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FACTORS ASSOCIATED WITH HEMOGLOBIN LEVELS IN CHILDREN UNDER 6 MONTHS OF AGE HOSPITALIZED IN A PEDIATRIC CENTER IN PERU.

FACTORES ASOCIADOS A LOS NIVELES DE HEMOGLOBINA EN NIÑOS MENORES DE 6 MESES DE EDAD HOSPITALIZADOS EN UN CENTRO PEDIÁTRICO DE PERÚ.

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ABSTRACT

Introduction: Anemia is a condition in which there is a low concentration of hemoglobin (Hb) levels. Although many causes of anemia have been identified, there are few studies in which they are related to epidemiological factors in the first months of life. Objective: To determine the factors associated with hemoglobin levels in children under 6 months of age hospitalized in a specialized pediatric center in Peru. **Methods:** Cross-sectional study in children under 6 months of age hospitalized in the medical services of a pediatric center during the year 2017, 267 medical records were reviewed, emphasizing clinical and epidemiological characteristics. **Results:** 61.4% of the infants were female, and only 6.7% of the proportion of the population studied were less than 1 month old. 6.7% had low birth weight, and 53.2% had a normal delivery. The level of anemia in hospitalized children under 6 months of age is 66.7%. **Conclusions:** According to the bivariate analysis, a significant association was found between hemoglobin levels with the variables age, nutritional status of weight for length and hospital causes. Regarding the multivariate analysis, only an association was found between age and the median Hb present in boys and girls aged 0 to 5 months hospitalized in a pediatric center in Peru.

Keywords: Child, Hospitalized; Anemia; Iron-Deficiency; Epidemiologic Study Characteristics; Hospitals, Pediatric. (Source: MESH-NLM)

RESUMEN

Introducción: La anemia es una condición en la cual hay una baja concentración de los niveles de hemoglobina (Hb). Si bien se ha identificado muchas causas de la anemia, existen pocos estudios en los cuales se relacionan con factores epidemiológicos en los primeros meses de vida. **Objetivo :** Determinar los factores asociados a los niveles de hemoglobina en niños menores de 6 meses de edad hospitalizados en un centro pediátrico especializado de Perú. **Métodos:** Estudio transversal en niños menores de 6 meses de edad hospitalizados en los servicios de medicina de un centro pediátrico durante el año 2017, se revisaron 267 historias clínicas dándose énfasis en características clínicas y epidemiológicas. **Resultados:** El 61,4% de los lactantes eran mujeres, y solo un 6,7% de la proporción de la población estudiada presentaba menos de 1 mes. El 6,7% tuvieron baso peso al nacer, y el 53,2% tuvo un parto eutócico. El nivel de anemia en niños menores de 6 meses de edad hospitalizados es del 66,7%. **Conclusiones:** Según el análisis bivariado se encuentra una asociación significativa, entre los niveles de hemoglobina con las variables edad, estado nutricional de peso para la longitud y causas hospitalarias. Con respecto al análisis multivariado solo se encontró asociación entre la edad con la mediana de Hb presente en los niños y niñas de 0 a 5 meses hospitalizados en un centro pediátrico de Perú.

Palabras clave: Niño Hospitalizado; Anemia Ferropénica; Características de Estudios Epidemiológicos; Hospitales Pediátricos. (Fuente: DeCS- BIREME)

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INTRODUCTION

Anemia is a condition in which there is a low concentration of hemoglobin (Hb) levels and red cell mass compared to the average [1]. Although many causes of anemia have been identified, there are few studies in which they are related to epidemiological factors in the first months of life. Worldwide, certain epidemiological factors related to anemia in infants are recognized. Studies carried out in Latin American countries have found two epidemiological characteristics associated with the presence of childhood anemia: poverty and low educational levels on the part of the parents [2,3].

In addition, these same components have been repeatedly found in countries such as Bangladesh and India [4-8]. At the level of Peru, the educational and socioeconomic level of the parents is associated with predisposing factors to anemia [9,10]. It is worth mentioning that childhood anemia is a topic of main national interest because 40.1% of boys and girls under three years of age present it [11]. The National Institute of Child Health (INSN) of Peru treats pediatric patients in the hospitalization area for various diseases, including infectious diseases; which, being linked to other epidemiological factors such as nutritional status and anemia, can impact immunity, increasing infant morbidity and mortality [12,13]. In addition, there are chronic diseases associated with anemia, such as heart failure, cancer, and inflammatory bowel disease [13]. For this reason, recognizing factors that predispose to presenting anemia in the first months of life is a strategy to consider to mitigate its prevalence at the national level and, above all, to avoid any in-hospital complication. The objective of this study was to determine the factors associated with hemoglobin levels in children under 6 months of age admitted to a specialized pediatric center in Peru.

