

Nutrition Uptake and Disease of Children with Anemia in Peru, A Cross-Sectional Analysis

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Abstract

Anemia is a multicausal problem affecting 41.7% of children under 5 worldwide. The prevalence of anemia in Peru has decreased only 6.8% from 2009 to 2017, despite great efforts made to distribute free multi-micronutrient supplements and promote the consumption of iron rich foods. The current study investigates the nutritional uptake and incidence of disease in children with anemia in Peru to better understand what is driving the high rates of anemia. **METHODS** A cross-sectional analysis of secondary data was conducted. Data from two national surveys were linked to evaluate the predictors of anemia. The associations were tested with Chi-square analysis and logistic multivariate regression analysis. **RESULTS** The sample included 586 children under 3. The prevalence of anemia was 53.2%, while 51.9% of the children consumed sufficient micronutrients to meet the daily recommended level for their age. Of those with anemia, 45.1% consumed sufficient micronutrients to meet the recommended level ($p < 0.001$). The children with anemia were more likely to have an infectious or parasitic disease in the last year and less likely to have access to safe drinking water ($p = 0.057$, $p = 0.002$, respectively). The logistic analysis displayed that having an infectious or parasitic disease increased the odds of having anemia ($OR = 1.6$, $p = 0.043$), and having access to safe drinking waters decreased the odds of having anemia ($OR = 0.58$, $p = 0.044$), while controlling for micronutrient uptake. **CONCLUSIONS** Nearly half of the children with anemia in Peru already consume sufficient nutrients to meet their daily requirement. However, they continue to have anemia, likely due to infectious diseases and parasites.

Background

Proper nutrition outcomes in children, especially during the first 1000 days, are critical for healthy growth and development.^{1–4} However, in 2016, 41.7% of children under 5 worldwide suffered from anemia, most often caused by micronutrient deficiencies.⁵ The health, development, and economic consequences of anemia are significant, and children under 5 bear the largest burden of the disease globally.⁶ Anemia delays the physical and cognitive development of children, reduces their energy level, and weakens their immune system.^{7,8} Additionally, the long-term economic costs from the decreased productivity and impaired cognitive development associated with childhood anemia have been estimated at US\$3.64 per person, or 0.81% of a country's gross domestic product (GDP).⁶ A deeper understanding of anemia's etiology is essential to appropriately combat the disease and reduce its effects on children's health and development, as well as on their ability to grow into productive members of their communities.

Anemia is a multicausal problem of complex etiology. The most common contributors to anemia are nutritional deficiencies, intestinal infections from parasites and bacteria, malaria, and genetic hemoglobin disorders.⁶ Iron deficiency is the most common cause of anemia which accounts for almost half of all cases in children under 5 years of age worldwide.⁶ Iron is an essential nutrient for hemoglobin and the production of red blood cells. Iron deficiency occurs when iron intake does not meet the body's iron requirements, due to poor diet or impaired absorption, causing the number of hemoglobin in the blood to decrease below the threshold of healthy levels determined by age, sex, and other factors.^{7,9} The body's need for iron is especially high during infancy and childhood when the body experiences rapid growth.

The prevalence and risk of iron deficiency anemia globally has also been linked to various socioeconomic determinants of health, such as proper sanitation and hygiene, parents' educational status, family income, and family size.^{10–12} Research in Peru has shown that childhood anemia is associated with poor intake of iron-rich foods, high prevalence of infectious diseases, a lack of safe water and basic sanitation, low birth weight, and reduced breastfeeding.¹³

In Peru, 43.6% of children below 3 years old had anemia in 2017, while 50.4% had anemia in 2009.¹⁴ A decrease of 6.8% in 8 years. Reducing childhood anemia has become a high priority of the Peruvian National Government. The Government has created a multisectoral plan that aims to reduce anemia in children under 3 by over 24%.¹⁵ National programs have focused primarily on providing multi-micronutrient supplement powders and educational campaigns to increase children's intake of iron rich foods.¹⁶ However, due to the multicausal nature of the disease, a multisectoral approach that goes beyond micronutrient supplementation and educational campaigns is needed.

A greater understanding of the nutritional, health, and behavioral characteristics of children with anemia in Peru will illuminate their needs and opportunities to create significant reduction of the illness. The current study conducts an analysis by linking two public data bases to illuminate the current situation of children with anemia in Peru, to improve understanding of their needs. The authors hypothesize infectious diseases and parasites in children and poor access to safe drinking water are significant drivers of anemia, independent of nutrition consumption. Therefore, improving nutrient uptake alone in the population will not solve the problem.

