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Hassan A. Al-Shamahy *

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Research Article

Anemia among under five years of age suffering from malnutrition in Sana'a city, Yemen

Ahmed Mohammed Al-Haddad [1], Hajar Razzaz Qaid Saif Alhaj [2], Amel Abdullah Almagrami [2,5], Khaled Abdulkarim Al-Moyed [3], Hassan Abdulwahab Al-Shamahy [3]*, Ibrahim Ali Al-Arashi [5]

[1]Department of Medical Laboratories, College of Medicine and Health Sciences, Hadhramout University, Al-Mukalla, Republic of Yemen.

[2]Yemeni Board for Medical and Health Specialties, Ministry of Health and Population, Republic of Yemen.

[3]Medical Microbiology and Clinical Immunology Department, Faculty of Medicine and Health Sciences, Sana'a University, Republic of Yemen.

[4]National center of Central Public health Laboratories, Ministry of Health and Population.

[5]Medical Microbiology and Clinical Immunology Department, Faculty of Health Sciences, Thamar University, Republic of Yemen.

***Corresponding Author:** Hassan A. Al-Shamahy, Medical Microbiology and Clinical Immunology Department, Faculty of Medicine and Health Sciences, Sana'a University, Republic of Yemen.

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Abstract:

Background: Anemia, a condition characterized by low red blood cell count or hemoglobin levels, is a significant public health issue, particularly among undernourished children under five years of age. Anemia is a significant public health problem in many low- and middle-income countries, with young children being especially vulnerable. In almost every nation on Earth, a sizable portion of the populace suffers from anemia.

Objective: The main objective of this study was to assess the prevalence of anemia and identify other blood parameters among children under five years suffering from malnutrition.

Methods: A cross-sectional study was carried out among 50 children from Sana'a city suffering from malnutrition from 1st of October 2023 until the end of February 2024. Data on socio-demographic, dietary, blood samples for hemoglobin level, and other blood markers were collected and then tested by automated methods.

Results: The study included 36% males and 64% females, with a mean age of 11.8 months and a range of 1-60 months. The mean RBC count was 4.2 cells x 106/µl with a SD of 0.72 and ranged from 2.6 to 5.5 cells x 106/µl. The mean WBC count was 10.3 cells x 109/L with an SD of 4.3 and ranged from 2.8 to 24 cells x 109/L. The mean hemoglobin level was 10.4 mg/dL and ranged from 6.2 to 12.9 mg/dL. (<11.1 mg/dL) was reported in 54% of all malnourished children.

Conclusion: The prevalence of anemia in children under five years is a pressing public health issue that necessitates urgent attention in the study area. The most important predictors are suboptimal child feeding practices, food insecurity, and a poor diet. Multi-sectoral efforts are needed to improve health, and interventions targeting nutritional security are recommended.

Key words: anemia; malnutrition; pre-school children; sana'a; yemen

1.Introduction

Anemia where there is a deficiency in red blood cells or the hemoglobin concentration within them falls below the normal levels [1]. This blood disorder, characterized by a reduced hemoglobin level, poses a significant public health threat to individuals in both developed and developing nations [2, 3].

Anemia in children under five years of age is a significant public health concern globally, particularly in low- and middle-income countries. It is characterized by a reduction in hemoglobin levels, which can lead to various health complications, including impaired cognitive and physical development, increased susceptibility to infections, and higher mortality

rates. The World Health Organization (WHO) estimates that approximately 43% of children under five are affected by anemia, with iron deficiency being the most prevalent cause [4, 5].

Anemia is a significant global health concern, affecting millions of individuals worldwide. In 2019, an estimated 30% of non-pregnant women and 37% of pregnant women aged 15-49 years were anemic, representing 539 million and 32 million women, respectively [6, 7]. Furthermore, a substantial proportion of children under five years old face nutritional challenges: 149 million are stunted, 45 million are wasted, and 38.9 million are overweight or obese in 2020 [3].

These figures underscore the urgent need for global efforts to address anemia and improve nutritional outcomes for vulnerable populations. Research from various studies consistently identifies multiple factors contributing to anemia within vulnerable populations. In developing countries, iron deficiency stands out as a primary cause, often accompanied by factors like malaria, parasitic infections, nutritional deficiencies, and genetic conditions such as hemoglobinopathies [4, 5, 6, 7].