METHODS

Cross-sectional analytical study carried out in a specialized hospital in the capital of Peru.

Population and sample

The population consisted of infants under 6 months of age hospitalized in the medical services of the INSN of Peru. A census of hospitalized patients was carried out taking as a reference the hospital discharges of the year 2017, finally 267 hospitalized infants were obtained who met the inclusion criteria of the study, being hospitalized in the INSN medicine services and with complete records of the study variables. in the medical records (Figure 1). Those with congenital malformation, genetic disorder, HIV infection.

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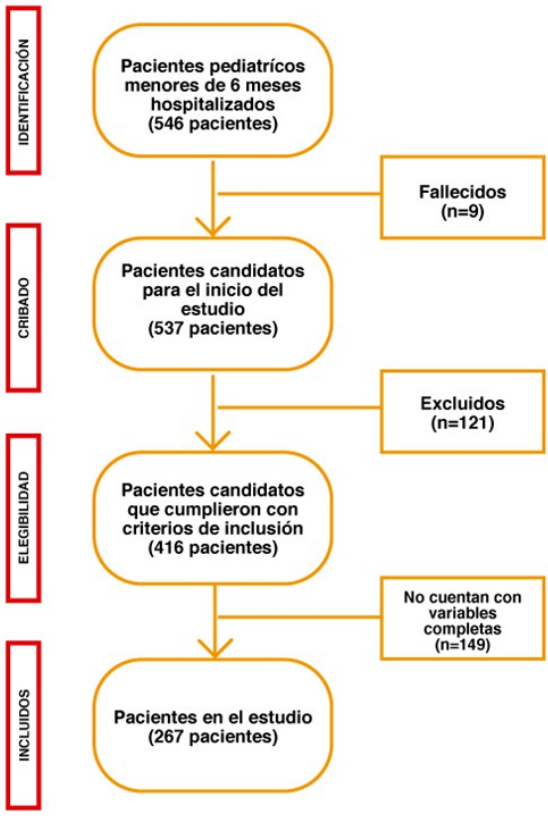

Figure 1. Flowchart for the selection of hospitalized children. Lima, Peru 2017.

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Variables and instruments

The dependent variable was the hemoglobin (Hb) level, taken on admission to hospitalization, determined from the medical records. For the determination of anemia, the ministerial resolution of the Ministry of Health of Peru No. 250-2017 was used, which uses the cut-off points pre-established by the WHO. Anemia was considered in children under 2 months of age with <13.5 g/dL of Hb in blood, and from 2 to 6 months with <9.5 g/dL of Hb in blood[14]. The independent variables were birth weight, length at birth, head circumference at birth, delivery characteristics, sex, origin, poverty quintile, age, nutritional status, causes of hospitalization, and hospital stay. The technique was data collection from medical records.

Procedure

Data collection from medical records was performed, with emphasis on clinical and epidemiological characteristics. There was a format designed for the study, the data entered in the formats was entered in an Excel spreadsheet for subsequent analysis. To establish the poverty quintiles, the infant's district of residence and the monetary poverty map of Peru were used. The quintiles are a subdivision of the population into 5 partially equal parts, with the first quintile being the one that groups the poorest population (154). On the other hand, the monetary poverty map can be estimated thanks to the National Household Survey (ENAHO) that allows obtaining an estimate of income and expenses of Peruvian households (156). The sample for the determination of Hb upon admission to hospitalization was obtained by venipuncture. All Hb blood analyzes were processed in the Sysmex Model XN-1000 Hematology Analyzer, using the cyanide-free sodium lauryl sulfate (SLS) methodology. Additionally, the analytical methodology had interlaboratory and external evaluation programs that ensured the quality of the results issued.

Statistical analysis

Statistical analyzes were performed using the Statistical Package for Social Science (SPSS, Inc.) software, version 26.0, which was also used for data management and cleaning. Descriptive statistics were reported as numbers and percentages for categorical variables. The evaluation of the normal distribution of the numerical variables was carried out with the Kolmogorov-Smirnov test, the student's T-test, and ANOVA were used to compare hospital hemoglobin between participants with different clinical epidemiological characteristics, for the bivariate analysis of the qualitative variables. the Chi-square test was used and regarding the multivariate analysis, a logistic regression was performed to obtain the Adjusted OR. The significance level was set at $p<0.05$ for all statistical analyses.

