

Effects of applied educational strategies on nutritional status and child development: A case of Riobamba schools



Efectos de estrategias educativas aplicadas en el estado nutricional y desarrollo infantil: Un caso de las escuelas de Riobamba

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Abstract

This paper presents a study on the nutritional status of children in a group of schools in Riobamba, and is part of the results of the project "Program in prevention, promotion and rehabilitation in nutrition, health with participation of school-age children, families and community based on local experiences and technologies of positive deviation of the Canton Riobamba". Using advanced statistical methodologies and R software to analyze the data. The results show variability in the growth and physical development of children, with height and weight measurements that reflect a diversity in these

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characteristics. In addition, an average increase in Body Mass Index for Age was observed, suggesting changes in weight relative to height. However, the z-score for Height-for-Age decreased, which may indicate slower than expected growth in height.

Keywords: Nutrition, infancy, Riobamba, growth, hemoglobin

Resumen

El presente documento presenta un estudio sobre el estado nutricional de los niños en un grupo de escuelas de Riobamba, y es parte de los resultados del proyecto “Programa en prevención, promoción y rehabilitación en nutrición, salud con participación de niños y niñas en edad escolar, familias y comunidad basado en experiencias y tecnologías locales de desviación positiva del Cantón Riobamba”. Utilizando metodologías estadísticas avanzadas y el software R para analizar los datos. Los resultados muestran variabilidad en el crecimiento y desarrollo físico de los niños, con mediciones de talla y peso que reflejan una diversidad en estas características. Además, se observó un incremento promedio en el Índice de Masa Corporal para la Edad, sugiriendo cambios en el peso relativo a la altura. Sin embargo, el z-score de la Talla para la Edad disminuyó, lo que podría indicar un crecimiento en estatura más lento de lo esperado.

Palabras clave: Nutrición, infancia, Riobamba, crecimiento, hemoglobina

Introduction

Chronic child undernutrition is a public health problem that affects the physical and cognitive development of children, limiting their potential to achieve a full and productive life (Black et al., 2008). In Ecuador, this problem has been the focus of governmental and international attention, given its prevalence and long-term consequences for society. Chronic undernutrition manifests mainly as stunting and is associated with factors such as insufficient food intake, nutritional quality of the diet, and unfavorable health and socioeconomic conditions (Cuascota & Navas, 2020; Vega, Meza, Solórzano, & Macías, 2022).

The Nutrition Action Strategy is an example of public policy that seeks to improve the nutritional situation in Ecuador, especially in children under five years of age. This strategy includes components

such as access to healthy food through the implementation of home gardens and the combination of health and education services (López, 2022). At the national level, 12 thousand home gardens have been implemented, which has contributed to a reduction in the prevalence of chronic malnutrition from 26% in 2010 to 22% in 2012.

Malnutrition manifests itself in various forms, including chronic malnutrition, acute malnutrition, overweight and obesity, and can be present in the entire population, mainly in rural areas (Candela, 2020). Among the direct causes of malnutrition are inadequate food consumption and lack of essential micronutrients for the body. Chronic malnutrition is related to the conditions of the mother's pregnancy and the care of the child from birth (FAO & Pan American Health Organization [PAHO], 2017).

In Latin America and the Caribbean, initiatives have been generated to combat hunger and malnutrition, highlighting the commitment of CELAC and the Framework Law on the Right to Food, Food Security and Food Sovereignty. Ecuador, despite its efforts, still faces challenges in reducing chronic malnutrition, especially among the indigenous population and in rural areas (Secretaría Nacional de Planificación y Desarrollo [SENPLADES], 2013).

The National Health and Nutrition Survey (ENSANUT 2012) reveals that chronic malnutrition is more prevalent in indigenous children and low-income families. In addition, anemia affects approximately one in four children aged 0 to 5 years in the country. Breastfeeding, a key practice for child nutrition, has declined in recent decades, underscoring the need for targeted interventions (Encuesta Nacional de Salud y Nutrición [ENSANUT], 2012).

The Nutrition Action Strategy was implemented in nine provinces and 30 cantons, with a focus on improving the nutritional situation of children under five, nursing mothers and pregnant women. The components of the strategy include access to basic services, health and nutrition, healthy food, education and community participation. The intervention modality involves the formation of concertation committees, problem analysis, concertation between supply and demand, establishment of commitments and implementation of concerted action plans (Secretaría Nacional de Planificación y Desarrollo [SENPLADES], 2013).

The results of the Strategy show significant progress in access to healthy food and in the reduction of chronic malnutrition. However,

challenges remain related to equity in access to services and the need to address structural factors that contribute to undernutrition.

In this context, it is crucial to understand the relationship between food security and child nutrition. Food security implies not only the availability of food, but also access to and appropriate use of food for optimal nutrition. Interventions that promote food security, such as home gardens and school feeding programs, can have a positive impact on child nutrition by providing sustainable sources of nutritious food.

In addition, it is important to consider the role of education and awareness in promoting healthy eating practices and preventing undernutrition. Nutrition education campaigns and training programs for parents and caregivers can improve knowledge about child nutrition and encourage healthy eating behaviors (Naranjo, Alcívar, Rodríguez, & Betancourt, 2020).

