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SEARCH STRATEGY

Set No.	Searched for	Databases	Results
S3	Journal of Blood Medicine	Ebook Central, Public Health Database, Publicly Available Content Database	704790*
S2	The Journal of Health Care Organization, Provision, and Financing	Ebook Central, Public Health Database, Publicly Available Content Database	20600*
S1	Organization, Provision, and Financing	Ebook Central, Public Health Database, Publicly Available Content Database	47773*

* Duplikat dihapus dari pencarian Anda, tetapi disertakan dalam jumlah hasil Anda.

Iron Deficiency and Iron Deficiency Anemia Are Common Epidemiological Conditions in Saudi Arabia: Report of the National Epidemiological Survey

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ABSTRAK (ENGLISH)

Iron deficiency is the most prevalent nutritional deficiency worldwide. According to an estimate by the World Health Organization, up to 27% of the world's population experience iron deficiency anemia (IDA). Studies conducted in the Middle East, including Saudi Arabia, have suggested that IDA is the most common cause of anemia, especially among females. This study aimed to determine the prevalence of IDA and iron deficiency (ID) among apparently healthy young university students from four regions in Saudi Arabia. Students were asked to complete a simple survey questionnaire; blood samples were then collected and analyzed after obtaining informed consent. A total of 981 students completed the survey, with 11% of the participants reporting symptoms of anemia; 34% of participants were diagnosed with IDA and 6% reported a diagnosis of hemoglobinopathy. Blood analysis confirmed the prevalence of ID and IDA in 28.6% and 10.7% of the participants, respectively; those with ID and IDA were mostly females (88.5% and 94%, resp.). Thalassemia trait and sickle cell trait were detected in 1.3% and 7% of participants, respectively. Our findings from a national survey among young university in Saudi Arabia indicate a high prevalence of ID and IDA.

TEKS LENGKAP

1. Introduction

Iron is a vital element in human metabolism and plays a central role in erythropoiesis. It is also involved in many other intracellular processes in the body tissues [1]. Iron is necessary to maintain healthy cells, skin, hair, and nails.

Iron metabolism in the body is a complex process that is regulated by hormones that balance the absorption by the cells that line the gastrointestinal tract, or pool in body compartments, storage, and excretions. The daily requirement of iron for erythrocyte production and cellular metabolism is 25 mg/day, which is met through iron absorption from the diet (1-2 mg/day), iron salvaged from erythrocyte breakdown by macrophages (20–25 mg/day), and through iron stores (total of 3–5 g in adults) [2]. Iron requirements change based on physiological changes. The adolescence phase is characterized by an accelerated rate of growth and development. Iron requirements in girls begin to increase after menarche, with 30–40 mL of blood loss during each menstruation cycle leading to a loss of 15–30 mg of iron per cycle. In boys, testosterone secretion and an increase in muscular mass require additional iron [3].

Various nonmodifiable and modifiable factors exert an influence on an individual’s iron balance, ranging from sociodemographic characteristics (including the individual’s age, sex, marital status, level of education, income, and ethnicity) to the amount and quality of the food and beverages they consume; iron balance is also affected by individuals’ mental and physical health, the medication they consume, any underlying medical conditions, and their genetic makeup [4–6].

Iron deficiency (ID) is a state in which there is insufficient iron to maintain normal physiological functions of tissues [7]. This condition results from an imbalance between iron requirements and the quantity ingested and absorbed. ID is associated with impaired physical work capacity, cognitive function, reproductive physiology, and poor pregnancy outcomes [8]. After the exhaustion of iron, the imbalance between the supply and requirement causes a decrease in the erythropoiesis leading to low Hb synthesis and anemia. Some functional changes may occur in the absence of anemia; however, most functional deficits occur with the development of anemia [9]. Functional iron deficiency (FID) describes a condition where there is insufficient iron incorporation into erythroid precursors in the face of apparently adequate body iron stores [10].

Anemia is a condition in which the number of red blood cells (consequently their oxygen-carrying capacity) is insufficient to meet the body’s physiological needs. Iron deficiency anemia (IDA) is presently the most prevalent and common type of micronutrient deficiency in developing countries that results from a long-term negative iron imbalance. The World Health Organization (WHO) has reported that approximately two billion individuals worldwide suffer from anemia, with 50% of all anemia secondary to IDA [11]. Usually, ID develops gradually and does not have clinically apparent symptoms until the anemia becomes severe [12]. The literature on anemia in adolescents and youth is scarce, with most studies focusing on women and children.

Serum ferritin has been suggested as the best test for diagnosing or excluding IDA; however, the cutoff values for the diagnosis of ID are an area of debate [13–17] with the cutoff used affecting the estimation of the real prevalence of IDA. Thus far, there is no consensus on the ferritin cutoffs used to define absolute or functional ID in the general population. Although the WHO has made some recommendations for the diagnosis of ID (based on low ferritin level) and IDA (based on low Hb plus low ferritin level), most of the reported prevalence studies have used unstandardized tools for the estimation of IDA prevalence, including studies from Saudi Arabia [13–17]. Another limitation of ferritin in the diagnosis of iron deficiency has been an acute phase reactant in conditions of inflammation and infection.

In Saudi Arabia, the overall prevalence of IDA is not well established by epidemiological surveys; however, there are many reports from single institutions and for specific age or sex populations with a reported prevalence ranging from 10 to 60% [7, 18–27]. The WHO reviewed publications on the prevalence of IDA in their country profile for Saudi Arabia and found that most of the reports were on anemia in general without any clear definition of IDA. Therefore, the present study aimed to report the prevalence of ID and IDA through a national epidemiological survey among apparently healthy young university students within four regions in Saudi Arabia.

2. Materials and Methods

This cross-sectional study was conducted among 981 young apparently healthy Saudi university students with high socioeconomic status identified and recruited by randomized sampling from universities within four regions in Saudi Arabia (Riyadh, Medina, Makkah, and Dammam). The study sample included 507 and 474 female and male students, respectively. This study was conducted in two parts: the first part involved the administration of a questionnaire to evaluate the knowledge about anemia among the participants and to correlate these with the laboratory findings (Table 1), while the second part of the study involved the collection of blood samples for the evaluation of anemia status, to confirm the presence of ID, and to evaluate the presence of hemoglobinopathy. Some of the blood samples had to be discarded because of the poor quality of blood samples; the final laboratory analysis was performed on 956 samples.

Table 1

Responses to the survey questionnaire (n=981).

Inquiry	Female (507) *n* (%)	Male (474) *n* (%)	Total (981) *n* (%)	p value
Do you suffer from any type of anemia?				
Yes	73 (14.4%)	36 (7.6%)	109 (11.1%)	0.001
G6PD	1 (20%)	4 (80%)	5 (4.6%)	Iron deficiency/IDA
33 (89.2%)	4 (10.8%)	37 (33.9%)	Anemia	8 (88.9%)
1 (11.1%)	9 (8.3%)	Sickle cell	2 (50.0%)	2 (50.0%)
4 (3.7%)	Sickle cell trait	-	2 (100%)	2 (1.8%)
Thalassemia	1 (100%)	-	1 (0.9%)	Spherocytosis
1 (100%)	-	1 (0.9%)	Type unknown	27 (54.0%)
23 (46.0%)	50 (45.9%)	-		
Do any of your family members have thalassemia or sickle cell disease?				
Yes	49 (9.7%)	72 (15.2%)	121 (12.3%)	0.009

–				
Do you have history of parental consanguinity?				
Yes	128 (25.2%)	171 (36.1%)	299 (30.5%)	0.1
–				
Have you ever been diagnosed with any bleeding disorders in the past?				
Yes	37 (7.3%)	31 (6.5%)	68 (6.9%)	0.706
Hemophilia	2 (100.0%)	-	2 (2.9%)	Platelet deficiency
1 (100.0%)	-	1 (1.5%)	Don't exactly know the diagnosis	7 (46.7 %)

2.1. Subjects

After multicenter Institutional Review Board approval, an epidemiological survey was carried out on a randomly selected sample of young adult Saudi university students of both sexes from four regions of Saudi Arabia (Riyadh, Medina, Makkah, and Dammam) between May 2016 and 2018. The participants were asked to complete a simple questionnaire. The survey was conducted on site by trained Arabic-speaking interviewers after explaining the aims of the study. After obtaining verbal consent, blood samples were collected from all the participating students. All questionnaires were coded for data entry. The study was approved by the research advisory committee of King Faisal Specialist Hospital as part of the national survey, with a science and technology grant from King Abdulaziz City.

2.2. Blood Sample Analysis

Blood samples were collected by trained nurses from each participant in two anticoagulants (5 mL each): EDTA and sodium heparin. Complete blood count (CBC), plasma ferritin level, and capillary zone electrophoresis were performed for each participant. CBC was estimated from the EDTA samples using an automated SYSMEX XN-10 instrument (Sysmex Corporation, Kobe, Japan). Plasma ferritin level was measured using an automated chemistry analyzer COBAS 601 (Roche Diagnostics, Basel, Switzerland), while Hb variants were detected from fresh hemolysate blood samples using capillary zone electrophoresis.

Based on the WHO criteria for the diagnosis of anemia, participants were categorized into normal, ID, and IDA groups. Normal levels were defined as Hb $\geq$ 12.0 g/dl for females and $\geq$13.0 g/dl for males, along with plasma ferritin levels $\geq$30.0 ng/ml. ID was defined as Hb > 12.0 g/dl for females and >13.0 g/dl for males, with a plasma ferritin level of either <15 ng/ml or <30.0 ng/ml. IDA was defined as Hb

2.3. Data Management and Quality Assurance

All participants were interviewed by Arabic-speaking trained individuals and the data were collected using specially designed Arabic-language Case Report Forms. Confidentiality was maintained by assigning each participant a unique identification number which was entered into a computerized database. Data were validated for data entry errors by cross-checking the improbable answers. Discrepancies were handled by reviewing the original forms. All data were analyzed using IBM SPSS Statistics Version 20 (IBM Corp., Armonk, NY, USA) after data cleaning and quality checks.

2.4. Statistical Analyses

Continuous data are presented as medians and accompanying ranges. For continuous data that did not conform with normality assumptions, an independent-sample Mann–Whitney *U* test was used to test for the significance of the difference between the two groups. For categorical data, the chi-square test or Fisher's exact test was used to test for independence of the association. The level of significance was set at 5%.

3. Results

Between January 2016 and June 2018, a total of 981 college students from four different cities in Saudi Arabia (representing four regions) were surveyed. There were 507 females and 474 males in our sample, with a median age of 19.5 (17.3–25.8) years for females and 18.9 (16.3–38.9) years for males. In response to the questionnaire, 11.1% (*n* = 109) of participants (73 females) indicated that they knew about their anemia status and reported different types of anemia, with IDA (33.9%) being the most common (Table 1).

A significant difference p≤0.001 in the levels of Hb, ferritin, hematocrit (HCT), platelets, mean platelet volume, Hb-A, and Hb-A2 was observed between male and female students (Table 2). The results of ferritin and Hb are presented as three groups: Groups A, B, and C (Table 3). The groups were based on three different cutoff values for ferritin; the internationally accepted cutoff value for ferritin is <30 ng/ml [15]. Additionally, we evaluated two other cutoff values based on previous reports: <15 ng/ml and <12 ng/m [12–14]. Based on these cutoffs, we found that 61.0% of students had normal Hb for sex and adequate iron stores while 5.6% of students showed anemia due to hemoglobinopathy. Different prevalence of ID and IDA was found based on the different cutoffs (Figure 1). The overall prevalence for ID and IDA was 28.1% and 10.7% with a female predominance of 88.9% and 94.1% in the two groups, respectively (Table 3).

Table 2

Age and hematological profile of the students at the interview.

Variable	*n*	Female (*n* = 507)		*n*	Male (*n* = 474)		p value
Median	(Min–Max)	Median	(Min–Max)	Age (years)	257	19.5	(17.3–25.8)
301	18.9	(16.3–38.9)	0.349	Hb (g/dL)	501	12.6	(6.8–17.0)
468	15.1	(8.7–17.7)	0.001	Ferritin (ng/mL)	502	20.5	(1.6–393.0)
466	90.0	(4.6–543.0)	0.001	HCT (%)	500	40.0	(4.3–56.3)
468	46.0	(29.8–57.4)	0.001	MCV (fL)	501	86.0	(9.4–108.5)
468	85.2	(10.0–111.8)	0.555	Plts (10^9/L)	490	236.0	(104–592)

455	230.0	(102–501)	0.001	MPV (fL)	499	10.0	(7.1–14.9)
467	9.3	(6.6–14.2)	0.001	HbA (%)	455	97.5	(55.5–98.7)
401	97.3	(53.9–99.2)	0.001	HbA2 (%)	457	2.5	(0.7–5.7)
402	2.6	(0.8–5.5)	0.001	HbF (%)	66	0.7	(0.2–28.9)
26	0.7	(0.1–7.1)	0.751	HbS (%)	25	35.6	(16.6–71.7)

Hb: hemoglobin; Hct: hematocrit; MCV: mean corpuscular volume; Plts: platelets; MPV: mean platelet volume; HbA: hemoglobin A; HbF: fetal hemoglobin; and HbS: an abnormal type of hemoglobin inherited from parents. None of the data conformed to the normality assumption.

Table 3

Observations based on hematological profile—full Cohort, all regions.

Observations	Female	Male	Total	p value
For confirmed lab values (n = 956)				
Group A (ferritin ≥30)	161 (27.5%)	424 (72.5%)	585 (61.2%)	<0.001
Ferritin ≥30, Hb above normal limits*	138	416		Ferritin ≥30, Hb low**
23	8		Group B (low ferritin, normal Hb)	239 (88.8%)
30 (11.2%)	269 (28.1%)	Ferritin ≥15 and <30, Hb above normal limits	136	25
	Ferritin ≥12 and <15, Hb above normal limits	30	3	

Ferritin <12, Hb above normal limits	73	2		Group C (low ferritin and low Hb)
96 (94.1%)	6 (5.9%)	102 (10.7%)	Ferritin ≥15 and <30, Hb low	20
2		Ferritin ≥12 and <15, Hb low	7	0
	Ferritin <12, Hb low	69	4	
–				
Thalassemia				
Hb-A2 ≤ 3.5%	450 (98.5%)	398 (99%)	848 (98.7%)	
Hb-A2 > 3.5%	7 (1.5%)	4 (1%)	11 (1.3%)	
–				
Sickle cell anemia				
Hb-S ≤ 23%	2 (8%)	1 (5.6%)	3 (7%)	
Hb-S > 23%	23 (92%)	17 (94.4%)	40 (93%)	

Two students were positive for both thalassemia and sickle cell anemia. ,*Male ≥13, female ≥12 ;**male[figure omitted; refer to PDF]

We found that 98.5% of females and 99% of males were within the normal range (<3.5%) of Hb-A2 (normal hemoglobin type), while 1.5% of females and 1% of males had elevated values (>3.5%) of Hb-A2; the diagnosis of β -thalassemia trait Hb-A2 was found to be significantly different for students without ID or IDA and with ID and IDA p< 0.001. There were 40 (4.1%) students with hemoglobin-S >23%, while three students had hemoglobin-S ≤23%, which could be due to coinheritance of the alpha thalassemia or another Hb variant that we could not confirm.

3.1. Regional Results

Regional variations in the prevalence of hemoglobinopathy, ID, and IDA were observed (Table 4). There were variations in the prevalence of hemoglobinopathy by region, with the Dammam region showing the highest prevalence (59.2%), followed by Makkah (22.4%), Riyadh (12.2%), and Medina (6.1%) p<0.001. However, we did not find any significant association between hemoglobinopathies and the incidence of ID or IDA in the overall cohort.

Table 4

Observations based on the hematological profile (excluding cases of thalassemia and sickle cell disease) by regions with confirmed lab values (*n* = 908).

Regions	Group B (low ferritin, normal Hb)	Female	Male	Total	p value	Group C (low ferritin and low Hb)	Female	Male	Total	p value
Dammam	Region total	34 (81.0%)	8 (19.0%)	42/174 (24.1%)	<0.001	Region total	17 (85%)	3 (15%)	20/174 (11.5%)	0.001
Ferritin ≥15 and <30, Hb ANL	19	5			Ferritin ≥15 and <30, Hb low	4	1			Ferritin ≥12 and <15, Hb ANL
5	1			Ferritin ≥12 and <15, Hb low	2	0			Ferritin <12, Hb ANL	10
2			Ferritin <12, Hb low	11	2				.	
Makkah	Region total	112 (95.7%)	5 (4.3%)	117/276 (42.4%)	<0.001	Region total	27 (100%)	0 (0%)	27/276 (9.8%)	-

Ferritin ≥15 and <30, Hb ANL	58	4			Ferritin ≥15 and <30, Hb low	5	0			Ferritin ≥12 and <15, Hb ANL
20	1			Ferritin ≥12 and <15, Hb low	1	0			Ferritin <12, Hb ANL	34
0			Ferritin <12, Hb low	21	0			·		
Madina	Region total	47 (81%)	11 (19.0%)	58/293 (21%)	<0.001	Region total	29 (96.7%)	1 (3.3%)	30/293 (10.2%)	0.033
Ferritin ≥15 and <30, Hb ANL	29	11			Ferritin ≥15 and <30, Hb low	4	1			Ferritin ≥12 and <15, Hb ANL
2	0			Ferritin ≥12 and <15, Hb low	0	0			Ferritin <12, Hb ANL	16

0			Ferritin <12, Hb low	25	0			·		
Riyadh	Region total	37 (86.0%)	6 (14.0%)	43/165 (26.1%)	<0.001	Region total	16 (88.9%)	2 (11.1%)	18/165 (10.9%)	0.007
Ferritin ≥15 and <30, Hb ANL	22	5			Ferritin ≥15 and <30, Hb low	5	0			Ferritin ≥12 and <15, Hb ANL
3	1			Ferritin ≥12 and <15, Hb low	3	0			Ferritin <12, Hb ANL	12

ANL: above normal limits.

4. Discussion

Iron deficiency anemia is a major health problem worldwide, especially in developing countries [28, 29]. This study establishes the prevalence of ID and IDA among young university students from four major regions of Saudi Arabia. Serum ferritin levels decrease during the early stages of ID as iron stores are depleted, leading to uncomplicated ID. In Saudi Arabia, there are many reports about the magnitude of this national health problem; however, these reports were either from a single institute, or for specific population groups, conducted among either males or females, or were from one region. The overall reported prevalence of IDA in Saudi Arabia ranges from as low as 10% to as high as 60% [7, 18–27]. This is a unique study as it is the first large scale study to determine the prevalence of IDA in healthy young university students from Saudi Arabia. To the best of our knowledge, based on a search of PubMed and Google scholar databases, this is the first study to be conducted in four regions of Saudi Arabia simultaneously. There are limited data on the definition of ID, with available data recommending a ferritin cutoff of <15 ng/mL with a normal hemoglobin (Hb) level for age and sex for the diagnosis of ID; this criterion seems to be specific but not sensitive [13, 14]. Pfeiffer and Looker suggested a cutoff of <12 ng/mL and observed that it was sensitive but not indicative of the severity of ID [15]. As these thresholds have not been universally adopted, the WHO has defined ID as serum or plasma ferritin levels <12 ng/mL in children younger than 5 years and less than 30 ng/mL when inflammation is concurrent. For children older than 5 years, ID is diagnosed when ferritin concentrations are <15 ng/mL [16]. Another suggested threshold that has not yet been validated but has been adopted by the Royal College of Pathologists of Australasia is a ferritin cutoff of 30 ng/mL [17].

Our results show a high frequency of ID (28.6%) among apparently healthy students. These findings are interesting and show the similarity between the central (Riyadh), eastern (Dammam), northern (Medina), and western (Makkah) regions of the country. Similar findings have been reported previously by Sinclair et al. in aerobics-trained males and females, where 33% of the participants had ID with a predominance of females (88%) [30]; similar results were also observed in our study. In a large retrospective study in the general population using ferritin level below 30 ng/mL as the cutoff to diagnose ID, Abuaisha et al. reported an ID prevalence of 57.5% and 7.6% among females and males, respectively, with overt IDA developing in 14% of the females within 5 years of follow-up [31]. Similar results have been reported in Japan, where 36–45% of women aged 20–29 years and 44–49% of women aged 30–49 years were diagnosed with ID using ferritin levels <15 ng/ml as the cutoff [32]. In the UK, 15.5% of women aged 19–64 years were found to have ID (ferritin <15 ng/mL) [33]. A study from the US National Health and Nutrition Examination Survey reported that 10.9% of women aged 18–49 years had ferritin levels <12 ng/mL [34].

The cutoff value for identifying people with ID has been the focus of many studies that looked at the impact of this deficiency on human well-being and the development of other symptoms. Although the percentage of individuals with ID who will develop IDA is not well established, Abuaisha et al. have shown in a follow-up of over 5 years that the development of IDA in females (14%) was much more than in males (0.5%) [31]. Soppi reviewed the symptoms of people with ID and reported many possible symptoms related to it, with some patients showing profound symptoms for many years before the development of IDA [35]. This study reports an overall prevalence of 10.5% for IDA as compared with previously published studies (10–60%) [7, 18–27]. The difference in methodologies used in these studies may be responsible for the observed variation. Some of these studies have used crude definitions of IDA by using MCV or Hb levels without proper estimation of iron status in the studied populations. Abalkhail and Shawky, in a facility-based study on 2,850 school children, reported the prevalence of anemia as 20.5% using Hb μ g/L as the cutoffs for Hb and ferritin, respectively. He reported similar results to our study, with an observed prevalence of 25.2% and 10.6% for ID and IDA, respectively [21]. In another study in female college students from the eastern province of Saudi Arabia, Al Jamea et al. evaluated anemia in 201 students using the WHO definition of Hb and ferritin (<120 g/L and <15 μg/L, resp.). They reported a prevalence of 8.2% and 28.8% for ID and IDA, respectively [36]. Alswailem et al. reported the prevalence of IDA as 41.6% in a large cohort of nonpregnant females in Riyadh City, which is much higher than our finding of 10.9%. However, this prevalence is similar to our questionnaire results, where 33.9% of the students indicated that they had IDA. This may have been because of the use of a questionnaire to report the prevalence of IDA without laboratory confirmation [37]. A study on the regional variations in the prevalence of ID and IDA indicated that the highest prevalence of ID was in the Makkah region (42.4%), while the lowest was in Medina (19.8%); for IDA, the highest prevalence was seen in Dammam (11.5%), while the lowest was in Makkah (9.8%). This variation has also been noticed in previous reports where Gari reported a prevalence of 25.2% in the Makkah region [21] while Taha et al. reported low ferritin level in 32.3% of the participants in the eastern province [38]; these results are not far from our report of 24.1%. Similar variability, though to a lesser extent, was found in IDA. Alquaiz et al. reported IDA in 49% of children (6-to-24-month-old) in the Medina region [25]. Further, 1.5% of the female students and 1% of the male students were diagnosed with β-thalassemia trait in the present study, which agrees with a recently reported study by Alsaeed et al. (1.3%) [39]. Additionally, the prevalence of sickle cell hemoglobin was 4.1% in our study population which is close to that reported by a study from the premarital program (2.7%) [40].

5. Conclusions

In conclusion, our results confirm a high prevalence of ID in all the studied regions of Saudi Arabia. IDA is a prevalent health problem in apparently healthy young adults from universities in the four regions of Saudi Arabia, with similar prevalence seen across different regions. We believe that there is an urgent need to develop effective strategies to alleviate iron deficiency and IDA in this population. Although Saudi Arabia is a wealthy country with a high socioeconomic status, there is a high prevalence of both ID and IDA. One of the limitations of this study is the lack of markers for inflammation or infection. More national surveys are required to explore the possible causes and to design preventive measures.

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DETAIL

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Barriers to Health Workers in Iron Deficiency Anemia Prevention among Indonesian Pregnant Women

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ABSTRAK (ENGLISH)

Background. Anemia is a global maternal health problem that commonly occurs in developing countries. During pregnancy, a woman will receive antenatal services to check her condition and prevent complications. This study aimed to explore barriers towards achieving eradication of iron deficiency anemia among pregnant women in Aceh Besar District, Indonesia. *Methods*. This qualitative study was conducted on 18 health workers who were recruited through a purposive sampling method. Data were collected through in-depth interviews using open-ended questions to gain insight about participants' experiences in managing iron deficiency anemia among pregnant women. Data analysis was conducted by an inductive content analysis method to evaluate, encode, and analyze the interview's result. *Result*. Three main themes emerged: (1) facilities, infrastructures, and supplement support; (2) sociocultural factors; and (3) health provider competency deficits and no developing guidelines. *Conclusion*. Our findings provide understanding that there are many obstacles and barriers encountered by health workers in iron deficiency anemia prevention management. Thus, the management of anemia must be supported by a skilled health worker and quality facilities. Health workers and pregnant women must work together to achieve optimal management of anemia prevention.

TEKS LENGKAP

1. Introduction

Anemia during pregnancy is a major health problem that often occurs in developing countries, and this situation can cause negative effects on pregnancy [1]. Anemia is a risk factor that contributes to 50% of maternal deaths [2]. The World Health Organization (WHO) defines a pregnant woman is classified into anemia if her hemoglobin (Hb) level is less than 11 gr/dl [3]. Globally, anemia in pregnancy is a severe hematologic disorder affecting 32.4 million pregnant women [4]. According to the WHO, anemia is considered to be a significant health problem if its prevalence in a study population is 5.0% or more. The prevalence of anemia ≥40% in a population is classified as a severe public health problem [5]. Currently, Indonesian prevalence of anemia during pregnancy in 2018 was 48.9%; this number increased from the last 5 years which was 37.1% [6, 7], with the prevalence in Aceh Besar district being 37.1% [8]. This condition is quite worrying, so it needs actions and research studies that can be used to overcome this problem. A study conducted by Woldegebriel et al. found that the maternal age, education, family income, religion, number of family members at home, and number of children were determinant factors that contribute to anemia in pregnancy [9].

Iron deficiency is the commonest nutritional problem causing anemia among pregnant women [10]. Half of all the cases of anemia can be attributed to iron deficiency [11]. Iron deficiency anemia (IDA) during pregnancy is associated with adverse health effects, including low birth weight and preterm birth. Iron deficiency at giving birth is also associated with developmental delays in children [12]. Also, adverse effects felt by the mother include fatigue, decreased body's immune system functions, poor work capacity, increased risk of heart disease, and death [13–15]. A study also showed that anemia during pregnancy contributed to 23% of indirect causes of maternal death in developing countries [13]. Due to the significant influence of anemia during pregnancy on maternal death, this condition must be treated immediately. This is also in line with one of the targets in Sustainable Development Goals (SDGs) which try to reduce maternal mortality until less than 70 per 100,000 live births in 2030 [16].

Pregnant women must prepare properly for their pregnancy and receive adequate antenatal care. Antenatal care is a program that becomes a way for pregnant women to know their condition so that health workers may be able to provide services based on what they need [2]. Previous studies also found that the quality of antenatal care and number of visits can prevent anemia during the prenatal period [17]. It shows that the role of quality antenatal care in preventing anemia cannot be ruled out [18]. During this time, the Indonesian Ministry of Health has been trying to improve the quality of antenatal services provided to pregnant women. Currently, antenatal care standards that apply in Indonesia consist of 11 procedures that must be met by health workers [19]. The procedures are (1) weight measurement, (2) upper arm circumference measurement, (3) blood pressure measurement, (4) fundal height measurement, (5) fetal heart rate measurement, (6) determine fetal presentation, (7) provide tetanus toxoid immunization, (8) provide iron tablet, (9) provide laboratory test, (10) provide referral properly, and (11) provide health education.

So far, the general antenatal services provided have not been able to manage anemia in pregnancy comprehensively. This is evidenced by the prevalence of anemia that tends not to decrease. The reason why this procedure cannot overcome the pregnancy complications is still not clear enough. Previous studies have not examined barriers perceived by health workers in undergoing IDA prevention management among pregnant women. More insight about these barriers needs to be studied more deeply, so it can support policy-making to improve the quality of antenatal care and suits the needs of pregnant women. The purpose of this study was to explore barriers towards achieving eradication of iron deficiency anemia among pregnant women in Aceh Besar District, Indonesia.

2. Materials and Methods

We used a qualitative method with in-depth interviews to explore the barriers perceived by health workers regarding IDA prevention management among pregnant women. The data were collected in Public Health Centers (PHCs) in Aceh Besar District, Indonesia. In total, there are 28 PHCs in this area. This study was done at 9 selected PHCs in Aceh Besar district and selected using a simple random sampling method. The participant recruitment process was done using purposive sampling methods. The purpose was to recruit participants using inclusion criteria, which were health workers with a minimum diploma level of education, worked at the selected Public Health Center, and responsible for the Mother and Child Health Department. There were 18 health workers who met these criteria and participated in this study.

In-depth interviews were conducted using open-ended questions. The questions used in this study include the following: (1) what is the incidence of anemia in your work area? (2) What are the PHC programs related to the management of anemia in pregnant women? (3) So far, what are the obstacles faced by health workers in managing and preventing anemia among pregnant women? (4) Do PHC have a special counseling program for pregnant women about anemia that been designed at this PHC? (5) What do you think if anemia counseling is designed separately from other conditions during pregnancy? (6) Have you previously trained to be an anemia counselor? (7) What do you think if there is a health worker who is prepared to do counseling about anemia in pregnant women? (8) Are there any suggestions from you to minimize the obstacles found in managing and preventing anemia in pregnant women? The data collection process started with recruiting participants from the selected PHCs. After informed consent was obtained and the participants agreed to participate in the study, interview began. The interview was held for 45–60 minutes. All information from the interview was recorded with digital voice recorders and noted by hand. Interviews were held in the health center hall to minimize noise. After a number of participants were obtained, data collection was stopped because no more new themes were found, so we concluded the data saturation had been achieved.

The inductive content analysis (ICA) method was used to evaluate, encode, and analyze the results of verbal interviews. The results of interviews and discussions were listened several times before being written into a transcript. After that, the results of the transcript were read several times to get a good contextualized understanding. Furthermore, a list of categories and subthemes was developed based on research objectives to answer the whole research questions [20]. Another investigator independently reviewed and verified these categories and subthemes. This study was approved by the Ethics Committee of the Nursing Faculty, Universitas Syiah Kuala, Aceh, with code number 1130041111218.

3. Results

In this study, the majority of the participants was midwife and had experience in providing health services, especially antenatal care for pregnant women (Table 1). The codes were classified into themes, categories, and subcategories.