Ethical aspects

The manuscript was part of the results of the research project approved by the Institutional Research Ethics Committee of the INSN of Peru (code: PI-79/2018).

RESULTS

It was observed that the population of infants was mostly male, with 61.4%. The analyzed population consisted predominantly of 2-month-old boys and girls, with 29.2%. 79.8% correspond to Metropolitan Lima and Callao districts, and 96.3% belong to the quintiles with the highest economic income. When observing the nutritional status at the hospitalization time, acute malnutrition was found in 5.6% and severe malnutrition in 3% of the cases. Regarding malnutrition due to excess, 7.9% presented overweight compared to 6.4% of the cases that presented obesity. The mean Hb was 10.4 g/dl with a standard deviation (SD) of 2. The mean Hb to the epidemiological characteristics was similar; however, it could only be associated with the age variable, reaching mean values of 14.4 g/dl (SD=2.2) in children under 1 month of age and up to a mean of 9.6 g/dl in infants of 2 months (SD=1.3), Table 1.

Table 1. Hospital hemoglobin among participants with different clinical characteristics epidemiological, INSN 2017.

Variables	Total		Hemoglobin (g/dL)		p Value
	n	%	Media	OF	
Total	267	100.0	10.4	2.0	
Sex					
Masculine	164	61.4	10.2	1.7	0.023
Femenine	103	38.6	10.7	2.3	

Age					
< 1us	18	6.7	14.4	2.2	
1us	67	25.1	10.8	1.5	
2 months	78	29.2	9.6	1.3	0.000
3 months	40	15.0	9.7	1.7	
4 months	36	13.5	10.2	1.8	
5 months	28	10.5	10.2	1.9	0.75
Residence area					
Metropolitan Lima and Callao	213	79.8	10.4	1.9	
Rest of the country	54	20.2	10.3	2.1	
Wealth quintile					
Quintile 2 and 3 - lowest income	10	3.7	10.0	3.0	0.680
Quintile 4 and 5 - higher income	257	96.3	10.4	1.9	
Birth weight					
Low birth weight (<2500 g)	18	6.7	9.8	2.8	0.335
Normal birth weight (≥2500 g)	249	93.3	10.4	1.9	
Length at birth					
Short length at birth (<45.4 cm-female; ≥46.1 cm-male)	28	10.5	10.1	2.4	0.483
Adequate length at birth (≥45.4 cm-female; ≥46.1 cm-male)	239	89.5	10.4	1.9	
Head circumference at birth					
Microcephaly risk (<2DS)	12	4.5	9.3	1.7	0.952
Normal (+-2DS)	208	77.9	10.4	2.0	
Macrocephaly risk (>2DS)	47	17.6	10.7	1.8	
Delivery characteristics					
Eutocic	142	53.2	10.5	2.3	0.428
Dystocia	125	46.8	10.3	1.6	
Nutritional status (deficit and excess)					
Obesity	17	6.4	9.5	2.1	
Overweight	21	7.9	10.4	1.5	0.426
Normal	206	77.2	10.4	1.9	
Acute malnutrition	15	5.6	10.5	2.7	
Severe malnutrition	8	3.0	10.5	3.5	

When making the association between the presence of anemia in infants with the clinical and epidemiological variables (Table 2), no association could be found with the parameters weight, length, head circumference, delivery characteristics, sex, origin, poverty quintile, hospital stay, and weight-for-age and length-for-age nutritional status. However, statistically significant associations were found in 3 different parameters: age, nutritional status, weight for length, and causes of hospitalization.

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Table 2. Association between Hb level and clinical-epidemiological characteristics of hospitalized children under 6 months of age, INSN 2017.

