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Evaluation of Hospitalized Pediatric Patients in Terms of Anemia: Single-Center Experience

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ABSTRACT

Introduction: Anemia, characterized by reduced hemoglobin and hematocrit levels, affects roughly one-third of the global population and is associated with increased morbidity and mortality. Iron deficiency anemia (IDA) is the most common form, particularly prevalent during childhood, a period of rapid growth. This study aimed to assess the frequency of anemia in pediatric patients hospitalized for various reasons.

Material and methods: This study was conducted at SBU Bakırköy Dr. Sadi Konuk Training and Research Hospital, Department of Pediatrics, from September 1 to November 30,2021. The records of pediatric patients treated during this period were retrospectively reviewed. Patients with hematologic diseases were excluded from the study. Demographic data and laboratory results were recorded, and patients were grouped by age (0-2, 2-6, 6-12, 12-17 years) to compare laboratory values across these groups.

Results: The study included 100 children, with an equal distribution of 50 girls (50%) and 50 boys (50%), hospitalized between September 1 and November 30, 2021, at SBÜ Bakırköy Dr. Sadi Konuk Training and Research Hospital. The patients' ages ranged from 1 month to 16.2 years, with a mean age of 3.34±3.90 years. The majority (59%) of patients were in the 0-2 age group, followed by 19% in the 2-6 age group, 19% in the 6-12 age group, and 3% in the 12-17 age group. It was observed that 31% of patients had chronic diseases. Hemoglobin levels were measured at 11.11±1.84 g/dL, hematocrit at 33.71±4.85%, mean corpuscular volume (MCV) at 81.35±8.48 fL, red cell distribution width (RDW) at 15.08±2.67%, iron (Fe) at 64.70±38.89 g/dL, ferritin at 228.50±200.04 µg/L, vitamin B12 at 554.83±389.46 ng/L, and folate at 11.34±6.23 ng/L.

Conclusions: Anemia is a prevalent issue during childhood in our country and should be carefully considered in hospitalized pediatric patients. Upon detection, a cause-specific treatment plan must be developed to address this condition effectively.

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Evaluación de pacientes pediátricos hospitalizados en términos de anemia: experiencia en un solo centro

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RESUMEN

Introducción: La anemia, caracterizada por niveles reducidos de hemoglobina y hematocrito, afecta aproximadamente a un tercio de la población mundial y se asocia con un aumento de la morbilidad y la mortalidad. La anemia ferropénica (AHF) es la forma más común, particularmente prevalente durante la infancia, un período de rápido crecimiento. Este estudio tuvo como objetivo evaluar la frecuencia de anemia en pacientes pediátricos hospitalizados por diversas razones.

Material y métodos: Este estudio se llevó a cabo en el Hospital de Formación e Investigación Dr. Sadi Konuk de la SBU Bakırköy, Departamento de Pediatría, del 1 de septiembre al 30 de noviembre de 2021. Se revisaron retrospectivamente los registros de los pacientes pediátricos tratados durante este período. Se excluyeron del estudio los pacientes con enfermedades hematológicas. Se registraron los datos demográficos y los resultados de laboratorio, y los pacientes se agruparon por edad (0-2, 2-6, 6-12, 12-17 años) para comparar los valores de laboratorio entre estos grupos.

Resultados: El estudio incluyó a 100 niños, con una distribución equitativa de 50 niñas (50%) y 50 niños (50%), hospitalizados entre el 1 de septiembre y el 30 de noviembre de 2021 en el Hospital de Formación e Investigación SBÜ Bakırköy Dr. Sadi Konuk. Las edades de los pacientes oscilaban entre 1 mes y 16,2 años, con una edad media de 3,34 ± 3,90 años. La mayoría (59%) de los pacientes estaban en el grupo de edad de 0 a 2 años, seguido del 19% en el grupo de edad de 2 a 6 años, el 19% en el grupo de edad de 6 a 12 años y el 3% en el grupo de edad de 12 a 17 años. Se observó que el 31% de los pacientes tenían enfermedades crónicas. Los niveles de hemoglobina fueron 11,11 ± 1,84 g/dL, hematocrito 33,71 ± 4,85%, volumen corpuscular medio (VCM) 81,35 ± 8,48 fL, ancho de distribución de glóbulos rojos (RDW) 15,08 ± 2,67%, hierro (Fe) 64,70 ± 38,89 g/dL, ferritina 228,50 ± 200,04 µg/L, vitamina B12 554,83 ± 389,46 ng/L y folato 11,34 ± 6,23 ng/L.