Iron deficiency serves as the leading factor behind anemia, which is why anemia prevalence is frequently used as a proxy for insufficient iron levels. Iron deficiency anemia (IDA) and anemia are hence used interchangeably [8]. Cognitive performance decline has been associated with iron-deficient anemia. Symptoms like weakness, fatigue, difficulty concentrating, and decreased work capacity can result from impaired tissue oxygen supply. Children, in particular, may face challenges in their mental and physical growth. Severe IDA may predispose individuals to infections and heart failure and increase the risks of preterm labor, low birth weight, and maternal and child mortality [9, 10].

Yemen's situation is dire, with an estimated 47% of children under five experiencing stunting and 15% suffering from wasting, showcasing the country's severe chronic malnutrition crisis [11]. The United Nations estimates that 22.2 million Yemenis are in need of humanitarian aid. Approximately 16.4 million individuals lack access to quality healthcare, and 17.8 million people grapple with food insecurity. Around 462,000 children are affected by severe acute malnutrition, and 1.8 million children suffer from acute malnutrition [12]. Due to escalating violence in Yemen, approximately 2 million people are being forcibly displaced from their homes at alarming rates, according to reports [13].

According to data from Ministry of Public Health and Population, the prevalence of anemia among children under five in Yemen saw a significant increase, despite a decrease from 54% in 2005 to 40% in 2011 [13]. The government's inaction in addressing the escalating anemia rates poses a serious public health challenge in Yemen. To determine the prevalence of anemia among malnourished children aged 6-60 months in Sana'a, Yemen, along with associated factors, a study was conducted. The WHO defines anemia variations based on factors such as altitude, race, smoking status, age, sex, and pregnancy status: Hb level < 11g/dL for children aged 6 to 59 months; < 11.5 g/dL for children aged 5 to 11; < 13 g/dL for adult males; < 12 g/dL for non-pregnant women; and < 11 g/dL for pregnant women. Severe anemia is classified as Hb < 7.0 g/dL, but adjustments for smoking and altitude are necessary [14].

Internally displaced persons are dispersed within communities and are challenging to identify or assess due to the absence of dedicated camps for them. Even before the conflict intensified in March 2015, Yemen faced considerable humanitarian needs [15]. Nearly 100,000 children under five in Hodeida are at risk of severe acute malnutrition, a stark increase from 23,000 before 2015. In Aden, this number has more than doubled from 3000 before 2015 to 7700 presently [16].

The objective of this cross-sectional study was to assess the prevalence of anemia and identify the contributing factors among malnourished children in Sana'a city, Yemen.

2. Subjects and Methods

2.1. Study design

This cross sectional active laboratory study was carried out in the children malnutrition centers in Sana'a, Yemen in the period from 1st of October 2023 until the end of February 2024.

2.2. Sample size

A sample size of 50 was calculated using the following parameters: confidence level = 95%, margin of error = 13.8%, and frequency of anemia among malnourished children = 54% [pilot study].

2.3. Data collection

Individual data were collected in a pre-designed questionnaire, including nutritional statistics, clinical data, demographic data, and laboratory results.

2.4. Statistical analysis

By using Epi Info statistical program version 6 (CDC, Atlanta, USA), the analysis of the data was performed. Expressing the quantitative data as mean values, or standard deviation (SD), when the data was normally distributed. Expressing the qualitative data as percentages.

2.5. Ethical consideration

Prior to gathering data, the institution's ethical review committee gave its approval. All participants or/and their guardians received an explanation of the study's goals and advantages prior to involvement, and their verbal informed agreement was obtained. Participants and their families were also told that their participation was optional and that they might decline it without giving a reason.

3. Fields and Laboratory Works

First clinical investigations of malnutrition was done by doctors in the hospitals and recorded in the pre-designed questionnaire. Then, a venous blood sample were taken for blood parameters testing with standard laboratory methods.