Collaboration between different sectors and levels of government is critical to effectively address chronic malnutrition. Coordination between the ministries of health, education, agriculture and social development, as well as the participation of local governments and community organizations, is essential to implement comprehensive and sustainable interventions (Vega Játiva, Meza Cruz, Solórzano José Elías, & Macías Enrique Javier, 2020).

Finally, research and continuous monitoring are key to assessing the impact of interventions and adjusting strategies as needed. Collecting and analyzing data on the nutritional status of children and the determinants of undernutrition will identify areas for improvement and target efforts to the most vulnerable populations.

Under this perspective, the present research focuses on determining linear growth (height/age), nutritional status (BMI age) and nutritional risk caused by micronutrient deficiencies and parasitosis in the school population, with the objective of contributing to the reduction of these problems. Through the analysis of strategies implemented in Ecuador, we seek to provide a comprehensive view of the efforts made and lessons learned in the fight against chronic child undernutrition.

Materials and methods

In the methodological phase of the study, a detailed statistical analysis of the data collected was performed. R statistical software,

which is widely recognized for its robustness and capacity to handle large data sets, was used to perform all the analysis operations. It was ensured that all values were numerical and missing data were handled appropriately, applying imputation methods where necessary to maintain statistical integrity.

Descriptive statistical tests were applied to evaluate central tendencies and data dispersion, including mean, median and standard deviation. For comparisons between baseline and follow-up measurements, Student's t-test for related samples was used to identify significant differences in the means of the variables of interest. This made it possible to determine whether the changes observed between the two measurements were statistically significant.

In addition, z-scores for height and BMI-for-age were calculated using the World Health Organization growth charts as a reference, thus allowing a standardized assessment of children's growth and nutritional status.

For the coproparasite variable, a qualitative and quantitative analysis was performed. The results for "presence" or "absence" of parasites were coded and the chi-square test was used to determine whether there was a significant decrease or increase in the prevalence of parasitosis between the two measurements. Interpretation of hemoglobin results was done in the context of clinical guidelines for identifying anemia and other conditions related to nutritional deficiencies.

Results

Table 1. *Statistical characteristics of height, weight and hemoglobin level measurements.*

Variable	Quantity	Most frequent value	Media	Standard deviation	Minimum	Maximum	Unique values
Size	870	130 cm (49 times)	N/A	N/A	N/A	N/A	155
Weight	870	22 kg (16 times)	N/A	N/A	N/A	N/A	330

Uncorrected hemoglobin	812	N/A	13.94 g/dL	1.23 g/dL	9.10 g/dL	21.40 g/dL	N/A
Corrected hemoglobin	811	N/A	12.45 g/dL	1.24 g/dL	7.60 g/dL	19.90 g/dL	N/A

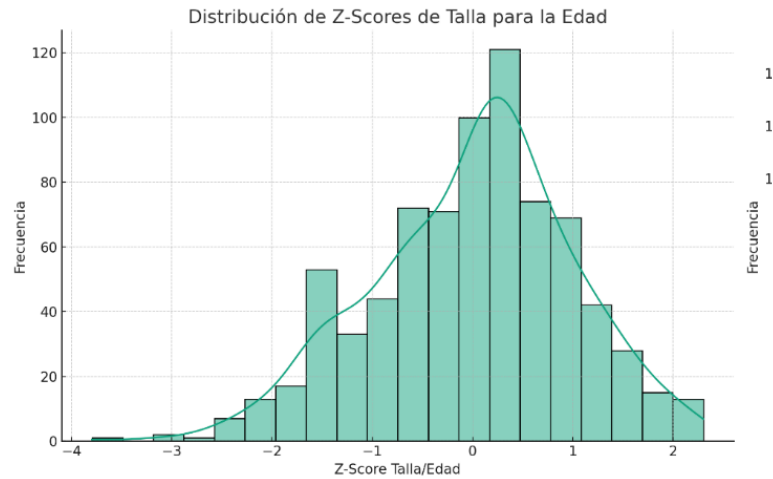
Source: linkage project, 2023

Table 1 summarizes the statistical characteristics of height, weight and hemoglobin level measurements in a school population. There were 870 measurements of both height and weight. The most common height was 130 cm, observed in 49 students, while the most common weight was 22 kg, recorded in 16 students. This suggests that a significant number of children in the sample had these measurements. In addition, 155 different values for height and 330 different values for weight were recorded, indicating variability in the physical growth and development of the children.

For uncorrected hemoglobin, 812 valid measurements were obtained, with a mean of 13.94 g/dL and a standard deviation of 1.23 g/dL. This reflects the average hemoglobin level in the sample and the variability of these levels. The extreme values were 9.10 g/dL and 21.40 g/dL, showing the range of variation in hemoglobin levels among the students. Similarly, there were 811 valid corrected hemoglobin measurements, with a mean of 12.45 g/dL and a standard deviation of 1.24 g/dL, and the extreme values were 7.60 g/dL and 19.90 g/dL.