Conclusiones: La anemia es un problema prevalente durante la infancia en nuestro país y debe considerarse cuidadosamente en pacientes pediátricos hospitalizados. Tras la detección, se debe desarrollar un plan de tratamiento específico para abordar esta condición de manera efectiva.

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1. INTRODUCTION

Anemia, a globally recognized public health concern, is defined by hemoglobin or hematocrit levels falling below two standard deviations for age, race, and sex [1]. Iron deficiency remains the most common cause of anemia, with the global prevalence of iron deficiency anemia (IDA) ranging from 25% to 47%, making it the most frequently identified hematological abnormality in infants and children. IDA in childhood, particularly among preschool children in developing countries, contributes to growth retardation, impaired motor and cognitive development, and heightened morbidity and mortality rates. Anemia can result from both hereditary and acquired causes, which vary significantly across different populations. Functionally, anemia occurs when the number of circulating erythrocytes, which serve as oxygen carriers, is insufficient to meet the body's metabolic demands [2]. Besides iron deficiency, anemia may also result from deficiencies in folic acid and vitamin B12, chronic illnesses, and genetic hemoglobin disorders [3].

Anemia can be classified in various ways, including acute or chronic, congenital or acquired, and hemolytic or non-hemolytic. Clinically, anemia is often categorized based on mean corpuscular volume (MCV) into microcytic, normocytic, or macrocytic, with further differentiation according to reticulocyte count. This approach is particularly helpful in determining the etiology of anemia in infants and children [2]. The World Health Organization (WHO) hemoglobin thresholds are used to define anemia in children and adolescents. However, in low- and middle-

income countries, these thresholds may be lower than those recommended by WHO [4]. According to this, hemoglobin levels below 11 g/dL in children aged 6-59 months, 11.5 g/dL in children aged 5-11 years, 12 g/dL in children aged 12-14 years, 13 g/dL in men aged 15 and older, and 12 g/dL in women aged 15 and older are considered indicative of anemia [4]. During childhood, IDA leads to growth retardation, motor and cognitive impairments, and increased chronic morbidity and mortality risks, especially in developing nations [5, 6]. Worldwide efforts to prevent IDA include breastfeeding support, nutritional recommendations, and, since 2004 in Turkey, daily prophylactic iron supplementation of 1-2 mg/kg [7, 8]. This study aims to contribute to the literature on anemia in hospitalized pediatric patients by investigating the prevalence of anemia in children admitted to our pediatric department.

Table 1: Distribution of descriptive characteristics

Variable	Value (%)
Age (years)	
Mean±Sd	3,34±3,90
Median (Min-Max)	1,58 (0,1-16,2)
0-2 years	59 (59)
2-6 years	19 (19)
6-12 years	19 (19)
12-17 years	3 (3)
Gender	
Male	50 (50)
Female	50 (50)
Chronic disease	
No	69 (69)
Yes	31 (31)
History of hospitalization	
No	73 (73)
Yes	27 (27)

2. MATERIAL AND METHODS

This study involved a retrospective review of the records of children aged 1 month to 18 years who were hospitalized between September 1 and November 30, 2021, at Bakırköy Dr. Sadi Konuk Training and Research Hospital, Department of Pediatrics. The study included patients who met the criteria for anemia defined by the World Health Organization for individuals and populations. Patients with known hematologic diseases (e.g. hemoglobinopathies, idiopathic thrombocytopenic purpura) were excluded. The patients' age, sex, diagnosis, and initial laboratory results upon admission (complete blood count parameters, iron, total iron-binding capacity (TIBC), ferritin, vitamin B12, folate, C-reactive protein levels) were recorded. The patients were divided into four age groups (0-2, 2-6, 6-12, and 12-17 years), and further into two groups based on prior hospitalization (yes / no) and the presence of chronic disease (neurological, endocrinological, metabolic, infectious). The presence of anemia and laboratory values related to anemia were evaluated between these groups. The study was conducted in accordance with the Declaration of Helsinki and received approval from the Clinical Research Ethics Committee of Bakırköy Dr. Sadi Konuk Training and Research Hospital (Decision dated April 4, 2022, no. 2022-07-03).