In the process of analyzing qualitative data after categorizing the code and removing the same code, 12 codes were obtained in 10 subcategories, 7 categories, and 3 main themes, which were facilities, infrastructures, and supplement support; sociocultural factors; and health provider competency deficits and no developing guidelines (Table 2).

Table 1

Characteristics of participants.

Characteristics	*n* = 18	%
Age		
40–50 years old>50 years old	4131	22.272.25.6
–		
Education		
DiplomaBachelor of Public HealthMaster of Public HealthMedical degreeBachelor of Dentistry	93231	5016.711.116.75.5
–		
Practical experience		
>20 years	126	66.733.3

Table 2

Major findings with code, subcategories, categories, and themes.

Code	Subcategory	Category	Theme
Inadequate counseling roomLimited funds for the management of anemia	Inappropriate and unspecified places inhibit the counseling processThere are no specific funds available for anemia treatment	Inadequate infrastructure in iron deficiency anemia prevention management	Facilities, infrastructures, and supplement support
Hb tool components are not sufficient	Inadequacy of the Hb tool component		
The available iron tablets have expired	Incorrect calculation of iron tablet supply	Inadequate supplement supply	
–			

Noncompliance for iron consumptionEating the wrong food	The behavior of pregnant women in consuming iron	An incorrect view of iron needs	Sociocultural factors
Embarrassed if the pregnancy is known by others			
Ashamed if accompanying a pregnant wife	Community perception about pregnancy	The wrong culture related to pregnancy	
Exchange iron-containing work results with nonnutritious foods	Food sources of iron are not consumed by the family	Bad behavior towards family	
–			
Anemia counselors are not trained	There are no trained health workers to become anemia counselors	Health workers' knowledge and competence	Health provider competency deficits and no developing guidelines
Incompatibility of staff competence in the management of anemia	Incompatibility of health workers' competencies		
No specific guidelines for anemia counseling	No special guidebook available	Specific guidelines for anemia counselors	

3.1. Facilities, Infrastructures, and Supplement Support

Health workers in this study revealed that they felt the facilities and infrastructure in IDA prevention management were inadequate. They stated that the place being not appropriate and not specific becomes the inhibiting factors for the counseling process, as they said:

"During this time, counseling is done in the nutrition room. Actually, the room is very narrow and uncomfortable for counseling. Sometimes it also feels hot, too." (P2)

Most of the participants revealed that only general funds were provided for maternal and child health. There were no special funds for the treatment of iron deficiency anemia. These limited funds were barriers for them in providing services to prevent iron deficiency anemia among pregnant women, as they said:

"The first obstacle may be from the funds…" (P6)

"Another obstacle I think is about the funds. There are funds but for the mother and child health overall, there are no special funds for anemia." (P4)

Some health workers stated that there were no clear calculations for the availability of iron tablets and hemoglobin measuring devices. As a result, there are too many iron tablets that have expired, and one component of the hemoglobin examination tool was not enough, which was the strips.

"For iron tablets, there are many in our place (in the Public Health Center). But because it supplied too much, so many of them now are out of date." (P7)

"Yes, we have the Hb meter tools. But the sticks aren't available. The amount is not enough." (P11)

3.2. Sociocultural Factors

Most of the participants revealed that the behavior of pregnant women and families poses a special obstacle for health workers to make sure they follow the advice stated by health workers. This sociocultural factor was very strongly held by pregnant women and their families. They had incorrect views in consuming iron tablets so that they become not compliance in consuming them, as they said:

"*Most of the behavior is not compliance in consuming iron tablets*." (P1)

"*I know they think they are given medicine, not supplements, they consider themselves not sick so they do not want to consume drugs…*" (P4)

In addition to the view of iron supplementation, the majority of participants also revealed that pregnant women continue to consume the wrong foods during pregnancy, which were foods that can inhibit iron absorption and trigger anemia, as they said:

"Many pregnant women drink coffee or tea. Even though she was told not to drink it during pregnancy. But they still drink." (P10)

Participants in this study also stated that there was a wrong view of society in perceiving a woman's pregnancy. Many pregnant women feel ashamed if their pregnancy is known to other people, and the husband also felt embarrassed to accompany a pregnant wife to do a pregnancy checkup, as they said:

"When she was in the first trimester of pregnancy, she was hiding from health workers, decided not to do a pregnancy check because they were shy if people found out she was pregnant. So, they did not get iron tablets in the first trimester." (P2)

"Pregnant women are rarely accompanied by her husband. Maybe only one or two, but most of what I have seen so far, their husbands do not accompany. It is because they embarrassed because their wives are pregnant." (P15)

Related to social factors, participants revealed that most of the husbands worked as fishermen. However, the work results are not provided as food sources for his family, but sold and replaced with other foods; they even bought instant noodles, as stated by the participants:

"*The catch (the work result as a fisherman) was immediately sold and, if possible, they would not eat the fish for even one piece. The money earned is used to buy other foods, such as indomie (instant noodles)*." (P9)

3.3. Health Provider Competency Deficits and No Developing Guidelines

The majority of participants in this study revealed that there were no specific guidelines on anemia management for counselors. The counseling that was carried out was general counseling with the guidance of the Mother and Child Health book published by the Indonesian Ministry of Health, as they said:

"There is a guideline for counseling, only from maternal and child health books. The book is general for all conditions during pregnancy, not specific for anemia." (P5)

Participants also revealed that there were no special health workers who became anemia counselors. Counselors who have been conducting counseling so far were nutritionists who had never undergone counseling training, including anemia counseling training, as they stated:

"The person who did the counseling is nutritionist. They have never been trained about counseling, especially for the counseling about anemia." (P12)

Some participants said that counseling was not carried out by health workers who examined pregnant women, but by the nutrition department. The counseling process was carried out by nutritionists after other health workers examined pregnant women in the Maternal and Child Health room, as they said:

"*Counseling is usually done by a nutritionist. After getting the conditions of what happens to pregnant women, we collaborate with nutritionists*." (P13)

4. Discussion

In the present study, it was found that there were obstacles that were complained by health workers in managing problems in pregnancy, especially anemia. They realized that anemia was a problem that must be handled. However, health workers feel they did not have adequate facilities and infrastructure, felt inadequate, and did not have complete clinical guidelines to manage anemia in pregnancy. The results of this study were supported by the previous study conducted by Widyawati et al. who found that insufficient facilities, high work load, lack of training opportunities, and learning resources for the health care providers are obstacles found in preventing anemia during

pregnancy in the PHC [21].
The inadequacy of facilities and infrastructure that support a service in overcoming a health problem was an aspect that should receive more attention. A literature study conducted by Manyisa and van Aswegen found that inadequate infrastructure and resources were the main factors contributing to the decline of the health service quality [22]. Other research also found that poor funding budgets were a major challenge in providing quality health services [23]. The reality that occurs was very contradictory to government programs that seek to reduce maternal mortality rates through improvements in antenatal care standards that have been carried out so far [19]. Improvement of health services, facilities, and financial support should be done especially in the management of anemia because this situation is one of the global health problems that contributes to increasing maternal mortality.
Besides the ineffectiveness of facilities and infrastructure, cultural beliefs held by pregnant women and their families regarding pregnancy were also an obstacle for health workers in conveying health information. A study proved that cultural beliefs that are believed to be true will affect a pregnant woman's daily life [24]. To make pregnant women and their families follow the advice stated by health workers, it is important for health workers to have effective communication with them and their families. When effective communication has established a trusting relationship, it will be easier for them to convey information by aligning cultural beliefs that are believed by pregnant women. When this trust is not built up, pregnant women will be closed and tend not to respect the information provided. It would be better if the pregnant woman was accompanied by her husband or close family so that the information would be conveyed thoroughly. A husband who accompanies his wife when receiving health services will positively correlate with the woman's own behavior in internalizing health-related advice. It is because as the main decision maker in the household, the husband will play a big role in all aspects including the behavior of seeking health assistance [25]. However, a literature study conducted by Chang et al. revealed that, in building a mutual trust relationship, it will also be influenced by the social status of pregnant women, the environment, the number of health workers, and their cultural beliefs [26].
In addition to barriers from facilities and clients, health workers also pointed out that while undergoing their role as information providers to pregnant women, they never had specific guidelines, especially when providing counseling about anemia. They have also never been trained how to do the right counseling. Previous research also found that the lack of quality health services to pregnant women is influenced by the ineffectiveness of work placement of health workers, lack of training opportunities, and learning resources [21]. Increased knowledge and quality of service by health workers are needed. Training programs must be specifically designed to demonstrate and enhance the knowledge and skills of health workers. Furthermore, it must be reevaluated after the training is done. It is done to ensure that good quality health services can still be provided by health workers, especially related to anemia management, so that this condition can be prevented earlier [27]. The training provided must also be able to run effectively. A study conducted by Naeem suggested that it is necessary to refresh knowledge regularly and periodically so that the knowledge possessed is not forgotten and can be updated according to the needs of pregnant women [28].
Overall, this study found important information about barriers perceived by health workers in managing and preventing iron deficiency anemia among pregnant women. Many barriers perceived by health workers can be used as a supporting reference for policy makers at the Public Health Center to make a comprehensive improvement in the management of anemia, both in terms of health care facilities and the ability of health workers. However, there are some limitations in this study. Additional interviews conducted with health workers will enrich the data. In addition, interviews with policy and decision makers at the Public Health Center will also help to explore this issue.

5. Conclusion

The effectiveness of managing and preventing iron deficiency anemia in pregnancy is influenced by factors that actually inhibit its application. So far, health workers have experienced many problems in managing anemia in primary care, such as inadequate facilities and infrastructure, incompetent staff, and inhibiting factors from pregnant women and their families. Based on our research findings, we conclude that health providers who provide antenatal care to pregnant women, especially in the management of iron deficiency anemia, need to be cared for and minimize the obstacles found so that the services provided can be more adequate.

Disclosure

This manuscript is part of requirement in fulfillment of the doctoral study.

Authors' Contributions

The main author (DD) was the person who conducted the research and wrote the principal draft of the manuscript. Quotes have been selected to illustrate the themes that emerged from the interviews and have been translated into English. NT, KH, and TT was the team that corrected each writing, directed the design of the study, supervised the research conducted, and revised the text. Furthermore, all authors read and approved the manuscript.

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DETAIL

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Determinants of Anemia among Pregnant Women at Public Hospitals in West Shewa, Central Ethiopia: A Case-Control Study

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ABSTRAK (ENGLISH)

Introduction. Anemia is highly dominant among pregnant women due to the need for iron for women themselves and their fetuses. Nearly half a billion globally and around one-third in Ethiopia of pregnant women were affected by anemia which has both health and economic impact. Therefore, this study aimed to identify the determinants of anemia among pregnant women attending antenatal care at public hospitals in the West Shewa zone, Oromia regional state, Central Ethiopia, 2019. *Methods*. An unmatched case-control study was conducted at public hospitals in the West Shewa zone, Ethiopia, from February to April 2019. A consecutive sampling was used to select study participants. Data were collected by a structured questionnaire, and the collected data were entered into Epi Info version 7 and SPSS version 23 for analyses. Descriptive statistics such as tables, graphs, and proportions were used to present the data. Binary and multiple logistic regression analyses were computed to identify the determinants of anemia. Adjusted odds ratio (AOR) with 95% confidence interval (CI) and p value <0.05 were used to determine the presence of an association. *Result*. A total of 426 women (142 cases and 284 controls) participated in this study with a 95.3% response rate. Family size >5 (AOR = 2.95, 95% CI: 1.34–6.50), peptic ulcer diseases (PUD) (AOR = 2.85, 95% CI: 1.14–7.13), having the previous history of abortion (AOR = 2.84, 95% CI: 1.08–7.47), birth interval <2 years (AOR = 2.61, 95% CI: 1.20–5.70), antepartum hemorrhage (APH) (AOR = 6.05, 95% CI: 1.95–18.81), and not using latrine (AOR = 3.45, 95% CI: 1.30–9.24) were the identified determinants of anemia. *Conclusions*. Family size, PUD, abortion, birth interval, APH, and unable to use latrine were the determinants of anemia among pregnant women. Therefore, the intervention on anemia prevention should consider the promotion of family planning methods and counseling on latrine utilization.

TEKS LENGKAP

1. Introduction

World Health Organization (WHO) explained anemia in pregnancy as a hemoglobin level below 11 gm/dl [1]. A type of anemia that most commonly affects women of childbearing age especially pregnant mothers is iron deficiency anemia [2]. Anemia is highly dominant among pregnant women due to the need for iron for women themselves and for their fetuses [1]. Globally, nearly half a billion of reproductive-age women are affected by anemia where about 29% of nonpregnant women and 38% of pregnant women aged 15–49 years [3]. In Ethiopia, around 32% of pregnant women are affected by anemia [4]. Anemia in pregnancy causes reduced cognitive and motor development outcomes in children due to inherited hemoglobin diseases [5]. It also contributed to 8.8% of disabilities globally [6]. Anemia causes 20% of maternal death globally [7, 8]. Anemia in pregnancy may result in premature birth, low birth weight, and maternal, perinatal, and neonatal mortality [9]. The reason why anemia remains a public health problem is mainly due to inadequate nutrient intake, excessive menstrual bleeding, acute or chronic blood loss (gastrointestinal bleeding), infections (malaria and HIV), chronic diseases, parasites infestation, hemolytic anemia (drugs), and frequent pregnancies [10–12]. Different factors are known to cause anemia in pregnancy in sub-Saharan Africa. These include diet deficiency and infections such as malaria, hookworms, and increasingly spread human immunodeficiency virus. Most of these circumstances can be prevented by creating awareness and affordable interventions [13]. WHO intended to decrease anemia among reproductive-age women including pregnant women by 50% up to 2025 [14]. The Ethiopian Ministry of Health tried to mitigate the problem of anemia and its impact through the implementation of essential nutrition action [15]. Despite the high magnitude of anemia among pregnant women which results in high morbidity and mortalities among pregnant women and high economic losses in Ethiopia, the majority of the previously conducted studies in different parts of the word including Ethiopia were done using a cross-sectional study which is weak in displaying real association between anemia and its risk factors [10, 16–24]. The availability of local information on the determinants of anemia is important to solve the problem of anemia at its grass roots. Most of the previous cross-sectional studies conducted in Ethiopia recommended analytic study like case-control studies to be conducted [10, 16, 22, 25, 26]. Moreover, personal hygiene and sanitation-related predictors of anemia like source of water for drinking, hand washing at important times, and utilization of latrine were not studied with regard to anemia in pregnancy in Ethiopia. Although open-field defecation is very common in Ethiopia, its relationship with anemia was not studied. Therefore, this study aimed to identify determinants of anemia among pregnant women attending antenatal care at public hospitals of the West Shewa zone, Oromia regional state, Central Ethiopia.

2. Method and Materials

2.1. Study Design, Period, and Setting

We have conducted an institution-based unmatched case-control study from February to April 2019 in all public hospitals available in the West Shewa zone. The capital city of the zone is Ambo which is 114 kilometers far from the capital city of the country, Addis Ababa. The West Shewa zone has a total population of 2,650,781 from which 91,982 were pregnant women according to West Shewa zonal health office report of January 2019 [27]. The zone has 90 health centers, three general hospitals, four district hospitals, and one referral hospital. The study was conducted in eight public hospitals that give ANC, delivery, and postnatal care services.

2.2. Source Population and Study Population

All pregnant women (15–49 years old) that came for the first antenatal care follow-up at public hospitals in the West Shewa zone during the data collection period were the source populations whereas all pregnant women (15–49 years old) who came for the first antenatal care follow-up at public hospitals in the West Shewa zone during the data collection period and included in the study were the study populations. All pregnant women attending the first visit of their antenatal care at public hospitals in the West Shewa zone and voluntary to participate were included in study. Pregnant women on therapy of severe anemia and unable to respond were excluded from the study. Those with hemoglobin level <11 g/dl were considered as cases whereas those with hemoglobin level greater than or equal to 11 g/dl were considered as controls according to the WHO definition for the diagnosis of anemia in pregnancy [1]. The reason why the first visit of ANC was selected was that because those who were on repeated follow-ups were likely to take iron and folic acid supplementations during their previous visit the risk of being anemic is reduced.

2.3. Sample Size Determination

The sample size was calculated by using two population proportion formula, and it was calculated through Epi Info 7 statistical software package with the assumption of confidence level 95% ($Z\alpha/2 = 1.96$), power 80% ($Z\beta = 0.84$), and case-control ratio 1:2, where p1 is the proportion of cases, exposed and p2 is the proportion of controls exposed. The variable first trimester of pregnancy was considered as a determinant of anemia as identified by a study conducted in Dessie town, Ethiopia, where p1=42.1%, p2=18.8%, and AOR = 2.07 [26]. Therefore, the final sample size was 149 cases and 298 controls with a total of 447 pregnant women after adding a 15% nonresponse rate.

2.4. Sampling Technique

The study was conducted in all (eight) hospitals present in the West Shewa zone. The numbers of study participants were allocated proportionally to the average number of pregnant women who could attend the first visit of the ANC during the data collection period, which was estimated from average numbers of previous months' (previous quarter) antenatal care users which was taken from ANC registration books of each hospital. Therefore, the sample of each hospital was calculated by multiplying the average number of pregnant women attending the first antenatal care in each hospital per month with a total sample size ($n = 447$), dividing by the total number of pregnant women attending antenatal care unit per month at all hospitals (2187) (Figure 1). Consecutive sampling was used to select study participants (after collecting data from one case, data were also collected from two consecutive controls at each public hospital).

[figure omitted; refer to PDF]

2.5. Operational Definitions

Anemia in pregnancy was defined by hemoglobin level adjusted at sea level altitude based on WHO criteria. So, anemia in pregnancy was defined as when the hemoglobin level is <11 gm/dl [1]. According to WHO definition for the diagnosis of anemia in pregnancy, pregnant women with hemoglobin level <11 g/dl were considered as cases (anemic), whereas those with hemoglobin level ≥11 g/dl were considered as controls (nonanemic) [1].

Gastritis/PUD is characterized by epigastric pain, epigastric tenderness, hematemesis, and positive for *H. pylori* test and ulcer identified by the endoscope. A respondent who had at least one of the health problems mentioned above was considered to have gastritis or PUD [28].

2.6. Data Collection Tool and Procedure

Data were collected through face-to-face interviews by standardized structured questionnaires; the majority of which were adapted and modified from the previous studies [29]. Eight BSC midwives and two senior experienced midwife professionals were selected for data collection and supervision, respectively. Information related to sociodemographic characteristics and pregnancy-related (obstetrics and gynecologic variables) factors of respondents was collected through face-to-face interview by using a pretested structured questionnaire which was done after laboratory test results were obtained because cases and controls cannot be identified before hemoglobin test results. Necessary history and physical examination with laboratory investigations were taken and done for all respondents who permitted their consent to identify diseases and pregnancy-related characteristics of mothers.

2.7. Specimen Collection and Processing

Eight trained laboratory technologists conducted specimen collection and processing at eight hospitals. Four senior experienced and trained laboratory technologists supervised every step of specimen collection, processing, and analysis. The blood for hemoglobin concentration, HIV (was done after counseling), and malaria diagnosis was done based on the standard operating procedures (SOPs). A venous blood sample 10 ml was taken from study participants, by using a HemoCue Hb 301 analyzer (manufactured by HemoCue AB) a precalibrated instrument was designed for measurement of hemoglobin concentration and labeled with identification number. The venous blood was drawn through micro cuvettes and inserted into HemoCue Hb analyzer and the result was recorded. To examine blood for malaria, HIV serostatus, and syphilis tests, the blood of pregnant women that was collected for hemoglobin test was used.

Stool specimen container was given to every pregnant woman with toilet tissue paper and clean applicator stick after questionnaire administration to bring fresh stool specimen. Information was to the pregnant woman on how to collect enough amount and contamination-free specimen. Woman was requested to bring the stool sample quickly to process and examine within two hours. The laboratory technologists checked whether sufficient amount of stool specimen was collected or not, when receiving the specimen. A portion of stool was processed with direct microscopic technique to detect intestinal parasites immediately. The sample was examined microscopically first with 10x and then with 40x objective for the detection of helminthes, eggs, and cysts of protozoan parasites. Stool examination was done by using formal ether concentration technique, which is considered the most sensitive for most intestinal helminthes. The same method was carried out across all (eight) hospitals.

2.8. Data Quality Control and Management

Two days of training were given for data collectors and supervisors on the objective of the study, contents of the questionnaire, confidentiality, the right of respondents, and how to collect data. The questionnaire was pretested on 5% (7 cases and 14 controls) of the sample to assess the reliability of the data collection instruments at Tulu Bolo Hospital. After the pretest, the investigators, data collectors, and supervisors discussed the questionnaire so that the tool was modified for any inconsistencies and ambiguity before actual data collection. The laboratory procedure quality was guaranteed by giving training for laboratory technologists through a standard operating procedure (SOP) and regular monitoring of reagents, expiry date, and proper storage. The collected data were checked by supervisors and data collectors for consistency and completeness every day at the end of each data collection day and necessary corrective measures were taken from the area where difficulty was identified.

2.9. Data Processing and Analysis

After data collection, data were checked for completeness and coded, cleaned, and entered into Epi Info version 7 and transported to SPSS version 23 for data cleaning and analysis. After cleaning data for inconsistencies and missing values, descriptive statistics such as tables, graphs, and proportions were used to present data. Bivariate and multivariate logistic regression analyses were carried out to determine the presence of an association between dependent and independent variables. Variables with a p value less than 0.25 at 95% CI in the bivariate logistic regression were entered into a multivariate logistic regression [30]. Multiple logistic regressions were carried out to identify the determinants of anemia among pregnant women. The model goodness-of-fit test was checked by Hosmer–Lemeshow goodness of fit, and the p value of the model fitness test was 0.87. Multicollinearity and confounding effect were checked by using standard error which was not inflated, and no collinearity exists between the independent variables. Then all candidate variables were entered into a multivariate model since no collinearity was found between them. Finally, AOR with 95% CI and p value <0.05 were considered as statistically significant.

2.10. Ethical Consideration

The study protocol and methodology were approved by Ambo University College of Medicine and health sciences ethical review committee with reference number MHSC-PG: 003/2019. The permission to conduct study was obtained from the West Shewa zone health office and from all hospitals. Written consent was obtained from study participants after explaining the objective and purpose of the study to all study participants who were above 18 years old, and written assent was obtained from their parents or guardians where the study participants were pregnant women under 18 years of age. Those mothers who were found to have anemia, PUD, STI, hypertension, diabetes, malnutrition, and parasites were treated and linked to appropriate units in the hospitals for follow-up immediately after diagnosis.

3. Result

3.1. Sociodemography-Related Characteristics of Study Participants

A total of 426 pregnant women (142 cases and 284 controls) participated in this study making a response rate of 95.3%. The age of respondents ranged from 17 to 39 years with the mean age of 26.11 ± 4.05 for cases and 27.57 ± 5.27 years for controls. Sixty (42.3%) of cases and 57 (20.9%) of the controls had a family size greater than five. Concerning educational status, 40 (28.2%) of cases and 39 (13.7%) of controls had no formal education and in 110 (77.5%) of cases and 252 (88.7%) of controls husbands had formal education (Table 1).

Table 1

Sociodemographic characteristics of pregnant women attending antenatal follow-up-care in public hospitals of the West Shewa zone, from February to April 2019.

Variables	Cases: *n* = 142 (%)	Controls: *n* = 284 (%)

Age groups		
15–19	7 (4.9)	12 (4.2)
20–24	30 (21.1)	91 (32)
25–29	68 (47.9)	140 (49.3)
30–34	18 (12.7)	34 (12)
≥35	19 (13.4)	7 (2.5)
–		
Family size in number		
≤5	82 (57.7)	227 (79.1)
>5	60 (42.3)	57 (20.9)
–		
The educational level of mother		
Have no formal education	40 (28.2)	39 (13.7)
Have a formal education	102 (71.8)	245 (86.3)
–		
Marital status		
Married	135 (95.1)	272 (95.8)
Others[a]	7 (4.9)	12 (4.2)
–		
The educational level of husband		
Have no formal education	32 (22.5)	32 (11.3)
Have a formal education	110 (77.5)	252 (88.7)
–		
Occupation of mother		

Employed	20 (14.1)	65 (22.9)
Unemployed	122 (85.9)	219 (77.1)
–		
Occupation of husband		
Employed	16 (11.3)	82 (28.9)
Unemployed	126 (88.7)	202 (71.1)
–		
Family income		
≤1499	58 (40.8)	29 (10.2)
1500–2499	21 (14.8)	29 (10.2)
2500–3499	20 (14.1)	42 (14.8)
≥3500	43 (30.3)	184 (64.8)

a = single, widowed, and divorced.

3.2. Obstetrics and Gynecology-Related Characteristics of Study Participants

From those who had a previous history of pregnancy, 40 (28.2%) of cases and 22 (7.7%) of control also had a previous history of abortion. From those who had a history of childbirth, more than half 53 (56.4%) of cases and 43 (28.3%) of controls had a birth interval of less than or equal to two years. From ANC attendees, 63 (44.4%) of cases and 24 (8.5%) of controls had vaginal bleeding (Table 2).

Table 2

Obstetrics and gynecology-related characteristics of pregnant women attending ANC in public hospitals of the West Shewa zone, from February to April 2019.

Variables	Cases: *n* = 142 (%)	Controls: *n* = 284 (%)
Regularity of menstrual cycle		
Regular	116 (81.7)	256 (90.1)
Irregular	26 (18.3)	28 (9.9)
–		
Duration of menstrual flow		

3–5 days	83 (58.5)	250 (88)
6–8 days	59 (41.5)	34 (12)
–		
Previous history of abortion		
Yes	40 (28.2)	22 (7.7)
No	102 (78.8)	262 (93.3)
–		
Number of abortions		
One	22 (55)	20 (90.9)
2 and above	18 (45)	2 (9.1)
–		
Used family planning before pregnancy		
Yes	62 (43.7)	134 (47.2)
No	80 (56.3)	150 (52.8)
–		
Parity		
1–4	58 (62.4)	144 (94.1)
≥5	36 (37.6)	9 (5.9)
–		
ANC follow-up for previous pregnancy		
Yes	52 (52.7)	131 (84.5)
No	47 (47.3)	24 (15.5)
–		
Place of delivery for the previous child		

Home	41 (43.6)	30 (19.7)
Health facility	53 (56.4)	122 (80.3)
–		
Mode of delivery for previous child		
Spontaneous vaginal delivery	85 (90.4)	124 (81.6)
Instrumental	4 (4.3)	13 (8.5)
Caesarean section	5 (5.3)	15 (9.9)
–		
Gravidity		
1–4	101 (71.1)	267 (94)
≥5	41 (28.9)	17 (6)
–		
Types of current pregnancy		
Wanted and planned	87 (61.3)	236 (83.1)
Wanted but not planned	28 (19.7)	30 (10.6)
Neither wanted nor planned	27 (19)	18 (6.3)
–		
The birth interval between current and previous birth		
<2 years	53 (56.4)	43 (28.3)
≥2 years	41 (43)	109 (71.7)
–		
Vaginal bleeding (antepartum hemorrhage)		
Yes	63 (44.4)	24 (8.5)
No	79 (55.6)	260 (91.5)

3.3. Disease-Related Characteristics of Study Participants

Nearly a quarter, 37 (27.5%) of cases and 35 (12.3%) of controls, were using different medications during current pregnancy for different reasons. More than one-third, 49 (34.5%) of cases and 45 (15.8%) of controls, had gastritis with peptic ulcers. Forty-six (30.3%) of cases and 33 (11.6%) of controls were affected by intestinal parasites (Figure 2).

[figure omitted; refer to PDF]

3.4. Hygiene and Sanitation-Related Characteristics of Study Participants

More than half, 91 (64.1%), of cases and about one-fourth, 215 (75.7%), of controls had tape water for drinking. Around two-thirds, 93 (65.5%), of cases and the majority, 261 (91.9%), of controls had latrine in their compound. Nearly one-third, 67 (72%), of cases and the majority, 235 (90%), of controls always use the latrine (Table 3).

Table 3

Hygiene and sanitation-related characteristics of pregnant women attending ANC care at public hospitals of West Shewa zone from February to April 2019.

Variables	Cases: $n = 142$ (%)	Controls: $n = 284$ (%)
Source of drinking water		
Tap water	91 (64.1)	215 (75.7)
River water	20 (14.1)	28 (9.9)
Protected spring	15 (10.6)	28 (9.9)
Others*	16 (11.3)	13 (4.6)
–		
Presence of latrine		
Yes	93 (65.5)	261 (91.9)
No	49 (34.5)	23 (8.11)
–		
Continuous utilization of latrine		
Yes	67 (72)	235 (90)
No	26 (28)	26 (10)
–		
Hand washing time		
Before meal	134 (94.4)	274 (96.50)

After meal	132 (93)	279 (98.2)
After using the toilet	48 (34)	225 (79.2)
Before preparing food	62 (43.7)	215 (75.7)
After cleaning the bottom of children	20 (14.1)	108 (38)
After touching the bare body of another person	8 (5.6)	52 (18.3)

* = protected well, unprotected well, and unprotected spring.

3.5. Determinants of Anemia in Pregnancy

Bivariate logistic regression was done for each independent variable. Multivariate analysis was done for those variables with a p value <0.25 in the bivariate logistic regression after adjusting for covariates. Fitness of the model was also assessed. The result of multiple logistic regressions showed that pregnant mothers who had more than five family members had 2.95-fold higher odds of getting anemia than the odds of pregnant women who had ≤5 family members (AOR = 2.95, 95% CI: 1.34–6.50). This study also showed that pregnant women who had birth intervals ≤2 years had 2.61 times higher odds of getting anemia compared to those who had birth interval >2 years (AOR = 2.61, 95% CI: 1.20–5.70). The result of this study signifies that the odds of getting anemia in pregnant women were higher among women who had gastritis (peptic ulcer disease) compared to their counterparts (AOR = 2.85, 95% CI: 1.14–7.13). According to this study, pregnant mothers who had the previous history of abortion had 2.84-fold higher odds of developing anemia than the odds of mothers who had no previous history of abortion (AOR = 2.84, 95% CI: 1.08–7.47). Pregnant women who had vaginal bleeding (APH) during their current pregnancies had sixfold higher odds of developing anemia compared to their counterparts (AOR = 6.05, 95% CI: 1.95–18.81). Similarly, the current study found that pregnant women who did not utilize latrine had 3.45-fold higher odds of getting anemia compared to the odds of those who utilize latrine (AOR = 3.45, 95% CI: 1.30–9.24) (Table 4).