Variables	Hb blood levels in infants				p Value
	Anemia		Well,		
	n	%	n	%	
Total	178	66,7	89	33,3	
Birth weight					
Low birth weight (<2500 g)	11	61,1	7	38,9	0,605
Normal weight at nacer (≥2500 g)	167	67,1	82	32,9	
Length at birth					
Short length at birth (<45.4 cm-female; <46.1 cm-male)	18	64,3	10	35,7	0,778
Adequate length at birth (≥45.4 cm-female; ≥46.1 cm-male)	160	66,9	79	33,1	
Head circumference at birth					
Microcephaly	9	75,0	3	25,0	0,531
Normal	138	66,3	70	33,7	0,835
Macrocephaly	31	66,0	16	34,0	0,910
Delivery characteristics					
Dystocia	86	68,8	39	31,2	0,488
Eutocic	92	64,8	50	35,2	
Sex					
Masculine	116	70,7	48	29,3	0,075
Femenine	62	60,2	41	39,8	
Origin					
Callao	2	50,0	2	50,0	0,476
Metropolitan Lima1/	143	68,4	66	31,6	0,248

Lima provincias2/	5	55,6	4	44,4	0,472
Rest of country	28	62,2	17	37,8	0,488
Poverty quintile					
Quintile 2	2	100,0	0	0,0	0,315
Quintile 3	3	37,5	5	62,5	0,076
Quintile 4	64	64,6	35	35,4	0,052
Quintile 5	109	69,0	49	31,0	0,591
Age					
<1 month	1	5,6	17	94,4	0,000
1 month	39	58,2	28	41,8	0,090
2 months	65	83,3	13	16,7	0,000
3 months	32	80,0	8	20,0	0,052
4 months	24	66,7	12	33,3	1,000
5 months	17	60,7	11	39,3	0,480
Nutritional Status- Weight for Age					
Normal	132	64,7	72	35,3	0,221
Overweight	31	79,5	8	20,5	0,066
Under weight	15	62,5	9	37,5	0,650
Nutritional Status - Weight for Length					
Over weight	29	76,3	9	23,7	0,173
Normal	138	67,0	68	33,0	0,837
Acute malnutrition	11	47,8	12	52,2	0,045
Nutritional Status - Length for Age					
Normal	161	66,0	83	34,0	0,441
low stature	17	73,9	6	26,1	
Causes of hospitalization (ICD-10)					
Acute bronchiolitis (J21)	52	73,2	19	26,8	0,170
Whooping cough (A37)	24	63,2	14	36,8	0,620
Intestinal infections (A09)	10	66,7	5	33,3	1,000
Septicemia (A41)	6	60,0	4	40,0	0,649
Pneumonia (J15-J18)	19	86,4	3	13,6	0,041
Urinary tract infection (N39)	8	80,0	2	20,0	0,362
Conditions of perinatal origin (P00)	0	0,0	8	100,0	0,000
Blood volume depletion (E86)	3	75,0	1	25,0	0,722
Epilepsy (G40)	9	56,3	7	43,8	0,362
Other causes of hospitalization	47	64,4	26	35,6	0,627
Hospital stay					
0 a 4	68	66,7	34	33,3	1,000
5 a 9	77	68,1	36	31,9	0,661
10 a 14	25	69,4	11	30,6	0,704
15 and over	8	50,0	8	50,0	0,145

1/ Comprende los 43 distritos que conforman la provincia de Lima.
2/ Comprende las provincias: Barranca, Cajatambo, Canta, Cañete, Huaral, Huarochirí, Huaura, Oyón y Yauyos.

Table 3. Multivariate analysis of Hb levels in hospitalized children under 6 months of age, INSN 2017.

Variables		Probability Hb levels				p value	adjusted OR	IC 95%	
		Hb<10.1 g/dl		Hb>10.1 g/dl					
		n	%	n	%			LI	LS
	Total	139	100,0	128	100,0				
Birth weight	Low birth weight (<2500 g)	10	7,2	8	6,3	0,4	0,5	0,1	2,3
	Normal birth weight (≥2500 g)	129	92,8	120	93,8				
Length at birth	Short length at birth (<45.4 cm-female; <46.1 cm-male)	13	9,4	15	11,7	0,2	2,2	0,7	7,2
	Adequate length at birth (≥45.4 cm-female; ≥46.1 cm-male)	126	90,6	113	88,3				
Head circumference at birth	Risk	32	23,0	27	21,1	0,1	0,6	0,3	1,1
	Normal (+-2DS)	107	77,0	101	78,9				
Delivery characteristics	dystocia	64	46,0	61	47,7	0,6	1,1	0,7	1,9
	eutocic	75	54,0	67	52,3				
Sex	masculine	91	65,5	73	57,0	0,2	0,7	0,4	1,2
	femenine	48	34,5	55	43,0				
Age	0 to 1 My	28	20,1	57	44,5	0,000	3,8	2,1	6,9
	2 to 5 months	111	79,9	71	55,5				
Hospital stay	0 to 6 days	86	61,9	72	56,3	0,3	0,8	0,4	1,3
	7 or more days	53	38,1	56	43,8				
Origin	Metropolitan Lima and Callao	110	79,1	103	80,5	0,5	1,3	0,6	2,6
	Rest of the country	29	20,9	25	19,5				
Quintile	Quintile 2 and 3 - Less income	5	3,6	5	3,9	0,6	1,5	0,3	6,3
	Quintile 4 and 5 - Higher income	134	96,4	123	96,1				