2.1. STATISTICAL ANALYSIS

Statistical analyses were performed using the NCSS (Number Cruncher Statistical System) program. Descriptive statistical methods (mean, standard deviation, median, frequency, percentage, minimum, maximum) were used to evaluate the study data. The normal distribution of quantitative data was tested using the Shapiro-Wilk test and graphical assessments. The Student t-test was used for comparisons between two groups for quantitative variables with normal distribution, and the Mann-Whitney U test was used for non-normally distributed variables. Pearson's chi-square test was used for comparisons of qualitative data. Statistical significance was set at $p<0.05$.

3. RESULTS

The study was conducted with 100 children, 50% female (n=50) and 50% male (n=50), who were hospitalized between September 1 and November 30, 2021, at SBU Bakırköy Dr. Sadi Konuk Training and Research Hospital. The age of the participants ranged from 1 month to 16.2 years, with a mean age of 3.34±3.90 years. The majority of the patients (59%, n=59) were between 0-2 years, while 19% (n=19) were aged 2-6 years, 19% (n=19) were aged 6-12 years, and 3% (n=3) were aged 12-17 years. It was observed that 31% (n=31) of the patients had chronic diseases, and 27% (n=27) had been previously hospitalized (Table 1).

The distribution of the laboratory results of the study participants is shown in Table 2.

There was no statistically significant difference in the prevalence of anemia based on the participants' age, gender, presence of chronic disease, or prior hospitalization ($p>0.05$) (Table 3).

The MCV, platelet, leukocyte, neutrophil, lymphocyte, TIBC, ferritin, vitamin B12, and folate values did not show statistically significant differences according to the presence of anemia ($p>0.05$) (Table 4).

Table 2: Distribution of biochemical results	
Variable	**Median (Min-Max)**
Hemoglobin	11,2 (6,3-14,9)
Hematocrit	33,7 (20,4-44,2)
Mean corpuscular volume	80,9 (51-101,5)
Red cell distribution width	14,6 (11,9-32,6)
Platelet	406 (60-937)
White blood cell count	9,9 (2-36)
Neutrophil	4,1 (1-23)
Lymphocyte	3,8 (1-15)
Iron	51,9 (12,6-210,7)
Total iron binding capacity	272 (2,9-546,9)
Ferritin	183,4 (7,1-701)
Vitamin B12	447 (107-2000)
Folate	10,3 (1,6-20)

Table 3: Evaluation of the presence of anemia according to descriptive characteristics			
Variable	**Presence**		**P value**
	No (%)	**Yes (%)**	
Age (years)			
Mean±Sd	3,95±4,15	2,74±3,57	**[a]0,181 (mean and median)**
Median (Min-Max)	0,1-14,2	0,2-16,2	
0-2 years	24 (40,7)	35 (59,3)	
2-6 years	13 (68,4)	6 (31,6)	**[a]0,130 (range of years)**
6-12 years	11 (57,9)	8 (42,1)	
12-17 years	2 (66,7)	1 (33,3)	
Gender			
Male	27 (54,0)	23 (46,0)	**[b]0,424**
Female	23 (46,0)	27 (54,0)	
Chronic disease			
No	33 (47,8)	36 (52,2)	**[b]0,517**
Yes	17 (54,8)	14 (45,2)	
History of hospitalization			
No	35 (47,9)	38 (52,1)	**[b]0,499**
Yes	15 (55,6)	12 (44,4)	

[a]Mann Whitney U Test; [b]Pearson Chi-Square Test.

