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Hematological profile in malnourished children and adolescents

Perfil hematológico em crianças e adolescentes com desnutrição

Perfil hematológico en niños y adolescentes con malnutrición

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This study explore the importance of comprehensive hematological evaluations, as alterations in blood profiles can occur even in apparently healthy children and adolescents, not solely due to malnutrition.
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The findings emphasize the need for broader assessments of hematological health in children and adolescents, irrespective of nutritional status, to better understand underlying health conditions.

ABSTRACT

Introduction: The hematological profile is a key diagnostic tool to assess the effects of malnutrition, revealing common abnormalities such as anemia, leukopenia, thrombocytopenia, and hypoalbuminemia. These abnormalities indicate nutritional deficiencies and related health problems such as iron deficiency anemia due to lack of iron, immune system weakness, and electrolyte imbalances. Adequate treatment based on correcting these deficiencies and continuous monitoring is essential to improve this vulnerable population's health status and prognosis. **Objective**: To determine the hematological profile in children between 5 and 9 years of age and adolescents from 10 to 19 years of age with malnutrition. **Methods**: Quantitative approach, non-experimental design, cross-sectional and descriptive in scope, with a population of 42 participants between children and adolescents from an Ecuadorian foundation dedicated to the care. The information was collected by taking anthropometric measurements and blood samples for the hematological profile study. **Results**: Hematological alterations are not limited to malnutrition states. They also occur in apparently healthy individuals. The high prevalence of alterations in the white blood cell series, particularly in lymphocytes and neutrophils, could indicate the presence of inflammatory processes or altered immunological responses in these age groups. These findings underscore the importance of a comprehensive hematological evaluation in children and adolescents, regardless of their nutritional status. **Conclusions**: The hematological profile in children and adolescents in this study is not related to malnutrition since there are hematological alterations in the population studied who are apparently healthy.

Keywords: hematological profile; children; teenagers; malnutrition, anemia.

RESUMO

Introdução: O perfil do hemograma é uma ferramenta de diagnóstico fundamental para avaliar os efeitos da desnutrição, revelando alterações comuns como anemia, leucopenia, trombocitopenia e hipoalbuminemia. Essas anormalidades indicam deficiências nutricionais e problemas de saúde relacionados, como anemia por deficiência de ferro, fraqueza do sistema imunológico e desequilíbrios eletrolíticos. O tratamento adequado, baseado na correção dessas deficiências e no monitoramento contínuo, é essencial para melhorar o estado de saúde e o prognóstico dessa população vulnerável. **Objetivo**: determinar o perfil hematológico em crianças de 5 a 9 anos e adolescentes de 10 a 19 anos com desnutrição. **Métodos**: abordagem quantitativa, desenho não experimental, transversal e descritivo, com uma população de 42 participantes, incluindo crianças e adolescentes de uma fundação equatoriana dedicada ao cuidado. As informações foram coletadas por meio de medidas antropométricas e amostras de sangue para o estudo do perfil hematológico. **Resultados**: As alterações hematológicas não se limitam aos estados de desnutrição, mas também ocorrem em indivíduos aparentemente saudáveis. A alta prevalência de alterações na série branca, particularmente em linfócitos e neutrófilos, pode indicar a presença de processos inflamatórios ou respostas imunológicas alteradas nessas faixas etárias. Esses achados destacam a importância de uma avaliação hematológica abrangente em crianças e adolescentes, independentemente de seu estado nutricional. **Conclusões**: O perfil hematológico em crianças e adolescentes na presente pesquisa não tem relação com a desnutrição, pois há alterações hematológicas na população estudada que é aparentemente saudável.

Palavras-chave: perfil hematológico; crianças; adolescentes; desnutrição, anemia.

RESUMEN

Introducción: El perfil hemático es una herramienta diagnóstica clave para evaluar los efectos de la malnutrición revelando alteraciones comunes como anemia, leucopenia, trombocitopenia e hipoalbuminemia. Estas anomalías indican deficiencias nutricionales y problemas de salud relacionados como la anemia ferropénica por falta de hierro, la debilidad del sistema inmune, y desequilibrios electrolíticos. El tratamiento adecuado, basado en la corrección de estas deficiencias y un monitoreo continuo, es esencial para mejorar el estado de salud y el pronóstico en esta población vulnerable. **Objetivo:** Determinar el perfil hematológico en niños de entre 5 a 9 años y adolescentes de 10 a 19 años con malnutrición. **Métodos**: Enfoque cuantitativo, diseño no experimental, corte transversal y de alcance descriptivo, con una población de 42 participantes entre niños y adolescentes de una fundación ecuatoriana dedicada al cuidado. La recolección de información se realizó mediante la toma de medidas antropométricas y la toma de muestras de sangre para el estudio perfil hematológico. **Resultados:** Las alteraciones hematológicas no se limitan a estados de malnutrición también se presentan en individuos aparentemente sanos. La alta prevalencia de alteraciones en la serie blanca, particularmente en linfocitos y neutrófilos, podría indicar la presencia de procesos inflamatorios o respuestas inmunológicas alteradas en estos grupos etarios. Estos hallazgos subrayan la importancia de una evaluación hematológica integral en niños y adolescentes, independientemente de su estado nutricional. **Conclusiones:** El perfil hematológico en niños y adolescentes de la presente investigación no tiene una relación con la malnutrición ya que existen alteraciones hematológicas en la población estudiada que se encuentran aparentemente sanos.