Table 4

Determinants of anemia among pregnant women attending antenatal care follow-up in public hospitals of the West Shewa zone, from February to April 2019 (multivariable analysis).

Variables	Cases: *n* = 142 (%)	Controls: *n* = 284 (%)	COR (95% CI)	AOR (95% CI)
Family size				
≤5	82 (57.7)	227 (79.1)	1	1
>5	60 (42.3)	57 (20.9)	3.1 (1.99, 4.80)	3.81 (1.73, 8.39)**
–				
Previous history of abortion				
Yes	40 (28.2)	22 (7.7)	4.67 (2.65, 8.24)	2.84 (1.08–7.47)**

No	102 (78.8)	262 (93.3)	1	1
–				
Birth interval				
≤2 years	53 (56.4)	43 (28.3)	3.28 (1.91, 5.62)	2.26 (1.16–4.40)**
>2 years	41 (43)	109 (71.7)	1	1
–				
Vaginal bleeding during current pregnancy				
Yes	63 (44.4)	24 (8.5)	1	1
No	79 (55.6)	260 (91.5)	2.66 (1.48, 4.79)	6.05 (1.95, 18.81)**
–				
Presence of gastritis or PUD				
Yes	49 (34.5)	45 (15.8)	2.80 (1.75, 4.4)	2.85 (1.14, 7.13)**
No	93 (65.5)	239 (84.2)	1	1
–				
Continuous utilization of latrine				
Yes	67 (72)	235 (90)	1	1
No	26 (28)	26 (10)	3.51 (1.91, 6.44)	3.45 (1.30–9.24)**

AOR = Adjusted Odds Ratio, COR = Crude Odds Ratio, CI = Confidence Interval. ** = statistically significant at p value <0.05, and 1 = reference group.

4. Discussion

Anemia is one of the major public health problems globally. Its impact which includes rising the chance of maternal and child morbidity and mortality reduced cognitive and physical development in children and decreased work activity in adults is high in developing countries like Ethiopia [2]. Therefore, it is important to identify determinants that contribute to the development of anemia in pregnant women to successfully prevent it. Family size >5, PUD, previous history of abortion, birth interval ≤2 years, APH, and unable to use latrine were determinants of anemia among pregnant women in the current study.

In this study, a family size was significantly associated with anemia. Pregnant women who had family size greater than five were at higher risk of developing anemia than those who had family size less than or equal to five. This finding is consistent with the study done in Gamo Gofa and West Arsi zones, Ethiopia, which indicated that family size greater than five was among the most significant risk factors for the development of anemia in pregnancy [31, 32]. This could be due to the sharing of resources among large families to meet different basic needs and results in food insecurity which in turn leads to anemia among pregnant mothers from large families' sizes. Moreover, large family size is a proxy indicator of high parity and the short interpregnancy interval that in turn reduces maternal hemoglobin.

The birth interval was another determinant that showed a significant association with anemia in pregnant women. Birth interval ≤2 years was positively associated with the occurrence of anemia in pregnancy. This finding is in agreement with a study conducted at Koppal, India, and other parts of Ethiopia [4, 31, 33–35] where birth interval less than or equal to 2 years was positively associated with the occurrence of anemia. This might be due to the depletion of iron because of frequent pregnancies and loss of blood during pregnancy, delivery, and a postpartum period where women who become pregnant in a short time before replenishing the lost blood are susceptible to anemia. Women who give birth more frequently can face stress and fear that in turn prevent them from eating adequate food which in turn leads to anemia [36].

In the current study, having previous history of abortion was statistically significantly associated with the occurrence of anemia when compared to not having previous history of abortion. This finding is consistent with other studies from Bahir Dar town and South Ethiopia where previous history of abortion was positively associated with the occurrence of anemia [37, 38]. This could be due to excess blood loss before pregnancy causes depletion of iron which in turn leads to anemia [29]. Antepartum hemorrhage during the current pregnancy was one of the independent predictors of anemia among pregnant women. Pregnant women who had antepartum hemorrhage were at higher risk of being anemic than those who did not have antepartum hemorrhage during pregnancy. This finding is consistent with the study done in Bahir Dar town [38]. This might be due to the fact that antepartum hemorrhage causes depletion of iron which in turn causes anemia among pregnant women [39, 40].

The presence of gastritis or PUD was statistically significantly associated with the occurrence of anemia among pregnant women during pregnancy. This finding is comparable with the study conducted in Hawassa and Yirgalem cities in which women who had gastritis were four times more likely to develop anemia than their counterparts [11]. This might be due to the fact that peptic ulcer disease causes upper gastrointestinal bleeding (blood loss) and loss of appetite that causes anemia [41].

Unable to use latrine continuously was also found to play a major driving role in the incident of anemia among pregnant women. Unable to use latrine continuously during pregnancy was positively associated with the occurrence of anemia. This could be because if one does not use toilet, open-field defecation is common practice that leads to contamination of environment and water which causes the intestinal parasites which in turn causes anemia [42]. This is because intestinal parasite consumes a digested diet from the intestine which in turn leads to micronutrient deficiency, specifically iron, that causes anemia. Parasite diseases, especially hookworms, contribute to iron deficiency anemia [43]. As far as we know, our study is the first or unique to identify such a significant association between not using toilets and anemia among pregnant women in Ethiopia.

5. Limitation of the study

The study may be affected by recall bias because it was retrospective and may be susceptible to social desirability bias.

6. Conclusion

In this study, family size greater than five, birth interval less than or equal to two years, gastritis or peptic ulcer diseases, having the previous history of abortion, vaginal bleeding during pregnancy, and not using toilet were identified determinants of anemia among pregnant women. Therefore, intervention on anemia prevention should consider the promotion of family planning methods, counseling and awareness creation on the importance of latrine construction and continuous utilization, and early identification and treatment of PUD among pregnant mothers through media, at ANC follow-up and through community engagements. Finally, we recommend further community-based study with large sample size and more strong study design to determine other determinants of anemia among pregnant women to address those pregnant women unable to attend antenatal care at public hospitals.

Authors' Contributions

BSD, ETB, and GAB involved in idea creation, proposal development, supervising data collection, data analysis, and interpreting results. TAG, AAG, HOD, MBS, AFA, and LZS were involved in editing, supervision, and guiding during the whole research proposal development and research result writing, while BSD and GAB contributed to the manuscript preparation. All the authors read and approved the manuscript.

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Glossary

Abbreviations

ANC:Antenatal care

APH:Antepartum hemorrhage

HIV:Human Immunodeficiency Virus

PUD:Peptic ulcer disease

WHO:World Health Organization.

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DETAIL

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Judul:	Determinants of Anemia among Pregnant Women at Public Hospitals in West Shewa, Central Ethiopia: A Case-Control Study

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Statistical Modeling of Determinants of Anemia Prevalence among Children Aged 6–59 Months in Nigeria: A Cross-Sectional Study

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ABSTRAK (ENGLISH)

Objective. Childhood anemia remains a significant public health challenge in developing countries, and it has negative consequences on the growth of the children. Therefore, it is essential to identify the determinants of childhood anemia, as these will help in formulating appropriate health policies in order to meet the United Nations MDG goal. This study aims to assess and model the determinants of the prevalence of anemia among children aged 6–59 months in Nigeria. To accomplish the aims of the study, the authors applied single-level and multilevel binary logistic regression models. *Methods*. To measure the relative impact of individual and household-level factors for childhood anemia among children aged 6–59 months, this study undertakes data from Nigeria Demographic and Health Surveys with both binary logistic and multilevel logistic regression models. The fit of the model was assessed by Hosmer–Lemeshow goodness-of-fit, variance inflation factor, and likelihood ratio tests. *Results*. The study established that about 67.01% of the children were anemic and identified sex of children, mother's education, religion, household wealth status, total children ever born, age of children, place of residence, and region to have a statistical significant effect on the prevalence of anemia. The adjusted odds ratio (aOR) for anemia was 0.56 (95% CI = 0.50, 0.63) in children aged from 24 to 42 months and 0.40 (95% CI = 0.36, 0.45) in children aged from 43 to 59 months. Also, children who reside in certain geographical-political zones of Nigeria are associated with increased childhood anemia. *Conclusion*. This study has highlighted the high prevalence of childhood anemia in Nigeria and indicated the need to improve mothers' education and regional variations. Findings from this study can help policymakers and public health institutions to map out programs targeting these regions as a measure of tackling the prevalence of anemia among the Nigerian populace.

TEKS LENGKAP

1. Introduction

The prevalence of anemia in children, particularly those below the age of 5 years, continues to be a significant public health challenge globally without sub-Saharan Africa (SSA). It is a severe concern for children because it can impair cognitive development and is associated with long-term health and economic consequences [1, 2]. Moreover, the consequences have a significant impact on the growth and development of children in the early stages of life. It poses a significant public health issue leading to an increased risk of child mortality. It is estimated that nearly half of all the cases of anemia are caused because of iron deficiency [3]. Unfortunately, despite all efforts made to curb the menace, anemia continues to be one of the significant and critical public health problems affecting children globally in both developing and developed countries. Based on the report from the World Health Organization (WHO) [4], it is one of the ten (10) most serious health problems globally. Approximately 273.2 million children aged 6–59 months across the world were suffering from anemia in 2011, according to a WHO report, with a prevalence rate of 42.4% [5, 6].

Furthermore, the estimated prevalence of anemia in children aged 6–59 months is 62.3% in SSA (approximately 84.5 million). These statistics put SSA as the region with the highest prevalence of anemia. Despite all the implementation of control programs such as iron supplementation and insecticide-treated bed nets distribution to curb the menace, anemia remains a major global concern in child health, particularly in SSA [7]. Meanwhile, the outcome of these community programs in SSA requires a good knowledge of the associated factors of anemia. Other studies conducted [8, 9] showed that anemia is present in 60.2–87.8% of children aged 6–59 months. A recent study found an association between anemia and some selected variables such as (age, female sex, and birth order), maternal (maternal anemia, mother's age, and mother's body mass index), and contextual (household income and family structure) characteristics of the child in children aged 6–59 months in SSA countries [10, 11].

In 2018, Nigeria Demographic Health Survey (NDHS) data revealed that the prevalence of anemia among children aged 6–59 months was also high, and anemia affected about 68.0% of these children, with 27% having mild anemia, 38% having moderate anemia, and 3% having severe anemia. Meanwhile, the WHO recommended that any prevalence of anemia that is higher than 40% among children aged 6–59 months should be considered as a severe public health problem [12]. Although many studies have examined determinants factors associated with anemia among children aged 6–59 months in Nigeria, the majority of such studies [10, 11, 13] relied on health facility-based data that are not representative considering the general population of children aged 6–59 months in the country. Also, there is information on anemia among under-five mortality prevalence in Nigeria [4]. However, limited information is reported in the literature on individual and contextual factors, especially modifiable factors that could explain the high rate of anemia in the country using nationally representative data. Because of the interrelationship of many of these factors, it is crucial to evaluate the potential determinants and assess the prevalence of anemia in a multivariable model using single-level logistic and multilevel logistic regression models. Besides, the fit of the model was examined using variance inflation factor and likelihood ratio tests. Thus, it is crucial to explore the latest Nigeria Demographic and Health Survey data that is a national representative on children aged 6–59 months by measuring the relative impact of individual and contextual determinants of the prevalence of anemia across the region of the Nigeria model. The goal is to use the findings from this study to inform and strengthen appropriate national policies and intervention strategies to reduce anemia among children in the country.

2. Materials and Methods

2.1. Study Design

This is a population-based cross-sectional study that used data obtained from the 2018 NDHS.

2.2. Study Population

The current study used data from the 2018 Nigeria Demographic Health Survey (NDHS) [14]. The 2018 Nigeria Demographic and Health Survey is the sixth comprehensive and national representative survey conducted in Nigeria as a part of the worldwide Demographic and Health Surveys project. The main objective of the 2018 NDHS was to provide timely and reliable data on health indicators and demographic outcomes at both national and state levels and for urban and rural areas. The sample was selected using a stratified, two-stage cluster design, with enumeration areas (EAs) as the sampling units for the first stage. The second stage was a complete listing of households carried out in each of the 1,400 selected enumeration areas (EAs). The primary sampling unit (PSU), referred to as a cluster for the 2018 NDHS, is defined based on EAs from the 2006 EA census frame. Before sample selection, all localities were classified separately into urban and rural areas based on predetermined minimum sizes of urban areas (cutoff points); consistent with the official definition in 2017, any locality with more than a minimum population size of 20,000 was classified as urban. The sample for the 2018 NDHS was a stratified sample selected in two stages. Stratification was achieved by separating each of the 36 states and the Federal Capital Territory into urban and rural areas. In total, 74 sampling strata were identified. Samples were selected independently in every stratum via a two-stage selection.

2.3. Ethical Consideration

This study was based on the analysis of existing survey datasets in the public domain that are available free online. The first author obtained permission for the download and usage of the NDHS datasets from http://www.dhsprogram.com/data/dataset_admin/login_main.cfm.

2.4. Outcome of Interest

Based on previous studies, hemoglobin concentration has been considered as the most reliable indicator of anemia at the population level. As the standard of the WHO, children aged 6–59 months with a hemoglobin level of less than 11 g/dL are declared as anemic. A drop of blood from the prick site was drawn into a microcuvette, and a hemoglobin analysis was carried out on-site with a battery-operated portable HemoCue analyzer to measure the prevalence of low hemoglobin [14, 15]. Besides, parents of children with a hemoglobin level below 11 g/dl were directed to take the child to a health facility for follow-up care. Based on hemoglobin levels, the prevalence of anemia is adjusted for altitude by hemoglobin in grams per deciliter (g/dl) [15]. In the present study, the outcome variable (anemia status) was dichotomized, suggesting whether one is anemic or not and is categorized as being anemic (coded as 1) or nonanemic (coded as 0). (1)yi=1 haemoglobin<12.0 g/dLanemic,0 haemoglobin≥12.0 g/dL non-anemic.

2.5. Description of the Explanatory Variables

The covariates considered include both individual and community-level factors as predictors of anemia among children aged 6–59 months. Among the selected explanatory variables, some were related to the child such as sex of the child, age (divided into three categories: 6–23 months, 24–42 months, and 43–59 months), anemia status, type of birth, and size of the child at birth. Other variables related to household-level factors included in the analysis are education, breastfeeding, the current age of the respondent, total children ever born, number of children under-five in the household, number of births in the last five years, religion, and wealth index. The wealth index is a proxy indicator of the socioeconomic status derived based on the scores allocated to various household items. Thus, the total scores were then grouped into wealth quintiles: most inferior, lower, middle, richer, and richest. The study also adjusts for potential confounders termed as community-level factors that include ethnicity, the region of the respondent, and place of residence.

The first inclusion criterion was that the child must be aged 6–59 months. Variables considered in this study were selected based on literature that has been conducted at the global level. Potential determinant factors expected to be correlated with anemia status were included as variables of the study. The exclusion criteria were the variables that have not been identified as modifiable factors in the literature. Besides, any variables with missing value > 80% were excluded from this study.

2.6. Statistical Analysis

Descriptive statistics of each of the selected variables and distribution of anemia by different factors were presented. Further analyses were conducted to examine child, individual, and community-level factors that might be significantly associated with childhood anemia and explored unobserved household-level effects on childhood anemia. Based on a previous study that utilized the type of data under investigation, a single-level model would not be sufficient for removing the cluster effect in hierarchical structure data. However, the hierarchical structure sometimes yields highly correlated data and thus cannot be assumed independent. A multilevel approach adequately represents the unexplained variability of the nested structure, often difficult to present in a single-level approach. Thus, the current study extends the best model from single-level binary logistic to multilevel logistic regression modeling in order to take into consideration the hierarchical structure and the possible correlation that may arise [16, 17]. Besides, the multilevel logistic regression model is a powerful statistical tool for removing the cluster effect and detecting associations between the outcome of interest and the explanatory variables at different levels of the data hierarchy. This model is particularly appropriate for research designs where participants are organized at more than one level [18].

To check for multicollinearity, some studies choose to use generalized variance inflation (GVIF) factors or variance inflation factors (VIF). According to [19, 20], if all terms in an unweighted linear model have one degree of freedom (DF), then the usual variance inflation factors are calculated; otherwise, generalized variance inflation factors are preferred. Based on this, the current study only investigates the VIF of all the covariates included in the model. The variance inflation factor represents the proportion of variance in one predictor explained by all the other explanatory variables in the model. The approach suggested by [21] is to calculate VIFs for each parameter in the model, and if they are larger than a cutoff, sequentially drop the covariate with the largest VIF, recalculate, and repeat until all values are below the cutoff (they suggested a cutoff of 2). VIFs are especially suitable for dealing with the collinearity of interaction terms. As a rule of thumb, a VIF value that exceeds 5 or 10 indicates a problematic amount of collinearity [22, 23]. Data management and cleaning were carried out using IBM Statistical Package for Social Sciences (SPSS) Statistics for Windows version 26.0. We fitted the model using the *R* software (R Core Team, Vienna, Austria) [24].

3. Results

3.1. Sample Characteristics

The details of the descriptive statistics are presented in Table 1. About 67.01% of the children was anemic. The children were relatively evenly distributed in terms of sex. The mean (SD) of the current respondent age was 30.00 ± 6.69, while that of the child age (in the month) was 31.46 ± 15.64. Out of 10,451 children aged 6–59 months in the dataset, 10,125 were born singletons and 284 (2.72%) were born very small (born underweight). The proportion of children belonging to the household with no formal education and higher education is 38.45% and 9.01%, respectively. The majority (52.48%) of the children belonged to women in Islamic religion, while 211 (20.20%) belonged to households with the poorest wealth index. About 60.94% of the children resides in rural communities, and the majority (59.63%) reside in the northern region of the country, of which northwest has the highest proportion (24.31%) (Table 1 for each covariate). The bivariate association between the anemia status of children aged 6–59 months and covariates was also assessed, and the results are shown in (Table 2). The results highlighted the significant determinants of variation in the prevalence of anemia among children aged between 6 and 59 months. Birth type and sex of household were the only explanatory variables that had no significant association with anemia status among children aged 6–59 months.

Table 1

Individual-level, community-level, and household-related characteristics of the study participants (n = 10,451).

Variables		Frequency (n)	Percentage
Respondent age: 30.00 ± 6.69			
Individual-level factors			
Sex of the child	Male	5288	50.6
Female	5163	49.4	Child age in month

6–23	3712	35.53	24–41
3229	30.90	42–59	144
1.38	Birth type	1st of multiple	182
1.74	2nd of multiple	144	1.38
–			
Community-level factors			
Type of residence	Urban	4082	39.06
Rural	6369	60.94	Geographical area
Northcentral	1808	17.30	Northeast
1883	18.02	Northwest	2541
24.31	Southeast	1527	14.61
South-south	1179	11.28	Southwest
1513	14.48	.	
Household factors			
Educational status	No formal education	4018	38.45
Primary	1763	16.87	Secondary school
3728	35.67	Higher education	942
9.01	Source of drinking water	Improved	6504
62.23	Unimproved	3947	37.77
Religion	Catholic	1069	10.23
Christian	3799	36.35	Islamic
5485	52.48	Traditionalist	98

0.41	No religion	55	0.53
Currently breastfeeding	No	5305	50.76
Yes	5146	49.24	·
Household factors			
Wealth index	Poorest	2111	20.20
Poorer	2075	19.85	Middle
2300	22.01	Richer	1780
17.03	Richest	6707	22.0
Size of child at birth	Very large	996	9.53
Larger than average	2542	24.32	Average
5531	52.92	Smaller than average	957
9.16	Very small	284	2.72

Table 2
Prevalence of anemia by various explanatory factors.

Covariates	Categories	Not anemic	Anemic	P value
Individual-level factors				
Sex of child	Male	1650 (31.20)	3638 (68.80)	<0.0001
Female	1798 (32.82)	3365 (65.18)	Child age (in month)	6–23
866 (23.33)	2846 (76.67)	0.0261	24–41	1229 (35.01)
2281 (64.90)	42–59	1353 (41.90)	1876 (58.10)	Birth type
Single birth	3351 (33.10)	6774 (66.90)	0.4092	1st of multiple

56 (30.77)	126 (69.23)	2nd of multiple	41 (28.47)	103 (71.53)
–				
Household level factors				
Educational level	No formal education	1063 (26.46)	2955 (73.54)	<0.0001
Primary	532 (30.18)	1231 (69.82)	Secondary	1356 (36.37)
2372 (63.63)	Tertiary	497 (52.76)	445 (47.24)	Source of drinking water
Improved	2255 (34.67)	4249 (65.33)	<0.0001	Unimproved
1193 (30.23)	2754 (69.77)	Wealth index	Poorest	487 (23.07)
1624 (76.93)	<0.0001	Poorer	537 (25.88)	1538 (74.12)
Middle	780 (33.91)	1520 (66.09)	Richer	781 (35.74)
1404 (64.26)	Richest	863 (48.48)	917 (51.52)	Currently breastfeeding
No	1946 (36.68)	3359 (63.32)	<0.0001	Yes
1502 (29.19)	3644 (70.81)	Don't know	47 (33.33)	94 (66.67)
Sex of household	Male	3012 (32.75)	6186 (67.25)	0.148
Female	436 (34.80)	817 (65.20)	Size of child at birth	Very large
334 (33.53)	662 (66.47)	0.045	Larger than average	821 (32.30)

1721 (67.70)	Average	1883 (34.04)	3648 (65.96)	Smaller than average
280 (29.26)	677 (70.74)	Very small	83 (29.23)	201 (70.77)
Don’t know	47 (33.33)	94 (66.67)	.	
Communitylevel factors				
Place of residence	Urban	1613 (39.51)	2469 (60.49)	<0.0001
Rural	1835 (28.81)	4534 (71.19)	Region	North-central
632 (34.96)	1776 (65.04)	<0.0001	North-east	610 (32.40)
1273 (67.60)	North-west	760 (29.91)	1781 (70.09)	South-east
477 (31.24)	1050 (68.76)	South-south	351 (29.77)	828 (70.23)

From Table 3, the analysis of single-level binary logistic regression revealed that the prevalence of anemia among children aged between 6 and 59 months varied among different explanatory variables. Besides, the total children ever born, sex of children, mother’s education, religion, household wealth status, age of children, place of residence, and region were also significant determinants of variation in the prevalence of anemia among children aged between 6 and 59 months. In contrast, the source of drinking water, currently breastfeeding, size of the child at birth, and ethnicity were insignificant predictors of variation in the prevalence of anemia among children aged between 6 and 59 months. Altogether, we fitted three (3) models, and model 3 provided the best fit to the data. Among the three models, the findings reveal model 3 to be the best fit to the data. Based on the explanation given under the statistical analysis section, we further extend model 3 to a multilevel (mixed effect) logistic regression model (model 4) to explore any unobserved household-level effects on childhood anemia. Comparing models 3 and 4, model 3 is preferred. Thus, no significant unobserved household-level variations were observed in anemia prevalence outcome after adjusting for the other explanatory variables in the model (Table 4).

Table 3

Estimates of multiple logistic regression models (NDHS 2018).

Covariates	Model 1	Model 2	Model 3
aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	Sex of child (ref: male)
			Female

0.85 (0.78, 0.92)*		0.84(0.77, 0.92)*	Type of birth (ref: single)
			1st of multiple
1.11 (0.80, 1.52)		1.15 (0.83, 1.62)	2nd of multiple
1.27 (0.88, 1.82)		1.42 (0.97, 2.09)	Education (ref: no formal education)
			Primary
	0.97 (0.85, 1.12)*	0.89 (0.76, 1.02)*	Secondary
	0.82 (0.72, 0.95)*	0.75 (0.65, 0.87)*	Tertiary
	0.53 (0.43, 0.64)	0.51 (0.41, 0.62)	Source of drinking water (ref: improved)
			Unimproved
	0.99 (0.90, 1.10)	0.98 (0.89, 1.09)	Religion (ref: Catholic)
			Christian
	1.04 (0.90, 1.21)	1.16 (0.99, 1.37)	Islamic
	0.92 (0.79, 1.08)	1.55 (1.28, 1.86)	Traditionalist
	0.49 (0.26, 0.92)*	0.61 (0.32, 1.18)	no religion
	1.35 (0.74, 2.46)	1.19 (0.62, 2.26)	Wealth index (ref: poorest)
			Poorer
	0.88 (0.76, 1.02)	0.86 (0.74, 1.01)	Middle
	0.62 (0.54, 0.73)8	0.58 (0.49, 0.68)*	Richer
	0.61 (0.53, 0.73)*	0.55 (0.46, 0.65)*	Richest

	0.42 (0.35, 0.50)*	0.38 (0.31, 0.46)*	Currently breastfeeding (ref: no)
			Yes
	1.05 (0.96, 1.15)	1.07 (0.97, 1.17)*	Total children ever born
	1.02 (1.00, 1.04)*	1.02 (1.00, 1.04)*	Size of child at birth (ref: very large)
			Larger than average
	0.99 (0.84, 1.16)	0.95 (0.81, 1.13)	Average
	0.93 (0.80, 1.08)	0.88 (0.76, 1.02)	Smaller than average
	1.06 (0.88, 1.30)	1.02 (0.83, 1.25)	Very small
	1.00 (0.75, 1.35)	0.92 (0.68, 1.24)	Do not know
	1.03 (0.70, 1.52)	0.89 (0.60, 1.32)	Child age in month (ref: 6–23)
			24–41
	0.56 (0.50, 0.63)*	0.56 (0.50, 0.63)	42–59
	0.41 (0.36, 0.45)*	0.40 (0.36, 0.45)*	Ethnicity (ref: ekoi)
			Fulani
		0.91 (0.70, 1.18)*	Hausa
		0.99 (0.74, 1.32)	Igbo
		0.95 (0.83, 1.11)	Yoruba
		0.96 (0.76, 1.23)	Place of residence (ref: urban)
			Rural

		1.14 (1.02, 1.27)*	Region (ref: north central)
			Northeast
		0.76 (0.63, 0.89)*	Northwest
		1.87 (1.41, 2.49)*	Southeast
		0.87 (1.54, 2.28)*	South-south
		1.19 (0.62, 2.26)*	Southwest

*p<0.05.

Table 4

Estimates of multilevel logistic regression model (NDHS 2018).

Covariates	aOR (95% CI)
Sex of child (ref: male)	—
Female	0.96 (0.94, 0.98)*
Type of birth (ref: single)	
1st of multiple	1.03 (0.07, 1.107)
2nd of multiple	1.07 (1.00, 1.16)*
Education (ref: no formal education)	—
Primary	0.97 (0.94, 1.01)
Secondary	0.94 (0.91, 0.97)*
Tertiary	0.86 (0.82, 0.90)
Source of drinking water (ref: improved)	—
Unimproved	1.00 (0.98, 1.02)
Religion (ref: catholic)	—
Christian	1.02 (0.98, 1.06)

Islamic	1.08 (1.04, 1.13)*
Traditionalist	0.89 (0.77, 1.03)
No religion	1.07 (0.93, 1.23)
Wealth index (ref: poorest)	—
Poorer	0.97 (0.94, 1.01)
Middle	0.91 (0.94, 1.01)*
Richer	0.89 (0.86, 0.93)*
Richest	0.83 (0.79, 0.87)*
Currently breastfeeding (ref: no)	—
Yes	1.01 (0.98, 1.03)
Total children born	1.00 (0.98, 1.03)
Size of child at birth (ref: very large)	—
Larger than average	0.99 (0.95, 1.02)
Average	0.97 (0.94, 1.01)
Smaller than average	1.00 (0.96, 1.04)
Very small	0.98 (0.92, 1.05)
Don't know	0.97 (0.89, 1.05)
Child age in month (ref: 6–23)	—
24–41	0.89 (0.87, 0.91)*
42–59	0.83 (0.81, 0.85)*
Ethnicity (ref: ekoi)	—
Fulani	0.99 (0.93, 1.05)
Hausa	0.99 (0.93, 1.06)

Igbo	0.94 (0.91, 1.03)
Yoruba	0.99 (0.94, 1.05)
Place of residence (ref: urban)	—
Rural	1.04 (1.01, 1.07)*
Region (ref: north central)	—
North-east	0.93 (0.90, 0.98)*
North-west	0.96 (0.92, 1.00)
South-east	1.14 (1.07, 1.22)*
South-south	1.13 (1.08, 1.19)*
South-west	1.04 (0.98, 1.09)

Furthermore, the total children ever born (aOR = 1.02 (95% CI = 1.00, 1.04)) is associated with an increase in childhood anemia. Before adjusting for all other covariates, being a reduced Christian odds of childhood anemia by 4%, it is not significantly associated with the anemia. Wealth status was found to have protective effects on childhood anemia before adjusting for all other factors. The likelihood of childhood anemia in children from the richest household was reduced by 58% compared to children from the poorest households (Table 3, model 2). Female children have decreased odds of childhood anemia compared to male children (aOR = 0.84 (95% CI = 0.77, 1.92)). The findings of this study also indicate that the child's late age and his mother's higher-level education were negatively associated with childhood anemia. The adjusted odds ratio (aOR) for anemia was 0.56 (95% CI = 0.50, 0.63) in children aged from 24 to 42 months and 0.40 (95% CI = 0.36, 0.45) in children aged from 43 to 59 months. Concerning mother's education, we observed that primary level education was positively associated with childhood anemia (aOR = 0.89 (95% CI = 0.76, 1.02)). Moreover, the odds of childhood anemia in rural areas increased by 14% compared to urban areas. On the other hand, odds of childhood anemia were noticed to vary across the regions; in southeast and southwest, it was observed to increase by 87% and 16%, respectively, but reduced by 31% in the northwest compared to northcentral (Table 3, model 3).

3.2. Model Fit and Selection

The fitness of the models was examined by employing the likelihood ratio test (deviance, AIC, and BIC Values) and Hosmer–Lemeshow goodness-of-fit test, and the findings indicate that the models were fitted well as indicated in Table 5. The likelihood ratio test (deviance, AIC, and BIC values) suggests that model 3 in Table 5 provides an excellent fit to the data. For the multicollinearity, the VIF was employed to check for multicollinearity, none of the VIF values was up to 10, and the mean VIF of the model was less than six (6). This implies that there was no collinearity in the model.

Table 5

Goodness-of-fit assessment for both single-level logistic and multilevel logistic models using AIC, BIC, and deviance.

Parameters	Model 1	Model 2	Model 3	Model 4
AIC	13244.90	12598.00	12470.60	13173.89
BIC	13273.92	12757.60	12724.51	13442.31
Deviance	13236.90	12554.00	12400.60	13099.89

4. Discussion

This study models the determinants of the prevalence of anemia among children aged 6–59 months using the 2018 Nigeria Demographic and Health Survey (NDHS).