Regarding age, an association was only found with children under 1 month and 2 months; with nutritional status, only those who presented acute malnutrition; and with the causes of hospitalization, pneumonia, and conditions of perinatal origin. It is important to highlight that anemia levels progressively increase to 83.3% in the second month of life, decreasing to 60.7% in the fifth month. Although there is no obvious association, it should be noted that 70.7% of men have anemia, 10% higher than women, and the 2 cases of the poorest quintile have anemia. Infants with excess weight present approximately a 10% increase in the level of anemia in relation to those classified with normal nutritional status, a progressive decrease in anemia levels is evident with longer hospitalization (Table 2). When performing a multivariate analysis between the median Hb (10.1 g/dL) and clinical-epidemiological factors (Table 3), it was only possible to determine a statistically significant relationship ($p<0.05$) between Hb levels with the age of infants and that age progress increases by 3.8 if Hb levels drop. Although another multivariate association could not be determined, it can be established that a short length at birth increases the chances by 2.2 of presenting lower Hb levels.

In figure 2, it can be verified that the Hb levels concerning the percentage of the infant population. It is observed that 65.1% present an average Hb between the values of 9 to 11 g/dL.

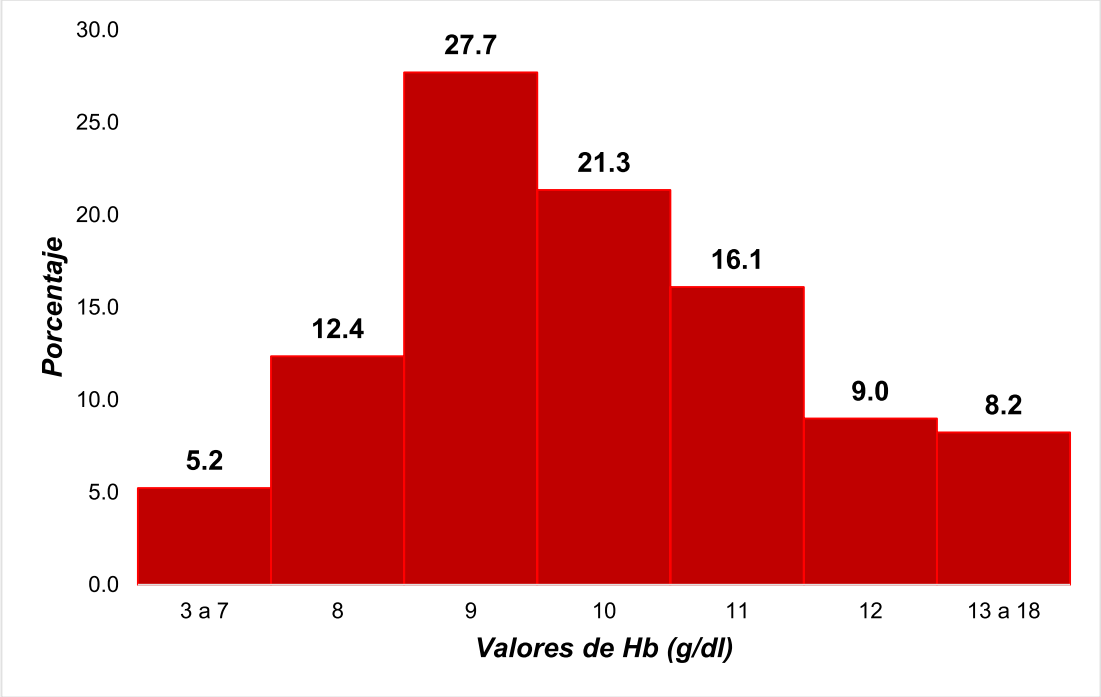

Figure 2. Distribution of hemoglobin (Hb) values in evaluated infants, INSN 2017.