Palabras clave: perfil hematológico; niños; adolescentes; malnutrición, anemia.

INTRODUCTION

The blood profile or blood count is one of the most requested laboratory tests in clinical practice and thus evaluate the patient's health status, the reference parameters are of great importance to identify if there is any pathology, it is important to take into account the values determined to our reality (population, age, sex) the hematological profile in children and adolescents with malnutrition It consists of counting the different types of cells found in the blood such as total hemoglobin, red blood cells, white blood cells and platelets. This test is important to perform in a timely manner to determine anemia and other conditions that may occur in the patient who is undergoing the hematological profile (Hauth et al., 2020).

In the hemogram, two concepts are grouped: one quantitative, which includes the counts of erythrocytes, leukocytes and platelets, quantification of hemoglobin, measurement of hematocrit and the calculation of erythrocyte indices and another qualitative (which is the leukocyte formula) malnutrition is characterized by the lack, excess or imbalance in the intake of energy and essential nutrients in the diet, including overweight, obesity and different forms of malnutrition in the child population (Reyes et al., 2024; Tamayo Andrade et al., 2024).

The determination of the hematocrit together with the quantification of hemoglobin allows the detection of a possible anemia depending on its cause, the red blood cells can have different sizes, as well as a variable hemoglobin content. The measurement of these characteristics, through the morphological assessment of the red blood cells, is very useful to establish the origin of the anemia (Morales et al., 2023). Thus, erythrocyte morphology is of great help to make the differential diagnosis of hemoglobinopathies, the most frequent causes of leukocytosis are acute and chronic infectious and inflammatory processes, although acute hematological diseases (leukemias) or chronic (chronic myeloproliferative syndromes) are also causes of leukocytosis. The results of the hematological profile help us in the early detection of diseases in children and adolescents (Rodríguez., 2019).

Malnutrition is a global health problem. The main cause of this is poverty (Petrou & Kupek, 2010), although it is not the only cause. It is also associated with a lack of iron consumption and an inadequate diet. The World Health Organization defines malnutrition as the cause of anemia in children and adolescents, where the detection of these pathologies in time through laboratory tests is essential (Fonseca et al., 2020).

Chronic childhood malnutrition currently affects 20.1% (National Survey on Child Malnutrition, 2023) of children under 2 years of age in Ecuador. This problem impacts the country's productivity and has an impact throughout people's lives (Jimenez et al., 2021). In Ecuador, the percentage of children under 2 years of age with chronic childhood malnutrition was 20.1%, in urban and rural areas it was 18.9% and 21.9%, respectively. At the sex level, it was 23.5% in boys and 16.5% in girls. According to information from the Observatory of Children and Adolescents, chronic malnutrition in the coastal provinces affects 21% of children between 0 and 5 years of age; in the Sierra, 16%; and in the Amazon, 27%. According to data from the World Health Organization (WHO), 1.62 billion people worldwide suffer from anemia, representing 24.8% of the world's population, mostly affecting preschool-aged children (Bonilla & Noriega, 2023).

The research highlights several challenges, including the limited scientific information on the subject. Recent research highlights the nutritional status of this population group considered vulnerable, and who present severe acute malnutrition that drastically affects hematological parameters, leading to anemia, reduced red blood cell count, and alterations in hematocrit and hemoglobin indices (Ding et al., 2024). Likewise, the consequences of malnutrition are evident in the increase in leukocyte and platelet levels associated with immunological deterioration (Jowik et al., 2024; Tewabe et al., 2020). There is also limited evidence of research that comprehensively explores the variations in the hematological profile in children and adolescents and that allows a clear differentiation of the levels of malnutrition in this group according to their age group (Burgaz et al., 2024; Ijaiya et al., 2024). Given this deficiency, it is difficult to give way to the development of clinical guidelines that facilitate the individualized management of each patient, which leaves a very large gap in the literature, especially in low-income countries where there is a high incidence of malnourished children (Maulina et al., 2024).

Therefore, it is considered relevant to gradually start research that delves into the specific and regional patterns of hematological alterations in children with malnutrition to provide valuable evidence for an exact intervention focused on prevention. Therefore, the present research contributes to identifying risk factors and promoting early diagnosis and appropriate treatment strategies, which represents a significant contribution to the field of pediatric hematology and child nutrition (Fabios et al., 2024; Barroso et al., 2022; Ijaiya et al., 2024).

