	n	%	
	16693	**(81.10)**	**3765**	**(18.10)**	
Yes	9290	(81.70)	2087	(18.30)	
Complete Rotavirus Scheme					**<0.001**
No	473	(76.70)	144	(23.30)	
Yes	16520	(82.00)	3621	(18.00)	
Complete Pneumococcus Scheme					**<0.001**
No	828	(77.70)	238	(22.30)	
Yes	16165	(82.10)	3527	(17.90)	
Birth Order					0.015
First	15220	(82.10)	3321	(17.90)	
Second	1773	(80.00)	444	(20.00)	
Mother's Age					**<0.001**
12 to 19	959	(76.40)	296	(23.60)	
20 to 26	5405	(79.70)	1379	(20.30)	
27 to 49	10629	(83.60)	2090	(16.40)	
Mother's Educational Level					**<0.001**
None/Basic Education	4493	(74.30)	1553	(25.70)	
Middle/High School	8192	(82.80)	1699	(17.20)	
Superior	4308	(89.40)	513	(10.60)	
Mother's Marital Status					0.441
Common Union	7666	(82.30)	1646	(17.70)	
Separated	1854	(82.10)	404	(17.90)	
Divorced/Widow	288	(82.10)	63	(17.90)	
Married	4665	(81.50)	1058	(18.50)	
Single	2520	(80.90)	594	(19.10)	
Institutional Delivery					**<0.001**
No	831	(65.40)	439	(34.60)	
Yes	16162	(82.90)	3326	(17.10)	

Variables	Stunting				p-value
	No		Yes		
	n	%	n	%	
	16693	**(81.10)**	**3765**	**(18.10)**	
Cesarean section					**<0.001**
No	9353	(79.10)	2474	(20.90)	
Yes	7640	(85.50)	1291	(14.50)	
Antenatal Care Visits					**<0.001**
< 4	1022	(67.30)	497	(32.70)	
5-8	11399	(82.10)	2482	(17.90)	
> 8	4572	(85.30)	786	(14.70)	
Iron and Acid Folic Suplementation					**<0.001**
No	1672	(74.60)	569	(25.40)	
Yes	15321	(82.70)	3196	(17.30)	
Time of Delivery					**<0.001**
On-Time	15728	(82.60)	3306	(17.40)	
Pre-term	1049	(72.00)	407	(28.00)	
Post-term	216	(86.00)	52	(19.40)	
Excrete Disposal Access					**<0.001**
No	13972	(83.20)	2831	(16.20)	
Yes	3021	(76.40)	934	(23.60)	
Safe Water Access					**<0.001**
No	13977	(81.40)	3197	(18.60)	
Yes	3016	(84.20)	568	(15.80)	
Poverty Due to Unmet Needs					**<0.001**
No	11299	(84.60)	2058	(15.40)	
Yes	5694	(76.90)	1707	(23.10)	
Area					**<0.001**
Urban	10787	(85.40)	1843	(14.60)	
Rural	6206	(76.40)	1922	(23.60)	

p-value <0.05

5.3. Analysis of Association between stunting and risk factors

Associated risk factors and stunting are given in Table 4, the logistic regression was constructed with the variables that showed a significant relation according to Table 3. Results showed that male children are 1.16 times more likely to be stunted than females (OR= 1.16, 95% CI: 1.08-1.25). Regarding age, compared with children under one year, children above one year are 1.94 times more likely to be stunted (OR= 1.94, 95% CI: 1.75-2.22) showing a proportionally inverse trend, which reduces the probability as the child increases in age.

The results also prove that children with episodes of diarrhea in the last 2 weeks before the interview are 1.04 times more likely to have stunting (OR= 1.04, 95% CI: 0.96-1.14). Children without a complete vaccination scheme for rotavirus and pneumococcus are respectively 1.07 and 1.03 times more likely to be stunted compared with children with a complete vaccination scheme (OR= 1.07, 95% CI: 0.88-1.34), (OR= 1.04, 95% CI: 0.96-1.14).

Children with mothers with no or basic education are 1.99 times more likely to be stunted, compared with mothers with higher education (OR= 1.99, 95% CI: 1.76-2.25). Additionally, mothers with middle or high school levels are 1.36 times more likely to have children with stunting when we compare with the reference level (OR= 1.36, 95% CI: 1.21-1.53). On the other hand, the mother´s age has shown a similar pattern among the subgroups; mothers aged between 12 to 19 years are 1.17 times more likely to have children with stunting (OR= 1.17, 95% CI: 1.01-1.36), and mothers aged between 20 to 26 years are 1.16 times more likely to have stunted children than mothers aged over 27 years (OR= 1.16, 95% CI: 1.07-1.26).