4. Results

The male children counts 36% and female children was 64%. The mean age of our patients was 11.8 months with SD equal to 12.1 months and ages ranged from 1-76 months. Most of our patients were in the age group of 7-12 months (44%), followed by the group of 1-6 months (28%), while other age groups were less frequent (Table 1). The mean RBC count was 4.2 cells × 106/µl with a SD of 0.72 and ranged from 2.6 to 5.5 cells × 106/µl. The result showed that 36% of our patients had a value lower than normal for children. Most of our patients were at 4.0-4.9 cells x 106/µl (44%) followed by 20% for a level of >4.9 (Table 2). Table 3 shows the mean WBC count was 10.3 cells × 109/L with an SD of 4.3 and ranged from 2.8 to 24 cells × 109/L. The result showed that 4% of our patients had a value lower than normal for children. Most of our patients were at

4.5-10 cells x 109/L (54%) followed by 34% for a level of ≥11.1. The mean hemoglobin level of the children patients was 10.4 mg/dL, the SD level was 1.6 mg/dL and ranged from 6.2 to 12.9 mg/dL. Anemia (<11.1 mg/dL) was reported in 54% of all patients. Most patients had less than 10 mg/dL (36%), while only 20% of patients had 12.1-13 mg/dL (Table 4). Below the normal level for PCV were 28% of patients, 40% in 30-35 PCV and 24% in 35.1-40% PCV, while only 8% reported >40 PCV (Table 5). Table 6 shows the mean MCV was 75.9 fl with SD equal to 8.3fl, and the MCV ranged from 52 fl to 91 fl. Most patients had <80 fl of the MCV, 64% (macrocytic anemia). 20% of patients had 80-84 fl, and only 16% of patients had >84 fl. Table 7 illustrates the mean corpuscular hemoglobin/picograms (pg) per cell (MCH) of our patients was 24.6 p/cell, with standard division of 3.3 p/cell and ranged from 18 to 37 pg/cell. Most patients had less than 27 pg/cell (826%) indicating iron deficiency anemia while 6% had 27-28 pg/cell and 12% had more than 28 p/cell indicating anemia due to low levels of folic acid or vitamin B12. The mean MCHC of our patients was 32 g/dl, with SD of 2.1 g/dl and ranged from 29 to 37 g/dl. About 58% of patients had less than 32 g/dL anemia while 16% had 32-33.9 g/dL and 26% had >33.9 g/dL (Table 8). The mean RDW for our patients was 14.9%, with an SD of 2.3% and ranged from 10 to 22%. About 4% of patients have a level of <12, 62% have a level of 12-15, and 16% have a level 15-16, while 18% had > 16 level. All of these findings indicate anisocytosis which is common in nutritional anemia (Table 9). The mean platelets counts for our patients was 372.2 cell x 109/L with an SD of 183.7 cell x 109/L and ranged from 16 to 883 cell x 109/L. About 4% of patients have a level of <150 cell x 109/L indicating thrombocytopenia (Table 10).

Characters	N (%)
Sex	
Male	18 (36)
Female	32 (64)
Age groups (months)	
1-6	14 (28)
7-12	22 (44)
13-24	13 (26)
25-36	3 (6)
>36	1 (2)
Total	50 (100)
Mean age	11.8 months
SD	12.1months
Median	10 months
Mode	12 months
Min-Max	1-76 months

Table 1: Sex and Age distribution of children under five years with malnutrition in Sana'a city, Yemen.

RBC (cell x 10^6/µL)	N (%)
Less than 4.0	18 (36)
4.0-4.9	22 (44)
>4.9	10 (20)
Total	50 (100)
Mean	4.2
SD	0.72
Median	4.2
Mode	3.5
Min-Max	2.6-5.5

A normal RBC count would be in children around 4.0 to 5.5 x 1012/L.

Table 2: Red blood cell counts of malnutrition children in Sana'a city, Yemen. (106/µL)

WBC (cell x 10^9/L)	N (%)
Less than 4.5	2 (4)
4.5-10.0	27 (54)
10.1-11.0	4 (8)
≥11.1	17 (34)
Total	50 (100)
Mean	10.3
SD	4.3
Median	9.6
Mode	6.4
Min-Max	2.8-24

A normal WBC count would be in children around 4.5 to 11.0 x 109/L.