Hematological parameters are essential indicators of the nutritional status in children and adolescents, as they reflect underlying deficiencies that could lead to significant health complications. Several studies have highlighted the prevalence of anemia and other hematological abnormalities in malnourished populations. Chowdhury and Ghosh (2013) identified a significant association between iron deficiency and malnutrition in Santal children, where iron deficiency anemia was

common among stunted children. Similarly, Getawa et al. (2020) observed a high prevalence of anemia and other hematological abnormalities such as leukocytosis and thrombocytosis in undernourished children under five years of age in Ethiopia. These findings are consistent with the results of Purnami et al. (2023), who also reported a high prevalence of anemia among stunted children, emphasizing the role of iron deficiency as a leading cause. In addition, the study by Veiga et al. (2010) suggested that the chronic undernutrition seen in impoverished children could lead to alterations in the lipid and endocrine profiles, further complicating the nutritional challenges and hematological health.

The general objective of this study was to determine the hematological profile in children between 5 and 9 years of age and adolescents from 10 to 19 years of age with malnutrition. The results of this analysis allowed us to identify hematological diseases in a timely manner and provide adequate treatment, as well as the results obtained on critical hematological markers such as hemoglobin, hematocrit and erythrocyte morphology. These findings are valuable for the timely design of effective interventions that promote comprehensive nutritional and erythrocyte health in order to take immediate action and provide treatment for the pathologies that are evident in the results of the blood profile in children and adolescents of the foundation where the research is carried out.

METHODS

The focus of the present research was quantitative and descriptive (Guevara et al., 2020). The design is not experimental and cross-sectional (Manterola et al., 2023) to demonstrate whether the values of the blood profile in children and adolescents with malnutrition due to deficit and excess are related.

The research was carried out from a quantitative approach, since the data obtained were examined and quantified statistically with the purpose of numerically explaining the results obtained in the research. The research design was based on a non-experimental approach, since it focused on the data obtained to analyze them without changing or manipulating the variable (Calle, 2023).

The study is cross-sectional, since it collects data from participants in a limited period of time. Finally, its scope was descriptive, since it highlights the characteristics of the hematological profile in children and adolescents with malnutrition. The type of sampling that was used in this research to select the sample was by convenience. The sample was chosen according to the convenience of the researcher, allowing him to arbitrarily choose how many participants there can be in the study (Arzuaga et al., 2023).

The study population refers (Vizcaíno et al., 2023) to the set of elements that contain certain characteristics that are intended to be studied, which is why the choice of the population for this research was based on the Comprehensive Health Care Model Manual (MAIS) according to life cycles, in which they mention that childhood goes from 0 to 9 years, so, according to age groups, children from 5 to 9 years old and adolescents from 10 to 19 years old were selected.

The population of this study is made up of 42 children and adolescents in their entirety whose place of residence is the province of Cotopaxi in the Canton of Salcedo belonging to the Jardín de Edén Foundation, being an easy-to-manage population consisting of children from 5 to 9 years old and adolescents from 10 to 19 years old belonging to the Edén Foundation where the present study was carried out (MSP, 2018).

Inclusion criteria

- Children from 5 to 9 years old and adolescents from 12 to 19 years old
- Children and adolescents belonging to the JARDIN DE EDEN foundation
- Representatives of children and adolescents who sign the informed consent

Exclusion criteria

- Children and adolescents who do not belong to the groups mentioned above
- Children and adolescents who do not belong to the Garden of Eden Foundation

The technique used to collect the research information was anthropometric evaluation and sampling to determine the blood profile. The first was used to identify children and adolescents with malnutrition by measuring weight and height (Kaufer & Toussaint, 2008). The second was used to determine the individual hematological problems that were obtained in the research and were collected in Excel format.

Anthropometric data were obtained by taking anthropometric measurements such as weight and height. Weight was measured with a scale calibrated to 0 to 1, with a precision of 100 milligrams and adjusted to 0 afterwards and before each measurement, height was subsequently measured with a measuring tape with meters and centimeters fixed to the wall and

the established formula was applied to determine the BMI.

This information was collected from each participant, maintaining the confidentiality of each of them. To do this, an alphanumeric code was developed for each of the participants, which was established according to the date of birth, day, month and year, initials of their names and surnames, and then this information was entered into an Excel format. Nutritional status was assessed according to the WHO criteria for the BMI/age indicator, using the percentile tables of the growth pattern for nutritional assessment and the zo score or standard deviation, which was expressed in units of SD with the following cut-off points: <-3SD: severe malnutrition; <-2SD to -3SD: moderate malnutrition; <-1SD to -2 SD: risk of malnutrition; between -1 and +1SD: no malnutrition or adequate; > +1 SD to +2SD: overweight; > 2SD: obesity (Rodríguez et al., 2018).

The hematological samples were taken in conjunction with the laboratory where they analyzed the laboratory tests, explaining to the participants and representatives how the blood samples were going to be taken, the samples were taken in the morning for which the patients had to be fasting, a small amount of blood was taken placed in a purple tube duly labeled with names and surnames, age and date of collection for study, the samples were quickly transferred to the San Juan clinical laboratory in the Canton of Salcedo and delivered to the laboratory staff for processing and analysis, the materials used were sterile material (syringe, purple tubes, tourniquet, alcohol, swabs).