Children born at home or other places are 1.56 times more likely to be stunted compared with those who were born at a hospital (OR= 1.56, 95% CI: 1.36-1.79). Having a vaginal birth increases by 1.25 times the possibility of stunting, compared with a cesarean section (OR= 1.25, 95% CI: 1.15-1.36). A lack of supplementation with iron

and folic acid during pregnancy increases by 1.16 times the possibility of having a stunted child (OR= 1.16, 95% CI: 1.04-1.31), preterm babies are 2.16 times more likely to be stunted compared with those born on time or post-term (OR= 2.16, 95% CI: 1.91-2.46). Having less than 4 prenatal care visits during pregnancy increases by 1.61 times the risk of having a stunted child (OR= 1.61, 95% CI: 1.39-1.87), while pregnant women who attended 5 to 8 antenatal care visits are 1.04 times more likely to have children with stunted compared with those who had more than 8 visits during the pregnancy (OR= 1.04, 95% CI: 0.95-1.14).

Households located in rural areas are 1.37 times more likely to have stunted children compared with households in urban areas (OR= 1.37, 95% CI: 1.27-1.49) as well as households having poverty due to unmet needs increases by 1.11 times the risk of having a stunted child compared with those households with no poverty risk (OR= 1.11, 95% CI: 1.02-1.21), or with those with safe water access that are at risk of 1 times more likely of stunted child (OR= 1.00, 95% CI: 0.91-1.11).

Table 4. Analysis of the Association between stunting and risk factors

Variables	aOR*	(95% CI)
Sex		
Male	1.16	(1.08-1.25)
Female	1	
Age		
0	1	
1	1.94	(1.75-2.22)
2	1.55	(1.37-1.75)
3	1.21	(1.07-1.38)
4	1.06	(0.93-1.20)
Diarrhea		
No	1	

Variables	aOR*	(95% CI)
Yes	1.04	(0.96-1.14)
Complete Rotavirus Scheme		
No	1.07	(0.88-1.34)
Yes	1	
Complete Pneumococcus Scheme		
No	1.03	(0.87-1.21)
Yes	1	
Mother's Age		
12 to 19	1.17	(1.01-1.36)
20 to 26	1.16	(1.07-1.26)
27 to 49	1	
Mother's Educational Level		
None/Basic Education	1.99	(1.76-2.25)
Middle/High School	1.36	(1.21-1.53)
Superior	1	
Institutional Delivery		
No	1.56	(1.36-1.79)
Yes	1	
Cesarean section		
No	1.25	(1.15-1.36)
Yes	1	
Antenatal Care Visits		
< 4	1.61	(1.39-1.87)
5-8	1.04	(0.95-1.14)
> 8	1	
Iron and Acid Folic Supplementation		
No	1.16	(1.04-1.31)

Variables	aOR*	(95% CI)
Yes	1	
Time of Delivery		
On-Time	1	
Pre-term	2.16	(1.91-2.46)
Post-term	0.81	(0.59-1.12)
Excrete Disposal Access		
No	0.9	(0.82-1.00)
Yes	1	
Safe Water Access		
No	1.00	(0.91-1.11)
Yes	1	
Poverty Due to Unmet Needs		
No	1	
Yes	1.11	(1.02-1.21)
Area		
Urban	1	
Rural	1.37	(1.27-1.49)

*aOR: Adjusted Odds Ratio CI: Confidence Interval

5.4. Analysis of the Association between stunting and risk factors by sex

In Table 5 an analysis to explore the relationship between stunting children regarding sex and risk factors was performed. In terms of age, one-year female children are 2.19 times more likely to be stunted compared with those under one year (OR= 2.19, 95% CI: 1.82-2.64). This risk shows a discrete reduction, but still, the risk increases by 1.87, 1.58, and 1.50 times for two, three, and four years respectively (OR= 1.87, 95% CI: 1.54-2.27; OR= 1.58, 95% CI: 1.54-2.27; OR= 1.50, 95% CI: 1.23-1.83). On the other hand, for males, the higher risk is present from 12 to 36 months, where the possibility of being

stunted increases by 1.80 and 1.28 times respectively (OR= 1.80, 95% CI: 1.54-2.11; OR= 1.28, 95% CI: 1.09-1.52).