Methods

To explore the hypothesis, a cross-sectional analysis of secondary data was conducted to understand the characteristics associated with anemia in children under 3 years. The study links two public data bases to conduct the analysis; 1) the Food and Nutrition Surveillance Survey for Stages of Life (FNSS) in 2015–2016 (In Spanish: Encuesta de Vigilancia Alimentaria y Nutricional por Etapas de Vida, VIANEV)¹⁷ and 2) Health Benefits Report from the Integrated Health Services Systems of Comprehensive Health Insurance (ISHS) from the Ministry of Health in 2015–2016 (In Spanish: Reporte de Prestaciones de Salud del Sistema Integrado de Aseguramiento en Salud del Seguro Integral de Salud del Ministerio de Salud, SIASIS).¹⁸

The FNSS was carried out nationwide in Peru by the National Center for Food and Nutrition, of the National Institute of Health (Centro Nacional de Alimentación y Nutrición). The survey aimed to examine nutritional outcomes and food consumption in children under 3 years. The survey utilized a random cluster sample survey design representative of the national population. The complete methodology is described in the survey's final report published on the National Institute of Health's website.¹⁷ The survey included a 24-hour dietary recall that occurred on two non-consecutive days. The dietary information was

converted into the amount of nutrients consumed and compared to the requirements for healthy growth of each nutrient to indicate if the child is meeting their nutritional requirements for their age.^{17,19-21}

The ISHS is a public data base that contains information reported by all public health establishments nationwide on the medical care provided to the population covered by the public health insurance system.¹⁸ The database is available by request from the Ministry of Health of Peru. The illnesses were categorized to analyze similar illnesses together as a group, according to the International Classification of Diseases: Preparation of Short Lists for Data Tabulation.²² The primary predictor of interest from the data base is a reported infectious or parasitic illness in a health center for the child in 2016. The ordinal variable (0–6 cases of infection reported) was converted into a binary variable for the analysis that indicates if the child has had 0 reported infectious or parasitic illnesses at the health center during the year (2016), or 1 or more reported cases.

The current study conducted several analyses to understand the characteristics of children with anemia compared to those who do not have anemia. First, a Chi-Square analysis was conducted to assess the association of anemia with the consumption of recommend levels of nutrients. Second, the FNSS and ISHS are linked to analyze the relationship between anemia, infectious or parasitic disease (IPD), and access to safe drinking water. Chi-square analyses are conducted to assess the association between children with anemia and incidence of IPD and safe drinking water. Two logistic multivariant regression analyses were conducted: 1. to assess the influence of IPD on anemia, holding micronutrient uptake constant, 2. to assess the influence of safe drinking water on anemia, holding micronutrient uptake constant.

Any cases that had omitted variables were not included in the analysis. The analysis adjusted for sampling design and clustering. The analysis was conducted with STATA/SE 16.1.²³

Results

The FNSS included 687 participants, with 586 participants between 6 to 35 months that included an indicator for anemia. Therefore, the sample size for our study was 586. The sample was 53% male with an average age of 20 months. The proportion living in Metropolitan Lima was 35%, 27% in Urban areas, and 37% in Rural areas. The demographics, rates of anemia, and nutrient uptake are included in Table 1.

Table 1
Characteristics of study population

Characteristics	N (%)
Children with anemia ¹	
No	274 (46.8)
Yes	312 (53.2)
Children that meet recommendation for iron ¹	
No	218 (38.4)
Yes	350 (61.6)
Children that meet recommendation for iron, zinc and vitamin A ¹	
No	282 (48.1)
Yes	304 (51.9)
Children that meet recommendation for iron, zinc, vitamin A, protein and, energy ¹	
No	342 (58.4)
Yes	244 (41.6)
Sex ¹	
Male	299 (52.6)
Female	269 (47.4)
Age (months) ¹	20 ± 8.5*
Area of residence ¹	
Metropolitan Lima	201 (35.4)
Urban área	154 (27.1)
Rural área	213 (37.5)
Access to safe drinking water ²	
Do not Access	106 (18.1)
Access	480 (81.9)
Children with a reported infectious or parasitic disease ²	
None	267 (68.8)
At least 1 reported infection	121 (31.2)
* Mean ± standard deviation	
† Some values may not add up to 586 due to missing data.	
¹ Reported from FNSS	
² Reported from ISHS	