Since this is a research with children and adolescents, an informed consent was applied in which the information on the subject of the research was disclosed, they were also informed that the data collected will be used for research purposes and if they refused to participate or did not want to continue, they could withdraw without any problem. It should be noted that this research complied with the code of ethics (respect for legal and moral norms, assessing aspects such as risk-benefit, informed consent or confidentiality and the Declaration of Helsinki is a proposal of ethical principles for medical research inhuman beings (Manzini, 2022). Including the research of human material that was endorsed by the research ethics committee of the Technical University of Ambato with the assigned code 048-CEISH-UTA-2024.

RESULTS AND DISCUSSION

Table 1. Distribution of nutritional status by sex and age group

			Frequency N	Percentage %
Children	Male	Normal weight	5	55.6
	Female	Normal weight	4	44.4
	Total		**9**	**100.0**
Teenagers	Male	Malnutrition	1	3.0
		Normal Weight	9	27.3
		Overweight	2	6.1
		Obesity	1	3.0
	Female	Malnutrition	1	3.0
		Normal Weight	12	36.4
		Overweight	7	21.2
	Total		**33**	**100.0**

Source: Authors' development.

Table 2. Erythrocyte profile in children (Hgb, HCT, PLT).

			Frequency N	Percentage %
Hemoglobin	Male	Normal hemoglobin level	5	55.6
	Female	Normal hemoglobin level	4	44.4
	Total		**9**	**100.0**
Hematocrit	Male	Normal hematocrit	5	55.6
	Female	Normal hematocrit	4	44.4
	Total		**9**	**100.0**
Platelets	Male	Normal platelet count	3	33.3
		Thrombocytosis	2	22.2
	Female	Normal platelet count	4	44.4
	Total		**9**	**100.0**

Source: Authors' development

Table 3. Erythrocyte profile in children (Leukocytes)

			Frequency N	Percentage %
Leukocytes	Male	Leukopenia	1	11.1
		Normal leukocyte count	4	44.4
	Female	Leukopenia	1	11.1
		Normal leukocyte count	3	33.3
	Total		**9**	**100.0**
Lymphocytes	Male	Lymphocytopenia	3	33.3
		Normal lymphocyte count	1	11.1
		Lymphocytosis	1	11.1
	Female	Lymphocytopenia	3	33.3
		Normal lymphocyte count	1	11.1
	Total		**9**	**100.0**
Monocytes	Male	Normal monocyte count	5	55.6
	Female	Monocytopenia	1	11.1
		Normal monocyte count	3	33.3
	Total		**9**	**100.0**
Neutrophils	Male	Neutropenia	1	11.1
		Normal neutrophil count	1	11.1
		Neutrophilia	3	33.3
	Female	Normal neutrophil count	1	11.1
		Neutrophilia	3	33.3
	Total		**9**	**100.0**
Eosinophils	Male	Normal eosinophil count	3	33.3
		Eosinophilia	2	22.2
	Female	Normal eosinophil count	2	22.2
		Eosinophilia	2	22.2
	Total		**9**	**100.0**
Basophils	Male	Normal basophil count	5	55.6
	Female	Normal basophil count	4	44.4
	Total		**9**	**100.0**

Source: Authors' development

Table 4. Erythrocyte profile in adolescents (Hgb, HCT, PLT).

			Frequency N	Percentage %
Hemoglobin	Male	Normal hemoglobin level	12	36.4
		Polycythemia	1	3.0
	Female	Normal hemoglobin level	20	60.6
	Total		**33**	**100.0**
Hematocrit	Male	Normal hematocrit	11	33.3
		Elevated hematocrit	2	6.1
	Female	Normal hematocrit	18	54.5
		Elevated hematocrit	2	6.1
	Total		**33**	**100.0**
Platelets	Male	Normal platelet count	11	33.3
		Thrombocytosis	2	6.1
	Female	Normal platelet count	11	33.3
		Thrombocytosis	9	27.3
	Total		**33**	**100.0**

Source: Authors' development

Table 5. Erythrocyte profile in adolescents (Leukocytes).

			Frequency N	Percentage %
Leukocytes	Men	Leukopenia	4	12.1
		Normal leukocyte count	9	27.3
	Women	Leukopenia	2	6.1
		Normal leukocyte count	16	48.5
		Leukocytosis	2	6.1
	Total		**33**	**100.0**
Lymphocytes	Men	Lymphocytopenia	6	18.2
		Normal lymphocyte count	5	15.2
		Lymphocytosis	2	6.1
	Women	Lymphocytopenia	8	24.2
		Normal lymphocyte count	9	27.3
		Lymphocytosis	3	9.1
	Total		**33**	**100.0**
Monocytes	Men	Normal monocyte count	13	39.4
	Women	Monocytopenia	3	9.1
		Normal monocyte count	17	51.5
	Total		**33**	**100.0**
Neutrophils	Men	Neutropenia	2	6.1
		Normal neutrophil count	4	12.1
		Neutrophilia	7	21.2
	Women	Neutropenia	4	12.1
		Normal neutrophil count	8	24.2
		Neutrophilia	8	24.2
	Total		**33**	**100.0**
Eosinophils	Men	Normal eosinophil count	10	30.3
		Eosinophilia	3	9.1
	Women	Normal eosinophil count	18	54.5
		Eosinophilia	2	6.1
	Total		**33**	**100.0**
Basophils	Men	Normal basophil count	13	39.4
	Women	Normal basophil count	20	60.6
	Total		**33**	**100.0**