In contrast, male children having an episode of diarrhea in the last two weeks increased by 1.09 times the probability of stunting (OR= 1.09, 95% CI: 0.97-1.24). Boys without a complete vaccination scheme for rotavirus and pneumococcus are respectively 1.17 and 1.02 times more likely to be stunted compared with children with a complete vaccination scheme (OR= 1.17, 95% CI: 0.88-1.56; OR= 1.02, 95% CI: 0.81-1.28).

Being a daughter of a mother aged between 12 to 19 years increases by 1.22 times the risk of stunting (OR= 1.22, 95% CI: 0.98-1.51), and 1.24 times if the mother is aged between 20 to 26 years (OR= 1.24, 95% CI: 1.10-1.39). Being the son of a mother aged between 12 to 19 years increases by 1.05 times the risk of stunting (OR= 1.05, 95% CI: 0.86-1.29), and 1.17 times if the mother is aged between 20 to 26 years (OR= 1.17, 95% CI: 1.04-1.31).

Female children whose mothers have no, or basic education have a 2.05 times higher likelihood of being stunted (OR= 2.05, 95% CI: 1.72-2.45). On the other hand, mothers with middle or high school education have a 1.40 times higher likelihood of having children with stunting compared to those with higher education (OR= 1.40, 95% CI: 1.19-1.66). Male children whose mothers have no, or basic education have a 1.94 times higher likelihood of being stunted (OR= 1.94, 95% CI: 1.64-2.29). On the other hand, mothers with middle or high school education have a 1.31 times higher likelihood of having children with stunting.

Having a delivery at home increases the probability of stunting by 1.61 for females and 1.53 for male children (OR= 1.61, 95% CI: 1.33-1.96; OR= 1.53, 95% CI: 1.27-1.85). Male children born by vaginal delivery are 1.31 times more likely to be stunted, while for females this possibility increases by 1.18 times compared with cesarean section (OR= 1.31, 95% CI: 1.17-1.46; OR= 1.18, 95% CI: 1.33-1.96).

There is a similar pattern for both genders when it comes to prenatal care during pregnancy. Having less than 4 prenatal care visits increases the risk of having a son with

stunting by 1.65 times and the risk of having a daughter with stunting by 1.60 times (OR= 1.65, 95% CI: 1.34-2.03; OR= 1.60, 95% CI: 1.29-1.98). On the other hand, having 5 to 8 antenatal care visits slightly increases the risk of stunting for males by 1.02 times and for females by 1.07 times, compared to those who had more than 8 consultations during pregnancy (OR= 1.02, 95% CI: 0.90-1.15; OR= 1.07, 95% CI: 0.94-1.22).

The absence of iron and folic acid supplementation during pregnancy raises the likelihood of having a female stunted kid by 1.29 times and by 1.06 times for males (OR= 1.29, 95% CI: 1.09-1.51; OR= 1.06, 95% CI: 0.90-1.24). Male preterm infants have a 2.32-fold higher likelihood of experiencing stunted growth (OR= 2.32, 95% CI: 1.95-2.76). For female infants, the risk of stunted growth is increased by 1.98 times for premature babies and 1.22 times for post-term babies (OR= 1.98, 95% CI: 1.64-2.39; OR= 1.22, 95% CI: 0.80-1.86).

For female children, living in a household with poverty due to unmet needs increases the possibility by 1.11 times of suffering from stunting, and for male children, the likelihood of being stunted is 1.13 times (OR= 1.11, 95% CI: 0.98-1.26; OR= 1.13, 95% CI: 1.00-1.28). Male children from households located in rural areas are 1.40 times more likely to have stunted children, while for a female child, the possibility is 1.34 times compared with households in urban areas (OR= 1.40, 95% CI: 1.26-1.56; OR= 1.34, 95% CI: 1.19-1.50), as well as females living in households with no safe water, are at risk of 1.03 times more likely of being stunted (OR= 1.03, 95% CI: 0.89-1.26).