Furthermore, we also examined unobserved household-level variations in childhood anemia that represents differences in childhood anemia outcomes across households. The present study has attempted to control for the effects of potential confounders by incorporating many explanatory factors into the analyses without overfitting the model. This study established a mother's education, religion, household wealth status, total children ever born, and age of children as the significant determinants of variation in the prevalence of anemia among children between 6 and 59 months. Confounding factors associated with childhood anemia were the sex of the child, ethnicity, place of residence, and region. The findings of this study also showed a high prevalence of anemia among Nigeria children aged from 6 to 59 months, making this a serious public health issue. The results also showed regional variations in the prevalence of childhood anemia among children aged 6–59 months, with the highest rate being observed in the Northern region of the country. More than half (67.01%) of the children studied were anemic, and the WHO considers anemia in children aged 6–59 months as a severe public health problem [4, 12]. However, more importantly, in this study is the unobserved household-level variations on childhood anemia.

In this study, we found anemia to be associated with the characteristics of the child and those of his mother. A possible explanation could be that children who are getting older receive a balanced diet that is richer and complete, with a sufficient intake of iron that could prevent the occurrence of anemia in the child. This finding is consistent with other previous studies in the literature [25, 26].

This study revealed that the mother's education level was negatively associated with childhood anemia except those with primary education. Notably, children whose mothers had a secondary and higher education were less likely to be anemic. A reduction in the likelihood of anemic among children from mothers with higher educational status compared to children from mothers without formal education suggests that improving maternal education will improve the likelihood of children being anemic, which is consistent with other previous studies [25, 27–29]. It is an occurrence phenomenon that improvements in the educational level of women would bring several advantages to their children and the community, as reported in the previous studies [30, 31]. A likely explanation for this is that mothers with higher educational status are more likely to provide a healthy and hygienic balanced diet, resulting in better health outcomes for both mothers and their children. It is essential to mention that this study also reveals that the likelihood of childhood anemia increases with total children ever born and the number of mothers currently breastfeeding. These findings were consistent with other previous studies [32–35]. An increment in total children ever born and currently breastfeeding could result in a lack of adequate care, low birth weight, premature births, and massive drain on the limited household resources. The implication is that children have to compete for the little resources available for their survival. The findings of this study also show that children raised in urban areas were less likely to be anemic than those in rural areas. This finding supported what has been reported in other studies [8, 10, 36]. A possible explanation for this relationship is that children in urban areas have better access to health facilities and other essential health-related services that are important in developing the children in the early stages of life.

Children residing in the southeast region have an increased risk of childhood anemia compared to children living in the Western region. The rate is highest in the northern, followed by the southeast. This study is consistent with

previous findings that geographical locations of children influence their health outcomes [11, 16, 18–20]. It is essential to mention that the distribution of socioeconomic resources and political power largely influences the health conditions of populations at the local and regional levels across Nigeria.
Also, the regional differences in childhood anemia in the country could be attributed to the variations in the implementation of national health policies and inadequate health services and poor living conditions of households. The wealth status of richer households is negatively associated with childhood anemia. The findings of this study reveal that children from less wealthy households have greater odds of being anemic than children from wealthy households. Similar results were documented in previous studies; our study gives further proof that poverty is a significant determinant of childhood anemia [37–42]. It is essential to mention that the level of socioeconomic status of a household is crucial. It often determines the availability of adequate and nutritious foods for the growth and development of children. For example, children from poorer households in most developing countries, such as Nigeria, where a publicly funded health care system lacks access to excellent and necessary infrastructural healthcare services may anytime fall ill. Additionally, childhood anemia is an urgent public health problem in Nigeria, and this study has provided vital information for understanding and addressing anemia in the country. Policies and intervention strategies targeted at improving the level of mother education could play a crucial role in the health status of children if supported with efforts to improve the general standard of living among households in the entire country.

5. Strengths and Limitations

The strengths of the study lie on the fact that the data are a national representative population-based study coupled with useful quality data on children’s health, their households, and communities. Besides, the study also has a large sample size drawn randomly nationwide, making it possible to generalize findings on children aged 6–59 months. The multilevel logistic modeling approach also allowed the determination of unobserved household-level differences in the prevalence of anemia, which cannot be determined through single-level binary logistic regression. The main limitation of this study stems from the fact that the demographic health survey datasets are prone to problems that result in the inability to measure causal effects due to the cross-sectional nature.

6. Conclusion

Summarily, results have highlighted a high prevalence of childhood anemia in Nigeria. The policymakers should pay attention to all the statistically significant factors outlined in the analysis of the current study. In light of the significant associated factors of anemia prevalence, a pragmatic approach is required from the policymakers. This would help in addressing the menace of childhood anemia in response to the growth and development of the children in the early stages of life, particularly for children who are living in the highest anemic prevalence regions.

Authors’ Contributions

REO conceived and designed the study. REO, BTB, and OA conceptualized and wrote the first draft of the manuscript. REO conducted the statistical analysis. All authors read the first draft and made relevant comments. BTB scrutinized the manuscript. REO implemented the suggestions and comments on the manuscript. All authors read the final manuscript preparation and approved the submission.

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Magnitude of Anemia and Its Associated Factors among Pregnant Women Attending Antenatal Care at Najo General Hospital, Northwest Ethiopia

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ABSTRAK (ENGLISH)

Anemia is one of the major causes of morbidity for pregnant women in resource-limited regions. Yet robust research-based evidence on this vital public health problem in remote areas where the problem could be massive is quite limited in Ethiopia, one of the developing countries. Thus, this study is aimed to assess the magnitude of anemia and its associated risk factors among pregnant women attending one of the health facilities in Ethiopia. A facility-based cross-sectional study design was employed in 2019. A total of 384 pregnant women attending the antenatal care (ANC) unit of Najo General Hospital, Northwest Ethiopia, were included in the study. Their sociodemographic characteristics, and medical, obstetric, and gynecological history were collected using pretested interview questionnaires. Blood samples were collected from each participant for the determination of malaria parasite and hemoglobin (Hb) level. In addition, stool samples were collected for examination of intestinal parasites. Data were analyzed using Statistical Package for Social Science (SPSS) software version 25. The overall magnitude of anemia among pregnant women was 37.8% (95% CI, 32.8%–42.3%). The proportion of mild anemia, moderate anemia, and severe anemia was 24%, 11%, and 2.3%, respectively. Some variables such as absence of malaria infection (AOR: 0.195, 95% CI: 0.066–0.576), lack of history of abortion (AOR: 0.469, 95% CI: 0.265–0.830), and absence of history of anemia (AOR: 0.227, 95% CI: 0.134–0.385) were identified as protective variables of anemia during pregnancy, while urban residence (AOR: 1.753, 95% CI: 1.013–3.034) was unexpectedly found as a predisposing factor. Despite the higher number of anemic pregnant women observed in the current study, pregnancy-associated anemia is moderate public health importance in the study area.

TEKS LENGKAP

1. Introduction

During pregnancy, anemia is a major public health problem in developing countries. The number of pregnant women affected by this health problem globally is estimated to 41.8%, with the highest number of cases in Africa (57.1% or

17.2 million) [1], while the prevalence is 18% in developed countries [2]. Its prevalence and severity could vary among different groups of population. According to the Ethiopian Demographic and Health Survey Report of 2016, the prevalence of anemia in pregnant women was 24% [3]. Other studies recently reported from different places of Ethiopia showed that the prevalence of anemia among pregnant women could range from 9.7% to 56.8% in central and Eastern part of the country, respectively [4, 5]. Untreated anemia in the pregnant women has severe consequences on health, social, and economic development of the nation in general [1]. Some of the associated threats are increased such as maternal morbidity and mortality (mainly it happens when the anemia is severe), low birth weight, preterm delivery, fetal anorexia, intrauterine growth restriction, perinatal mortality, and maternal mortality [6–9]. This health problems, unless diagnosed early and treated, could have multifactorial risks to the pregnant women.

The major cause of anemia in pregnant women is shortage of red blood cells (RBCs). This happens when there are deficiencies of Iron, folate, vitamin B12, and vitamin A, intestinal or blood parasite infections, and other chronic illness [6, 9–11]. Despite presence of many reports on high prevalence of anemia among pregnant women in Ethiopia, lack of regular surveillance and management plan at all levels are among major concerns for pregnant women in general and those living in remote areas of the country in particular. Therefore, this study was designed to give an insight on the current prevalence of anemia and its determinants in one of the remote areas never surveyed for anemia in pregnant women in Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at Najo General Hospital, Northwest Ethiopia, in May, 2019. The study area is located in the Northwest of Ethiopia at a distance of 515 km from Addis Ababa, the capital city of Ethiopia. Geographically, the study site is located at latitude and longitude of 9°30 0 N and 35°30 0E, respectively. The hospital has been serving population estimated to about 1,000,000 (223,000 of whom were females in reproductive age) (unpublished data, annual report of Nejo General Hospital, 2017/18).

2.2. Operational Definitions

Light/normal menstrual level: menstrual cycle in 21–35 days of duration, with bleeding lasting an average of 5 days and total blood flow between 25 and 80 mL.

Heavy menstrual level: a menstrual bleeding with a total menstrual flow of >80 ml per cycle, soaking a pad/tampon at least every 2 hours, or bleeding lasting for >7 days [12].

2.3. Study Participants and Design

A facility-based cross-sectional study design was employed. All pregnant women who live in the catchment area of the hospital and attending an ANC during the study period were included in the study. Pregnant women who were seriously ill, with known multiple pregnancies, and had history of chronic disease such as tuberculosis (TB) and human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) were excluded from the study.

2.4. Sample Size and Data Collection Method

The sample size was calculated considering 95% CI, and using 56.8% prevalence rate reported from Eastern Ethiopia [4], the highest proportion of anemia, and ±5% precision [13]. Considering 10% nonresponse rate, a total of 414 samples were computed, but only 384 pregnant women attended the ANC during the study period and fulfilled the inclusion criteria were recruited using simple random sampling technique. Then, data were collected using the pretested interview questionnaire comprising questions related to sociodemographic characteristics, obstetric and gynecological history, and clinical feature of the participants [14].

2.5. Sample Collection and Examination

The participants were given a universal bottle and instructed on how to do proper stool collection. About 1gm of stool sample was collected from each study participant. Some portion (~50 mg) of the sample was used for direct wet mount preparation and then examined under a microscope within 10 minutes of the collection. The remaining portion of the fecal sample was preserved in formalin and then after used for formal-ether sedimentation concentration technique. In addition, on the same date, few drops of blood samples were collected from pricked finger of the participants on a glass slide for malaria diagnosis. Accordingly, a thin smear was stained using Giemsa (10%) right after fixed in methanol. Then, the slides were examined under a microscope (high magnification lens). Again, small amount of blood (~100 μl) was drawn into a microcuvette to measure hemoglobin level using portable HemoCue Hb301 (HemoCue, Haemoglobinometrer, Angelholm, Sweden). Moreover, for each pregnant woman, the body mass index (BMI) was calculated using their height and weight data.

2.6. Data Analysis

Data were checked for their completeness, then entered into Microsoft Excel spreadsheets. Then, data were exported to software (Statistical Package for Social Science (SPSS)) version 25.0 for analysis. Descriptive statistics such as percentage and standard deviation (SD) were used to compute some basic sociodemographic characteristics, and obstetric and gynecologic, and clinical data. Bivariate and multivariate logistic regression analyses were conducted to identify independent predictors of anemia. Bivariate analysis was conducted to select candidate variables (P<0.25) for multivariate analysis, and the later was used to identify independent predictors of anemia. The goodness of fit of the final logistic model was tested using the Hosmer and Lemeshow test at P>0.05. 95% confidence interval (CI) was used for all analysis, and the significant level was considered at P<0.05.

3. Results

3.1. Description of Study Participants and Response Rate

More than half of the pregnant women, 220 (57.3%), who participated in this study were found in the age range between 15–24 years, with a mean age of 23.57 years (SD ± 3.8 year). Majority of them were married, 378 (98%), from the Oromo ethnic group, 379 (98.7%), had ≤2 family size, 195 (51%), followers of protestant religion, 228 (59.6%), attended at least primary school, 151 (39.3%), housewives, 253 (66%), and urban dwellers, 276 (72%) (Table 1).

Table 1

Sociodemographic characteristics of pregnant women attending ANC of Najo General Hospital, 2019.

Variable	Category	Frequency (%)
Age	15–24	220 (57.3)
25–30	135 (35.2)	>30
29 (7.6)	-	
Marital status	Married	376 (98)
Others[a]	8 (2.1)	·
Ethnicity	Oromo	379 (98.7)
Others[b]	5 (1.3)	·
Family size	≤2	195 (51)
2–4	178 (46.4)	>4
11 (2.9)	-	

Religion	Orthodox	133 (34.6)
Muslim	21 (5.5)	Protestant
228 (59.4)	Wakefeta	2 (0.5)
–		
Educational status	Illiteracy	25 (6.5)
Primary school (grade 1–8)	151 (39.3)	Secondary school (grade 9–12)
144 (37.5)	Higher education (above grade 12)	64 (16.7)
–		
Occupation	Employed	62 (16.1)
Housewife	253 (66)	Farmer
29 (7.6)	Others[c]	40 (10.4)
–		
Residence	Urban	276 (72)

[a]Others = single and widowed; [b]Others = Amhara and Gurage; [c]Others = self-employee, daily laborer, and business women.

3.2. Obstetric and Medical Factors

Finding from the blood film and stool sample examination revealed that, a total of 20 (5.2%) pregnant women were infected with malaria and 4 (1%) were infected with different intestinal parasites. Most of the pregnant women involved in the study responded that they have history of light menstrual level, 293 (76.3%), and history of using contraceptive, 329 (85.7%), and some had history of abortion, 113 (29.4%). Regarding the obstetrical history, 144 (37.5%) pregnant women were multigravidas, 122 (44.8%) were nullipara, and 170 (44.3%) had ≤ 1 year birth interval. The gestational age for 116 (30.2%), 95 (24.7%), 102 (26.6%), and 71 (18.5%) was at first, second, third, and fourth trimester of pregnancy, respectively. A total of 336 (87.5%) participants had normal BMI (Table 2).

Table 2

Obstetric and medical factors of pregnant women attending ANC of Najo General Hospital, 2019.

Variable	Category	Frequency (%)
Helminthic infected	Yes	4 (1)
No	380 (99)	·

Malaria infected	Yes	20 (5.2)
No	364 (94.8)	·
History of use contraceptive	Yes	329 (85.7)
No	55 (14.3)	·
History of menstrual level	Heavy	91 (23.7)
Light	293 (76.3)	·
Trimesters	First	116 (30.2)
Second	95 (24.7)	Third
102 (26.6)	Fourth	71 (18.5)
–		
History of abortion	Yes	113 (29.4)
No	271 (70.6)	·
Body Mass index	Overweight (>25 Kg/m^2)	39 (10.2)
Normal (18.5–25 Kg/m^2)	336 (87.5)	Underweight (18.5 Kg/m^2)
9 (2.3)	-	
Birth spacing	≤1 year	170 (44.3)
2–3 year	65 (16.9)	>3 year
149 (38.8)	-	
Parity (number of deliveries)	Nullipara	172 (44.8)
Primipara	113 (29.4)	Multipara
97 (25.3)	Grand multipara	2 (5)
–		
Hemoglobin level	≤7 g/dL	9 (2.3)

7–9.9 g/dL	43 (11.2)	10–11 g/dL
93 (24.2)	>11 g/dL	239 (62.2)
–		
Gravid	First	144 (37.5)
Second	117 (30.5)	Third
76 (19.8)	Fourth	35 (.9.1)
≥fifth	12 (3.1)	·
History of contraceptive use	Depo-Provera	182 (47.4)
Implanon	89 (23.2)	Loop
11 (2.9)	Combined contraceptive	9 (2.3)

3.3. Magnitude of Anemia

Concerning the anemic status of the pregnant women, 145 (37.8%, 95%CI: 32.8%–42.3%) were anemic (their Hb level was <11 g/dL). About 93 (24.2%) of them were with mild anemia (Hb level: 10–11 g/dL), 43 (11.2%) had moderate anemia (Hb level: 7–9.9 g/dL), and the rest, 9 (2.3%), were diagnosed with severe anemia (Hb level: ≤7 g/dL).

3.4. Factors Associated with Anemia

Findings of bivariate and multivariate regression analyses showed that almost all sociodemographic characteristics including age, marital status, family size, monthly income, and occupation did not show significant (P>0.05) association with the incidence of anemia, except for residence of the participants, where prevalence of anemia was significantly higher among pregnant women's residing in urban area than in rural (Table 3).

Table 3

Association of sociodemographic factors and anemia among pregnant women attending ANC of Najo General Hospital, 2019.

Variables	Category	Anemic	Not anemic	COR (95% CI)	P value	AOR (95% CI)	P value
Age	15–24	91	129	0.685 (0.438–1.074)	0.099	0.765 (0.45–1.3)	0.325
25–30	44	91	1	1	1	1	>30
10	19	0.919 (0.394–2.14)	0.844	1.76 (0.6–5.2)	0.309	·	

Marital status	Married	140	236	2.81 (0.661–11.94)	0.162	2.5 (0.41–15.34)	0.323
Others	5	3	1		1	1	·
Family size	≤2	68	127	3.27 (0.924–11.56)	0.066	2.14 (0.42–10.97)	0.361
2–4	70	108	2.7 (0.762–9.56)	0.124	1.45 (0.3–7.1)	0.649	5–6
7	4	1		1	1	·	
Educational status	Illiteracy	12	13	0.74 (0.29–1.88)	0.528		
Primary school	55	96	1.19 (0.656–2.17)	0.561			Secondary school
52	92	1.21 (0.66–2.21)	0.535			> grade 12	26
38	1				-		
Occupation	Employed	23	39	1		1	1
Housewife	102	151	0.73 (0.31–1.7)	0.462	1.13 (0.59–2.17)	0.712	Farmer
8	21	0.63 (0.31–1.3)	0.216	2.73 (0.82–9.08)	0.101	Others	12
28	1.12 (0.39–3.24)	0.827	2.36 (0.82–6.78)	0.111	-		
Residence	Urban	95	181	1.64 (1.045–2.58)	0.032*	1.75 (1.01–3.03)	0.045*

NB: *indicates significant difference.

Medical factors such as lack of malaria infection, absence of history of abortion, and history of anemia showed significant association (P<0.05) with the current low prevalence of anemia among the pregnant women. The rest such as helminthic infection, history of contraceptive use, intensity of menstrual level, trimester, body mass index (BMI), birth space, parity, gravidity, and type of contraceptives being used did not show significant (P>0.05) association with occurrence of anemia among the pregnant women (Table 4). In this last step of multiple logistic regression analysis, four variables were found to be statistically independently associated with anemia in pregnancy. Accordingly, absence of malaria infection (AOR = 0.195, 95% CI: 0.07–0.58, P=0.003), absence of history of abortion (AOR = 0.47, 95% CI: 0.26–0.83, P=0.009), and absence of anemia history (AOR = 0.23, 95% CI: 0.134–0.385, P< 0.001) were identified as protective variables from anemia, while urban residence (AOR: 1.75, 95%CI: 1.01–3.034, P =0.045) was found as exposing variable to anemia during pregnancy. Pregnant women with a history of anemia, abortion, and infected with malaria could be potentially vulnerable to anemic condition. Also, pregnant women who resided in urban had 1.75 times more likely to be anemic compared to those who live in rural residence (Table 4).

Table 4

Association of medical factors and anemic conditions among pregnant women attending ANC of Najo General Hospital, 2019.

Variables	Category	Anemic	Not anemic	COR (95% CI)	P value	AOR (95% CI)	P value
Helminthic infection	Yes	3	1	1	1	1	1
No	142	238	0.2 (0.02–1.9)	0.164	0.095 (0.01–1.02)	0.052	·
Malaria infection	Yes	12	8	1	1	1	1
No	133	231	0.38 (0.15–0.96)	0.041*	0.195 (0.07–0.58)	0.003*	·
History of contraceptive	Yes	123	206	1.11 (0.62–2.0)	0.711		
No	22	33	1	1			·
Menstrual level	Heavy	36	55	0.9 (0.56–1.47)	0.685		
Light	109	184	1	1			·
Trimester	1st trimester	49	67	1	1		
2nd trimester	35	60	0.89 (0.49–1.62)	0.705			3rd trimester

33	69	1.12 (0.59 –2.1)	0.733			4th trimester	28
43	1.362 (0.72–2.56)	0.338			-		
History of abortion	Yes	53	60	1	1	1	1
No	92	179	0.58 (0.37–091)	0.018*	0.469 (0.27–0.83)	0.009*	·
Birth space	≤1 year	64	106	0.91 (0.58–1.44)	0.701		
2–3 year	28	37	0.73 (0.40–1.32)	0.299			>3 year
53	96	1	1			·	
Parity status	Nullipara	65	107	1	1		
Primipara	41	72	1.65 (0.1–26.7)	0.726			Multipara
38	59	01.76 (0.11 –28.8)	0.693			Grand multipara	1
1	1.55 (0.09–25.57)	0.758			-		
History of anemia	Present	62	37	0.24 (0.15–0.39)	0.000*	0.23 (0.13–0.385)	P<0.001*
Absent	83	202	1	1	1	1	·
Gravid	First	52	92	1	1	1	1
Second	38	79	3.54 (1.02–12.32)	0.047*	1.6 (0.8–3.2)	0.181	Third

28	48	4.16 (1.18–14.67)	0.027*	1.62 (0.66–4)	0.292	Fourth	19
16	3.43 (0.95–12.45)	0.061	0.54 (0.19–1.55)	0.250	Fifth	8	4
1.68 (0.43–6.64)	0.457	0.23 (0.04–1.26)	0.091	-			
History of contraceptive use	DP	70	112	0.84 (0.39–1.8)	0.641		
Implanon	36	53	0.77 (0.34–1.74)	0.526			Loop
3	8	1.39 (0.31–6.23)	0.666			Combined	1
8	6.23 (0.47–37.4)	0.311			DPI	12	23

4. Discussion

Magnitude of anemia documented in this study was 37.8% (95% CI: 32.8%–42.3%), from which 2.3% were due to severe anemia. Conferring to the Ethiopia Demographic and Health Survey (EDHS) report, about 24% of Ethiopian pregnant women aged 15–49 years were anemic, among which 18%, 5%, and 1% were mildly anemic, moderately anemia, and severely anemic, respectively [3]. In line with the 2016 EDHS survey, the proportion of anemic pregnant women of reproductive age documented in the current study area was much higher than the national survey. Also, the severe anemia cases observed were higher than the reported national survey and also reports from other African countries such as Nigeria (0.3%), Kenya (0.8%), Libya (1%), and Tanzania (2.1%) [11, 15–17]. However, it showed consistent pattern with reports from Ethiopia (Southern (39.94%), Central (36.6%), and Northwestern Ethiopia (36%)) [15, 18, 19]. The discrepancy might be due to difference in socioeconomic status, living style, prevalence of parasitic infection (e.g., malaria), geographical, study time difference (currently improved health facilities are accessible to the pregnant women with better awareness), and interventional activities (such as iron tablet supplementation) being undertaken in different countries [20].

Various sociodemographic factors were found as determinants of anemia in pregnant women [11,15]. Some of these factors are residence, educational and economic status, age of the mother, family size, and occupational status of the mother [20, 21]. In this study, some of these variables did not show significant association with the occurrence of anemia, except for urban residents, which was strongly associated with anemia among pregnant women. This finding agreed with the finding reported from a study conducted at the Nekemte health center, Ethiopia [19], where sociodemographic variables did not show statistically significant association with anemia. Absence of malaria infection was found as protective variable to anemia. It is strongly accepted that malaria is one of the major causes of anemia in tropics [22]. Hemolysis that occurs due to rupturing of malaria infected and noninfected red blood cells is responsible for the development of anemia [22, 23]. Additionally, during pregnancy, malaria tends to be more a typical in presentation. This could be due to the hormonal, immunological, and hematological changes during pregnancy [24]. Hormonal changes during pregnancy reduced synthesis of immunoglobulins (Igs) and reduced reticuloendothelial function [25, 26]. These changes result in loss of acquired immunity to malaria, making the pregnant women more vulnerable to malaria infection as well as the parasitaemia tends to be 10 times higher and, as a result, malaria tends to be more severe in pregnancy compared to the nonpregnant population [25, 27].

In resource-limited countries such as Ethiopia, the cause of anemia during pregnancy is multifactorial. The degree of bleeding resulted from complicated unsafe abortion [28–30] could be manifested by incidence of anemia [31, 32]. The risk will increase to a greater extent if the woman was anemic before she got pregnant [29]. In support of this view, findings of this study showed that pregnant women without a previous history of anemia and lack history of abortion are less likely to become anemic. In Africa, 60% of unsafe abortions generally occur in women aged below 25 years and 40% occur in the adolescent age [31]. Likewise, most of the pregnant women involved in the current study were found aged between 15 and 24 years, and the number of pregnant women with the experience of abortion was significantly higher in this age group. Unlike other reports from the same country and abroad [4], obstetric and gynecological factors such as parity, trimesters, history of menstrual level, history of contraceptive use, and gravidity did not show significant association with anemia in the current study. The observed difference might be due to the fact that high percentage of pregnant women participated in the study was nullipara (44.8%) compared to other parities. However, it was similar with reports from urban area of Eastern Ethiopia, Saudi Arabia, and India [4, 33, 34], where most of the obstetric and medical factors have no association with incidence of anemia.

5. Conclusion

The overall prevalence of anemia among pregnant women (37.8%) in the current study was high. According to the WHO classification of anemia, this prevalence could be considered as a moderate public health problem. However, it is higher than the national anemia prevalence (24%) reported by the Ethiopian Demographic Health Survey (EDHS) in 2016. Urban residence, presence of malaria infections, having history of abortion, and history of anemia were identified as predisposing factors of anemia among the pregnant women, whereas absence of these variables was found protective against this public health problem.

6. Ethical Consideration

The study was ethically approved by Research and Ethical Review Board of Jimma University, College of Natural Sciences. Oral consent agreements and written informed consent were obtained from all study participants prior to data collection; anemic (mild and moderate) pregnant women were consulted to eat iron-rich foods and given iron tablets. Also, those with severe anemic condition got treated at the hospital.

Authors’ Contributions

Wakshuma Gari was involved in project designing, proposal development, data collection and analysis, and write-up of the manuscript. Arega Tsegaye and Tsige Ketema were involved in designing of the project, proposal development, project supervision, and write-up of the manuscript. Tsige Ketema managed the submission and revision of this manuscript during publication.

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DETAIL

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First Trimester Ferritin Is Superior over Soluble Transferrin Receptor and Hepcidin in Predicting Anemia in the Third Trimester: Result from a Cohort

Study in Indonesia

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ABSTRAK (ENGLISH)

Introduction. Anemia in the third trimester has been identified as a risk factor for maternal and fetal morbidity that might lead to mortality. Due to its high cost, finding the best marker to predict anemia became more important to allow early prevention. Only one of ferritin, hepcidin, or soluble transferrin receptors can be picked for the prediction of anemia in the third trimester especially in low-resource setting. *Objective*. This study aimed at defining the best marker among ferritin, hepcidin, or soluble transferrin receptor (sTfR) in the first trimester for prediction of anemia in the third trimester. *Materials, Methods*, *and Setting*. This diagnostic study was nested on the cohort study of vitamin D and its impact during pregnancy in Indonesia. Singleton pregnant mothers with normal fetus were recruited in the first trimester from four cities in West Java, Indonesia. The 304 pregnant women were screened for hepcidin, ferritin, and sTfR level in the sera. All biomarkers were measured by ELISA. Complete blood count (CBC) was done by impedance method measurement (Sysmex[R]). Only subjects with complete data were included in analysis for diagnostic study to compare the three markers by finding the best receiver operating curve (RoC), likelihood ratio (LR), and risk estimate (RR). *Result*. One-hundred and eighty-one pregnant women were eligible for analysis. The result of this study showed that the serum ferritin level in the first trimester was the best marker to predict anemia in the third trimester of pregnancy. Hepcidin and sTfR performed poorly. A new cutoff point of ferritin level ≤27.23 ng/ml yielded the best ROC with 67% area under curve (95% CI 60%–75%, p<0.0001, Youden index *J* 0.28), specificity 86.29% (95% CI 79.0%–91.8%), LR (+) 3.07 (95% CI 1.8–5.3), and RR 2.48 (95% CI 1.67–3.68). These last figures were better than the previously used cutoff point of ferritin level below 30 ng/ml. *Conclusion*. This study provided evidence that the serum ferritin level ≤27.23 ng/ml in the first trimester was the best marker to predict anemia in the third trimester. It was valuably useful for secondary screening of anemia in pregnancy, targeting subjects who may need rigorous approach for iron deficiency treatment in the prevention of anemia in pregnancy.