Source: Authors' development

Table 6. Relationship between malnutrition and erythrocyte abnormalities

Relationship between malnutrition and erythrocyte abnormalities		**Children**		**Teenagers**		
		BMI				
Erythrocyte Profile	**Disturbance**	**Weight Normal**	**Malnutrition**	**Normal Weight**	**Overweight**	**Obesity**
Hemoglobin	Normal	9	2	20	9	1
	hyperhemoglobinemia	0	0	1	0	0
Platelets	Normal	7	2	14	5	1
	Thrombocytosis	2	0	7	4	0
Leukocytes	Leukocytopenia	2	1	3	2	0
	Normal	7	1	16	7	1
	Leukocytosis	0	0	2	0	0
Lymphocytes	Lymphocytopenia	6	0	8	4	1
	Normal	2	1	9	5	0
	Lymphocytosis	1	1	4	0	0
Monocytes	Monocytosis	1	0	2	1	0
	Normal	8	1	19	8	1
Neutrophils	Neutropenia	1	1	3	2	0
	Normal	2	1	8	3	0
	Neutrophilia	7	0	10	4	1
Eosinophils	Normal	5	1	18	8	1
	Eosinophilia	4	1	3	1	0
Basophils	Normal	9	2	21	9	0

Source: Authors' development

Discussion

The hematological profile in malnourished children and adolescents may show significant alterations due to nutritional deficiencies that affect the production and function of blood cells. These alterations vary according to the type and degree of malnutrition (protein-calorie malnutrition, micronutrient deficiency such as iron, zinc, folic acid, and vitamin B12, among others). A study was conducted in children aged 5 to 9 years and adolescents aged 10 to 19 years at the Jardín del Edén Foundation, in which 42 children and adolescents participated, of which 21.5% were children and 78.5% were adolescents.

The results reveal multiple alterations in the hematological profile of the participants, evidencing the impact of malnutrition on key hematological parameters, such as hemoglobin, hematocrit, and platelets. These findings are consistent with previous research, which has also highlighted the negative impact of malnutrition on the hematological health of children (Morales et al., 2023; Reyes et al., 2024).

On the other hand, 100% of the children had normal levels of hemoglobin and hematocrit, however, cases of thrombocytosis were observed in 22.2% of the children. On the other hand, in adolescents, 3% had polycythemia and 12.2% had elevated hematocrit, in addition to a high proportion of thrombocytosis (33.4%). Previous studies have also reported the appearance of thrombocytosis in malnourished children, which could be linked to chronic inflammatory responses or the activation of defense mechanisms in response to nutritional stress (Katoch, 2022; Ding et al., 2024). These changes are significant as they reflect not only the impact of malnutrition, but also a possible adaptation of the organism to compensate for the low availability of nutrients.

Additionally, the leukocyte analysis showed important variations. In children, 22.2% had leukopenia and 66.6% had lymphocytopenia, which is consistent with existing literature, which suggests that malnourished children are more prone to immunosuppression, weakening their ability to respond to infections (Fonseca et al., 2020). In adolescents, the data indicated leukopenia in 18.2% and neutrophilia in 45.4%, with a considerable proportion of lymphocytopenia. These results are consistent with studies showing how malnutrition impacts the production of leukocytes and other immune system cells, weakening the immune system of adolescents and increasing the risk of infections (Ijaiya et al., 2024; Jowik et al., 2024). After conducting the research and evaluating the results, they suggest a complex interaction between nutritional status and hematological parameters in the pediatric and adolescent population.

It is observed that hematological alterations are not limited to malnutrition states but are also present in individuals with normal weight. The high prevalence of alterations in the white series, particularly in lymphocytes and neutrophils, could indicate the presence of inflammatory processes or altered immunological responses in these age groups. These findings underline the importance of a comprehensive hematological evaluation in children and adolescents, regardless of their apparently healthy nutritional status (Fabios et al., 2024).

The comparison of the results obtained with other studies suggests that hematological alterations derived from malnutrition may vary depending on the specific nutritional status and sociodemographic factors. For example, Barroso et al. (2022) indicated that alterations in the hematological profile are more marked in cases of chronic malnutrition, while in the present study significant variations were also observed in overweight and obese adolescents. This finding is relevant as it reinforces the importance of monitoring the hematological profile in all cases of malnutrition, not only in cases of severe malnutrition, given the prevalence of conditions such as thrombocytosis and lymphocytopenia in overweight patients (Ding et al., 2024; Reyes et al., 2024).