The population had a prevalence of childhood anemia of 53.2%. The distribution of children affected by anemia showed great discrepancy among the areas of residence, with the highest number in rural areas (Rural area: 64.3%, Urban area: 54.5%, Metropolitan Lima: 40.3%). Children who met their iron recommendations for age was 61.6%. Of the children with anemia, 45.1% meet their iron recommendation ($p < 0.001$). The children who met their recommendations for iron, zinc, and vitamin A was 51.9%. Of the children with anemia, 45.1% met their recommendations for iron, zinc, and vitamin A ($p < 0.001$). The children who met their recommendations for iron, zinc, vitamin A, protein and energy was 41.6%. Of those with anemia, 45.1% meet their recommendations for iron, zinc, vitamin A, protein, and energy ($p = 0.001$). The association between nutrition uptake and anemia is displayed in Table 2.

Table 2
Factors associated with anemia in bivariate analysis

Variables	Children with anemia		p
	No (n = 274)	Yes (n = 312)	
	n(%)	n(%)	
Area of residence			< 0.001
Metropolitan Lima	120 (59.7)	81 (40.3)	
Urban	70 (45.5)	84 (54.5)	
Rural	76 (35.7)	137 (64.3)	
Children that meet recommendation for iron			< 0.001
No	74 (33.9)	144 (60.1)	
Yes	192 (54.9)	158 (45.1)	
Children that meet recommendation for iron, zinc, and vitamin A			< 0.001
No	107 (37.9)	175 (62.1)	
Yes	167 (54.9)	137 (45.1)	
Children that meet recommendation for iron, zinc, vitamin A, protein and energy			0.001
No	140 (40.9)	202 (59.1)	
Yes	134 (54.9)	110 (45.1)	
Children with an infectious or parasitic disease reported			0.057
None	121 (73.8)	143 (64.4)	
At least 1	43 (26.2)	78 (35.6)	
Access to safe drinking water			0.002
No	39 (14.1)	73 (23.4)	
Yes	235 (85.9)	239 (76.6)	
	Children with safe drinking water		
	No (n = 75)	Yes (n = 293)	
Children with an infectious or parasitic disease reported			0.002
None	47 (62.7)	245 (84.6)	
At least 1	28 (37.3)	48 (15.4)	

The second-round of analysis included data linked from FNSS and the ISHS and had 388 participants. The prevalence of children who were reported to have an infectious or parasitic disease (IPD) in the last year was 31.2%. Of those with anemia, 35% had an IPD, while those without anemia, 26% reported having an IPD, a difference of 35% ($p = 0.057$). Regarding household sanitation, 18.1% of the children did not have access to safe drinking water. Of those with anemia, 23% did not have access to safe drinking water, while of those without anemia, 14% did not have access to safe drinking water ($p = 0.020$). Among the group of children who do not have access to safe drinking water, 37% had an IPD reported, of those that have safe drinking water, 15% had an IPD reported ($p = 0.002$). The data on IPD, access to safe drinking water, and their relationship with children with anemia are included in Table 2. An additional analysis was conducted to assess methods of water treatment: 85.8% (332) of the participants who have access to safe drinking water report boiling their water to treat it, 3.88% (15) report treating the water with chlorine, and 0.78% (3) report treating another way.

The logistic multivariate regression analysis displayed that having a IPD increases the odds of having anemia (OR = 1.6, $p = 0.043$), independent of satisfying micronutrient uptake requirements (iron, zinc, and vitamin A). Additionally, having access to clean drinking water decreases the odds of anemia (OR = 0.58, $p = 0.044$), independent of satisfying micronutrient requirements. The results of the logistic regressions are in Table 3.

Table 3
Logistic Regression Analysis to predict effect on anemia

N = 398	OR	P-value	95% Confidence Interval
IPD	1.6	0.043*	1.02–2.53
Iron Requirements	0.54	0.019*	0.32–0.90
Zinc Requirements	0.94	0.827	0.54–1.62
Vitamin A Requirements	0.92	0.78	0.52–1.62
Intercept	1.86	0.014	1.14–3.05
Safe Drinking Water	0.58	0.044	0.34–0.99
Iron Requirements	0.59	0.038	0.36–0.97
Zinc Requirements	0.86	0.591	0.51–1.48
Vitamin A Requirements	0.98	0.940	0.56–1.70
Intercept	3.04	0.000	1.63–5.65

Discussion

The results display that 41.6% of children with anemia in Peru already consume the recommended amount of micro- and macro-nutrients and 61.6% consume the recommended amount of iron. The portion of children in this study that consume the recommended amount of nutrients were similar to a study in Peru in 2014, which showed that 51% of children under 3 met their iron uptake requirements and 60% met their energy intake requirements.²⁴ The similarity in findings gives us greater confidence in the results of the current study. The study in 2014, however, did not assess the nutrient and disease profile of the children with anemia. It could have been assumed that the children with anemia were those that did not consume the recommended levels of micronutrients.