TEKS LENGKAP

1. Introduction

Anemia is a global major health problem [1]. Based on surveys in South Asia around 1993–2005, anemia affected 48.5% of pregnant women, and the figured changed to 48.7% in 2011 [1, 2]. The prevalence of anemia was relatively constant despite increment in the proportion of pregnant women population being surveyed from 80% to

97.8% [1, 2].
Due to the devastating impact of anemia, especially among vulnerable subjects like pregnant women, adequate strategies in prevention, early detection, and prompt treatment are needed. A report from South Africa showed that anemia in pregnancy had deleterious effects such as abruptio placenta, preterm birth, and stillbirth [3]. Another report concluded that maternal anemia increased the risk for small for gestational babies [4]. The cohort study in which this study was nested also reported high prevalence of anemia and hypovitaminosis D and intrauterine growth restriction (10%) [5–7]. Reports stated that the prevalence of anemia increased by gestational age [5, 8]. In the pregnancy cohort of this study, anemia had 4-fold increase of prevalence in the third trimester, and relative risk (95% CI) for anemia in the third trimester among subjects with vitamin D deficiency and insufficiency in the first trimester (combined) was 2.96 (0.36–24.63) [5].
Anemia is included as a target in Sustainable Development Goals (SDGs) number 2, which were to end hunger, achieve food security, and improve nutrition [9]. Furthermore, the effort to combat anemia can be related to SDG goal number 3 that is to ensure healthy lives and promote well-being for all at all ages [9]. The goal in reduction of anemia prevalence was set at 50 percent from 40% to 20% [10].
The complexity of causal factors and the delay of detection/treatment could be the root of the problems that interventions for anemia seemed to fail; therefore, early detection is important. Most reports stated that anemia in pregnancy is mostly due to nutrient deficiency, such as iron, folic acid, vitamin A, and vitamin B12 [1, 2, 11, 12]. Other diseases such as malaria, hookworm infestations, schistosomiasis, HIV infection, and genetically inherited hemoglobinopathies should also be considered [11, 12]. Less availability and affordability of laboratory methods to determine the causes of anemia may limit opportunities to treat anemia. One also needs to consider that anemia of inflammatory condition may disguise the root cause [13].
Inflammation is part of the physiological changes of pregnancy. Some inflammation marker levels have been detected in higher level among pregnant women than in nonpregnant women, such as C-reactive protein and proinflammatory cytokines [14]. Anemia of inflammation (AI) is a common, typically normocytic normochromic anemia that is caused by an underlying inflammation, indicated by low serum iron concentrations despite adequate iron stores (ferritin) [13]. Differentiating AI from iron deficiency anemia (IDA) is difficult; furthermore, the two conditions may coexist. Traditionally, ferritin has been used as the marker for iron storage, because iron stores in the body exist primarily in the form of ferritin. One disadvantage of ferritin was that ferritin has been known as a positive acute phase response protein, so that it may not reflect the size of the iron store in inflammatory condition [15]. Adjusting thresholds of serum ferritin for iron deficiency was needed [16]. Another marker for iron metabolism in inflammation is hepcidin which has been addressed as the master of regulator of systemic iron bioavailability, including in pregnancy [8]. Hepcidin was found at lower level in nonpregnant state and that pregnant women with lower hepcidin level had higher rate of maternal-ingested transplacental iron transfer [8]. Although the hepcidin level was significantly associated with ferritin, the study by Koenig et al. did not assess their diagnostic value for the detection of anemia [8].
In a report, it was stated that soluble transferrin receptor (sTfR) concentration in serum was useful for diagnosis of iron deficiency, especially in a state when one is compromised by inflammatory condition; however, the report did not include pregnant women [17]. Another study reported that serum transferrin receptors were significantly higher in anemic pregnancies than in nonanemic pregnancies and that the rise is higher by severity of anemia [18].
From the cohort of this study, it was reported that the correlation of ferritin level and anemia in the first trimester was weak (r= 0.147, p=0.038), but no correlation was found between first trimester ferritin level and second or third trimester anemia [5]. For public health and clinical purposes, we need to use the best available evidence. Ferritin has been readily used in almost in every laboratory in big cities, but the use of hepcidin and sTFr is still limited in research field only. This diagnostic study aimed at finding the best marker in the first trimester to predict anemia in the third trimester. Our previous report showed that the proportion of anemia in the third trimester increased among pregnant women with cholecalciferol deficiency in the first trimester, but it did not show correlation with the ferritin level [5]. Three markers were picked: hepcidin, ferritin, and soluble transferrin receptor.

Sharma et al. reported that the serum ferritin level was found lower among pregnant women with anemia [18]. The cross-sectional study compared ferritin and serum transferrin receptors among pregnant women with and without anemia [18]. Achebe and Gafter-Gvili stated that iron deficiency was the only clinical situation associated with extremely low values of ferritin [19]. Previous studies were mostly in cross-sectional design and did not evaluate the diagnostic value of hepcidin or ferritin or transferrin receptor for detection of anemia in pregnancy [8, 15, 18–20]. To the best of our knowledge, until this paper was written, only three cohort studies on pregnant women in Indonesia were found in Pubmed, but none of the cohorts studied anemia in pregnancy [21–23]. The need to find the best possible marker to predict anemia is evident, so that secondary prevention of anemia progression can be managed as in the recommendations by WHO [24] and its complication can be avoided. In this study, diagnostic study was performed on ferritin, hepcidin, and sTfR in the first trimester, with additional analysis for cholecalciferol and calcitriol.

2. Materials and Methods

This study is a part of cohort study on vitamin D status and its impact during pregnancy and childhood in Indonesia. The cohort also studied some more nutritional aspects besides vitamin D. Submission of pregnant women in the first trimester as subjects began from late 2016, and the follow up of the offspring has been ongoing until 2020. The selection and recruitment processes of the cohort have been published previously [5]. The number of subjects was added to the previous report as the cohort progressed. Participations in the study and publications of laboratory results were based on written consent, without disclosing the identity of pregnant women.

Ten millilitres of blood was drawn from each pregnant woman on the first, second, and third trimesters; it was required for routine analysis and also for the purpose of the cohort study. Serum was separated and stored in −20°C prior to laboratory analysis. Complete blood count was calculated using the automated hematology analyzer with impedance method measurement (Sysmex XP-100, Japan). Measurements of serum ferritin, hepcidin, sTfR, cholecalciferol, and calcitriol were performed by ELISA.

Descriptive statistics were compared between subjects with and without anemia in the third trimester, which required that subjects had complete data on haemoglobin in all trimesters. Diagnostic study analysis and risk estimates were performed among subjects with complete data on hemoglobin in all trimesters and the three markers ferritin, hepcidin, and sTfR. Additional analysis was done for cholecalciferol and calcitriol in the first trimester due to new results. The correlation test between all variables was done by SPSS version 10. The receiver operating curve (ROC) and likelihood ratios analysis were performed by Med Calc©. Linear regression analysis was performed to find the factors that would be most influential to the hemoglobin level and development of anemia in the third trimester.

3. Results

The recruitment of pregnant women in the cohort is depicted in Figure 1.

[figure omitted; refer to PDF]

Overall, there were 181 sets of data in the cohort which were eligible for analysis of anemia and the diagnostic study. The prevalence of anemia by consecutive trimesters was 8.48%, 14.29%, and 29.91%. Descriptive statistics of hemoglobin level in the third trimester are presented in Table 1.

Table 1

Descriptive statistics of hemoglobin levels in the third trimester.

	Anemia	Non anemia	Total
tm 3	tm 3	*n* of subjects (%)	67 (29.91)
157 (70.09)	224 (100)	Hb mean (SD)	9.96 (0.88)

12.01 (0.77)	11.40 (1.24)	Hb median (IQR)	10.02 (1.20)
11.80 (1.05)	11.50 (1.47)	Hb min-max	7.3–10.90

tm3 = third trimester; *n* = number; Hb = hemoglobin; SD = standard deviation; IQR = interquartile range; Min = minimum value; max = maximum value. Kolmogorov-Smirnof test result $p<0.001$; data were not normally distributed.

The nonparametric correlation test showed that first trimester hemoglobin was significantly correlated with the second and third trimester hemoglobin ($r=0.596$ and $r=0.565$, $p<0.01$). First trimester ferritin was significantly correlated with the first and third trimester hemoglobin ($r=0.182$ and $r=0.321$, $p<0.1$). Hepcidin, sTfR, cholecalciferol, and calcitriol showed no correlation with hemoglobin at any trimester.

To find the best predictor of anemia, ROC analysis was performed on the five markers being evaluated. The results turned that ferritin was the only marker which fulfilled the criteria $p<0.05$ (Table 2). All the other markers performed poorly on ROC analysis (data not shown). Table 2 presents the test details on ferritin.

Table 2

Diagnostic study results on the ferritin level in the first trimester to predict anemia in the third trimester.

Variable classification	Ferritin and anemia
Sample size	181
Positive group	57 (31.49%)
Negative group	124 (68.51%)
Area under the ROC curve (AUC)	0.672
Standard error	0.0448
95% confidence interval	0.598 to 0.739
z statistic	3.829
Significance level p (area = 0.5)	0.0001
Youden index *J*	0.2840
Associated criterion	≤27.23
Sensitivity	42.11
Specificity	86.29
Likelihood ratio (+) (95% CI)	3.07 (1.8–5.3)
Likelihood ratio (−) (95% CI)	0.67 (0.5–0.8)

Based on the new cutoff, the distribution of subjects in the groups changed as shown in Table 3.
Table 3
Distribution of pregnant women with and without anemia based on two cutoff values of ferritin level.

Test results	Anemia (*n* (%))		Nonanemia (*n* (%))	
New cutoff (ferritin ≤ 27.23 ng/ml)				
Positive	24	(58.5)	17	(41.5)
Negative	33	(23.6)	107	(76.4)
–				
Pervious cutoff (ferritin				
Positive	*24*	*(52.2)*	*22*	*(47.8)*
Negative	*33*	*(24.4)*	*102*	*(75.6)*

Although the prevalence was still the same, the likelihood ratio (+) of the new cutoff point of ferritin was better, as shown in Table 4.
Table 4
Likelihood ratio and risk estimates of maternal ferritin level in the first trimester to predict anemia in the third trimester.

	Ferritin ≤ 27.23 ng/ml	*Ferritin*
Number of subjects	*181*	*181*
Likelihood ratio (+) (95% CI)	*3.07 (1.80–5.30)*	*2.27 (1.40–3.70)*
Risk estimates (95% CI)	*2.48 (1.67–3.68)*	*2.13 (1.42–3.20)*

4. Discussion

Anemia among pregnant women has high prevalence worldwide, with possible serious fetal-maternal sequelae, such as low birth weight and preterm delivery [11]. This study was the continuation of the cohort which was previously reported [5], but with additional data from additional subjects and different purposes, new analyses were added. Some changes were observed in the prevalence of anemia in this study population. Although the curves and tables were not shown in this report, it was reconfirmed in the analysis that cholecalciferol and calcitriol in the first trimester had no correlation with anemia in the third trimester, and they came out poor in the ROC curve. The same thing was found for hepcidin and sTfR, which was unexpected as some experts consider that hepcidin and sTfR were superior to ferritin.

It was previously reported that anemia in the first trimester was 7.5% among the population in the cohort [5] which turned into 8.48% in this study. The new prevalence of anemia in the third trimester was 29.91%, which meant that there was 3.5 times increase from the prevalence in the first trimester. The prevalence of anemia in the third trimester in this study was still in the moderate level of public health significance [24]. The prevalence of anemia among pregnant women was 43% in Cambodia and 63% among pregnant women in Kolar, India [25, 26]. In Tasmania, the prevalence of anemia also increased by trimester, which were 13.4% in 14–25 weeks of gestations, 17.7% in 26–36 weeks, and 21.9% in 37–42 weeks of gestation [12]. However, the mean value for third trimester hemoglobin among women with anemia was lower in this study, at 9.96 gr/dl, which fell in the moderate category by the WHO [24]. The proportion of pregnant women with ferritin below 30 ng/ml was previously 24.9% [5]; in this final report, it slightly increased to 25.41%. The median for serum ferritin among pregnant women in Tasmania was 24.8 ng/ml, and 33.3% of the subjects fell below median value [12].

The area under curves in the ROC for hepcidin and sTfR were small, and they were of no significance. This had practically eliminated the two biomarkers as predictor for anemia. In a clinical trial, it was concluded that hepcidin-guided screen-and-treat approaches had no advantages over the WHO's recommended regimen in terms of adherence, side-effects, or safety outcomes [27]. In a review, it was concluded that hepcidin is a regulator of iron homeostasis and may be a useful biomarker to determine iron bioavailability in pregnancy, but there was no conclusive result for prediction of anemia [8]. Proper distinction between true iron deficiency anemia versus inflammation-mediated iron restriction during pregnancy may be helpful in clinical setting as iron may need to be prescribed appropriately [8]. In this study, first trimester hepcidin also performed poorly in prediction of anemia in the third trimester. The use of sTfR for prediction of anemia in several previous studies was conflicting [28–30]. But, it became clear that first trimester sTfR is not candidate for prediction in the third trimester.

In the applications for improving health care service, the findings of this study are very important. The new cutoff would give some benefit to reassure any pregnant woman with anemia and low ferritin level, to pay more attention on improving her health, and to avoid anemia in the third trimester and its detrimental consequences. There was a 4.8% increase in specificity (from 81.45 to 86.26). This means that an additional 5 out 100 pregnant women would be screened for treatment of restoring iron stores and that those without adequate management might fall worse.

Based on the correlation tests, only hemoglobin and ferritin in the first trimester had shown consistent result with third trimester hemoglobin level and the occurrence of anemia.

The serum ferritin level, known as one of many markers of iron stores, was below the two cutoff points evaluated in this study. It is of major concern as it resulted in approximately 3 times higher risk for anemia in the third trimester.

5. Conclusion

This cohort study provided evidence that the serum ferritin level in the first trimester (≤27.23 ng/ml) was the best marker to predict anemia in the third trimester. It will be valuable in targeting subjects for more rigorous approach for the prevention and treatment of anemia in pregnancy, especially in low-resource setting. The usefulness of ferritin as the marker for treatment of anemia in pregnancy would need a carefully designed randomized controlled trial.

Ethical Approval

Ethical clearance was provided from the Health Research Ethical Committee of Universitas Padjadjaran (number 330/UN6.KEP/EC/2018).

Consent

Written informed consent and consent for publication without exposing personal identification were obtained from the participants orally during the interview.

Authors' Contributions

RTDJ and THM equally contributed to this study in designing and writing of article. RTDJ and HS performed the statistical analysis. BH, LG, SA, and SI contributed to data collection and monitoring of subjects. RTDJ and BS contributed to designing and writing of research proposal and discussion.

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DETAIL

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Lokasi:	Indonesia
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Anemia and Its Determinants among Male and Female Adolescents in Southern Ethiopia: A Comparative Cross-Sectional Study

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ABSTRAK (ENGLISH)

Background. Adolescent anemia is a major public health problem worldwide. Adolescents (10–19 years) are at an increased risk of developing anemia due to increased iron demand during puberty, menstrual losses, limited dietary iron intake, and faulty dietary habits. *Objective*. To assess the prevalence of anemia and associated factors among male and female adolescent students in Dilla Town, Gedeo Zone, Southern Ethiopia, May 2018. *Methods*. A school-based comparative cross-sectional study was employed among 742 school adolescents. Basic characteristics, anthropometric measurements, haemoglobin measurement, and others were collected. Data were analyzed using SPSS version 20 software, and descriptive statistics were computed for all variables. Bivariate and multivariable logistic regression analyses using binary logistic regression were done, the results were interpreted by using AOR with their corresponding 95% CI, and statistically significant difference was declared at $p<0.05$*Result*. Out of the total 742 respondents, 377 (50.8%) were males and 365 (49.2%) were females. The overall prevalence of anemia was 21.1%, and the prevalence of anemia was 22.5% among male adolescents and 19.7% among females. Male adolescent students within the early adolescence age group (10–13 yrs) (AOR 0.27, 95% CI, 0.08–0.87), those consuming fibre-rich foods daily (AOR 0.11, 95% CI, 0.02–0.61), and those having no intestinal parasites (AOR 0.04, 95% CI, 0.02–0.09) were less likely to be anemic. Similarly, female adolescent students not having intestinal parasites (AOR 0.05, 95% CI, 0.01–0.11) were less likely to develop anemia while those from malaria endemic area (AOR 2.57, 95% CI, 1.13–5.83) were identified to be more anemic. *Conclusion*. This study identified that anemia was a moderate public health significance in the study area, and the prevalence of anemia was slightly higher among male than female adolescents. Age category, frequency of eating fibre-rich foods, and positive intestinal parasite tests were factors contributing for anemia among male adolescents while presence of intestinal parasite and malaria endemicity were the determinants of anemia among female adolescents.

TEKS LENGKAP

1. Background

Anemia is defined as a decrease in the concentration of circulating red blood cells or haemoglobin concentration resulting in insufficient oxygen carrying capacity of red blood cells to meet the physiological needs of the body [1, 2]. Anemia generally results from blood loss, decreased red blood cell (RBC) production, poor RBC maturation, or increased RBC destruction [3, 4]. The WHO defines anemia in adolescents as a haemoglobin value below 11 g/dl for children 5–11 years of age, below 12 g/dl for children 12–14 years of age, below 13 g/dl in men 15 years of age, and above and below 12 g/dl in nonpregnant women 15 years of age and above [2]. Preschool children, pregnant woman, and adolescents constitute a vulnerable group for anemia [5].

According to the World Health Organization (WHO), adolescence has been defined as the period of life between 10 and 19 years of age [6] and constitutes about 25% of the world population. During adolescence, the velocity of growth is at the faster stage next to the critical window of the first 1,000 days of life, and adequate nutrition during this age is very important than any other age. This is the formative period of life when the maximum amount of physical, psychological, and behavioural changes takes place [7].

During childhood and adolescence period, the nutritional needs of boys slightly differ from that of girls. Iron requirements peak during adolescence due to rapid growth and increase in blood volume. Anemia during adolescence causes reduced physical and mental capacity and diminished concentration in work and educational performance, and also poses a major threat to future safe motherhood in girls [8]. Despite the fact that iron is the second most abundant metal in the earth’s crust, anemia is considered as the most common micronutrient deficiency worldwide, and in 95% of cases, it is associated with an iron-poor diet. Iron deficiency is thought to be the most common cause of anemia [9, 10].

Globally anemia affects the lives of more than 2 billion people, accounting for over 30% of the world’s population which is the most common public health problem particularly in developing countries occurring at all stages of the life cycle [11]. In developed countries, 4.3 to 20% of the population, depending on age and gender, are affected by iron deficiency anemia, while in developing countries, these figures range from 30 to 48% [3]. The worldwide prevalence of anemia among adolescents is 15% (27% in developing countries and 6% in developed countries) [12]. Notwithstanding this, few data are currently available on the prevalence of iron deficiency anemia among adolescents.

Adolescents are at an increased risk of developing anemia due to increased iron demand during puberty, menstrual losses, limited dietary iron intake, and faulty dietary habits. This dramatic increase in iron requirement among adolescents peaks between the ages of 14-15 years for girls and one to two years later for boys. The requirement for iron doubles during adolescence as compared to the younger age group. The overall iron requirement increases two to three folds from a preadolescence level of approximately 0.7–0.9 mg Fe/day to as much as 1.37–1.88 mg Fe/day in adolescent boys and 1.40–3.27 mg Fe/day in adolescent girls. This is due to the expansion of total blood volume, increase in lean body mass, and the onset of menstruation in adolescent females [13, 14].

In spite of increased iron needs, many adolescents, particularly females have iron intakes of only 10-11 mg/day of total iron, resulting in approximately 1 mg of absorbed. About three fourths of adolescent females and 17% of males do not get their dietary iron requirement which makes the adolescents vulnerable to the development of anemia [15].

The most common causes of anemia in adolescent, especially in developing countries and Sub-Saharan Africa, are poverty and ignorance that leads to lack of purchasing power to afford foods containing heme iron, low socioeconomic status leader to poor sanitation and hygiene, low iron intake, poor bioavailability of dietary iron, infections, and parasitic infestation [16].

Anemia in adolescent has serious implications for a wide range of outcomes, and nearly all of the functional consequences of iron deficiency are strongly related to the severity of anemia. It causes reduced resistance to infection, impaired physical growth and mental development, and reduced physical fitness, work capacity, and school performance [17, 18].

In Ethiopia, adolescents, who constitute a sizable segment of its population, form a vulnerable group and are at a greater risk of morbidity and mortality. Anemia is widely prevalent in Ethiopia and affects both sexes in all age groups. Among adolescents, girls constitute a vulnerable group, particularly in developing countries such as Ethiopia. In a family with limited resources, the female child is more likely to be neglected due to sociocultural factors [19]. In Ethiopia, the prevalence of anemia among the age group of 15–19 year-old males and females was 18.2% and 19.9%, respectively [20].
Even though the study of anemia among both male and female adolescents is very limited in Ethiopia, few studies have been conducted on school female children, reproductive age women, and pregnant women and the results of all these studies put anemia as a moderate-to-severe public concern. The National Nutrition Program (NNP) of Ethiopia gives special attention to address these age groups, but the implementation of this program at the grass root level is very weak as compared with other vulnerable groups [21].
Therefore, the main aim of this study was to compare the prevalence of anemia and associated factors of anemia among male and female school adolescents in Dilla Town. Results from this research are important to clarify how to approach with adolescent-specific nutrition intervention to reduce anemia-related morbidity and increase productivity. Also, the findings will be used as input for different health sectors at zonal and woreda levels to plan interventions to reduce the problem of anemia.

2. Methods and Materials

2.1. Study Design and Setup

A school-based comparative cross-sectional study was conducted from 14th May to 1st June 2018 among school adolescents (10 to 19 years) in Dilla Town, Gedeo Zone, Southern Nations, Nationalities, and Peoples' Region (SNNPR), Southern Ethiopia. Dilla Town is located at 367 km to the south of Addis Ababa, the capital of the country, and 90 km from Hawassa, the center of the region, SNNPR. The study area has a longitude and latitude of 6°24′30″N 38°18′30″E Coordinates: 6°24′30″N 38°18′30″E, with an elevation of 1570 meters above sea level [22] and monthly temperature range of 10°c to 30°c [23].

2.2. Population

The source population for this study was all school adolescents from 10 to 19 years attending both private and government schools in Dilla Town, and the study population was adolescents attending the selected schools during the study period. Adolescents with known chronic diseases were excluded from the study.

2.3. Sample Size Determination

The sample size for this study was determined using two population proportion formulas considering prevalence of anemia among male and female taken from a previous cross-sectional study [24]. Accordingly, the sample size was determined using the following formula:
(1)$n=Z\alpha/22pq+Z\beta p1q1+p2q22\Delta 2$.
In the formula, n = sample size, $Z\alpha/2$ = at 95% CI which is 1.96, Power 80% is 0.84, r = 1 (ratio of exposed to nonexposed), $p1$ = percent of a male with anemia = 24.3% = 0.243, $p2$ = percent of a female with anemia = 18.1% = 0.181,(2)$p=p1+p22=0.212$,(3)$q=1-p=0.788$,(4)$q1=1-p1=0.757$,(5)$q2=1-p2=0.819$,(6)$\Delta=p1-p2-0.062$.
The calculated sample based on the above assumption was 688, and by adding ten percent nonresponse rate, the final sample size became 756 (378 males and 378 females).

2.4. Study Variable

2.4.1. Dependent Variable

Adolescent anemia.

2.4.2. Independent Variables

Demographic characteristics of the adolescents: age of adolescents, place of residence, grade of adolescents, educational status of mother and father, occupational status of mother and father, livening condition (with family or separate from family), parental condition (existence of mother and father), family size, and marital status.
Water and sanitation: source of drinking water, type of latrine, and wear shoe.
Dietary diversity/practice: food consumption, food frequency, food sources, postmeal consumption of tea and coffee,

and school feeding program.
Knowledge of anemia: information on anemia, knowledge of food sources rich in iron, knowledge of causes of anemia, and knowledge of consequences of anemia.
Health and nutrition condition: body mass index for age, height for age, menstrual status, malaria endemicity, malaria and parasitic infection, deworming, and accessibility of adolescent health service.

2.5. Sampling Technique/Sampling Procedures

There are a total of 23 schools in Dilla Town out of which six schools were randomly selected with simple random sampling technique. Then, a total sample was proportionally allocated to each schools based on the number of adolescents in the selected schools. Finally, a simple random sampling (SRS) technique was applied to select study participants using the school roaster as a frame.

2.6. Data Collection Procedures and Measurements

For data collection, a pretested questionnaire, anthropometric assessment, haemoglobin measurement, and stool examination checklists were used. The questionnaire was adapted from different literature studies and EDHS [20, 24, 25]. For anthropometric assessment, height and weight were measured with standardized protocols and calibrated equipment. Weights were measured with minimal (light) clothing, shoes removed, and hats using a digital weighting scale (SECA, UNICEF, and Copenhagen) and recorded to the nearest 0.1 kg. Heights were measured using a wooden measuring board with a sliding head bar in Frankfurt position and recorded to the nearest 0.1 cm [26].
Haemoglobin determination was done for the selected students in the school compound by laboratory technicians that were working outside of the respective district. The haemoglobin concentration of each student was measured by taking a finger-prick blood sample using a HemoCue haemoglobinometer (HemoCue Hb 301+, Angelholm, Sweden). Standardization of the HemoCue haemoglobinometer was checked by crosschecking CBC machine [27]. Both interview and blood sample collection were taken from each adolescent student in a separate room. Haemoglobin measurements were adjusted for altitude, sex, and age as proposed by the WHO, and the cutoff point for anemia was based on the WHO recommendation for adolescents [2].
The stool examination was conducted by laboratory technicians using the portable microscope in each school compound. Stool samples were collected from each study participant using clean, wide-mouthed, and leak-proof stool cups and examined at the data collection site within 10–15 minutes of collection by the wet mount for identification of intestinal parasites.
The food and nutrition technical assistance questionnaire was used to collect data for dietary diversity. The types of food adolescents took within the last 24 hours were asked, and the information collected on dietary consumption was used to calculate the dietary diversity score (DDS).
Data were collected by four laboratory professionals and eight nurse diploma professionals. The data collectors were trained for two days on the data collection tools and anthropometric measurement procedures.

2.7. Data Analysis Procedures

Data were entered into EpiData version 3.1 and then exported to SPSS version 20 statistical packages for analysis. Anthropometric data were entered and calculated using the WHO AnthroPlus software. The dietary diversity scores (DDS) for 24-hour recall were calculated per adolescent by summing the number of different consumed food groups. The DDS was categorized into tertiles which include low dietary diversity with ≤2 food groups, medium dietary diversity with 3 food groups, and high dietary diversity with ≥4 food groups [28]. Stunting was defined using height for age *Z*-score of less than −2 SD. Descriptive statistics were computed to give a clear picture of background information and determine the prevalence. Then, data were analyzed using binary and multivariable logistic regression to assess the factors associated with anemia. Model fitness was done using the Hosmer–Lemeshow goodness of fit test for logistic regression. Statistical precision was estimated with 95% CI (confidence interval) and statistical significance determined at p value ≤0.05.

2.8. Data Quality Management

The questionnaire was originally developed in English and later translated into Amharic and Gedeofa. To keep the consistency of its content, the questionnaire was translated back to English by a language expert. Two-day training was given for data collectors and supervisors. Before data collection, a pretest was conducted among 38 students (5% of the sample size) to centexualize the questionnaires before the actual data collection and revisions were made accordingly. During the study period, the questionnaire was checked every evening for its completeness. Unrecorded data and unlikely responses were manually separated and reinterviewed the next day. All laboratory activities were performed by strictly following manufacturers' instructions and specific standard operating procedures. All anthropometric measurements were taken twice by two data collectors, and the mean values were used for data analysis. The weighing scale was calibrated with a known weight object regularly, and the scale indicator was checked against zero reading after weighing every adolescent.

3. Results

3.1. Sociodemographic and Socioeconomic Characteristics

From a total of 756 adolescent students expected to participate in this study, 742 (377 males and 365 females) were actually participated making the response rate 98.1%. Among the participants, about 50% (186) of males and about 40% (141) of females were in a late adolescence period with a mean age of 16 years (SD, 2.4) among males and 17 (SD, 2.1) among females. With regard to grade levels, 179 (47.5%) of males and 190 (52.1%) of females were from grade 5 to 8. Protestant religion followers constitute 293 (77.7%) among males and 237 (64.9%) among females in this study.

Regarding family characteristics, 179 (47.5) of male adolescents and 174 (47.7%) of female adolescents were from households with a family size of 5–7 members. With respect to family education, 191 (50.7) of males' fathers and 198 (54.2) of females' fathers had attended secondary school or above (Table 1).

Table 1

Sociodemographic and socioeconomic characteristics of male and female adolescent students in Dilla Town, Gedeo Zone, Southern Ethiopia, May 2018.

Variables	Male number (%)	Female number (%)
Age category	377	365
Early adolescence (10–13 yrs)	61 (16.2)	74 (20.3)
Middle adolescence (14–16 yrs)	130 (34.5)	150 (41.1)
Late adolescence (17–19 yrs)	186 (49.3)	141 (38.6)
Mean age (±SD)	16 ± 2.4	17 ± 2.1
–		
Grade	377	365
5–8	179 (47.5)	190 (52.1)
9-10	140 (37.1)	142 (38.9)
11-12	58 (15.4)	33 (9.0).

–		
Ethnicity	377	365
Gedeo	258 (70.9)	214 (61.7)
Oromo	44 (12.1)	41 (11.8)
Amhara	31 (8.5)	36 (10.4)
Gurage	25 (6.9)	43 (12.4)
Others [a]	19 (5.0)	31 (8.6)
–		
Religion	377	365
Protestant	293 (77.7)	237 (64.9)
Orthodox	67 (17.8)	95 (26.0)
Muslim	7 (1.9)	21 (5.8)
Catholic	10 (2.7)	12 (3.3)
–		
Father's educational status	377	365
Illiterate/cannot read or write	26 (6.9)	13 (3.6)
Can read and write	91 (24.1)	82 (22.5)
Primary school	69 (18.3)	72 (19.7)
Secondary school and above	191 (50.7)	198 (54.2)
–		
Mother's educational status	377	365
Illiterate/cannot read or write	65 (17.2)	42 (11.5)
Can read and write	92 (24.4)	98 (26.8)
Primary school	112 (29.7)	101 (27.7)

Secondary school and above	108 (28.6)	124 (34.0)
–		
Father’s occupational status	377	365
Farmer	73 (19.8)	54 (15.3)
Government employee	155 (42.1)	147 (41.8)
Merchant	140 (38.0)	151 (42.9)
Others [b]	9 (2.4)	13 (3.6)
–		
Mother’s occupational status	377	365
Housewife	152 (41.1)	156 (43.9)
Farmer	21 (5.7)	14 (3.9)
Government employee	80 (21.6)	71 (20.0)
Merchant	177 (31.6)	114 (32.1)
Others [c]	7 (1.9)	10 (2.7)
–		
Your current marital status	377	365
Never married	341 (90.5)	337 (92.3)
On promise	25 (6.6)	16 (4.4)
Married	11 (2.9)	12 (3.3)
–		
Family size	377	365
≤4	35 (9.3)	33 (9.0)
5–7	179 (47.5)	174 (47.7)
≥8	163 (43.2)	158 (43.3)

–		
Place of residence	377	365
Urban	329 (87.3)	337 (92.3)
Rural	48 (12.7)	28 (7.7)
Parental status	377	365
Both parent alive	343 (91.0)	333 (91.2)
Father alive	7 (1.9)	6 (1.6)
Mother alive	23 (6.1)	25 (6.8)
Both parent died	4 (1.1)	1 (0.3)
–		
Current living status	377	365
Living with parent	305 (80.9)	316 (86.6)
Living with relatives	18 (4.8)	26 (7.1)
Living separately from family	54 (14.3)	23 (6.3)

[a]=Wolaita, Silte, Sidama, and others; [b]=private employee, daily laborer, student, and others; [c]=private employee, daily laborer, and student.