4. DISCUSSION

Anemia, recognized as a global public health issue, is defined as a decrease in hemoglobin or hematocrit levels below two standard deviations for age, race, and sex [1]. The most common cause of anemia is iron deficiency. Anemia prevalence varies by geographic region but remains highest across all age groups and both sexes, particularly in developing countries [9]. Other causes of anemia include folate and vitamin B12 deficiencies, chronic diseases, and genetic hemoglobin disorders [3].

Globally, the prevalence of iron deficiency anemia (IDA) ranges from 25% to 47% [2]. In childhood, IDA contributes to growth retardation, impaired motor and cognitive development, and increased chronic morbidity and mortality, particularly in developing countries [5, 6]. Although global strategies to prevent iron deficiency have reduced the prevalence of IDA, the condition remains significant. Studies in different regions of Turkey indicate a decreasing prevalence of IDA over the years [8, 10, 11]. The Ministry of Health of the Republic of Turkey reported a reduction in IDA prevalence following the introduction of a project in 2004 that provided 1-2 mg/kg/day iron supplementation for children aged 4-12 months [12]. In a study conducted in Brazil, 23.1% of children aged 11-15 months who visited healthcare facilities were found to be anemic [7]. A study in India conducted from April to September 2016 found anemia in 42.5% of 697 patients, a reduction compared to studies from 2011-2014 [9, 13, 14]. In the United States, a study of hospitalized patients revealed that iron deficiency anemia was the most common form of nutritional anemia, accounting for 92.88% of cases, while other nutritional anemias (due to folic acid, vitamin B12, and other nutritional deficiencies) accounted for 7.12% [15]. A systematic review by Rosas-Jiménez et al. found anemia prevalence in indigenous children in Latin America ranged from 40% to 70%, with the highest rates observed in children aged 6-35 months [16]. Speckert et al. conducted a study in Canada comparing treatment methods for patients with severe IDA, grouping patients by age (0-1, 1-6, 6-11, and 11-18 years). Nutritional causes were the most frequent, particularly in children under 3 years old [17]. In a study by Gürsoy et al., the anemia prevalence among hospitalized children was 27.6%, with the highest prevalence seen in children aged 6-24 months. The high prevalence of anemia in infants was attributed to the inability to meet increased nutritional demands during growth [1]. In our study, the

patients' ages ranged from 1 month to 16.2 years, with a mean age of 3.34 ± 3.90 years. Patients were divided into four age groups (0-2, 2-6, 6-12, and 12-17 years). No significant difference was found in anemia prevalence or laboratory values between the groups. The most frequent age group for anemia was 6-24 months, consistent with the literature.

Table 4: Evaluation of biochemical results according to the presence of anemia

Variable	Presence (mean±Sd)		P value
	No	Yes	
Hemoglobin	12,45±1,07	9,51±1,18	**[c]0,001****
Hematocrit	37,28±3,14	30,13±3,42	**[c]0,001****
Mean corpuscular volume	82,79±6,94	79,91±9,63	**[c]0,089**
Red cell distribution width	14,43±1,34	15,72±3,43	**[a]0,029***
Platelet	408,54±149,8	453,28±197,61	[c]0,205
White blood cell count	11,18±4,58	11,16±5,81	[a]0,544
Neutrophil	5,59±3,94	4,99±4,25	[a]0,252
Lymphocyte	4,49±2,88	5,06±3,38	[a]0,463
Iron	79,33±43,34	50,07±27,22	**[a]0,001****
Total iron binding capacity	268,28±76,34	286,38±86,37	[c]0,269
Ferritin	214,82±183,57	244,29±224,09	[a]0,800
Vitamin B12	548,32±333,87	561,34±441,47	[a]0,402
Folate	10,61±6,23	12,07±6,21	[a]0,173