Table 5. Analysis of the Association between stunting and risk factors by sex

Variables	Stunting = Yes			
	Male		Female	
	aOR*	95% CI	aOR*	95% CI
Age				
0	1		1	
1	1.80	(1.54-2.11)	2.19	(1.82-2.64)

Variables	Stunting = Yes			
	Male		Female	
	aOR*	95% CI	aOR*	95% CI
2	1.28	(1.09-1.52)	1.87	(1.54-2.27)
3	0.92	(0.77-1.09)	1.58	(1.30-1.92)
4	0.73	(0.61-0.87)	1.50	(1.23-1.83)
Diarrhea				
No	1		1	
Yes	1.09	(0.97-1.24)	1.00	(0.88-1.15)
Complete Rotavirus Scheme				
No	1.17	(0.88-1.56)	0.95	(0.69-1.30)
Yes	1		1	
Complete Pneumococcus Scheme				
No	1.02	(0.81-1.28)	0.98	(0.76-1.25)
Yes	1		1	
Mother's Age				
12 to 19	1.05	(0.86-1.29)	1.22	(0.98-1.51)
20 to 26	1.17	(1.04-1.31)	1.24	(1.10-1.39)
27 to 49	1		1	
Mother's Educational Level				
None/Basic Education	1.94	(1.64-2.29)	2.05	(1.72-2.45)
Middle/High School	1.31	(1.12-1.53)	1.40	(1.19-1.66)
Superior	1		1	
Institutional Delivery				
No	1.53	(1.27-1.85)	1.61	(1.33-1.96)
Yes	1		1	
Cesarean section				
No	1.31	(1.17-1.46)	1.18	(1.33-1.96)
Yes	1		1	

Variables	Stunting = Yes			
	Male		Female	
	aOR*	95% CI	aOR*	95% CI
Antenatal Care Visits				
< 4	1.65	(1.34-2.03)	1.60	(1.29-1.98)
5-8	1.02	(0.90-1.15)	1.07	(0.94-1.22)
> 8	1		1	
Iron and Acid Folic Suplementation				
No	1.06	(0.90-1.24)	1.29	(1.09-1.51)
Yes	1		1	
Time of Delivery				
On-Time	1		1	
Pre-term	2.32	(1.95-2.76)	1.98	(1.64-2.39)
Post-term	0.50	(0.30-0.83)	1.22	(0.80-1.86)
Excrete Disposal Access				
No	0.88	(0.77-1.07)	0.94	(0.81-1.08)
Yes	1		1	
Safe Water Access				
No	0.97	(0.84-1.12)	1.03	(0.89-1.26)
Yes	1		1	
Poverty Due to Unmet Needs				
No	1		1	
Yes	1.13	(1.00-1.28)	1.11	(0.98-1.26)
Area				
Urban	1		1	
Rural	1.40	(1.26-1.56)	1.34	(1.19-1.50)

*aOR: Adjusted Odds Ratio CI: Confidence Interval

5.5. Analysis of the association between stunting and risk factors by area

Table 6 presents the results of an analysis conducted to investigate the association between area and risk factors and stunting in children. Compared to children under one year old, one-year-olds in rural settings have a 2.29-fold higher likelihood of stunting (OR= 2.29, 95% CI:1.92-2.47). This risk exhibits a discontinuous decrease; nevertheless, over the next two, three, and four years, the risk will increase by 2.02, 1.42, and 1.39 times, respectively (OR= 2.02, 95% CI: 1.69-2.43; OR= 1.42, 95% CI: 1.17-1.71; OR= 1.39, 95% CI: 1.14-1.68). However, in an urban setting, the risk is greater between the ages of 12 and 36 months, during which time the likelihood of stunting rises by 1.67 and 1.17 times, respectively (OR= 1.67, 95% CI: 1.42-1.96; OR= 1.17, 95% CI: 0.99-1.39).

On the other hand, children who experienced diarrheal illness within the previous two weeks and reside in urban areas had a 1.12-fold higher risk of stunting (OR= 1.12, 95% CI: 0.99-1.27). Children who live in rural regions and do not receive the full pneumococcal and rotavirus immunization series are 1.19 and 1.07 times more likely to be stunted, respectively (OR= 1.19, 95% CI: 0.88-1.62; OR= 1.07, 95% CI: 0.83-1.38).

Living in urban areas and having a mother between the ages of 12 and 19 increases the risk of stunting by 1.18 times (OR= 1.18, 95% CI: 0.94-1.47), and 1.21 times if the mother is between the ages of 20 and 26 (OR= 1.21, 95% CI: 1.09-1.36), while children of a mother between the ages of 12 and 19 living in rural areas increases the risk of stunting by 1.13 times (OR= 1.13, 95% CI: 0.92-1.39) and 1.20 times if the mother is between 20 and 26 years (OR= 1.20, 95% CI: 1.07-1.35).