3.2. Dietary Practices and Related Factors

Information about the source of food shows that the majority of the family of male (70.8%) and female (76.4%) adolescents achieve food need through buying/purchasing. Most of the study participants in both sexes 272 (72.1%) among male and 262 (71.8%) among female had low DDS in the last 24-hour recall. Concerning daily meal frequency, 335 (88.9%) of male adolescents and 342 (93.7%) female adolescents eat three times or more (Table 2).

Table 2

Dietary practices and related factors among male and female adolescent students in Dilla Town, Gedeo Zone, Southern Ethiopia, May 2018.

Variables	Male (*n*=377) number (%)	Female (*n*=365) number (%)
Daily meal frequency (usual)	377	365
Two times or below	42 (11.1)	23 (6.3)
Three times or more	335 (88.9)	342 (93.7)

–		
Daily meal frequency (24 hours)	377	365
Two times or below	113 (30.0)	83 (22.7)
Three times or more	264 (70.0)	282 (77.3)
–		
Main sources of family food needs	377	365
Grow their own	99 (26.3)	74 (20.3)
Buy/purchase	267 (70.8)	279 (76.4)
Subsidies/food aid	11 (2.9)	12 (3.3)
–		
DDS in last 24 hours	377	365
Low	272 (72.1)	262 (71.8)
Medium	100 (26.5)	99 (27.1)
High	5 (1.3)	4 (1.1)
–		
Green leafy vegetable consumption	377	365
None	15 (4.0)	20 (5.5)
Once a week	53 (14.1)	32 (8.8)
Twice in a week	98 (26.0)	99 (27.1)
Every other day	80 (21.2)	74 (20.3)
Every day	87 (23.1)	86 (23.6)
Do not remember	44 (11.7)	54 (14.8)
–		
Frequency of fibre foods	377	365

None	24 (6.4)	29 (7.9)
Once a week	83 (22.0)	61 (16.7)
Twice in a week	71 (18.8)	81 (22.2)
Every other day	61 (16.2)	47 (12.9)
Every day	67 (17.8)	81 (22.2)
Do not remember	71(18.8)	66 (18.1)
–		
Frequency of foods of animal origin	377	365
None	34 (9.0)	21 (5.8)
Once a week	147 (39.0)	118 (32.3)
Twice in a week	75 (19.9)	105 (28.8)
Every other day	38 (10.1)	48 (13.2)
Every day	42 (11.1)	41 (11.2)
Do not remember	41 (10.9)	32 (8.8)
–		
Consumption of tea after a meal	377	365
Always	118 (31.3)	123 (33.7)
Sometimes	207 (54.9)	194 (53.2)
Not at all	40 (10.6)	33 (9.0)
Do not remember	12 (3.2)	15 (4.1)

3.3. Health Services, Personal Practices, and Related Factors

About 50% (140) of males and 43.2% (115) of female respondents have poor knowledge about anemia. About 10.3% (39) of male adolescents and 9.6% (35) of female adolescents have history of malaria infection in the last one month. Regarding stool parasite assessment result, 104 (31.5%) of male study participants and 78 (22.0%) of female adolescents have parasite infestation (Table 3).

Table 3

Health service, personal practices, and related factors among male and female adolescent students in Dilla Town, Gedeo Zone, Southern Ethiopia, May 2018.

Variables	Male (n=377) number (%)	Female (n=365) number (%)
Knowledge of anemia	281	266
Good knowledge	141 (50.2)	151 (56.8)
Poor knowledge	140 (49.8)	115 (43.2)
–		
Malaria endemicity	377	365
Yes	184 (48.8)	178 (48.8)
No	193 (51.2)	187 (51.2)
–		
History of malaria last one month	377	365
Yes	39 (10.3)	35 (9.6)
No	338 (89.7)	330 (90.4)
–		
Deworming in the last one month	377	365
Yes	48 (12.7)	62 (17.0)
No	329 (87.3)	303 (83.0)
–		
Menstruation		365
Yes		329 (90.1)
No		36 (9.9)
–		
Days of menstruation		329
<3 days		183 (55.6)

>3 days		146 (44.4)
–		
Frequency of pad change		329
<3 times		271 (82.4)
>3 times		58 (17.6)
–		
Source of drinking water	377	365
Piped water	295 (78.2)	318 (87.1)
Stand pipe	31 (8.2)	20 (5.5)
Protected spring	51 (13.5)	27 (7.4)
–		
Shoe wearing frequency	377	365
Some of the time	90 (23.9)	35 (9.6)
Most of the time	87 (23.1)	44 (12.1)
Always	200 (53.1)	286 (78.4)

3.4. Prevalence of Anemia and Anthropometric Measurements

In this study, the overall prevalence of anemia was 157 (21.1%) and it is 85 (22.5%) among male adolescents and 72 (19.7%) among female adolescents. The mean haemoglobin levels were 14.4 (±2.3) among male and 13.4 (±1.9) among female study participants. Regarding nutritional status of the adolescents, the level of stunting was 48 (12.7%) among males and 37 (10.1%) among females. According to BMI *Z*-score for age result, 39 (10.3%) of male adolescents and 19 (5.2%) of female adolescents were thin (Table 4).

Table 4

Prevalence of anemia among male and female adolescents in Dilla Town, Southern Ethiopia, May 2018.

Variables	Male (*n*=377)	Female (*n*=365)
Number (%)	Number (%)	Anemia status
377	365	Anemic
85 (22.5)	72 (19.7)	Nonanemic

292 (77.5)	293 (80.3)	-
Types of anemia	85	72
Sever	1 (0.3)	4 (1.1)
Moderate	46 (12.2)	43 (11.8)
Mild	38 (10.1)	25 (6.8)
Mean (SD)	14.4 ± 2.3	13.4 ± 1.9
–		
HAZ	377	365
Stunted	48 (12.7)	37 (10.1)
Normal	329 (87.3)	328 (89.9)
–		
BAZ	377	365
Thin	39 (10.3)	19 (5.2)
Normal	338 (89.7)	346 (94.8)

3.5. Factors Associated with Anemia among School Adolescents in Dilla Town

The multivariable analysis result showed that age category, the frequency of eating fibre foods, and presence of stool parasites were significantly associated with the prevalence of anemia among male adolescent students and malaria endemicity and presence of stool parasites were significantly associated with the prevalence of anemia among female adolescent students.

With regard to factors associated with anemia among males, adolescents in the age range of 10–13 years were 76% less likely to develop anemia (AOR 0.24, 95% CI, 0.07–0.77) compared to those respondents in the age group of 17–19 years. Adolescent males who eat fibre foods every day were 88% less likely to develop anemia compared to those who eat none through the week days (AOR 0.12, 0.02–0.64). Adolescent males who have no stool parasite were 99.5% less likely to develop anemia than adolescent males who have stool parasite (AOR 0.05, 95% CI, 0.02–0.09).

Adolescent females from malaria endemic area were 2.5 times more likely to develop anemia than adolescent females from the less endemic area (AOR 2.52, 95% CI, 1.12–5.62). Adolescent females who have no intestinal parasite were 99.5% less likely to develop anemia than adolescent females who have intestinal parasite (AOR 0.05, 95% CI, 0.01–0.11) (Table 5).

Table 5

Associated factors of anemia among male and female adolescent students in Dilla Town, Southern Ethiopia, May 2018.

Variables	Male				Female			
Anemic	Nonanemic	COR (95% CI)	AOR (95% CI)	Anemic	Nonanemic	COR (95% CI)	AOR (95% CI)	Age
85	292			72	293			10–13
25 (41.0)	36 (59.0)	0.29 (0.15–0.55)*	0.24 (0.07–0.77)*	29 (39.2)	45 (61.8)	0.27 (0.14–0.52)*	0.27 (0.05–1.38)	13–16
29 (22.3)	101 (77.7)	0.69 (0.39–1.23)	0.44 (0.17–1.11)	22 (14.7)	128 (85.3)	1.02 (0.53–1.95)	0.90 (0.30–2.66)	17–19
31 (16.7)	155 (83.3)	1	1	21 (14.9)	120 (85.1)	1	1	
Grade	85	292			72	293		
5–8	51 (28.5)	128 (71.5)	1	1	46 (24.2)	144 (75.8)	1	1
9-10	24 (17.1)	116 (82.9)	1.93 (1.12–3.33)*	0.62 (0.24–1.58)	21 (14.8)	121 (85.2)	1.84 (1.04–3.25)*	1.63 (0.57–4.63)
11-12	10 (17.2)	48 (82.8)	1.91 (0.89–4.07)	0.56 (0.14–2.10)	5 (15.2)	28 (84.8)	1.79 (0.65–4.90)	0.84 (0.14–4.79)
				–				
Father's education	85	292			72	293		
No formal education	8 (30.8)	18 (69.2)	0.73 (0.30–1.79)		3 (23.1)	10 (76.9)	0.64 (0.17–2.46)	0.39 (0.06–2.47)
Read and write	14 (15.4)	77 (84.6)	1.79 (0.93–3.47)		22 (26.8)	60 (73.2)	0.53 (0.28–0.97)*	0.57 (0.18–1.73)
Primary school	16 (23.2)	53 (76.8)	1.08 (0.56–2.07)		15 (20.8)	57 (79.2)	0.73 (0.37–1.45)	0.89 (0.27–2.91)
Secondary and above	47 (24.6)	144 (75.4)	1		32 (16.2)	166 (83.8)	1	1
				–				

Father's occupation	85	292			72	293		
Farmer	13 (17.8)	60 (82.2)	1		7 (13.0)	47 (87.0)	1	1
Government employee	35 (22.6)	120 (76.4)	0.74 (0.36–1.50)		21 (14.3)	126 (85.7)	0.89 (0.35–2.23)	2.00 (0.42–9.53)
Merchant	36 (25.7)	104 (74.3)	0.63 (0.31–1.27)		43 (28.5)	108 (71.5)	0.37 (0.15–0.89)*	1.38 (0.36–5.20)
Others	1 (11.1)	8 (88.9)	0.80 (0.57–1.12)		1 (7.7)	12 (92.3)	0.53 (0.35–0.80)*	0.26 (0.01–4.16)
–								
Mother's occupation	85	292			72	292		
Housewife	37 (24.3)	115 (75.7)	1		26(16.7)	130 (83.3)	1	1
Farmer	4 (19.1)	17 (80.9)	1.37 (0.43–4.32)		1 (7.1)	13 (92.9)	2.60(0.32–20.75)	1.31 (0.11–15.72)
Government employee	17 (21.3)	63 (78.7)	1.19 (0.62–2.29)		11 (15.5)	60 (84.5)	1.09 (0.51–2.35)	0.79 (0.25–2.47)
Merchant	24 (20.5)	93 (79.5)	1.25 (0.69–2.23)		33 (29.8)	80 (70.2)	0.47 (0.26–0.84)*	0.68 (0.27–1.69)
Others	3 (42.9)	4 (57.1)	1.08 (0.89–1.29)		1 (10.0)	9 (90.0)	0.73 (0.59–0.87)*	1.29 (0.14–11.19)
–								
Shoe wearing	85	292			72	293		
Some of the time	17 (18.9)	73 (81.1)	1.47 (0.79–2.72)		6 (17.1)	29 (82.9)	0.95 (0.37–2.42)	1.19 (0.30–4.79)
Most of the time	17 (19.5)	70 (80.5)	1.41 (0.76–2.61)		19 (43.2)	25 (56.8)	0.26 (0.13–0.50)*	0.39 (0.12–1.27)
Always	51 (25.5)	149 (84.5)	1		47 (16.4)	239 (83.6)	1	1

–								
Sources of family food	85	292			72	293		
Grow their own	18 (18.2)	81 (81.8)	1		8 (10.8)	66 (89.2)	1	1
Buy/purchase	65 (24.3)	202 (75.7)	0.69 (0.38–1.23)		62 (22.2)	217 (77.8)	0.42 (0.19–0.93)*	0.55 (0.17–1.67)
Subsidies/food aid	2 (18.2)	9 (81.8)	1.00 (0.19–5.02)		2 (16.7)	10 (83.3)	0.61 (0.11–3.27)	5.85 (0.33–101.37)
Fibre foods per week	85	292			72	293		
None	4 (16.7)	20 (83.3)	1	1	4 (13.8)	25 (86.2)	1	1
Once a week	11 (13.3)	72 (86.7)	1.31 (0.37–4.55)	0.68 (0.12–3.67)	11 (18.0)	50 (82.0)	0.73 (0.21–2.52)	0.53 (0.09–2.94)
Twice in a week	18 (25.4)	53 (74.6)	0.59 (0.17–1.95)	0.24(0.04–1.27)	8 (9.9)	73 (90.1)	1.460 (0.40–5.26)	3.36 (0.50–22.24)
Every other day	11 (18.0)	50 (82.0)	0.91 (0.26–3.19)	0.61(0.11–3.36)	12 (25.5)	35 (74.5)	0.47 (0.13–1.61)	0.73 (0.13–4.12)
Every day	27 (40.3)	40 (59.7)	0.29 (0.09–0.96)*	0.12 (0.02–0.64)*	28 (34.6)	53 (65.4)	0.30 (0.09–0.95)*	0.63 (0.12–3.11)
Do not remember	14 (19.7)	57 (80.3)	0.81 (0.24–2.76)	0.55 (0.10–2.95)	9 (13.6)	57 (86.4)	1.01 (0.28–3.60)	1.55 (0.26–9.06)
–								
Animal food per week	85	292			72	293		
None	3 (9.1)	31 (90.9)	1	1	6 (28.6)	15 (71.4)	1	
Once a week	38 (25.9)	109 (84.1)	0.28 (0.08–0.96)*	0.36 (0.08–1.58)	20 (16.9)	98 (73.1)	1.96 (0.67–5.66)	

Twice in a week	16 (21.3)	59 (78.7)	0.36 (0.09–1.32)	0.43 (0.09–2.09)	20 (19.0)	85 (81.0)	1.70 (0.58–4.93)	
Every other day	8 (21.1)	30 (78.9)	0.36 (0.08–1.49)	0.64 (0.11–3.61)	9 (18.8)	39 (81.2)	1.73 (0.52–5.71)	
Every day	11 (26.2)	31 (73.8)	0.27 (0.06–1.07)	0.74 (0.13–4.01)	11 (26.8)	30 (73.2)	1.09 (0.33–3.52)	
Do not remember	9 (22.0)	32 (78.0)	0.34 (0.08–1.39)	0.40 (0.07–2.23)	6 (18.8)	26 (81.2)	1.73 (0.47–6.34)	
–								
Stool parasite	82	272			63	267		
No	30 (10.9)	246 (89.1)	0.06 (0.03–0.11)*	0.05 (0.02–0.09)*	13 (5.8)	213 (94.2)	0.07 (0.03–0.13)*	0.05 (0.01–0.11)*
Yes	52 (66.7)	26 (33.3)	1	1	50 (48.1)	54 (51.9)	1	1
–								
Malaria endemicity	85	292			67	293		
Yes	37 (20.1)	147 (79.9)	1.31 (0.80–2.13)		27 (15.2)	151 (84.8)	1.77 (1.04–3.00)*	2.52 (1.12–5.62)*
No	48 (24.9)	145 (75.1)	1		45 (24.1)	142 (75.9)	1	1
–								
Start menstruating					72	293		
Yes					57 (17.3)	272 (82.7)	1	1
No					15 (41.7)	21 (58.3)	0.29 (0.14–0.60)*	2.56 (0.53–12.28)

*Statistically significant at p<0.05; COR = crudes odds ratio; AOR = adjusted odds ratio.

4. Discussion

The result of this study indicated that the overall prevalence of anemia among adolescents in the study areas was 21.1%. According to the WHO established criterion, this prevalence is of a moderate public health concern. The comparative assessment revealed that male adolescents (22.5%) were slightly more anemic than female (19.3%) adolescents. However, the difference was found to be not statistically significant. Another finding of a study conducted among adolescents in Wonago District, Gedeo Zone, Southern Ethiopia, found significantly higher prevalence of anemia among male adolescents (24.3%) than among female adolescents (18.1%) [24]. The finding from South Kerala in India also found that male adolescents were more anemic than female adolescents [29]. However, the finding of the study conducted in Bonga Town, Southwest Ethiopia, found that the prevalence of anemia among male adolescents was lower among males (9.4%) than females (19.3%) [25]. This might be due to certain difference in the population included in the study conducted in Bonga Town where the study included older adolescents, and the higher prevalence of anemia among females might be due to mensus. The finding of this study in this regard implies that the trend of considering male adolescents as a less vulnerable group to anemia than the female counterparts in programs attempting to intervene nutritional problems such as anemia should be reconsidered.

Regarding the overall prevalence, the result of this study revealed that the prevalence of anemia was comparable to the other studies in Ethiopia including those conducted in Wonago Town [24] and Bonga Town [25]. On the other hand, the overall prevalence is much lower than the study conducted in India (62.0% in females and 46.1% in males, respectively) [29] and Chennai, Tamil Nadu, among adolescent female students which found 78.8% [30]. The difference in the finding of our study from different regions of the world could be due to the difference in cultural and behavioural practices in different areas of the world. This could also be due to Ethiopia being the country with widespread teff, cereal rich in iron, consuming country than other developing countries.

In the present study, the prevalence of anemia among adolescent males whose age 10–13 years is lower than the prevalence among adolescent males with an age group of 17–19 years. This study is not in agreement with another comparable study conducted in Wonago District, Gedeo Zone, which indicated anemia to be higher among early adolescent periods (10–13 years) compared to the late adolescent period (17–19 years) [24]. The differences may be due to the larger number of menstruating adolescents (females) in this study compared to the previous one.

This study also revealed that adolescent males who eat fibre foods every day were less likely to develop anemia than adolescent males who eat none throughout the weeks. This finding is in line with the study done in Alexandria, Egypt, which reported high consumption of whole wheat bread and bread, low dietary intake of iron-rich foods, and low consumption of vitamin C rich foods to have a significant association with anemia [31]. This suggests that dietary iron intake in fruits and other vegetables is good sources of Vit-A and Vit-C and those food items are also good iron absorption enhancers [32]. Adolescent males who have no intestinal parasite were less likely to develop anemia than adolescent males who have intestinal parasites. This finding is also in agreement with the finding reported from Bonga Town, Southwest Ethiopia, which indicated intestinal parasite infection as one of the factors increasing the risk of anemia among adolescents [25]. This might be due to the fact that most identified intestinal parasites have their own contribution to blood loss and/or red cell destruction [33].

Regarding the factors associated with anemia among adolescent females, those coming from where malaria was common in their area were more likely to develop anemia than adolescent females for whom malaria is not common in their area of residence. This is because malaria is a main cause of anemia in adolescents in Sub-Saharan Africa, and it behaves such as an endemic disease in some areas, such as Ethiopia. Malaria infection is associated with a reduction in haemoglobin levels by the destruction of red blood cells, frequently leading to anemia. This study also identified that the prevalence of anemia among female adolescents who had been infected with intestinal parasites was significantly higher compared to those not infected with intestinal parasites. A similar finding was reported from a study conducted in Siaya District, Kenya; female adolescents who were infected by worms were to develop anemia as opposed to those who did not have worm infestation [34]. This finding is also in contrary to a similar study conducted in Tigray, Northern Ethiopia [35]. This implies that intestinal parasites have also their own contribution for developing anemia among females.

The current study attemted to reveal the level of anemia among male and female adolescents employing a comparative cross-sectional study to have enough sample among the comparison groups. It also addressed a wide range of factors that are associated with anemia in both sexes. The measurement used to assess anemia using HemoCue Hb 301+machine is precise and accurate proxy indicator for anemia study. The limitation of this study was the exclusion of adolescents who are out of school. In addition, there could also be a social-desirability bias in dietary questions asked for food habit.

5. Conclusion

The prevalence of anemia was higher in male adolescent students than females. Age, the frequency of eating fibre foods, and intestinal parasites were significantly associated factors for anemia among male adolescents, and malaria endemicity and stool parasites were factors significantly associated with anemia among female adolescent students. Hence, nutrition programs focusing on anemia among adolescents should give due consideration for both sexes and male adolescents need to have more emphasis. Furthermore, stronger studies with better designs need to be conducted to confirm this finding and to come up with concrete evidence for policy making.

Ethical Approval

The ethical clearance letter to conduct this study was obtained from the Institutional Review Board (IRB) of Dilla University, College of Health Sciences and Medicine. Permission to conduct the study was obtained from each school director’s office. The data collectors explained the objectives and benefits of the study for study participants to obtain informed written consent prior to data collection. The authors obtained written informed consent from 18- to 19-year-old study participants and assent from guardians of less than 18-year-old study participants. Participants confirmed as severe anemic and having an intestinal parasitic infection were linked to the nearby health facility.

Disclosure

There was no role of the funding body in designing, execution of the study, and writeup of the manuscript.

Authors’ Contributions

MB, MF, and SH conceived the idea, designed the methodology, analyzed data, interpreted the finding, and drafted the manuscript. AT participated in data analysis, interpretation, and manuscript writeup. All authors have read and approved the manuscript.

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Prevalence of Anemia and Associated Factors among Secondary School Adolescent Girls in Jimma Town, Oromia Regional State, Southwest Ethiopia

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ABSTRAK (ENGLISH)

Background. Anemia defined as a low blood hemoglobin concentration is public health importance. The adolescence age group is the most neglected in public health and nutrition research as priorities are usually given to pregnant women, lactating mothers, and their children less than 2 years. Current Ethiopian Food and Nutrition policy included adolescent girls in the most at-risk group for nutritional demands; however, only a few published studies have assessed a deficiency of anemia and associated factors to tackle the intergenerational cycle of malnutrition. *Objective*. To assess the prevalence of anemia and associated factors among high school adolescent girls in Jimma town. *Methods*. Data were collected from 528 secondary school adolescent girls by a school-based cross-sectional study design in Jimma town from 1/1/2019 to 1/2/2019, southwest Ethiopia. A multistage sampling technique was used to select the study participants. A portable battery-operated HemoCue Hb 301+ analyzer was used to measure the hemoglobin level, and then reading was classified as normal Hb ≥ 12 g\dl and anemic if the hemoglobin value <12 g/dl based on the WHO 2011 recommended cutoff points after adjustments to altitude was made. Bivariate analysis at p value ≤0.25 was considered as a candidate for multivariable logistic regression. Multivariable logistic regression was done to control for confounders and to identify factors independently associated with anemia. Level of statistical significance was declared at p<0.05. *Results*. A total of 528 adolescent girls were included in the study yielding a response rate of 95.8%. The prevalence of anemia was found to be 26.7%, 95% CI (22.7, 30.50). In multivariate logistic regression analysis, those living separately from their family (AOR = 4.430, 95% CI (2.20, 8.90)), low dietary diversity score (AOR = 3.57, 95% CI (1.88, 6.75)), menstrual bleeding more than 5 days (AOR = 2.25, 95% CI (1.17, 4.33)), and low economic status (AOR = 2.16, 95% CI (1.17, 4.33)) were positively associated factors with anemia and only having at least a secondary school in mother's educational status AOR = 0.43, 95% CI (0.18, 0.97) was negatively associated with anemia in the study area. *Conclusion*. Prevalence of anemia among school adolescent girls was moderate public health importance according to the World Health Organization prevalence estimation of anemia. The living condition of the adolescent girls, dietary diversity score, duration of menses, and low economic status were positive predictor variables, whereas mothers who are being secondary school and above was a protective factor for anemia. Therefore, iron-rich and diversified food consumption should be given attention.

TEKS LENGKAP

1. Introduction

Adolescents are young people between the ages of 10 and 19 years [1]. More than 1.2 billion adolescents are found in the world. The vast majority of adolescents (90%) live in low- or middle-income countries (LMICs) [2]. Adolescents and children constitute about 48% of the Ethiopian population, and about 25% of this age group is girls [3]. It is a period of rapid growth when up to 45% of skeletal growth takes place and 15 to 25% of adult height is achieved during this period [4]. During the growth spurt of adolescence, up to 37% of total bone mass may be accumulated. Although, nutrition influences growth and development throughout infancy, childhood, and adolescence, pieces of evidence show that nutrient needs including that of iron are the greatest during the period of adolescence [4].

Anemia, defined as a low blood hemoglobin concentration, is a public health problem that affects LMICs and has significant adverse health consequences including morbidity and mortality as well as adverse impacts on social and economic development [5]. Iron deficiency is the most prevalent nutritional deficiency and the most common cause of anemia in the world. It is characterized by a defect in hemoglobin synthesis, resulting in red blood cells that are abnormally small (microcytic) and a decreased amount of hemoglobin (hypochromic). Asia and Africa are regions with a higher prevalence of anemia. Nutritional deficiencies are regarded as the most important cause of anemia in the world and a major potential contributor to adolescent anemia in sub-Saharan Africa [6].

WHO defines anemia as a condition in which hemoglobin (Hb) content of blood is lower than normal as a result of deficiency of one or more essential nutrients. Based on WHO 2011, if the hemoglobin level is ≥12 g/dl, it does not indicate anemia for males and females of age between 12 and 14 years and for nonpregnant women >15 years. Anemia is established if the level of hemoglobin is <12 g/dl for nonpregnant women >15 years and children 12–14 years old and 11–11.9 g/dl, 8–10.9 g/dl, and 8 mg/dl were consider as having mild, moderate, and severe anemia respectively [7]. Based on the public health importance, if the prevalence of anemia ≤4.9% is no public health problem, 5.0–19.9% mild public health problem, 20.0–39.9 moderate public health problem, and ≥40 severe health problem [8].

The WHO estimates the prevalence of anemia among adolescent girls in southwest Asian countries like Indonesia, Nepal, and Bhutan was 30%, 46%, and 58.6%, respectively [9]. Similarly, in sub-Saharan Africa, about half of adolescent girls are anemic [5]. Local studies in Babile, eastern Ethiopia, were 32%, and this study concluded the nutritional status of adolescent girls contributes to the nutritional status of the community [10]. Another study conducted in the Afar region, Ethiopia, shows that the prevalence of anemia among school-going adolescent girls was 22.9%, and it was a moderate public health problem [11].

Globally, the prevalence of anemia had shown dramatic increment among women of nonpregnant reproductive age groups from 464 million in 2000 to 578 million in 2016. A condition persists in LMICs which reported the overall prevalence of anemia was over 35%. So, there is still a long road ahead to achieve the SDG 2030 targets anemia in adolescent girls. In Ethiopia, eighteen percent (17.7%) nonpregnant women aged 15 to 49 are anemic, of which Somali regional state has the highest prevalence of anemia (34.8%) followed by the Gambella region where 26.7% and 19% of reproductive age nonpregnant women were anemic in Oromia regional state [12, 13].

The associated factors of anemia among adolescent girls differ from study to study, like low dietary diversity score, living status of adolescents with either of the two parents, duration of menstruation, history of parasitic infestation, low socioeconomic status, household family size, inadequacy of dietary iron intake, drinking tea immediately after a meal, high consumption of whole wheat bread, and low consumption of vitamin C rich foods and molasses, parent’s level of education, parasite infections, low BMI, being stunted, and underweight [10, 11, 14, 15].

The risk of anemia increases during adolescent years with the onset of menstruation and pregnancy. Iron loss from menstruation must be countered by further high iron intake for young women; the other is ever-increasing evidence that control anemia in pregnant women may be more easily achieved if satisfactory iron status can be ensured during adolescence [6, 16]. Most of the previous studies on anemia in Ethiopia were conducted on pregnant and lactating women and children. A few studies assessed anemia and its predictors among adolescent girls in the country. Some of the reasons why there are few studies done in this age groups are they are assumed as being less vulnerable to nutritional deficiency than the other groups which are not true, given the fact that adolescence exerts significantly increased demands on both micro- and macronutrients due to the rapid changes occurring in physical as well as in body composition particularly among ladies experiencing their menarche. So, this study aimed to assess the prevalence and factors associated with anemia among school adolescent girls in Jimma town secondary schools.

2. Materials and Methods

2.1. Study Area and Period

A school-based cross-sectional study was conducted from 1/1/2019 to 1/2/2019 among adolescent girls aged 14 to 19 years. Jimma, the study area, is located 347 km away from Addis Ababa which is the capital city of Ethiopia. The town has 14 secondary schools both private and government. A total of 5694 adolescent girls were attending secondary school in the town. One teaching specialized hospital, one primary hospital, 5 health centers, and numerous private clinics are giving health care services of the population of the town.

2.2. Study Population and Sampling Procedure

Adolescent girls who attended their education in Jimma town secondary schools, who were healthy, and lived in the study area for greater than six month, and nonpregnant adolescent girls during the study period were included in the study. The sample size was determined using single population proportion formula based on the following assumptions: estimated 32% prevalence (p) of anemia among adolescent girls in Babile district eastern, Ethiopia, 95% confidence interval (CI), margin of error (d) 5%, and design effect of 1.5. Secondly, factors associated with anemia among adolescent girls were considered to calculate the sample size from the previous literature, and finally, the largest sample size was used for this study which is 551.

Multistage sampling was used to select the study participants. First, five schools (30%) were randomly selected from

14 secondary schools found in Jimma town. Then, the total number of students was obtained from each school director office. The sample size was distributed among the selected schools proportionally based on the students' size in each school. Finally, the allocated sample size was selected from each school by using simple random sampling technique (computer generated random number) (Annex 1).

2.3. Data Collection Procedure and Instrument

A structured questionnaire, an anthropometric measurement for thinness and stunting, a standard Dietary Diversity Score (DDS) questionnaire from FAO 2010, knowledge related to anemia, and laboratory investigation for hemoglobin were used to collect the data. Sociodemographic and socioeconomic factors (age, marital status, occupational status of the parents, educational status of the parents, living status of the adolescents, parental condition (existence of both father and mother), ethnicity, religion, and wealth index), knowledge regarding anemia, health-related questionnaires (status of menarche, age of menarche, duration of menses, current status menses, frequency of changing sanitary pad, history of worm infestation, history of malaria infection, and taking deworm medicine), anthropometric measurement (to determine stunting and thinness), dietary pattern (meal frequency per day, DDs (using 24 h recall methods), and time and frequency of consumption of tea/coffee in the schools were addressed for adolescents.