The results also align with previous research showing a significant burden of anemia and other hematological abnormalities in malnourished children and adolescents. The high prevalence of anemia found in this study is consistent with findings by Thakur et al. (2014), who reported severe anemia in children with severe acute malnutrition in India. In a similar vein, Nogueira-de-Almeida et al. (2001) found a high prevalence of anemia among Brazilian children from low socioeconomic backgrounds, despite having relatively good anthropometric nutritional status. This suggests that the presence of anemia may not always be directly linked to stunted growth but could be an independent marker of nutritional deficiencies, particularly iron. The absence of a direct relationship between malnutrition and hematological alterations in our study mirrors the findings of Andriastuti et al. (2020), who highlighted the importance of considering multiple factors, such as socioeconomic status and diet, when assessing the hematological health of children and adolescents. These results underscore the complexity of malnutrition's impact on hematological health, where deficiencies in specific nutrients such as iron, protein, and vitamins may not always present in predictable ways, and further research is needed to explore the multifaceted relationship between nutritional status and hematological abnormalities in vulnerable populations

These findings suggest possible immunological or inflammatory alterations in a significant proportion of the studied pediatric population. These results indicate that, although the majority maintain normal parameters, there is a significant proportion with alterations in the red blood cell and platelet series (Torrens, 2023).

FINAL REMARKS

The blood profile in malnourished children and adolescents reveals multiple alterations that can have a significant impact on their physical and cognitive development. These alterations can be prevented or treated with adequate nutritional interventions and continuous monitoring to ensure the correction of deficiencies and the restoration of an optimal nutritional status.

Based on this research, it is possible to contribute to future research to improve the health status of the population studied. The research can also lead to the development of new diagnostic methods and treatments to prevent morbidity and mortality due to hematological problems in both the red and white blood cells, since it is a public health problem that not only occurs in children and adolescents in this Foundation, but in the entire general population worldwide.

The role of nursing in the management of the hematological profile in children and adolescents with malnutrition is essential for the identification, prevention and treatment of the alterations derived from this condition. The role of nursing is of vital importance since they play a key role in the comprehensive care of these patients, which ranges from taking samples for blood analysis to the implementation of nutritional and educational strategies. The study revealed important findings on nutritional status in a vulnerable group, but also presents certain theoretical and methodological limitations that must be recognized to adequately interpret the results and guide future research.

The limitations found for the development of this research were the limited literature, which made it difficult to formulate a theoretical framework that addresses the various forms and degrees of malnutrition at a methodological level. The sample size and the specific context of the study also represent limitations. The sample included only 42 participants, which reduces the representativeness of the results and limits the generalization of the findings to other populations or regions. In addition, the focus on a single institution limits variability in terms of environmental and socioeconomic factors, which could have a considerable impact on the hematological profile of malnourished individuals. The lack of control groups with similar demographic characteristics and adequate nutritional status also restricts the ability to make direct comparisons and attribute causality to the observed findings. It is essential to acknowledge the diversity of potential outcomes and biases when designing a study of this nature (Guzman-Leon et al., 2024).

Based on the results obtained during the research, the development of a future research agenda is suggested. This research would include complementary studies that allow for further investigation of the current findings and address new areas of interest that could arise from the results presented in the text.

Table 7. Value propositions for future research

Context	Research proposal
Randomized experiment	Comparison of the hematological profile in children and adolescents with malnutrition and those with adequate nutritional status
Hematologic variations and nutrition	Relationship between type of malnutrition and hematological alterations
Nursing role	Nursing interventions for the prevention of anemia in areas with a high prevalence of malnutrition
Cognitive implications	Relationship between hematological profile and cognitive performance in children with malnutrition
Quality of life impact	The impact of nutritional interventions on health-related quality of life in malnourished children

Source: Authors' development

REFERENCES

Andriastuti, M., Ilmana, G., Nawangwulan, S. A., & Kosasih, K. A. (2020). Prevalence of anemia and iron profile among children and adolescent with low socio-economic status. *International Journal of pediatrics and adolescent medicine*, *7*(2), 88-92. https://doi.org/10.1016/j.ijpam.2019.11.001

Arzuaga, M., Cabrera, J., Álvarez, A. (2023). Research competences in higher education in Latin America: analysis of indexed papers. *Revista Universidad y Sociedad*, *15*(1). Retrieved on October 02, 2024, from: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2218-36202023000100012&lng=es&tlng=en.