Concerning the comparison of educational attainment between residential areas, a comparable pattern is evident: children residing in urban areas with mothers possessing no or basic education are 1.93 times more prone to stunting (OR= 1.93, 95% CI: 1.65-2.26); conversely, children with mothers possessing middle or high school education are 1.41 times more likely to have stunting when compared to higher education (OR= 1.41, 95% CI: 1.23-1.62). Compared with higher education, children of mothers in

middle or high school are 1.24 times more likely to have children with stunting (OR= 1.24, 95% CI: 1.00-1.52). However, children living in rural areas with mothers with no or basic education are 1.92 times more likely to have stunted children (OR= 1.92, 95% CI: 1.55-2.36).

Stunting is 1.83 times more likely to occur in rural settings when a baby is delivered at home (OR= 1.83, 95% CI: 1.55-2.15). Vaginal deliveries in rural areas increase the likelihood of stunting by 1.22 times and 1.26 in urban areas (OR= 1.22, 95% CI: 1.08-1.38; OR= 1.26, 95% CI: 1.13-1.40).

Prenatal care during pregnancy shows a similar trend for both areas: less than four prenatal care visits increases the risk of stunting by 1.41 times in urban areas and 1.78 times in rural areas (OR= 1.41, 95% CI: 1.13-1.76; OR= 1.78, 95% CI: 1.44-2.19); on the other hand, five to eight prenatal care visits increases the risk of stunting by 1.03 times in urban areas and 1.06 times in rural areas when compared to counterparts who had more than eight consultations during pregnancy (OR= 1.03, 95% CI: 0.91-1.16; OR= 1.06, 95% CI: 0.92-1.22).

In rural areas, the likelihood of having a stunted kid increases by 1.15 times, and in urban areas, it increases by 1.19 times if iron and folic acid supplements are not taken during pregnancy (OR= 1.15, 95% CI: 0.98-1.34; OR= 1.19, 95% CI: 1.00-1.41). Preterm babies born in the rural area are 2.21 times more likely to be stunted (OR= 2.21, 95% CI: 1.80-2.71), this risk is increased by 2.16 times for premature babies born in urban areas (OR= 2.16, 95% CI: 1.95-2.76).

Lastly, the likelihood that a child may experience stunting increases by 1.32 times while living in a household where poverty results from unmet needs in urban settings (OR= 1.32, 95% CI: 1.26-1.56).

Table 6. Analysis of the Association between stunting and risk factors by area

Variables	Stunting = Yes			
	Urban		Rural	
	aOR*	95% CI	aOR*	95% CI
Sex				
Male	1.14	(1.03-1.26)	1.19	(1.07-1.33)
Female	1		1	
Age				
0	1		1	
1	1.67	(1.42-1.96)	2.29	(1.92-2.47)
2	1.17	(0.99-1.39)	2.02	(1.69-2.43)
3	1.00	(0.84-1.19)	1.42	(1.17-1.71)
4	0.79	(0.66-0.94)	1.39	(1.14-1.68)
Diarrhea				
No	1		1	
Yes	1.12	(0.99-1.27)	0.98	(0.86-1.12)
Complete Rotavirus Scheme				
No	0.95	(0.71-1.28)	1.19	(0.88-1.62)
Yes	1		1	
Complete Pneumococcus Scheme				
No	0.95	(0.76-1.19)	1.07	(0.83-1.38)
Yes	1		1	
Mother's Age				
12 to 19	1.18	(0.94-1.47)	1.13	(0.92-1.39)
20 to 26	1.21	(1.09-1.36)	1.20	(1.07-1.35)
27 to 49	1		1	
Mother's Educational Level				
None/Basic Education	1.93	(1.65-2.26)	1.92	(1.55-2.36)
Middle/High School	1.41	(1.23-1.62)	1.24	(1.00-1.52)
Superior	1		1	