DISCUSSION

The results of this investigation are important because they allow associating clinical-epidemiological factors with anemia, especially at an early age; considering that the level of anemia in hospitalized children is usually 55%[17] or reaches values of 66.7% as in this investigation. In this first stage of life, one of the most common anemias occurs in neonates, known as physiological anemia. This occurs due to the progressive decrease in erythropoiesis that occurs from birth and reaches a peak between weeks 6 and 9 [18]. Internationally; it has been seen that the prevalence of anemia in this age group is slightly below that found in the present study. In Nepal, a prevalence of 49% was found in children under 2 to 6 months of age[19]; in a study from Argentina carried out on children from 4 to 5 months, 28.9%(20); and in another in Brazil carried out on children from 3 to 5 months, 20.2%[21]. Regarding age, an association was found between anemia and children in their first month and 2 months of life in the bivariate analysis and a lower median Hb in infants from 2 to 5 months in the multivariate analysis. Some studies associate changes in hemoglobin with the increasing age of the infant, up to 18 and 12 months, respectively, with the presence of anemia [12,22]. Although this research worked with children under 6 months of age, the decrease in Hb levels due to the previously mentioned physiological anemia could still be extrapolated [18]. On the other hand, infants, despite being hospitalized, present a decrease within what was expected in Hb levels given from month 1 to month 5. These results are similar to other studies in hospitalized infants in Lebanon and Turkey, where they observed that younger age of newborn hemoglobin levels[23] and ferritin[24] are older.

Another significant association found in this study, according to the bivariate analysis, was the causes of hospitalization. Only 2 complications that presented statistically representative associations with anemia could be determined: pneumonia and perinatal conditions. Previously published research has found an association between respiratory infections and

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anemia [25,26]; in this case, similar results were found, specifically with pneumonia. It should be noted that respiratory conditions are the most common cause of hospitalization in children[17,27]. Therefore, evaluating the repercussions of this association could be vital to grant better treatment. In the same way, perinatal conditions have already been associated in previous studies with childhood anemia[28-30], which in turn has been seen to be the cause of abnormal neurological development if children have severe anemia due to the constant hypoxia to which they are subjected [31].

Acute malnutrition, due to low weight for height, was another statistically associated variable in the bivariate analysis. Some studies on children under 1 year of age in Asia have reached this same association[23-32]; In addition, in the first of these, carried out specifically on the island of Sri Lanka, it was concluded that anemia has a greater association with acute malnutrition when hospitalized infants are younger and decreases concerning the age of the children [32]. The prevalence of anemia with hospital stay is another clinical-epidemiological factor that could not be associated in this investigation. This differs from the Lebanese study carried out on children older than 6 months, where a statistically significant association was found with the presence of anemia, but from the fifth day of hospitalization[23].

Also, a second study conducted in adults associated an increase in hospital stay with the presence of any degree of preoperative anemia [33]. It should be considered that a possible cause of this non-association in the present study may be due to the age difference of the patients in the two mentioned cases. It should be considered that finding patients with anemia is recurrent in the hospitalization área [17-34], and some investigations associate it with an increase in hospital mortality[35,36].

In addition, it has already been determined by other studies that this condition could aggravate the outcome of other diseases [35,36]. For this reason, further research to relate this variable to anemia should be considered. One limitation of the study was not having evaluated the parents' educational level, since in various investigations, it has been possible to determine a quite significant inverse association with the presence of anemia[2,3,5-8,17]. Despite this, apart from the study carried out at the INSN in 2015 [17], the associations were made in infants from 6 months of age and under 5 years.

Although in this investigation, no association was found between the level of wealth and the presence of anemia, the 2 infants who were within the second quintile of poverty were anemic; which can be compared to a study from Tanzania that associated parental unemployment with the presence of anemia in hospitalized children under 5 years of age[37]. Likewise, it has been seen in various studies carried out nationally and internationally, that the socioeconomic level does greatly influence the presence of this disease [9,10]. It is recommended to continue investigating the characteristics of anemia in the first months of life, in order to ensure a decrease in intrahospital mortality and have more tools against the fight against childhood anemia in Peru.

CONCLUSIÓN

In conclusion, according to the bivariate analysis, a statistically significant association was found between age, acute malnutrition and causes of hospitalization and the presence of anemia; and regarding the multivariate analysis, it was possible to associate the median of the Hb levels with the age of boys and girls from 0 to 5 months of age hospitalized in the INSN.

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