Table 3: White blood cell counts of malnutrition children in Sana'a city, Yemen (106/µL)

Hb (mg/dL)	N (%)
Less than 10	18 (36)
10-11	9 (18)
11.1-12	13 (26)
12.1-13	10 (20)
>13	0 (0.0)
Total	50 (100)
Mean	10.4
SD	1.6
Median	10.8
Mode	10.7
Min-Max	6.2-12.9

The normal Hb level for children (males and females) is 11.9 to 15 g/dl

Table 4: Hemoglobin level of malnutrition children patients

PCV	N (%)
Less than 30.0	14 (28)
30-35	20 (40)
35.1-40.0	12 (24)
>40.0	4 (8)
Total	50 (100)
Mean	31.9
SD	5.3
Median	31.4
Mode	31
Min-Max	17-42.7

Normal levels of PCV in children range from 30% to 44%.

Table 5: Packed cell volume level of malnutrition children in Sana'a city, Yemen.

MCV /fl (Mean corpuscular volume/femtoleter)	N (%)
Less than 80	32 (64)
80-84	10 (20)
>84	8 (6)
Total	50 (100)
Mean	75.9
SD	8.3
Median	77
Mode	69
Min-Max	52-91

Below 80 fl (femtoliters), they will likely develop or have microcytic anemia. Alternatively, if their MCV levels are greater than 100 fl, they could experience macrocytic anemia.

Table 6: MCV level of malnutrition children, Sana'a city, Yemen.

MCH (mean corpuscular hemoglobin/picograms per cell)	N (%)
Less than 27	41 (82)
27-28	3 (6)
>28	6 (12)
Total	50 (100)
Mean	24.6
SD	3.3
Median	24
Mode	24
Min-Max	18-37

Table 7: MCH level of malnutrition children, Sana'a city, Yemen.

The normal range for MCH is 27 to 31 picograms per cell. Anything above or below that may indicate an underlying condition, usually a type of anemia. Low levels of MCH can indicate iron-deficiency anemia while high levels of MCH can signal anemia caused by low levels of folic acid or vitamin B12. mean corpuscular hemoglobin

MCHC g/dl	N (%)
Less than 32	29 (58)
32-33.9	8 (16)
>33.9	13 (26)
Total	50 (100)
Mean	32
SD	2.1
Median	31
Mode	31
Min-Max	29-37

Table 8: MCHC level of malnutrition children, Sana'a city, Yemen.

A typical MCHC result is 32-36 grams/deciliter (g/dL) or 320–360 grams per liter (g/L), although this may vary depending on the lab. Levels outside this range can indicate anemia.

RDW percent	N (%)
Less than 12	2 (4)
12-15	31 (62)
15-16	8 (16)
>16	9 (18)
Total	50 (100)
Mean	14.9
SD	2.3
Median	15
Mode	13
Min-Max	10-22

Table 9: Red cell distribution width level of malnutrition children, Sana'a city, Yemen.

A normal range for red cell distribution width is 11.8 to 14.5 percent in children.

platelet count (cell x 10^9/L)	N (%)
Less than 150	4 (8)
150-350	20 (40)
351-450	14 (28)
≥451	12 (24)
Total	50 (100)
Mean	372.2
SD	183.7
Median	359.5
Mode	345
Min-Max	16-883

A normal platelet count ranges between 150-450x109/L

Table 10: Platelets Counts of malnutrition children in Sana'a city, Yemen (109/L)

5. Discussion

A person is considered to be malnourished if their energy and/or certain nutrients are inadequate, excessive, or out of balance for their needs [17]. It's among the biggest issues that humanity is now dealing with. Malnutrition is caused in large part by variables such as poverty, regional conflicts, inadequate food supply, fast population increase, and social, political, and educational issues—all of which are present in Yemen. Anemia is considered to be harmful to one's health, especially for mothers during pregnancy and young children [18, 19]. The youngsters would therefore be more susceptible to a range of infectious illnesses, including malaria and helminthic infections—all of which are common in Yemen [20].

Additionally, infections worsen malnutrition by lowering appetite, triggering catabolism, and raising nutritional requirements. Well-established research suggests that malnourished children are more likely to die from an infection, even if it is debatable whether malnutrition causes infections more frequently or just makes them worse [21,22]. Global estimates for 2020 indicated that 149 million children under five were stunted (too little for their age), 45 million were wasted (too thin for their height), and 38.9 million were overweight or obese [23]. As per the assessment on the status of food security and nutrition, 40% of Yemeni children were found to be undernourished, with 16% experiencing severe malnutrition and 41% experiencing stunting.