Variables	Stunting = Yes			
	Urban		Rural	
	aOR*	95% CI	aOR*	95% CI
Institutional Delivery				
No	1.00	(0.76-1.32)	1.83	(1.55-2.15)
Yes	1		1	
Cesarean section				
No	1.26	(1.13-1.40)	1.22	(1.08-1.38)
Yes	1		1	
Antenatal Care Visits				
< 4	1.41	(1.13-1.76)	1.78	(1.44-2.19)
5-8	1.03	(0.91-1.16)	1.06	(0.92-1.22)
> 8	1		1	
Iron and Acid Folic Suplementation				
No	1.19	(1.00-1.41)	1.15	(0.98-1.34)
Yes	1		1	
Time of Delivery				
On-Time	1		1	
Pre-term	2.16	(1.95-2.76)	2.21	(1.80-2.71)
Post-term	0.65	(0.37-1.16)	0.86	(0.57-1.28)
Excrete Disposal Access				
No	0.96	(0.84-1.11)	0.83	(0.71-0.96)
Yes	1		1	
Safe Water Access				
No	1.00	(0.88-1.15)	1.00	(0.86-1.18)
Yes	1		1	
Poverty Due to Unmet Needs				
No	1		1	
Yes	1.32	(1.18-1.49)	0.92	(0.80-1.05)

*aOR: Adjusted Odds Ratio CI: Confidence Interval

VI. DISCUSSION

The findings of the present study explored the factors associated with stunting under 5 years living in Ecuador.

It is crucial to intervene during the initial 1000 days of a child's life to prevent stunting, a condition that has significant impacts on both physical and cognitive development. During this crucial period, the body and brain experience accelerated growth and development, emphasizing the importance of addressing nutritional and healthcare requirements to achieve the best possible results. Identifying risk factors, such as insufficient maternal education, limited access to adequate healthcare, and socio-economic inequalities, is essential for developing specific interventions. Malnutrition, infections, and environmental factors can greatly contribute to the occurrence of stunting. Through the early identification and mitigation of these risk factors, interventions can be customized to deliver vital nutrients, healthcare, and assistance to individuals and communities at risk.

The results of this study concluded that, in Ecuador, male children have a significantly higher risk of being stunted compared with their female counterparts. Males are recognized to have a higher susceptibility to harm than females, starting from the moment of conception where male fetuses have a higher likelihood of experiencing adverse outcomes compared to female fetuses, and are more prone to issues such as placental insufficiency, infections, and pre-term delivery. Male individuals exhibit a decreased likelihood of surviving premature delivery due to underdeveloped lungs, including delayed surfactant production. Research suggests that newborn females possess a physiological maturity level comparable to that of a 4-6-week-old male. This indicates that females are born with a higher level of development, making them more equipped to endure unfavorable circumstances, and are more prone to experiencing some conditions during childhood, including lower respiratory infections, diarrheal diseases, malaria, and preterm birth. However, it is worth noting that females are more susceptible to measles,

whooping cough, and tuberculosis. These factors not only contribute to mortality but also weight loss, stunted growth, or severe malnutrition in young children (Thurstans et al., 2020).

Findings from studies carried out in Nigeria, Iran, Indonesia, Ghana, Tanzania, Pakistan, and Kenya (Ezeh et al., 2021; Shibre et al., 2021; Siddiqa et al., 2023) showed evidence that male children have high odds of being stunted compared with female children. A systematic review and meta-analysis on sex differences in undernutrition in children under the age of 5 revealed that, in the majority of cases, males have a higher likelihood of experiencing wasting, stunting, and being underweight compared to girls. Regional disparities were seen, as the rise in risk was comparatively less significant for boys in South Asia. An aggregated analysis of 35 longitudinal cohorts from 15 low- and middle-income countries (LMICs) revealed that being male is a significant predictor for both wasting and stunting. Numerous research investigating the coexistence of wasting and stunting have consistently found that males are more susceptible to this condition than girls. These studies encompass population-level data, some of which comprise numerous data sets, as well as data from Severe Acute Malnutrition (SAM) treatment programs (Thurstans et al., 2022).

In contrast, sociological and anthropological research demonstrates that in numerous areas, female children face greater social vulnerability as a result of gender norms that favor male children, especially first-born sons. Gender norms, inheritance patterns, marital dynamics, and differential economic outcomes for sons and daughters all contribute to parenting practices, including the duration of nursing and the choice to seek healthcare for illnesses, which in turn impact child stunting. The elevated prevalence of stunting and mortality observed in girls in certain regions of East Africa, East and South Asia, the Middle East, and North Africa, may be attributed to the preference for male offspring in civilizations that follow patrilineal descent and exhibit differential caregiving patterns (Alderman et al., 2021; Thompson, 2021).