*[a]Mann Whitney U Test; [c]Student-t Test; *p<0,05; **p<0,01.*

No significant difference in anemia prevalence was observed between patients previously hospitalized and those admitted for the first time. Among previously hospitalized patients, 44.4% were found to be anemic, while the anemia prevalence in first-time hospitalized patients was 52.1%. In the study by Gürsoy et al. the anemia prevalence among hospitalized children was 27.6% [1]. Salami et al. found an anemia prevalence of 33.2% in hospitalized children aged 1 month to 12 years, with anemia 3-4 times more common in malnourished children compared to those without malnutrition [18]. In a study by Çetinkaya et al. involving 3117 children aged 7-24 months, 61.6% were found to have anemia [11]. A study in Brazil by Da Silva et al. reported a higher anemia risk in children who had been hospitalized at least once compared to those who had never been hospitalized [7]. The study in India found that 42.5% of hospitalized children were anemic, and despite a reduction in anemia rates, it remains a significant public health concern in India [13]. The wide age range (1-168 months) in this study may have led to a lower overall anemia burden in the total population. Since serum iron levels rise as an acute phase reactant during acute infection and inflammation, serum iron is positively correlated with acute infection [19]. Conversely, increased inflammatory cytokine release disrupts erythropoietin synthesis and hemoglobin production, negatively correlating with acute infection/inflammation.

No significant difference in anemia prevalence was observed between patients with chronic diseases and those without. Chronic diseases can lead to iron deficiency through mechanisms such as hemolysis, cytokine-mediated inflammation, reduced production, and absorption defects, increasing the likelihood of anemia [2]. However, the frequent monitoring of patients with chronic diseases may prevent iron deficiency before anemia develops. Similarly, patients requiring frequent hospitalization are often more thoroughly examined, enabling earlier prevention of iron deficiency and anemia.

When the laboratory values of patients with and without anemia were compared in our study, hemoglobin, hematocrit, and RDW levels differed significantly between the two groups, as expected ($p<0.01$, $p<0.01$, and $p<0.05$, respectively). In the study by Maiti et al., the mean hemoglobin level was 9.3 ± 1.4 g/dL (range: 4.5–11 g/dL), and RDW was 16.3 ± 3.4%, with no significant difference in hemoglobin levels across different age groups [13]. Behara et al. divided patients into preschool (6-59 months) and school-age (6-11 years) groups, finding mean hemoglobin levels of 10.45 ± 2.99 g/dL in the preschool group and 10.42 ± 3.491 g/dL in the school-age group [20]. Gürsoy et al. compared hemoglobin levels at admission and discharge in infants and adolescents, finding a significant difference between the two time points [1].

Ferritin is released into the plasma in small amounts and is positively correlated with body iron stores in the absence of inflammation. Low serum ferritin indicates depleted iron stores [8, 21]. The evaluation of anemia is complicated when

serum ferritin concentrations rise in the presence of inflammatory disease or subclinical infection [5]. Phiri's study found a mean ferritin level of 729.2 µg/L in patients with severe anemia and infection, suggesting the ferritin threshold should be raised from 30 to 273 µg/L [22]. Akın et al. found a mean ferritin level of µg/L (min: 2.4; max: 179.4) in patients with concomitant inflammatory disease, with 34% of patients having ferritin levels above 30 mcg/L [8]. In our study, no significant differences in ferritin or other laboratory values were found between patients with and without anemia.

Beyond iron deficiency, vitamin B12 deficiency is another common cause of nutritional anemia. In children, B12 deficiency may result from insufficient intake, poor absorption, or abnormalities in B12 metabolism, leading to macrocytic anemia and neurological symptoms. Another nutritional cause of anemia is folate deficiency, which may occur due to inadequate intake, poor absorption, or increased demand. Folate deficiency leads to macrocytic anemia. Treatment for both B12 and folate deficiency involves addressing dietary deficiencies and providing supplements [2]. In our study, no significant differences were found in vitamin B12 and folate levels between patients with and without anemia.

In conclusion, despite a decreasing trend over the years, anemia remains a significant public health issue worldwide. Anemia adversely affects children's cognitive development, highlighting the need for more effective preventive measures. In Turkey, extending prophylactic iron supplementation to 24 months and reevaluating ferritin threshold values is recommended.

5. CONFLICT OF INTERESTS

The authors have no conflict of interest to declare. The authors declared that this study has received no financial support.

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