Fifty two million of the children under five had a mortality rate of 45%, according to the research [24]. This suggests that Yemen and other developing countries are susceptible to malnutrition [25]. One of the main causes of disease and death in preschool-aged children is under nutrition [26]. The malnourished young patients in this study had a mean hemoglobin level of 10.4 mg/dL, with a standard deviation of 1.6 mg/dL and a range of 6.2 to 12.9 mg/dL. Of all patients, 54% had anemia (<11.1 mg/dL). Furthermore, only 20% of patients had 12.1-13 mg/dL, while the majority of patients (36%), had less than 10 mg/dL. According to all of

these facts, anemia is a major issue for the youngsters under study. Protein deficiency and adaptation anemia, iron deficiency, vitamin deficiencies (folic acid, B12, E, pyridoxine, and riboflavin) or trace element deficiencies (copper, selenium, and zinc), erythropoietin deficiency, infection, chronic inflammation, and parasitic infections can all contribute to PEM anemia. Therefore, anemia is caused by any decrease in these micro components [27]. According to physiological definitions, anemia is any illness in which the patient has tissue hypoxia [28]. Furthermore, it may also be described as a decrease in Hb levels [29]. When the rate of RBC production is greater than the rate of RBC loss or destruction, anemia develops.

The RBC count in this study varied from 2.6 to 5.5 cells x 106/µl, with a mean of 4.2 cells × 106/µl and a standard deviation of 0.72. The outcome demonstrated that 36% of our patients had values below the typical range for kids. As a result, variables that may contribute to the development of anemia include those that reduce red blood cell formation, increase their loss or destruction, or, in certain situations, both [30]. Over one-third of the world's population suffers from anemia, a public health issue that affects both industrialized and developing countries. However, in developing nations like Yemen, it is higher. Anemia is the most common hematologic symptom, according to a WHO publication [31]. Globally, the prevalence of anemia in children aged 6 to 59 months was 39.8% in 2019, which translates to 269 million children suffering from anemia. This percentage is lower than our 54% rate. In children under five, the frequency of anemia was highest in the African Region (60.2%) [32]. Anemia's effects on a nation's social and economic development are influenced by its lowering of immunity, which leaves youngsters more susceptible to infectious diseases and increases their risk of death [33]. Furthermore, it has been connected to stunted growth, lower psychomotor growth, and decreased social, emotional, and cognitive functioning in children [34]. These are serious effects for children as their bodies mature.

The results of this study indicated that 54% of children under five had anemia overall. Following adjustments for a variety of socioeconomic and demographic factors, care-related factors, environmental health and sanitation, dietary and household food modifications, household food insecurity, and morbidity-related factors, it was found that anemic children were more likely to reside in households experiencing food insecurity, have a diet lacking in diversity, initiate supplemental feedings either early or late, receive subpar breast milk, and have mothers who used less iron and folate during their pregnancies. The WHO categorized the prevalence of anemia in children found in this study as a serious public health concern [3].

When comparing the prevalence of anemia and related variables in children with earlier international research, the frequency in this study was greater than Ethiopia's in the 2016 regional report (49.6%). This could be the result of food scarcity brought on by war, which lowers consumption of a variety of foods and causes disorders linked to micronutrient deficiencies, like anemia [35]. However, it was significantly lower than the 72.7% national survey for Ethiopia as a whole done in 2016 [36] and the 66.6% research carried out in the Wag-Himra zone in north Ethiopia [37]. Even so, it was far lower than research from Cameroon [38] and Sudan [39], where the frequency was 86% and 66.7%, respectively. The reduced prevalence in this study could be attributed to various variables, such as changes brought about by current nutritional practices, public health programs, and the ease with which health information can be accessed through health extension workers. However, with this tiny cross-sectional study, the sample size is still insufficient to compare with the national data of the EDHS; hence, large sample sizes and analytical investigations are required to understand temporal and seasonal differences.

6. Conclusion

This study determined that the prevalence of anemia among children under five years old in Sana'a city, central Yemen, was 54%. Such prevalence is categorized as a severe public health concern by WHO classification criteria. Initiation time of complementary feeding, breast feeding practice, maternal history of iron folate (IFA) utilization, dietary diversity, and household food insecurity should be investigated because these might be the significantly associated factors with anemia in Yemen.

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Conflict of Interest

This work does not include any conflicts of interest.

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