Barroso, R. B., Silva, A. C., Santos, F. S. S. D., Costa, J. D. R. M., Santos, L. H. D., Pascoal, L. M., ... & Costa, A. C. P. D. J. (2022). Hematological parameters of malnourished children after nutritional intervention: A randomized clinical trial. *Acta Paulista de Enfermagem*, *35*, eAPE0010345. https://doi.org/10.37689/acta-ape/2022AO00103459

Bonilla, D. L., & Noriega, V. R. . (2023). Desnutrición en la primera infancia en el Ecuador . *Revista Científica Arbitrada Multidisciplinaria PENTACIENCIAS*, *5*(4), 551–562. https://doi.org/10.59169/pentaciencias.v5i4.692

Burgaz, C., Van-Dam, I., Garton, K., Swinburn, B. A., Sacks, G., Asiki, G., Claro, R., Diouf, A., Bartoletto Martins, A. P., & Vandevijvere, S. (2024). Which government policies to create sustainable food systems have the potential to simultaneously address undernutrition, obesity and environmental sustainability?. *Globalization and health*, *20*(1), 56. https://doi.org/10.1186/s12992-024-01060-w

Calle Mollo, S. E. (2023). Diseños de investigación cualitativa y cuantitativa. *Ciencia Latina Revista Científica Multidisciplinar*, *7*(4), 1865-1879. https://doi.org/10.37811/cl_rcm.v7i4.7016

Chowdhury, S. D., & Ghosh, T. (2013). Undernutrition in Santal children: A biochemical and hematological study. *Homo*, *64*(3), 215-227. https://doi.org/10.1016/j.jchb.2013.03.006

Ding, C., Khan, K. A., AbdulKareem, H. K., Kumar, S., Minani, L. M., & Abbas, S. (2024). Towards a healthier future for the achievement of SDGs: unveiling the effects of agricultural financing, energy poverty, human capital, and corruption on malnutrition. *Humanities and Social Sciences Communications*, *11*(1), 1-12. https://doi.org/10.1057/s41599-024-03628-8

Fabios, E., Zazpe, I., García-Blanco, L., de la O, V., Martínez-González, M. Á., & Martín-Calvo, N. (2024). Macronutrient quality and its association with micronutrient adequacy in children. *Clinical nutrition ESPEN*, *63*, 796–804. https://doi.org/10.1016/j.clnesp.2024.08.006

Fonseca, Z., Quesada, A., Meireles, M., Cabrera, E., Boada, A. (2020). La malnutrición; problema de salud pública de escala mundial. *Multimed*, *24*(1), 237-246. Retrieved on October 02, 2024, from: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1028-48182020000100237&lng=es&tlng=es.

Getawa, S., Getaneh, Z., & Melku, M. (2020). Hematological Abnormalities and Associated Factors Among Undernourished Under-Five Children Attending University of Gondar Specialized Referral Hospital, Northwest Ethiopia. *Journal of Blood Medicine*, 11, 465–478. https://doi.org/10.2147/JBM.S284572

Guevara Alban, G. P., Verdesoto Arguello, A. E., & Castro Molina, N. E. (2020). Metodologías de investigación educativa (descriptivas, experimentales, participativas, y de investigación-acción). *RECIMUNDO*, *4*(3), 163–173. https://doi.org/10.26820/recimundo/4.(3).julio.2020.163-173

Guzmán-León, A. E., Avila-Prado, J., Bracamontes-Picos, L. R., Haby, M. M., Stein, K., Astiazaran-Garcia, H., & Lopez-Teros, V. (2024). Nutritional interventions in children with acute lymphoblastic leukemia undergoing antineoplastic treatment: a systematic review. *BMC nutrition*, *10*(1), 89. https://doi.org/10.1186/s40795-024-00892-4

Hauth, J., Reuter, C. P., De Borba Schneiders, L., Sehn, A. P., De Oliveira, C. F., & Pollo Renner, J. D. (2020). RELAÇÃO ENTRE INDICADORES ANTROPOMÉTRICOS, APTIDÃO CARDIORRESPIRATÓRIA E PERFIL HEMATOLÓGICO DE ADOLESCENTES NO SUL DO BRASIL. *Revista Brasileira de Ciência e Movimento*, *28*(2). https://doi.org/10.31501/rbcm.v28i2.10650

Ijaiya, M. A., Anjorin, S., & Uthman, O. A. (2024). Quantifying the increased risk of illness in malnourished children: a global meta-analysis and propensity score matching approach. *Global health research and policy*, *9*(1), 29. https://doi.org/10.1186/s41256-024-00371-0

Jiménez, A., Martínez, A., Salas, M., Martínez, R., González, L. (2021). Evaluando la desnutrición en pediatría, un reto vigente. *Nutrición Hospitalaria*, *38*(spe2), 64-67. Epub November 01, 2021. https://dx.doi.org/10.20960/nh.3801

Jowik-Krzemińska, K., Dylewska, D., Pawlińska-Maćkowiak, A., Słopień, A., & Tyszkiewicz-Nwafor, M. (2024). Cognitive Functions in Adolescent Girls with Anorexia Nervosa during Nutritional Rehabilitation. *Nutrients*, *16*(20), 3435. https://doi.org/10.3390/nu16203435

Katoch, O. R. (2022). Determinants of malnutrition among children: A systematic review. *Nutrition*, *96*, 111565. https://doi.org/10.1016/j.nut.2021.111565

Kaufer, Martha., & Toussaint, G. (2008). Indicadores antropométricos para evaluar sobrepeso y obesidad en pediatría. *Boletín médico del Hospital Infantil de México*, *65*(6), 502-518. Retrieved on October 02, 2024, from: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1665-11462008000600009&lng=es&tlng=es.