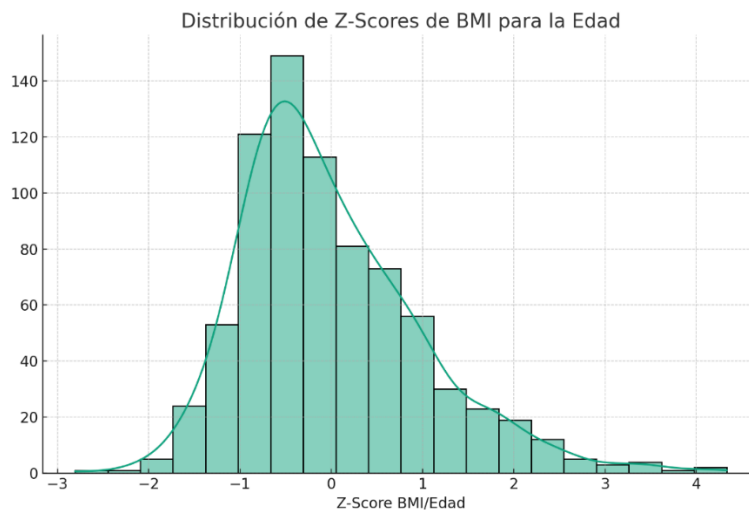
These results provide a quantitative view of the physical and health characteristics of the school population studied. Height and weight measurements show diversity in physical growth and development, while hemoglobin levels provide information on the iron status and general health of the students. The mean and standard deviation are key indicators for understanding the central tendency and variability of the data, and the minimum and maximum values provide insight into the extremes in the measurements.

Figure 1. Distribution of Z-scores of Height for age



Graph 1 reflected a centered distribution, with a mean of $-1.74e-16$ and a slightly positive median of 0.14. 16.37% of the schoolchildren fell below the mean by more than one standard deviation, and 14.18% exceeded it, indicating growth generally in line with expectations.

Figure 2. Distribution of BMI Z-scores for age.



For BMI-for-age (Figure 2) we found a mean of $-3.75e-16$ and a median of -0.18, with 11.21% of the children below and 14.95% above one standard deviation, pointing to a slight tendency toward overweight in some cases.

Both graphs suggest that the majority of children were within normal ranges of growth and nutritional status. The presence of values outside one standard deviation highlights the importance of targeted interventions for those with significant deviations.

With respect to the coproparasitic examination they show a variety of findings which are shown below.

Absence: 487 samples indicated the absence of parasites, which represents the majority of the results. This is a good sign, as it indicates that many of the children evaluated do not have parasitic infections.

Entamoeba coli cyst (+): 94 samples showed the presence of entamoeba coli cysts, a parasite commonly found in the human intestinal tract that generally does not cause disease.

Chilomastix mesnili cyst (+): 92 samples had chilomastix mesnili cysts, another parasite that is generally considered non-pathogenic.

Entamoeba histolytica cyst (+): 45 samples showed the presence of entamoeba histolytica cysts, a parasite that can cause amoebic dysentery and other health problems.

Other results: several other types of parasites were found in smaller quantities, including giardia lamblia, which can cause diarrhea and other gastrointestinal symptoms.

Comparative analyses between the two data sheets reveal several trends in the health and growth measures of the school population studied. An average increase in Body Mass Index for Age (Z BMI/E) was observed, with an increase of 0.49 in the z-score. This suggests that, in general, children's BMI has increased between the two measurements, which could be indicative of changes in weight relative to height within the period studied.

In contrast, the z-score for Height-for-Age (Z SIZE/ AGE) experienced an average decrease of -0.56. This decline may signal that children's growth in height has not kept pace with expected growth compared to standardized growth patterns, or it could reflect a particular stage of growth depending on the age of the children and the time interval between measurements.

In terms of general health and nutrition, improvements in hemoglobin levels were observed. Uncorrected hemoglobin showed an average increase of 0.37 g/dL, while corrected hemoglobin increased by an average of 0.33 g/dL. These changes indicate a positive improvement in hemoglobin levels, suggesting a possible

reduction in the prevalence of anemia or an improvement in the iron status of the children.

These trends provide evidence of changes in children's nutrition and health status. The increase in BMI may need attention to ensure that it is within healthy ranges and to avoid risks of overweight or obesity. Meanwhile, improvement in hemoglobin levels is a positive indicator of possible improvements in nutrition and overall health of the school population.

Discussion

Research has demonstrated changes in growth and nutrition measures in the child population studied. The increase in BMI requires continued monitoring to prevent possible negative effects associated with overweight and obesity. The decrease in height-for-age z-score raises questions that warrant future research to better understand the underlying causes and possible long-term implications for children's well-being and development.

Improvements in hemoglobin levels are encouraging and could be the result of successful public health policies or positive changes in nutritional behavior within the school community. These results underscore the importance of proper nutrition and suggest that efforts to improve the quality of children's diets can have a tangible positive impact.

Finally, this study highlights the need for targeted interventions and regular monitoring of growth and nutritional status in school populations. Furthermore, it encourages the adoption of multidisciplinary approaches that include nutrition education, physical activity promotion and health surveillance to promote healthy lifestyle habits from childhood onwards.

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