Data were collected face-to-face by trained four diploma nurses using a pretested and structured "Afaan Oromo and Amharic" language version questionnaires which were adapted from EDHS and FAO and reviewed from the existed literature, two lab technicians to determine the Hb level, four clinical nurses data collectors, and two BSC nurse supervisors. The questionnaire was prepared in English and then translated into the languages of both Afaan Oromo and Amharic version then retranslated back to English by experts to ensure consistency of the instrument. Two days of training were provided by the principal investigator which is focusing on the objective of the study to create a common understanding of the questionnaire administrations, anthropometric measurements, interviewing approach, and ethical issues. A pretest was conducted among 28 adolescents in Agaro town secondary school, which is 42 kilometers (km) from Jimma town. After pretesting, the necessary corrections were made based on the results of the pretest and the reliability test was performed through Cronbach's alpha (0.758) for selected tools.

Standardization was done for anthropometric measurements, the weight scale was calibrated before data collection with a known standardized object weighing 2 kg, and it checked the functionality routine in between and before measuring the respondent's weight. The HemoCue Hb301 analyzer was validated before starting the actual data collection in Jimma University Medical Center, which is found in southwest Ethiopia by comparing with the Sysmex Pyramid XT-1800i model which was taken as a golden standard at a facility level to determine different hematological tests including hemoglobin. Hemoglobin measurement took place at a time with the same sample for 20 individuals' blood samples in both machines and the relationship of them were compared through the Pearson correlation coefficient ($r = 0.985$) and coefficient of variation (CV = 0.44).

Data coding and cleaning were performed by cross-checking the printout data for obvious errors. Missing values and outliers were checked before analysis by running descriptive statistics. Supervision was carried out throughout the data collection period both by the supervisors and by the principal investigator to keep the quality of data correctly completed.

2.3.1. Dietary Diversity Score (DDS)

It was assessed in adolescent girls consuming 9 food groups over 24 hours which are starch (cereals and white roots), vegetables, fruits, fish, tubers, meat (including organ meat), milk, egg, and legumes. Each food group had been counted only once resulting in a possible score of 0 to 9. In this study, food groups are categorized into low dietary diversity (≤3 food groups), medium dietary diversity score who consumed four and five food groups, and high dietary diversity (≥6) [17, 18].

2.3.2. Anthropometry

Weight was measured by an electronic digital weight scale (Secca Germany) with minimum/lightly/clothing and no shoes/jewelry and recorded to the nearest 0.1 kg. Calibration was done every morning, and before every weight measurement, the data collectors assured the scales reading exactly at zero. The weight scale was validated against known object weighing 2 kg measured regularly. The same measurer was employed for a given anthropometric measurement to avoid variability after intensive training was given. All measurements had been taken twice, and the average was computed. Similarly, height measurements were carried out using a wooden height measuring board with a sliding head bar. The subjects were asked to stand straight on the leveled surface with heels together and their heads positioned and eyes looking straight ahead (frankfert plane) without shoes. Heals, buttocks, and shoulder blades should touch the vertical surface of the stadiometer. The moving headpiece of the stadiometer was applied to lower to rest flat on the top of the head, and reading was near to 0.1 cm [19].

2.3.3. Knowledge

Anemia-related knowledge was assessed by using a pretested questionnaire. Adolescents in this study have been interviewed on anemia-related knowledge questionnaire that had been adapted from assessing KAP FAO guidelines. It had consisted of eight questions: how can recognize someone who had anemia, consequence of anemia for infants and children, causes of iron deficiency anemia, consequence of anemia in pregnant mother, prevention methods of anemia, sources of iron rich foods, foods increase iron absorption, and foods decrease iron absorption. Then, if the respondents answered the correct answer coded as "1" and "0" if they give the wrong answer regarding anemia. The maximum attainable score was 8 and the minimum possible score is zero. The answers to each question changed to a percentage. An individual who scored 50% and above was considered to have good knowledge and adolescent girls who scored below 50% have been considered to have poor knowledge [20].

2.3.4. Wealth Status

26 items used to assess household fixed assets. The tool was adapted from the Ethiopian demographic and health survey (EDHS), and it was ranked as tertile (low, medium, and high).

2.3.5. Hemoglobin

A portable battery-operated HemoCue Hb 301+ analyzer was used to measure the hemoglobin. It is used mainly in primary care and blood donation setting; it is a simple and convenient solution in poor resource settings. A sample of capillary blood was collected from the ring finger using lancet under strict aseptic precaution, using the thumb, lightly pressing the finger from the top of the knuckle towards the tip. This stimulates the blood flow towards the sampling point. The first drop of blood was wiped away, and the second drop was used for Hb determination. One microcuvette is used only once per individual. After that, the microcuvette was put in the haemoglobinometer, and the reading was observed within 1 minute. Then, reading was classified as normal hg ≥ 12 g\dl and anemic if the hemoglobin value <12 g/dl based on the WHO 2011 recommended cutoff points after adjustments to altitude was made. Adjusted Hb (hemoglobin) concentration was made calculated as Hb = −0.32 * (altitude in meters * 0.0033) + 0.22 * (altitude in meters * 0.0033) 2 for an average altitude of the Jimma town (1780 m) above sea level to subtract (which was 0.56 gm/dl) the adjustment from the individual measured Hb concentration values [7].

2.4. Data Processing and Analysis

The collected data were checked for completeness and consistency by manually before entry into a computer. Then, the questionnaires were coded, and data was entered into Epidata version 3.1. Then, the data were exported to SPSS for windows version 20 for further analysis.

Height and weight are transferred into WHO Anthro plus considering the age to convert nutritional data into *Z*-score of indices HAZ and BAZ using the standard of WHO 2007 growth reference. According to this reference, if adolescent girls had BAZ

Descriptive statistics like table and pie charts were used to present data. Frequencies and Percentages were used to organize the categorical independent variables, mean/standard deviation was used to describe a continuous variable, and cross tabs were done to identify adolescents with and without anemia and the prevalence of anemia by its severity.

Both bivariate and multivariable logistic regression analyses were employed to identify the candidate variables and contributing factors of anemia in adolescent girls, respectively. Binary logistic regression analysis was used to identify the candidate variables for multivariable logistic regression at p value ≤ 0.25. Adjusted odds ratio (AOR) with

95% CI was used to determine the predictors of the outcome variable independently and to show the strength of an association; p value less than 0.05 was considered as statistically significant.
The household wealth status was computed using the PCA method by considering locally available household assets, which were dummy coded. Before running the PCA, assumptions were checked: sampling adequacy with KaiserMeyerOlkin and the results of each analysis was >0.5; presence of substantial correlation was checked by correlation matrix, which showed more than two items has a correlation coefficient >0.3. In addition, Bartlett's test of sphericity was checked, and it was significant at $p<0.05$. After the entire checkup from the total 26 variables, 18 variables with six components were left. Finally, the household wealth status was computed and ranked into three categories after checking chi-squared assumptions.

2.5. Ethical Consideration

Ethical clearance was obtained from the Ethical Review Board of Jimma University, Institute of Health, College of public health and medical science, and we also got permission from Jimma Zone Education Department, Jimma zone health office, Jimma town health office, Jimma town administrative education office, school directors, and Keble units. Capillary blood collection was performed after obtaining a signed written informed consent from parents for adolescent girls less than 18 years of age and oral assent from the girls. Girls who are 18 years and above signed a written informed consent form. The aim of the study was explained to all students. Each study participants was informed about the right to withdraw the consent and stop participation at any time without any form of prejudice. Privacy and confidentiality were maintained at each step of the study process. Aseptic techniques were assured by wearing gloves during blood collection and using new lancet for finger pricking. Penetrating injuries were avoided by using fresh self-retractable lancets for all participants to draw a minimal drop of blood for the anemia testing.
The sample blood was never used for further investigation other than hemoglobin analysis and subjects were informed accordingly. Adolescent girls who have anemia were given nutritional education and were asked to visit the nearest health facility.

3. Results

3.1. Socioeconomic and Demographic Characteristics of Adolescent Girls in Jimma Town, Oromia, Southwest Ethiopia

Five-hundred twenty-eight adolescent girls were interviewed in this study and yielded a 95.6% response rate. The mean ages with a standard deviation of the respondents were 16.48 ± 1.17 years. The majority (89.2%) of respondents was from government schools, and 224 (40.3%) students were from grade 9. More than half (52.8%) of the respondents belong to the Oromo ethnic group. Two-hundred nineteen (41.5%) of the respondents were orthodox by religion followed by Muslims (179 (33.9%)). The majority of (498 (94.3%)) of the adolescent girls' marital status was single. Three-fourth (394 (74.6%)) of the adolescent girls are living with their parents. The majority (80.1%) of the respondent's parents were alive. Regarding the parental level of education, more than one-fourth (151 (28.6%)) adolescent girls' fathers had finished grade 12 and above followed by secondary school (grade 9–12) (22.5%). Similarly, one-fourth (25%) of girl's mothers were above grade 12 by education and 12.5% of adolescent girl's mothers were not able to read and write. Similarly, as of the parental occupational status, 232 (43.9%) of mothers were housewives, whereas 26.9% of mothers were government employees. Forty-three percent of fathers of adolescent girls were government employees, and 29.2% of them were merchants. More than one-third (35%) of adolescent parents were under low economic class (Table 1).

Table 1

Socioeconomic and demographic characteristics of adolescent girls and their parents in Jimma town, Oromia, southwest Ethiopia.

Variables (*N* = 528)	Categories	Frequency (*n* = 528)	Percent (%)

Age	14–16	274	51.9
17–19	254	48.1	·
Ethnicity	Oromo	279	52.8
Amhara	100	18.9	Guraga
42	8.0	Dawuro	28
5.3	Keffa	23	4.4
Yeme	30	5.7	Others[1]
26	4.9	-	
Religion	Orthodox	219	41.48
Muslim	179	33.9	Protestant
117	22.16	Catholic	13
2.46	-		
Family size	≤5	239	45.3
>5	289	54.7	·
Marital status	Single	498	94.3
Married	30	5.7	·
Parental condition	Parents alive	423	80.1
Only father alive	47	8.9	Only mother alive
40	7.6	Dead	18
3.4	-		
Living status of adolescent girls	Living with parents	394	74.6

Living with relatives	69	13.1	Living separately from family
65	12.3	-	
Maternal educational status	Cannot read and write	66	12.5
Can read and write	95	18.0	Primary (1–8)
117	22.2	Secondary (9–12)	118
22.3	Above 12	132	25.0
–			
Father educational status	Cannot read and write	29	5.5
Can read and write	119	22.5	Primary (1–8)
109	20.6	Secondary (9–12)	120
22.7	Above 12	151	28.6
–			
Maternal occupation	House wife	232	43.9
Merchant	91	17.2	Government employee
145	26.9	Private employee	48
9.1	Daily laborer	12	2.3
–			
Father occupational status	Government employee	228	43.2
Merchant	154	29.2	Daily laborer
18	3.4	Private employee	103
19.5	Farmer	25	4.7
–			

Wealth status	Low	185	35
Medium	172	32.6	High

Others[1], Tigray, Silte, Wolayita.

3.2. Prevalence of Anemia among Secondary School Adolescent Girls in Jimma Town

The prevalence of anemia among adolescent girls was 141 (26.7% (95% CI: 22.70, 30.5)) (Figure 1), of which 16.3% were mildly and 10.4% were moderately anemic. No girls reported having severe anemia. The hemoglobin level of the adolescent girls ranged from 8.34 g/dl to 16.84 g/dl with a mean (±SD) value of 13.04 ± 1.70 g/dl.

[figure omitted; refer to PDF]

Seventy-three (52%) of adolescent girls who had anemia were in the age group of 17–19 years, whereas 68 (48%) of them were in the age group 14–16 years old. Similarly, from the total anemic adolescent girls, 48.9% of them live with their family followed by 29.8% of girls who live away from their family and the rest 21.3% of them living with relatives. The proportion of anemia among adolescent girls was 61% and 23.9% among girls who were thin and stunt, respectively.

3.3. Knowledge of Adolescent Girls Related to Anemia

Three-hundred seventy-one (70.3%) girls heard about iron deficiency anemia. From the total anemic adolescent girls, about 53.2% of girls heard or have information about anemia. The majority of 302 (82.7%) of them responded to have less energy/weakness to recognize somebody has anemia. One-hundred sixty (43.0%) of adolescent girls responded that lack of iron in the diet or eating too little was the cause of iron deficiency anemia followed by heavy bleeding during menstruation 117 (22.2%). Out of 371 respondents who heard about anemia, 296 (79.6%) study participants had poor knowledge related to anemia (Figure 2).

[figure omitted; refer to PDF]

3.4. Dietary Diversity Practice of the Adolescent Girls

Regarding DDS, the mean dietary diversity score of the adolescent girls was 5.15 (±1.99). Two-hundred thirty (43.6%) girls had a high dietary diversity score of six and above food groups followed by 195 (36.9%) adolescent girls who had medium dietary diversity scores who consumed four and five different food groups, and the rest respondents had low DDS of three and below food groups. The minimum dietary diversity score of adolescent girls was 1 (consumed only one food group), and the maximum dietary diversity score was 9 out of nine food group items (Figure 3).

[figure omitted; refer to PDF]

3.5. Health and Anthropometric Characteristics of Adolescent Girls

Almost all 519 (98.2%) adolescent girls had attained menarche with a reported age of menarche ranging from 9 years to 16 years with a mean age of 14 years of menarche. Out of five-hundred nineteen girls, 57 (10.7%) were on menstruation during data collection time. Four-hundred twenty-three (81.5%) girls changed their pads three and below three times per day. A small number of adolescent girls had a history of malaria infection within one month. Ninety-two (17.4%) girls had a history of worm infestation within one month during data collection time, and 83 (15.7%) of adolescent girls had taken deworm medicine within one month (Table 2).

Table 2

Health-related characteristics of the study participants among adolescent high school girls in Jimma town, Oromia, southwest Ethiopia.

Variables	Category	Frequency	Percent
Status of menarche	Attained	519	98.3

Not attained	9	1.7	·
Age at the onset of menarche (*N*=519)	≤14	412	79.4
>14	107	20.6	·
Duration of menses in each cycle (*N*=519)	≤5 days	452	87.1
>5 days	67	12.9	·
Frequency of changed pad/day (*N*=519)	≤3 times	427	82.3
>3 times	92	17.7	·
Had menstruation currently (*N*=519)	Yes	57	10.7
No	462	89.3	·
History of malaria (*N*=528)	Yes	51	9.7
No	477	90.3	·
History of worm infestation (*N*=528)	Yes	92	17.4
No	436	82.6	·
Taking deworm medicine (*N*=528)	Yes	83	15.7

The mean height and weight of the adolescent girls were 157.3 (±6.056) cm and 50.66 (±7.35) kg, respectively. The mean body mass index for age *Z* score was −0.259 (±1.0775), and the mean height for age *Z* score was −0.7690 (±0.895), respectively. Thinness was recorded in 41 (7.8%) of which 10 (1.9) were severed thinness. Sixty-one (11.6%) of girls were overweight, of which only a few individuals 4 (0.8%) were obese. Stunting which is the chronic form of malnutrition is seen in 46 (8.7%) adolescent girls in the study area.

3.6. Factors Associated with Anemia

The mother's educational status, living condition of the adolescent girls, dietary diversity score, and duration of menses, meal frequency, and wealth index were found to be a significant association with anemia by multivariate logistic regression at p value <0.05.

The odds of having anemia were 4.4 times higher among girls who lived separately from their parents compared to girls live with their parents (AOR=4.43 (95% CI, 2.20, 8.90), p<0.001)). Similarly, the odds of having anemia were 3.6 times higher among adolescent girls who had low DDS compared with girls who had high DDS (AOR=3.57 (95% CI, 1.88, 6.76, p<0.001)). Additionally, the odds of having anemia were 2.2 times higher among adolescent girls having a duration of menses greater than five days compared with girls who had a duration of menses less than or equal to five days (AOR=2.25 (95% CI, 1.17, 4.33, p=0.028). Adolescent girls who were from low-income families were 2 times more likely to be anemic compared with girls who had high-income families AOR=2.16 (95% CI, 1.17, 3.99, p=0.002). However, maternal educational status of having at least attended a secondary school was negatively associated with anemia among adolescent girls compared with mothers who cannot read and write AOR=0.43 (95%

CI, 0.19, 0.98, p=0.016) (Table 3).

Table 3

Binary and multivariable logistic regression model to identify factors associated with anemia among adolescent high school girls in Jimma town, Oromia, southwest Ethiopia.

Variables	Category	Outcome variables		COR 95% CI	AOR 95% CI
Anemia (%)	Normal (%)	Father education	Cannot read and write	12 (41.4)	17 (58.6)
1	—	Can read and write	38 (36.2)	81 (63.8)	0.66 (0.29, 1.53)
0.540 (0.19, 1.56)	Primary (1–8)	33 (30.3)	76 (69.7)	0.62 (0.26, 1.43)	0.672 (0.28, 1.99)
Secondary (9–12)	27 (22.5)	93 (77.5)	0.41 (0.17, 0.97)*	0.48 (0.16, 1.43)	Above 12
31 (20.5)	120 (79.5)	0.37 (0.16, 0.85)*	0.90 (0.30, 2.70)	-	
Mother education	Cannot read and write	29 (43.9)	37 (56.1)	1	1
Can read and write	42 (44.2)	53 (55.8)	1.10 (0.54, 1.90)	1.56 (0.73, 3.35)	Primary (1–8)
36 (30.8)	81 (69.2)	0.57 (0.30, 1.06)	0.85 (0.40, 1.81)	Secondary (9–12)	18 (15.3)
100 (84.7)	0.23 (0.11, 0.46)*	0.43 (0.19, 0.98)**	Above 12	16 (12.1)	116 (87.9)
0.18 (0.09, 0.36)*	0.44 (0.18, 0.95)**	-			
Living status	Living with parent	69 (17.50)	325 (82.5)	1	1
Living with relatives	30 (43.5)	39 (56.5)	3.62 (2.11, 6.23)*	2.51 (1.35, 4.67)**	Living separately from family
42 (64.6)	23 (35.4)	8.60 (4.86, 15.22)*	4.43 (2.20, 8.90)**	-	

Heard about anemia	Yes	75 (20.2)	296 (79.8)	1	1
No	66 (42)	91 (58.0)	2.86 (1.91, 4.29)*	1.140 (0.66, 1.96)	.
Meal frequency per day	Once	7 (11.1)	5 (88.9)	4.97 (1.42, 17.35)*	1.23 (0.231, 6.62)
Two times	38 (56.6)	43 (43.4)	3.14 (1.62, 6.07)*	1.08 (0.47, 2.49)	Three times
76 (21.2)	268 (78.8)	1.07 (0.58, 1.76)*	0.58 (0.30, 1.09)	Four and above	20 (22.0)
71 (78.0)	1		-		
Menstruation status (N= 519)	Yes	22 (61.4)	35 (38.6)	1.92 (1.08, 3.40)*	1.93 (0.94, 3.94)
No	114 (73.8)	348 (24.7)	1	1	.
Thinness	Thinness	25 (61.0)	16 (39.0)	4.99 (2.58, 9.68)*	2.31 (0.91, 5.45)
Normal	116 (23.8)	371 (76.2)	1	1	.
DDS	Low	59 (57.3)	44 (42.7)	7.73 (4.53, 13.18)*	3.57 (1.88, 6.76)**
Medium	48 (24.6)	147 (75.4)	1.88 (1.15, 3.07)*	1.90 (1.11, 3.27)**	High
34 (14.8)	196 (85.2)	1	1	-	
Family size	≤5	43 (18.6)	188 (81.4)	1	1
>5	98 (33.0)	199 (67.0)	2.15 (1.43, 3.24)*	1.24 (0.74, 2.07)	.
Wealth index	Low	77 (42.5)	104 (57.5)	4.77 (2.84, 8.02)*	2.16 (1.17, 3.99)**
Medium	39 (22.3)	136 (77.7)	1.69 (0.97, 2.93)	1.24 (0.66, 2.32)	High
25 (14.5)	147 (85.5)	1		-	

Frequency of changed pad (*N*=519)	≤3 times p/day	102 (23.9	325 (76.1)	1	1
3> times p/day	34 (37)	58 (63.0)	1.87 (1.16,3.01)*	1.68 (0.92, 2.97)	.
Duration of menses (*N*= 519)	≤5 days	100 (21.1)	352 (77.9)	1	

*variables at p-value ≤0.25 in bivariate logistic regression, **predictor variables in multivariate logistic regression at p <0.05.

4. Discussions

The study was attempted to assess the magnitude of anemia and associated factors among adolescent girls in Jimma town high schools. The result of this study indicated that the overall prevalence of anemia among adolescent girls was 26.7% (95% CI, 22.7–30.5). According to WHO criterion, if the prevalence of anemia was within 20% to 39.9%, it is considered as a moderate public health concern, so anemia in adolescent girls in Jimma town is a moderate public health concern. Among adolescent girls who had anemia, the magnitude of mild and moderate anemia was 61%, and 39%, and no one was reported to have severe anemia. The factors associated with having anemia among adolescent girls include mother education, duration of menses, low dietary diversity score, living condition of adolescent girls, and lower economic class of the family.

This finding is in line with that reported in Kenya (26.5%) [15], the local study reported from Filtu town Somali region (23.66%) [11], consistent somehow in Berhale district afar region (22.8%) [13], Dembia, northwest Ethiopia (25.5%) [22], from research done in three districts of Ethiopia, namely, Debrelibanose, Laygayint, and Damotegale, an average prevalence of anemia was 29% [23].

However, the finding of this result is found to be lower than that of studies conducted in Nigeria which showed the overall prevalence of anemia of 47.5% [24]. The possible reason could be that a low proportion of (1.7%) of adolescents consumed organ meat like that of the current study (12.3%). Similarly higher prevalence of anemia was reported in Lahore, Pakistan, where about 68.9% of participants were anemic, this might be because about three-fourth (77%) of the participants did not have green vegetables in their diet like that of the current study which was 28.2% [25]. The finding of the current study was lower than that of the study reported in Nepal, where the overall prevalence of anemia was 42.5%; the possible reason might be 42.4% of adolescent girls had a history of worm infestation as compared with the current study 17.4% [26].

The finding of this study was higher than that reported in central Kerala, India, where the overall prevalence of anemia was 21%; the possible reason might be more than half (56.25%) of the respondents were taken deworm medication like that of the current study (15.7%) [27]. Similarly, the current study result was higher than the finding reported in Turkey where the overall prevalence of anemia among adolescent school girls was 8.3% [28]. This could be due to differences in socioeconomic and cultural behaviors including dietary habit differences.

The result of this study is also higher than that conducted in the local studies, Bahirdar, northern Ethiopia, where the overall prevalence of anemia was 11.1% [29]. The difference might be because nearly half of adolescent girls had a medium dietary diversity score as compared with that of our study (36.9%). A similar study performed in the Kebena Guraga zone, southwest Ethiopia, revealed that the overall prevalence of anemia was 12% and Mekelle 11% which is lower than that of the current finding [30, 31].

In addition to the abovementioned factors, to make difference regarding the magnitude of anemia among adolescent girls could be due to differences in sociocultural and behavioral practice including dietary habit differences between one another in the world. The result of our study also varied with the result of local studies; it might be because the differences of the study period could lead to seasonal variation.

Adolescent girls whose mothers attended at least secondary school were 59.6% less likely to develop anemia than

adolescent girls whose mothers cannot read and write. Similar studies were reported in four populous villages of India and the urban slum of Kanpur, Uttar Pradesh, India, adolescent girls whose mothers were either illiterate or had only primary education developed anemia than their counterparts [32, 33]. This is in contrast with the finding of the study in Nepal [26] and Kenya [15] where mother's educational status did not show significant association with anemia among adolescent girls. The possible justification is that there is a difference in the study area and sociocultural factors regarding the education and feeding habits of the children and adolescents. In our context, it gives a high sense that when women are more educated, they will have knowledge regarding a balanced diet and know the sources of nutrients especially in this case iron sources of foods and know how to give care to their children. In addition to this, as we know, most of the time, mothers collected a variety of foods which are used for eating purpose at home and knowledge might be required in order to incorporate foods that contain iron-rich foods.
The odds of having anemia were 4.4 times higher among adolescents living separately from their family than those lived with the family. Similarly, the odds of having anemia were 2.5 times higher among adolescents who lived with their relatives compared with those who lived with their families. A similar finding was reported from a study conducted in Dembia, northwest Ethiopia, where school going adolescent girls who lived with their guardians are more affected by anemia compared with their counterparts [22]. The possible reason might be, out of the adolescent girls who lived separately from their family, about 59.6% of adolescent girls had low dietary diversity scores and 63.1% were from low household wealth status. Similarly, adolescent girls who lived with relatives (44.9%) of their families were under low wealth status. This is because the economic status has significant implications in their purchasing power in order to get a balanced diet.

The present study also tells the odds of having anemia were 3.5 times higher among adolescents whose DDS is low compared with those who have high DDS. A similar study was reported from India, Nepal, Nigeria, and Kenya as consumption of low diversified foods was associated with anemia among adolescent girls [15, 24, 27, 34]. It might be the dietary diversity that tells the number of variety of food groups consumed over 24 hours prior to the data collection period is widely recognized as a key dimension of diet quality in individuals and households. Diet diversity is strongly associated with nutrient adequacy including iron adequacy [17].

This finding was also consistent with the report of the study result conducted in Tigray, north Ethiopia [10] and Dembia district, northwest Ethiopia [24], and this might be due to socioeconomic similarity. This means that adolescents who consumed less quality diet are more likely to be anemic since the probability of nutrient adequacy increases as diet variety or diversity increases.

In this study, the history of worm infestation for the last one month before data collection was not significantly associated with anemia among adolescent girls; this is not in agreement with a similar study in Bahirdar where adolescent girls with a history of parasitic infection were 2.8 times more likely to be anemic than those without intestinal parasite [29]. This study is also not consistent with the study result reported in Kenya where the adolescent girls who had a history of worm infestation were 12 times more likely to be anemic than those who did not have a history of worm infestation [15]. This variation might be because the number of girls with a history of worm infestation in our study is small in number that could lead to the regression to generate no association between worm infestation and anemia. The second reason might be because girls who are actually infected with an intestinal worm are missed and reported as not having worm infestation as this study is limited to history taking rather than laboratory stool examination.

The history of malaria infection for the last one month before data collection period also was not significantly associated with anemia in this study which is in contrast with the study result reported in Kenya where the presence of malaria parasitemia was 3.8 times more likely to be anemic than who did not have malaria parasitemia [15]. The reason for this study not having an association with anemia may be smaller number of cases reported to have a history of malaria, and this also might be because the history was collected verbally from the participants instead of any test of blood, and this might have masked the actual status of the respondents. Another possible reason might be our country Ethiopia had implemented a mass campaign distributed nearly 29.6 million long-lasting insecticidal nets (ITNs) to protect all Ethiopians living in areas with ongoing malaria transmission through an expansion of health extension workers [35].

The odds of anemia were 2 times higher among adolescents who had menstrual bleeding more than 5 days as compared with adolescents girls with menstrual bleeding less than or equal to 5 days. This finding was consistent with the study result reported in the Tang ail region of Bangladesh, central Kerala, India, Nepal, and locally Bahirdar, northwest Ethiopia [27, 29, 34, 36]. This might be due to the fact that with an increased duration of menstruation, there will be a high chance of more blood loss that can lead to anemia.

This study revealed that low economic status has been one factor for anemia in adolescent girls (AOR = 2.684 (1.457, 4.945)). The odds of anemia were 2.6 times higher among adolescents whose families are under low wealth status than those who had high wealth status families. This finding is also comparable with the study report result conducted in the Berhale afar region [37]; in this study, adolescent girls with low economic status were 2.8 times more likely to be anemic compared with counterpart. This finding is also consistent with that conducted in the Tang ail region of Bangladesh [36], Amravati city, India, and Chennai, Tamil Nadu, India [38]. This implies that, in low family income, it is difficult to obtain a variety of foods including iron-rich food sources.

5. Conclusion and Recommendation

In this study, the prevalence of anemia was a moderate public health problem. Factors associated with anemia were low wealth status, adolescent girls living separately from their parents, low dietary diversity score, and duration of menses greater than five days. However, adolescents' mother who had attended at least secondary school was a protective factor for anemia in adolescent girls in this study.

Authors' Contributions

Kelemu Fentie and Tolassa Wakayo were involved in designing the study, drafting the proposal, data collection, analysis, and writing up the first draft of the manuscript. Getu Gizaw reviewed and reanalyzed the data set and reviewed the manuscript and references to get the final version. All authors agreed with the final format of the manuscript for publication.

Glossary

Abbreviations

AOR:Adjusted odds ratio
BAZ:Body Mass Index for age, *Z* score
BMI:Body Mass Index
BSc:Bachelor of Science
CI:Confidence interval
COR:Crude odds ratio
CSA:Central Statistics Authority
DALYs:Disability adjusted life years
DDs:Dietary Diversity Score
FANTA:Food and Nutrition Technical Assistance
FAO:Food and Agriculture Organization
Hb:Hemoglobin
IDA:Iron Deficiency Anemia
LMICs:Low- and Middle-Income Countries
MOH:Ministry of Health
NCHS:National Center for Health Statistics
OR:Odds ratio
PCA:Principal component analysis
SD:Standard deviation
SPSS:Statistical package for social science
UNICEF:United Nations International Children Emergency Fund
WHO:World Health Organization.

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DETAIL

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Pregnancy Outcomes among Patients with Sickle Cell Disease in Brazzaville

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ABSTRAK (ENGLISH)

Introduction. Sickle cell disease (SCD) is one of the most common genetic diseases in the world. It combines, in its homozygous form, chronic hemolytic anemia, vasoocclusive complications, and susceptibility to infections. It is well known that the combination of pregnancy and sickle cell disease promotes the occurrence of complications that are sometimes fatal for the mother and/or the fetus. *Objective*. The objective of the current study was to compare pregnancy outcomes among women with SCD with those of women without the diagnosis of SCD. *Materials and methods*. It was a case-control study carried out in four maternity hospitals in Brazzaville in 2 years (July 2017–June 2019). It concerned 65 parturients with SS homozygous SCD. The mode of childbirth and maternal and perinatal morbidity and mortality were compared with those of 130 non-sickle cell pregnant women. *Results*. The average age was 27 years for SCD women and 31 years for non-SCD women. The average gestational age at delivery was 35 weeks for SCD women and 38 weeks for non-SCD women. From the logistic regression analysis using the comparison group as the reference group, there was excessive risk in SCD compared to non-SCD of infection (29.3% vs. 4.6%, OR = 21.7, 95% CI [7.6–62.7]; p=0.001), cesarean (63% vs. 35.4%, OR = 3.1, 95% CI [1.6–5.7]; p= 0.001), prematurity (75.4% vs. 30.8%, OR = 8, 95% CI [3.0–23.2]; p=0.001), low birth weight (52.3% vs. 16.1%, OR = 4.7, 95% CI [2.4–9.4]; p=0.001), neonatal requiring admission to the intensive care unit (40.3% vs. 17.5%, OR = 3.2, 95% CI [1.6–6.3]; p=0.01), and neonatal death (21.5% vs. 4.8%, OR = 4.3, 95% CI [1.5–12.2]; p=0.01). *Conclusion*. The risk of pregnancy in patients with homozygous sickle cell anemia remains high, on both the maternal and fetal sides.