The disparity in growth between males and females is significantly affected by socially

and culturally mediated disparities in resource access, exposure to environmental stressors, as well as sex preferences, and gender norms. These factors can interact either in a cumulative or conflicting manner. Hence, the inherent physiological inequalities in how males and females respond to their surroundings may either be amplified or concealed due to the diverse cultural and social environments that vary based on gender (Wali, Agho, & Renzaho, 2020).

These opposing observations indicate that boys are more susceptible to biological vulnerabilities, while girls are more susceptible to social vulnerabilities. Instead of considering one gender to be at a higher risk for stunting, it is crucial to comprehend how biological mechanisms that contribute to vulnerability interact with social and cultural factors that contribute to differential nutritional or environmental exposures. This understanding is essential for identifying the children who are most prone to growth faltering.

The onset of stunting commonly initiates during the prenatal period. Research conducted in African countries and India indicates that the average height-for-age z scores are already diminished at birth in underprivileged populations and experience a significant decline after the initial 24 months of life (Das et al., 2020; Umwali, Kunyanga, & Kaindi, 2022). This study yielded comparable findings, with stunting increasing within 1.97 and 1.55 times the likelihood by the time children reached 12 and 24 months respectively, a critical phase for growth impairment, but remains still high after this age. The correlation between age and the prevalence of child stunting highlights the importance of promptly and appropriately introducing supplementary feeding to adequately address the increasing nutritional needs of children.

In this study children who experienced diarrhea within the two weeks preceding the survey demonstrated a higher susceptibility to stunting compared to those who did not undergo such an episode, which we can appreciate is increased by 1.04 times according to this study. Findings have shown that this could be linked to the possibility that diarrhea, might be an ongoing or recurring diarrhea issue, leading to poor nutritional

status, increased catabolism, impaired intestinal absorption, and the redirection of essential nutrients away from growth towards immune response causing growth failure (Girma et al., 2021; Schlaudecker, Steinhoff, & Moore, 2011).

By 2023, Ecuador has reached more than 90% vaccination coverage. A study in Indonesia showed that complete immunization was associated with lower morbidity and lower prevalence of stunting in children aged 12–59 months, being coherent with our findings where children without a complete vaccination scheme for rotavirus and pneumococcus are respectively 1.07 and 1.03 times more likely to be stunted compared with children with a complete vaccination scheme (Ekholuenetale et al., 2022).

In general, this study shows a substantial association between the educational level and age of mothers and the occurrence of stunting in children under the age of 5. This finding aligns with prior research conducted in Afghanistan, Bangladesh, and India, which has established a correlation between improved conditions in educational levels and extended life expectancies, decreased mortality rates, and overall enhancement in child health and nutrition (Ickes, Hurst, & Flax, 2015). These improvements can be attributed to a deeper comprehension of healthcare treatment and prevention strategies, as well as the adoption of proactive health-seeking behaviors in the UK, Sweden, and rural China (Lakshman et al., 2013).

This study's results to show that preterm babies, children born at home, by vaginal delivery, and had no supplementation with micronutrients have a greater likelihood of experiencing stunted growth. Children of mothers who had fewer than four or no antenatal care visits at the health facility before giving birth had an increased likelihood of experiencing stunting.

The World Health Organization recommends a minimum of five antenatal care appointments during pregnancy, as research has demonstrated that better coverage of ANC leads to notable improvements in reducing stunting outcomes and preterm deliveries. Through the analysis of child vital data and child anthropometry collected from 193 surveys conducted in 69 low-income and middle-income countries, research has

discovered a significant correlation between ANC and a decrease in neonatal and infant mortality rates, low birth weight cases, stunting, and underweight conditions. Women who attend at least one antenatal care (ANC) appointment have a 1.04 percentage point decrease in the likelihood of their newborn dying, this association is particularly strong in Latin America and the Caribbean, Sub-Saharan Africa, and South and Southeast Asia. (Kuhnt & Vollmer, 2017).

The acquisition of this knowledge has resulted in the implementation of enhanced policy initiatives in Ecuador aimed at enhancing the availability and inclusivity of maternity services, encompassing prenatal and postnatal care as well as facilitating access to healthcare facilities. A comparative study between 1994 and 2012 of the National coverage for reproductive, maternal, and child services in Ecuador showed that the coverage of all the interventions assessed tended to rise significantly over the given time, at a rate of around 1.5 to 1.6% each year. The lowest coverage between 1994 and 2004 was of early commencement of breastfeeding with considerable improvement between 2004 and 2012 (29.1 to 52.6%). In contrast, coverage of interventions related to sanitation showed a different pattern, where improved sanitary facilities showed important progress from 43.7 to 69.2% between 1994 to 1999, but it did not show any progress between 2004 to 2012, while Improved drinking water sources merely increased from 84.6% to 85.6 between 2004 to 2012 (Rios Quituizaca et al., 2021).