Manterola, Carlos, Hernández-Leal, María José, Otzen, Tamara, Espinosa, María Elena, & Grande, Luis. (2023). Cross Section Studies. A Research Design to Consider in Morphological Sciences. *International Journal of Morphology*, *41*(1), 146-155. https://dx.doi.org/10.4067/S0717-95022023000100146

Manzini, JL (2022). Declaración de Helsinki: Principios éticos para la investigación médica sobre sujetos humanos. *Acta bioethica*, 6(2), 321-334. https://doi.org/10.4067/S1726-569X2000000200010}

Maulina, R., Qomaruddin, M. B., Prasetyo, B., Indawati, R., & Alfitri, R. (2024). The effect of stunting on the cognitive development in children: A systematic review and meta-analysis. *Journal of Child Development Research*, 17(1-2), 45-67. https://doi.org/ 10.31901/24566772.2023/17.1-2.661

Ministerio de Salud Pública. *La ACESS y la Dirección Nacional de Normatización desarrollaron reunión de Trabajo*. (2018, April 24). ACESS. http://www.acess.gob.ec/la-acess-y-la-direccion-nacional-de-normatizacion-del-ministerio-de-salud-publica-desarrollaron-reunion-de-trabajo/

Morales, E. A., Ludeña, L. J., & Rosero, M. A. (2023). Malnutrición y su repercusión en estudios inmunológicos en niños de Latinoamérica. *MQRInvestigar*, *7*(3), 3809–3824. https://doi.org/10.56048/mqr20225.7.3.2023.3809-3824

Nogueira-de-Almeida, C. A., Ricco, R. G., Del Ciampo, L. A., de Souza, A. M., & Dutra-de-Oliveira, J. E. (2001). Growth and hematological studies on Brazilian children of low socioeconomic level. *Archivos Latinoamericanos de Nutrición*, *51*(3), 230-235.

Petrou, S., & Kupek, E. (2010). Poverty and childhood undernutrition in developing countries: a multi-national cohort study. *Social science & medicine*, *71*(7), 1366-1373. https://doi.org/10.1016/j.socscimed.2010.06.038

Purnami, G. M., Praba, K. D., Fauziah, I. L., Dewi, M. M., Judistiani, R. T. D., & Setiabudiawan, B. (2023). Anemia Prevalence, Characteristics, and Hematological Profile among Stunted Children Under 2 Years Old in Bandung Regency, Indonesia. *Journal of Child Science*, *13*(01), e75-e84

Reyes, J. M., Chinga, J. J., Peralta, J. J. (2024). Estado nutricional: parámetros hematológicos y antropométricos en niños con malnutrición. *MQRInvestigar*, *8*(1), 2980–2998. https://doi.org/10.56048/mqr20225.8.1.2024.2980-2998

Rodríguez, L., Herrera, Y., Leyton, C., Pinheiro, A. (2018). *Patrones de crecimiento para la evaluación nutricional de niños, niñas y adolescentes desde el nacimiento hasta los 19 años de edad*. Ministry of Health of Chile. Undersecretary of Public Health. Healthy Public Policies and Promotion Division. Department of Nutrition and Food.

Rodríguez, M. (2019). Hematología: Diagnóstico y terapéutica (4a Edición). *Revista médica de Chile*, *147*(7), 940. https://dx.doi.org/10.4067/S0034-98872019000700940

Tamayo Andrade, E. M., Moreira Guerrero, T. L., Fernández Alfonso, A., & Guaña Bravo, E. S. (2024). Evaluación de la efectividad de programas nutricionales en atención primaria en la malnutrición: Revisión Sistemática. *Ibero-American Journal of Health Science Research*, *4*(2), 29–38. https://doi.org/10.56183/iberojhr.v4i2.638

Thakur, N., Chandra, J., Pemde, H., & Singh, V. (2014). Anemia in severe acute malnutrition. *Nutrition*, *30*(4), 440-442. https://doi.org/10.1016/j.nut.2013.09.011

Torrens, M. (2023). Interpretación Clínica Del Hemograma. *Revista médica Clínica Las Condes*, *26*(6), 713–725. https://doi.org/10.1016/j.rmclc.2015.11.001

Veiga, G. R., Ferreira, H. S., Sawaya, A. L., Calado, J., & Florêncio, T. M. (2010). Dyslipidaemia and undernutrition in children from impoverished areas of Maceió, state of Alagoas, Brazil. *International journal of environmental research and public health*, *7*(12), 4139-4151. https://doi.org/10.3390/ijerph7124139

Vizcaíno Zúñiga , P. I., Cedeño Cedeño , R. J., & Maldonado Palacios , I. A. (2023). Metodología de la investigación científica: guía práctica. *Ciencia Latina Revista Científica Multidisciplinar*, *7*(4), 9723-9762. https://doi.org/10.37811/cl_rcm.v7i4.7658

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