The causes of anemia include poor nutrient intake, infectious diseases, parasites, inflammation, and hemoglobinopathies.⁶ The risk of anemia is greater when a population has frequent infection and does not have safe drinking water or proper sanitation, and does not have access to education and economic opportunities.¹⁹ We see in the current study that nearly half of the children with anemia consume enough nutrients, but it is not being appropriately absorbed and converted into hemoglobin. We must look beyond diet to fully understand the drivers of anemia. By integrating medical care data with the nutrition survey we were able to investigate other drivers of anemia, independent of nutrition uptake. We analyzed the association between anemia and IPD. IPD, including diarrhea and helminth infections, have been linked to the development of anemia.^{26–30} The current study found that the children with anemia have 37% more cases of IPD per year than children without anemia. The logistic regression displayed that the presence of an IPD increases the odds of having anemia (OR = 1.6, $p = 0.043$), while holding micronutrient uptake constant. The results help explain why so many children still have anemia, following years of national campaigns to provide micronutrient supplements and education campaigns to increase iron uptake. Strategies that do not address the presence of disease in children will continue to produce poor impact on the reduction of anemia.^{24–26} We must look at ways to prevent diarrhea, infectious diseases, and helminth infections in order to reduce children's risk of anemia.

Access to safe drinking water is associated with a lower risk of diarrhea and helminth infections; and diarrhea and helminth infections can cause anemia.^{26,27,33} The current study found that children with access to safe drinking water are less likely to have anemia (OR = 0.58, $p = 0.044$), while holding micronutrient uptake constant. However, in a country that is prioritizing the reduction of anemia, 19.6% still do not have access to safe drinking water. This study highlights the importance of improving access to safe drinking water and promoting proper sanitation and hygiene, as a way to reduce children's risk for anemia.

A limitation of the data used is that the indicator for IPD includes only the cases that are reported in the health posts, and thus misses many incidences of diseases that are not reported due to poor access to health services and poor reporting. The number of IPDs children experience is expected to be much higher. Nutritional surveys also have their limitations that must be considered, included over or under reporting the amount and type of food consumed during the previous day. The bias was reduced by surveying the home on two separate, non-consecutive days.

Conclusion

The present study has provided us with the opportunity to explore more deeply the characteristics of children with anemia in Peru to understand the factors that maintain the high prevalence of anemia in children below 3 years of age. The analysis hopes to show that the causes of anemia are diverse, and thus demand a diverse national strategy. The problem cannot be solved while children continue to live with poor sanitation and high incidence of disease. The promotion of iron consumption and micronutrient supplements alone will not be enough.

Our study has found that access to safe drinking water and incidence of IPD are significantly associated with anemia. To reduce the incidence of IPD and anemia, national policies to improve access to safe drinking water must be implemented. It is essential that any approach to combat anemia in Peru focuses not only on the dietary causes of anemia, but also addresses the social determinants that affect children's health.

Abbreviations

FNSS: Food and Nutrition Surveillance Survey for Stages of Life

IPD: Infectious or Parasitic disease

ISHS: Health Benefits Report from the Integrated Health Services Systems of Comprehensive Health Insurance

SIASIS: Reporte de Prestaciones de Salud del Sistema Integrado de Aseguramiento en Salud del Seguro Integral de Salud del Ministerio de Salud

VIANEV: Encuesta de Vigilancia Alimentaria y Nutricional por Etapas de Vida

Declarations

Ethics Approval and Consent to Participate

The current study was approved by the Institutional Review Board of the Office of Human Research Ethics of the University of North Carolina – Chapel Hill (Reference ID 281768).

Consent for Publication

Not applicable

Availability of Data and Materials

The dataset supporting the conclusions of this article is available in the figshare repository, [10.6084/m9.figshare.12574001](https://doi.org/10.6084/m9.figshare.12574001).

Competing Interests

The authors declare that they have no competing interests

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Authors' Contributions

CMW, LAOF, and LFC designed the study, analyzed the data, and wrote the manuscript. AMR wrote the manuscript and revised the analysis.

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