Antenatal care visits play a pivotal role in safeguarding maternal and child health, serving as a cornerstone in preventing preterm births, detecting diseases, and promoting overall well-being during pregnancy. Regular check-ups enable healthcare professionals to monitor the progression of the pregnancy, identify potential complications, and intervene early to mitigate risks associated with preterm births. These visits also offer a crucial platform for educating expectant mothers on proper nutrition, hygiene practices, and essential healthcare measures. By addressing potential health issues during pregnancy, antenatal care significantly contributes to preventing stunting and ensuring optimal fetal growth and development. Moreover, health promotion strategies

implemented during these visits empower women with the knowledge and resources necessary for a healthy pregnancy, reducing the likelihood of adverse outcomes for both the mother and the child. In essence, antenatal care emerges as a fundamental component in the broader effort to enhance maternal and child health, creating a foundation for a healthier and more resilient start to life.

Prior research has established a strong correlation between stunting and poverty. A higher level of family wealth typically allows for greater allocation of resources towards nutrition and overall healthcare, thereby reducing the likelihood of undernutrition in children. The socio-economic status of a household continues to be a crucial factor in determining the nutritional outcomes of children. Moreover, the place of residence is a significant indicator of child stunting. Children residing in urban regions benefit from superior socioeconomic circumstances that foster improved nutritional well-being compared to their rural peers.

Although evidence indicates that water, sanitation, and hygiene (WASH) play a crucial role in determining childhood stunting, according to this study the availability of proper excrete disposal and access to safe water did not demonstrate an increased likelihood of stunting.

6.3. Limitations

The cross-sectional form of the study restricts the capacity to establish a causal relationship between variables, so only an associative relationship can be assessed.

While this study examines various risk factors to explain the connections with stunting, it was not possible to include breastfeeding indicators such as exclusive breastfeeding, continuous breastfeeding, and complementary feeding due to methodological differences in the analysis subgroups. Including these indicators could have significantly reduced the sample size, which is why they were omitted.

VII. CONCLUSION AND SUGGESTIONS

7.1 Conclusion

The prevalence of stunting in children under five years in this study is 18.1%. The factors with a positive association with stunting are age between 12 to 48 months, recent episodes of diarrhea, incomplete vaccination scheme, mother´s age and no or low educational level, delivery at home, vaginal delivery, no or less than 4 antenatal care visits during pregnancy, no supplementation with iron and folic acid, being a pre-term baby, having poverty due to unmet needs and living in rural areas.

The study reveals that male children are 1.16-fold more likely to be stunted than females, and older children are 1.94-fold more likely. Diarrhea, lack of full immunization, limited education, and delivery outside a hospital setting are also linked to stunted growth. Rural homes have a 37% higher likelihood of stunted children, while households with unmet requirements have an 11% higher likelihood.

The analysis based on gender and area revealed that factors such as the mother's age, educational level, delivery at a healthcare facility, antenatal care visits, and timing of delivery are consistently observed across categories. This indicates the need for the Ecuadorian government to reinforce initiatives and programs aimed at improving health and education to address the linkages with stunting.

7.2 Suggestions

This study emphasizes the importance of thoroughly investigating maternal and child factors, access to health services, and maternal socio-demographic factors concerning stunting. These factors should be examined to implement appropriate interventions aimed at reducing the burden of stunting and improving the nutritional status of children under the age of five.

Hence, it is imperative to implement policies that specifically target poverty reduction and enhancement of the nutritional well-being of disadvantaged children to effectively tackle the problem of malnutrition among children under the age of five in Ecuador. This should include a collaborative endeavor including multiple parties to guarantee the efficacy of interventions that specifically address nutrition and improve the educational level of mothers.

Finally, it is important to mention that previous administrations have implemented policies to address persistent childhood malnutrition, but no assessment has been conducted to measure the effectiveness of these initiatives. Additionally, it is unclear on what basis the present government has set its objectives. Hence, the government and its agents must conduct a thorough assessment of their roles and functions using current evidence and statistical data. This evaluation will enable the formulation of policies that promote the development of programs, projects, and initiatives that are grounded in an evidence-based approach and ultimately benefit the population.

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