TEKS LENGKAP

1. Introduction

The substitution of glutamic acid by valine in position 6 in the *β*-globin chain characterizes the abnormal hemoglobin (HbS) of sickle cell anemia. This results in the fragility of the red blood cell which deforms when the oxygen pressure decreases [1]. Its homozygous form combines anemia, vasoocclusive complications, and susceptibility to infections. In sub-Saharan Africa, where the majority of patients are found, the disease is often fatal before the age of 5 [2]. The improvement in survival secondary to therapeutic progress allows more and more pregnancies in sickle cell women [3]. However, these pregnancies are at very high maternal and fetal risk [4]. In Congo Brazzaville, a study carried out over 25 years ago reported alarming results with high rates of maternal and fetal mortality [5]. Since then, the prognosis of these patients seems to have improved considerably, as shown by a more recent study [6]. However, the latter has limitations, in particular, its descriptive and especially monocentric nature. The objective of this work was to describe the mode of delivery and the outcome of pregnancy in homozygous sickle cell patients in the four main maternity hospitals in Brazzaville.

2. Materials and Methods

This was a case-control study carried out in the obstetrics and gynecology departments of the 4 main hospitals in the city of Brazzaville: University Hospital of Brazzaville (UHB), Specialized Mother and Child Hospital Blanche Gomez (SMCH), Talangaï Hospital (TH), and Makélékélé Hospital (MH). It was conducted over a period of 24 months (July 01, 2017–June 30, 2019). The case group was made up of pregnant women with SS homozygous sickle cell disease. The control group was made up of non-SCD gestants (Hb AA), two controls for one case. Excluded were women whose delivery time was less than 28 weeks of amenorrhea (in our country, the resuscitation of children born before 28 weeks of gestation is extremely delicate, and we therefore chose this age limit to assess the fetal prognosis), women admitted to the expulsion phase, or women who gave birth outside the centers mentioned above.

The minimum sample size was calculated according to the Schlesselman formula taking into account the data from the Muganyizi study in Tanzania [3].

The parameters analyzed were as follows:

(i)

Maternal: age, complications linked to sickle cell disease

(ii)

Obstetric: gestational age (prematurity before 37 weeks of gestation), mode of delivery, postpartum complications

(iii)

Fetal: birth weight (low birth weight was defined as a birth weight <2500 g), complications requiring admission to the intensive care unit, mortality.

The chi-square test was used for the comparison of the proportions, the Student *t*-test for that of the means, and the Mann–Whitney for that of the medians. The odds ratio with the 95% confidence interval was calculated to assess the association between two variables. The p value of the probability was considered significant for a value

3. Results

During the study period, there were 80 deliveries of pregnant SCD women. Sixty-five of them were included in the study and their data had been compared to that of 130 non-SCD parturients. The average age was 27 years (17 years–42 years) for SCD women and 31 years (16 years–41 years) for non-SCD women. The average gestational age at delivery was 35 weeks (34 weeks–37 weeks) for SCD women and 38 weeks (37 weeks–39 weeks) for non-SCD women.

Among SCD women, thirty-seven of them were followed either by a hematologist (89.2%) or by a pediatrician (10.8%). Twenty-seven of these had received prophylactic blood transfusions either simple or in the form of a transfusion exchange. On admission, the average hemoglobin level was 7.5 g/dL (5.5 g/dL–11 g/dL).

Table 1 shows the distribution of pregnant women according to their reproductive characteristics. During the prenatal period, infections were found in 25 women (76% vs. 24%, $p<0.05$). The overall term delivery rate was 54.3%, with a significant difference between the two groups. Prematurity was more present in sickle cell anemia (75.4% vs. 24.6%, $p<0.05$). Cesarean was performed in 85 women. Table 2 shows the distribution between cases and controls. This same table also shows the other parameters analyzed and compared between the women of the two groups.

Table 1

Comparison of obstetric characteristics between women with SCD and non-SCD women seen in 4 maternity hospitals in Brazzaville between July 2017 and June 2019.

Variable	SCD (*n*=65)	Non-SCD (*n*=130)	OR	95% CI	p
Gravidity					
Median (*q*1–*q*3)	1 (0–2)	3 (1.5–4)			**0.0001**
Min–max	0–7	0–11			
Parity					
Median (*q*1–*q*3)	0.5 (0–1)	1 (0–3)			**0.0001**
Min–max	0–4	0–8			
History of miscarriage, *n* (%)	20 (30.7%)	71(54.6%)	**0.4**	**0.2–0.7**	**0.002**
History of fetal death in utero, *n* (%)	14 (21.6%)	6(4.6%)	**5.7**	**2.1–15.9**	**0.001**

SCD: sickle cell disease; non-SCD: non-sickle cell disease; CI: confidence interval; OR: odds ratio.

Table 2

Comparison of perinatal characteristics and the outcome of pregnancy between SCD women and non-SCD women seen in 4 maternity hospitals in Brazzaville between July 2017 and June 2019.

Outcomes	SCD	Non-SCD	p	OR	95% CI
Bacterial infections					
No	46 (70.7%)	124 (95.4%)			
Yes	19 (29.3%)	6 (4.6%)	0,001	21.7	7.6–62.7
Mean gestation age (weeks)	35	38			
Min–max	28–42	29–42	0,0001		
Preterm birth					
No	16 (24.6%)	90 (69.2%)			
Yes	49 (75.4%)	40 (30.8%)	0,001	8.0	3.0–23.2
Mode of delivery					

Vaginal	24 (37%)	86 (65.6%)			
Cesarean	41 (63%)	46 (35.4%)	0,001	3.1	1.6–5.7
Mean birth weight (g)	2400	3000			
Min–max	1400–3750	2675–4100	0,001		
Low birth weight					
No	31 (47.7%)	109 (83.9%)			
Yes	34 (52.3%)	21 (16.1%)	0,001	4.7	2.4–9.4
NICU (n = 188)					
No	37 (59.7%)	104 (82.5%)			
Yes	25 (40.3%)	22 (17.5%)	0,01	3.2	1.6–6.3
Fetal/child death (n = 195)					
No	51 (78.5%)	120 (93.2%)			
Yes	14 (21.5%)	10 (4.8%)	0,01	4.3	1.5–12.2
Maternal outcome					
Alive	61 (93.8%)	123 (94.6%)			
Died	4 (6.2%)	7 (5.4%)	0,9		

NICU: neonatal intensive care unit; SCD: sickle cell disease; non-SCD: non-sickle cell disease; CI: confidence interval; OR: odds ratio.

4. Discussion

It is well known that pregnancy and sickle cell disease have reciprocal influences on each other and that their association is a risky situation. The maternal and fetal complications observed in our study are those conventionally found in the literature [3, 7–14]. In sickle cell anemia, the risk of infection is significantly higher during pregnancy [1]. Our study did not reveal any statistical link between sickle cell anemia and maternal death. According to studies, the risk is multiplied by 19, 29, or even 117 compared to a control population [3, 4, 15]. The causes are variable: infections, embolism, eclampsia, acute chest syndrome, or multivisceral failure [3, 4, 14, 15].

Homozygous sickle cell disease is associated with a risk of low birth weight 4 times higher than in the general population [4]. The cause is chronic hypoxia of the fetal-placental unit, which itself is the consequence of anemia and rheological anomalies in the placental level [16–18]. Our results are comparable to those of the literature.

The risk of preterm delivery is very high in sickle cell women with reported rates between 9% and 48%. Several etiologies can be advanced to explain these rates. The infection encountered during pregnancy is a recognized factor in “spontaneous” prematurity. In addition, the frequency of fetal pathologies is at the origin of the medical induction of preterm birth [3, 8, 9, 11–14]. A meta-analysis found twice the risk for patients with sickle cell disease SS than for controls [4]. Its causes deserve to be studied in our context where the frequency and the risk are particularly high and higher than those reported in the studies cited above.

The high cesarean rate in sickle cell women is explained by the presence or conjunction of several risk factors: chronic fetal distress, vasculorenal syndrome, acute vasoocclusive crisis, or pelvic dystocia due to bone lesions of the pelvis [19]. The frequency found in our study is comparable to that of British, Indian, and Cuban studies where it varies from 53% to 72%, justified by fetal complications [9, 10, 14]. In sub-Saharan Africa, a comparable frequency (64%) is observed in Burkina-Faso [20], which is higher than those reported in Tanzania (26.8%) and Ghana (48, 7%) [3, 11]. In a previous study carried out in Brazzaville [7], it was most often prophylactic, motivated simply by the sickle cell field and without obstetric indication. The challenge in our context is to avoid systematizing this mode of delivery which, moreover, is associated with a high risk of vasoocclusive crisis in the postpartum [21]. As soon as childbirth is imminent, certain preventive measures, such as warming, oxygenation, and optimal hydration of the patient, even premature epidural locoregional analgesia, can be implemented to limit the risks of complications that can be induced by vaginal delivery [22].

Almost half of women with sickle cell disease experienced a vasoocclusive crisis in the postpartum period. The postpartum is a period at high risk of decompensation of sickle cell disease. Indeed, it combines maternal fatigue (working time, expulsive efforts), intense pain in the absence of epidural analgesia, fasting with dehydration, a state of metabolic acidosis linked to uterine muscle work and respiratory alkalosis (hyperventilation). All of these factors can lead to a vasoocclusive accident. Thus, the first 48 hours require close monitoring [22].

5. Conclusion

Maternal and fetal complications are significantly higher in pregnant sickle cell patients. A close supervisor of these pregnancies with a multidisciplinary approach between hematologist, obstetrician, and pediatrician is essential. Information, education, and communication sessions for sickle cell women are essential to minimize these risks.

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DETAIL

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Blood Transfusion Frequency and Indications in Yemeni Children with Sickle Cell Disease

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ABSTRAK (ENGLISH)

Background. Blood transfusion is an essential component in the care of patients with sickle cell disease (SCD), but it might be associated with serious acute and delayed complications. This study was aimed to describe red cell transfusion patterns and indications among hospitalized SCD children in a low-resource setting. *Patients and Methods.* A retrospective, descriptive study of all children (≤16 years) with SCD who received blood transfusion therapy during their hospital admissions in the pediatric department at Al-Sadaqa Teaching Hospital in Aden, Yemen, for a period of one year. *Results*. Out of 217 hospitalized children with SCD, 169 (77.9%) were transfused and received 275 RBC transfusion episodes. The mean age of transfused children was 6.9 ± 4.6 years and 103 (60.9%) were males, with a male/female ratio of 1.6 : 1 (p=0.004). Hemoglobin (Hb) levels were significantly lower in the transfused than in the nontransfused (Hb 5.5 ± 1.5 vs. 7.7 ± 1.5 g/dL, p=0.03). Pretransfusion Hb levels were ˂7.0 g/dL in 86.2% and ˂5.0 g/dL in 39.3% of patients. Single transfusion was given to 122 (72.2%) and 5 or more transfusions in 9 (4.15%) of patients on different occasions. Simple (top-up) transfusion was used in all transfusion events. Commonest indications for transfusion were anemic crises (41.1%), vasoocclusive crises (VOC) (13.8%), VOC with anemic event (11.3%), acute chest syndrome (8.7%), and stroke (7.3%). *Conclusion*. Intermittent blood transfusion remains a common practice for the management of children with acute SCD complications. Main indications were acute anemic crises, severe pain crises, ACS, and stroke. In limited resource settings, such as Yemen, conservative transfusion policy appears to be appropriate.

TEKS LENGKAP

DETAIL

Subjek:	Infections; Medical records; Patients; Hemoglobin; Anemia; Stroke; Blood transfusions; Age; Sickle cell disease; Females; Blood &organ donations; Haplotypes; Pediatrics; Males; Teaching hospitals; Hematology; Hospitalization
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Prevalence and Associated Factors of Anemia among Reproductive-Aged Women in Sayint Adjibar Town, Northeast Ethiopia: Community-Based Cross-Sectional Study

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ABSTRAK (ENGLISH)

Background. Globally, anemia affects one-fourth of the world population including 30% of nonpregnant reproductive-aged women. It has a number of causes including micronutrient deficiencies and chronic infections, inherited or acquired disorders of hemoglobin synthesis and red blood cell production, or survival alterations. The aim of this study was to assess the prevalence and associated factors of anemia among reproductive-aged women in Sayint Adjibar town, South Wollo Zone, Northeast Ethiopia. *Methods*. A community-based cross-sectional study was conducted from February to April among 359 reproductive-aged women (RAW). Systematic random sampling technique was implemented to select study participants. Sociodemographic, socioeconomic, and reproductive histories of study participants were collected using the structured and pretested questionnaire. Capillary blood and stool samples were collected from each study participant for hemoglobin and parasitological analysis, respectively. Data were entered into Epi Info version 7 and transferred to SPSS version 20 for analysis. Both bivariable and multivariable binary logistic regression models were fitted to identify associated factors of anemia. p value <0.05 was considered as statistically significant. *Result*. The median age of the study participants was 25 years. The overall prevalence of anemia was 24.2%. Among those anemic individuals, 49 (56.3%) were mildly anemic. Age category 36–49 years (AOR = 2.64; 95% CI: 1.05, 6.60), no formal educational status (AOR = 2.28; 95% CI: 1.06, 4.92), food insecurity (AOR = 1.92; 95% CI: 1.01–3.65), and body mass index of above 25 kg/m^2 (AOR = 0.27; 95% CI: 0.08–0.87) were found to be statistically significant with anemia. *Conclusion*. The prevalence of anemia in this study was found as a moderate public health problem. The prevalence was significantly associated with women who had no formal education and were of older age group and those women living with household food insecurity and with higher body mass index. Therefore, it is better to design appropriate interventional strategies to reduce reproductive-aged women anemia. These include information, education, and communication activities focused on reproductive-aged women with no formal education and life-cycle-focused food security rather than targeted to only infants and young children or pregnant women.

TEKS LENGKAP

1. Background

Anemia is defined as a decrease in Red Blood Cells (RBCs), Hemoglobin (Hb), and hematocrit below the reference range for healthy individuals of the same age, sex, and race, under similar environmental conditions [1]. For nonpregnant women, it is defined when the Hb level is below 12 g/dl [2]. Anemia indicates a deficiency of one or more essential nutrients, heavy blood loss, hookworm infection, acute and chronic infections, and hemoglobinopathies [3]. Based on its public health problem, anemia can be categorized as follows: greater than 40%, 20–39%, and 5–19%, corresponding to severe, moderate, and mild public health problems, respectively [4]. Hb measurement plays a vital role in the diagnosis of anemia since it is inexpensive and easy to measure at field testing [3].

Anemia is a global problem affecting persons of all ages [5]. It results in reduced oxygen-carrying capacity of RBCs which will cause chronic fatigue and ill health [6]. Pallor, low blood pressure, headache, and edema are the most common manifestations of anemia. Moreover, general clinical findings may be characteristically associated with a specific type of anemia [7].

Globally, anemia affects 24.8% of the population [8]. Nonpregnant reproductive-aged women were the third most affected group next to preschool-aged children and pregnant women [9]. According to 2011 report, globally, the prevalence of anemia among nonpregnant reproductive-aged women was 29% with 1.1% of them being severely anemic. Report showed that the prevalence of anemia in East Africa was 28%, of which 1.2% were classified as severe anemia [10]. Based on the Ethiopian Demographic and Health Survey (EDHS) 2016 report, the prevalence of anemia among RAW in Ethiopia was 23% [11].

Anemia has a number of causes, with the most significant cause being iron deficiency. Approximately 50% of cases of anemia are considered to be caused by iron deficiency, but the proportion probably varies across population groups and in different geographical areas, based on the local conditions. In this regard, a systematic analysis of national surveys revealed that iron deficiency contributes to 37.0% of anemic cases. The other causes of anemia include other micronutrient deficiencies like folate, riboflavin, vitamins A and B12, acute and chronic infections and inherited or acquired disorders of hemoglobin synthesis, red blood cell production, or survival alterations [12, 13]. It is more common in women due to the loss of iron during menstruation, high demand throughout pregnancy, and puberty. Deprived nourishment, detrimental eating lifestyle, parasitic infestations, particularly malaria and hookworm, and rural residence are other contributing factors to the prevalence of anemia among women [14].

The World Health Organization targets a 50% reduction of anemia in RAW by the year 2025 [15]. Most of the studies conducted in Ethiopia were mainly focused on anemia of pregnant women even though RAW are also vulnerable. However, in Ethiopia, there are limited studies conducted to assess the prevalence and associated factors of anemia among RAW. Understanding the prevalence and associated factors will enable formulating effective interventions which are evidence based. So, this study aimed to assess the prevalence and associated factors of anemia among RAW at Sayint Adjibar town, South Wollo zone, Amhara region, Northeast Ethiopia.

2. Methods

2.1. Study Design and Period

A community-based cross-sectional study was conducted from February to April 2018 in Sayint Adjibar town.

2.2. Study Setting, Population, Sample Size, and Sampling Techniques

The study was conducted in Sayint Adjibar town, Amhara Sayint District, South Wollo Zone of Amhara Regional State. It is located between 12°13′N latitude and 38°53′E latitude covering a total area of 1,437.30 square kilometers. It is 189 km far from Dessie and 590 km from the capital city, Addis Ababa, Ethiopia, in Northeast direction. According to the 2011 sample survey data, Amhara Sayint district has a total population of 154,142, of whom 75,979 are men and 78,163 are women [16]. Based on the town municipality 2010 Ethiopian calendar demographic data, the town population size was 9693 which comprises 5306 females and 4387 males. There are a total of 2254 households in the town. The altitude of Sayint Adjibar town is 2885 meters above sea level, and the altitude of the Amhara Sayint District ranges from 500 meters to 3,700 meters above sea level. Selected and voluntary RAW who were living at Sayint Adjibar town during the study period were used as the study population. The sample size was calculated using a single population proportion formula (n=Zα/22×p1−p/d2) by considering a 30.4% prevalence of anemia among RAW [17], 5% margin of error, 95% confidence interval, and a 10% nonresponse rate. The final sample size then becomes 359. A systematic random sampling technique was used to select the study participants. Based on the size of the RAW and house number, the *K* value was calculated as 6. The first study participant (household) was selected randomly between 1st and 6th using the lottery method, and the next participants were selected in accordance with the 6th values until the calculated sample size was reached. A household with more than one RAW, one woman was randomly selected and included in the study. If there is no eligible woman within the selected household, the next house was selected.

2.3. Study Variables

The dependent variable was anemia status, and the independent variables were sociodemographic characteristics (age, marital status, education, household size, religion, and occupation), intestinal parasitic infections, socioeconomic status of the women (wealth index of the household and food security), the anthropometric measurement that is Body Mass Index (BMI), and reproductive health history of the women.

2.4. Data Collection Tools and Method of Data Collection

A pretested structured questionnaire was used to collect data about the study participants. Three data collectors (one clinical nurse and two laboratory technicians) participated in the data collection. The questionnaire was organized into different categories. The first part of section one includes the sociodemographic part of the study participants; section two dealt with the home environment like house nature. The second part contained questions about reproductive health-related questions, and the third part includes house food security status. The food security of the household was assessed by the response of seven questions with each response coded as no (0) and yes (1). Then, the possible food security of the household was calculated as the sum of the responses of the food security assessment questions, all responses coded “no” or 0, representing the most food-secure state and all responses coded “yes” or 1, representing the most food-insecure state. The scores were categorized as food secure, moderately food insecure, and severely food insecure [18]. The principal component analysis was used to derive a wealth index from information on ownership of the household assets. Principal components with eigenvalues greater than one retained to construct wealth index values and then categorized into three relative measures of the socioeconomic status of households as low, medium, and high.

2.5. Sociodemographic, Reproductive History, and Socioeconomic Data Collection

The sociodemographic data about the study participants were collected using a structured questionnaire which was adopted from the Ethiopian national micronutrient survey report as a data collection tool [19]. The questionnaire included sociodemographic characteristics like age, educational status, occupation, menstrual history including frequency and duration, contraceptive use, and number of pregnancies.

2.6. Anthropometric Measurements

Height and weight of the women were measured, and BMI was calculated. Weight was measured to the nearest 0.1 kg with an electronic digital scale. Each woman was weighed with minimum clothing and barefoot. The weighing scale was set to zero before every measurement and was calibrated using the standard calibration weight of 2 kg iron bars every day. For height and weight, individuals were requested to remove their shoes before taking measurements. Height was measured to the nearest 0.5 cm using a locally manufactured wooden stadiometer with a sliding headpiece. The women were instructed to stand straight with their heads, backs, and buttocks vertically aligned to the height gauge, and then their heights were taken and rounded to the nearest 0.5 cm. The BMI was calculated by taking the ratio of weight to height squared [weight (kg)]/[height in m^2)] [20]. According to WHO, the standard cut-off value for underweight in RAW of nonpregnant women is a BMI of <18.5. BMI is normal when it is between 18.5 and 24.9, and it is considered overweight when it is greater than 25 kg/m^2 [21].

3. Laboratory Examinations

3.1. Hemoglobin Determination

The Hb concentration of each participant was measured by taking a finger-prick blood sample using a portable hemoglobinometer instrument (HemoCue 301+, Ängelholm, Sweden) which is recommended by WHO for the use of field surveys [22] by using the procedure [23]. Then, Hb was corrected for altitude of town as proposed by the WHO [24].

3.2. Stool Sample Examination

The women were given a clean and leakproof container and kindly requested to bring a pea-sized stool sample. The samples were collected during the data collection day. Then, the stool sample was transported to Sayint health center and examined for intestinal parasites. Samples were preserved by 10% formalin, if not examined within 1 hour of collection. Wet mount examination method was employed to examine for the presence of intestinal parasites. Fresh stool sample was used for wet mount preparation, while on uncertain situations where we were unable to run immediately, the sample was preserved and examined later. Quality of preservative solution had been checked before being used.

3.3. Data Quality Management

In order to keep the consistency, the questionnaire was prepared in English and translated to Amharic then back to English to check for consistency. The data collectors were given training about the objective, relevance of the study, confidentiality of information, and study participants' rights before actual data collection. To standardize the questionnaire, pretest was conducted on 5% of the sample size outside of the study area among RAW before the actual data collection will take place. All laboratory reagents were checked for their expiry date. The quality control for HemoCue machine was carried out based on the manufacturer's instruction. The quality of the balance was checked by measuring known weight.

3.4. Data Processing and Analysis

The data entered into EPI Info 7 and checked and cleaned for completeness and consistency. Then, the data was transferred to a Statistical Package for the Social Sciences (SPSS) version 20 for analysis. Descriptive analysis like frequencies, percentages, means, medians, interquartile range (IQR), and standard deviations were calculated using the software. A bivariable binary logistic regression model was fitted to identify factors associated with anemia. Variables with a p value of <0.25 in the bivariable analysis were fitted into the multivariable binary logistic regression analysis to adjust the confounding factors. Both Crude Odds Ratio (COR) and Adjusted Odds Ratio (AOR) with the corresponding 95% Confidence Interval (CI) were calculated to show the strength of association. In the multivariable analysis, variables with a p value of <0.05 were considered statistically significant.

4. Results

4.1. Sociodemographic, Socioeconomic, and Reproductive Health-Related Characteristics of the Study Participants

The median (IQR) age of the study participants was 25 [18–32] years. From a total of 359 study participants, the majority—169 (47.1%)—of them were in the age group of 15–24 years. About 19% of the participants were living in households with a family size of greater than four members. Out of the total study participants, 87 (24.2%) were with no formal education, 210 (58.5%) had a secondary school and above education, and 128 (35.7%) were students (Table 1).

Table 1

Sociodemographic, socioeconomic, and reproductive health-related characteristics of the study participants, from February to April 2018.

Variables		Frequency (*n*)	Percent
Age category	15–24	169	47.1
25–35	130	36.2	36–49
60	16.7	·	
Marital status	Married	140	39.0
Single	157	43.7	Divorced
54	15.0	Widowed	8
2.2	-		
Educational status	No formal education	87	24.2
Elementary school	62	17.3	Secondary school and above
210	58.5	·	
Religion	Orthodox	334	93.0
Muslim	25	7.0	·
Household size	≤2	147	40.9
3-4	145	40.4	≥5
67	18.7	·	
Occupation	Employee	31	8.6
Housewife	122	34.0	Student
128	35.7	Merchant	31

8.6	*Others	47	13.1
–			
Wealth index	Poor	150	41.8
Middle	91	25.3	Rich
118	32.9	·	
Experience of pregnancy	Yes	171	47.6
No	188	52.4	·
Number of pregnancies (*n* = 171)	1-2	98	27.3
>2	73	20.3	·
Time gap between each birth (*n* = 130)	≤2	31	23.8
>2	99	76.2	·
Bleeding history	Yes	26	7.2
No	333	92.8	·
Oral contraceptive usage	Yes	26	7.2
No	333	92.8	·
Menstruation cycle	Once per month	323	90.0
More than once per month	36	10.0	·
Length of day blood flow in each menstruation	1–5	299	83.3

*Others = daily laborers and job seekers.

4.2. Prevalence and Associated Factors of Anemia among RAW

The overall prevalence of anemia among RAW in Sayint Adjibar town was found to be 87 (24.2%; 95% CI: 19.8, 28.7%). The Hb value of the study participants ranged from 8.1 g/dl to 15.7 g/dl after an adjustment to altitude. The median (IQR) Hb of the study participants was 12.7 (12.00–13.6 g/dl). Of the anemic study participants, 49 (46.3%) were found mildly anemic. However, there was no severe anemic case. Among anemic RAW, 23 (37.1%) were divorced and widowed and 27 (45.0%) were greater than 35 years old. Out of the anemic study participants, 37 (42.5%) had no formal education (Table 2).

Table 2

Prevalence and associated factors of anemia among RAW in Sayint Adjibar town, February to April 2018.

Variables	Variable categories	Anemia status			
Nonanemic	Anemic	COR (95% CI)	AOR (95% CI)	Age	15–24
136 (80.5%)	33 (19.5%)	1.00	1.00	25–35	103 (79.2%)
27 (20.8%)	1.08 (0.61–1.91)	0.83 (0.41–1.65)	36–49	33 (55.0%)	27 (45.0%)
3.37 (1.79–6.36)	2.64 (1.05–6.60)	-			
Marital status	Married	110 (78.6%)	30 (21.4%)	1.00	
Single	123 (78.3%)	34 (21.7%)	1.01 (0.58–1.76)		Divorced and widowed
34 (63.0%)	20 (37.0%)	2.16 (1.12–4.16)		-	
Educational status	No formal education	50 (57.5%)	37 (42.5%)	3.35 (1.93–5.81)	2.28 (1.06–4.92)
Elementary school	50 (80.6%)	12 (19.4%)	1.09 (0.53–2.24)	0.82 (0.34–1.95)	Secondary school and above
172 (81.9%)	38 (18.1%)	1.00	1.00	-	
Occupation	Employee	25 (80.6%)	6 (19.4%)	1.50 (0.844–2.648)	
Housewife	86 (70.5%)	36 (29.5%)	1.00		Student
100 (78.1%)	28 (21.9%)	0.86 (0.320–2.294)		Merchant	23 (74.2%)
8 (25.8%)	1.24 (0.501–3.077)		*Others	38 (80.9%)	9 (19.1%)
0.85 (0.366–1.957)		-			

BMI	<18.5	48 (80.0%)	12 (20.0%)	0.71 (0.36–1.41)	0.92 (0.45–1.92)
18.5–24.9	201 (73.9%)	71 (26.1%)	1.00	1.00	≥25
23 (85.2%)	4 (14.8%)	0.50 (0.17–1.47)	0.27 (0.08–0.87)	·	
Presence of intestinal parasites	Yes	158 (78.2%)	44 (21.8%)	1.354 (0.834–2.199)	
No	114 (72.6%)	43 (27.4%)	1.00		·
HHFS	Secured food	236 (79.2%)	62 (20.8%)	1.00	1.00
Insecure food	36 (59.0%)	25 (41.0%)	2.64 (1.48–4.73)	1.92 (1.01–3.65)	·
Bleeding history	Yes	16 (61.5%)	10 (38.5%)	2.08 (0.91–4.77)	

AOR = adjusted odds ratio, BMI = body mass index, CI = confidence interval, COR = crude odds ratio, and HHFS = household food security. *Others = daily laborers and job seekers.

To determine the association, bivariable and multivariable logistic regression analyses were done. Based on the analysis, variables with a p value less than 0.25 were included for multivariate logistic regression. Accordingly, age category, marital status, educational status, household food security, bleeding history, and the presence of intestinal parasites were significantly associated with anemia. However, in multivariable binary logistic regression analysis, age category (AOR = 2.64; 95% CI: 1.05, 6.60), educational status (AOR = 2.28; 95% CI: 1.06, 4.92), food security (AOR = 1.92; 95% CI: 1.01, 3.65), and BMI (AOR = 0.27; 95% CI: 0.08, 0.87) remained significantly associated with anemia with a p value less than 0.05 among RAW, but wealth index which might be related with the socioeconomic status and food security of the study participants was not significantly associated with the prevalence of anemia (Table 2).

We checked all 359 study participants' stool samples for intestinal parasites. From a total of RAW, 157 (43.7%) of the study participants had one of the seven intestinal parasites with a prevalence of *Ascaris lumbricoides* 82 (22.8%), *Entamoeba histolytica/dispar* 24 (6.7%), *Tania* species 15 (4.2%), *Giardia lamblia* 10 (2.8%), *Enterobius vermicularis* 9 (2.5%), *Trichuris trichiura* 9 (2.5%), and *Hymenolepis nana* 8 (2.2%). Of those women infected by intestinal parasites, 43 (27.7%) were found as anemic.

5. Discussion

The prevalence of anemia can be classified as severe, moderate, and mild public health problem when the prevalence is greater than 40%, 20–39%, and 5–19%, respectively. Based on the public health importance, our finding is categorized under moderate public health importance [4]. This indicated that a considerable number of women in the community were suffering from anemia. Anemia is negatively correlated with physical activity, leading to poor productivity and poor health outcomes. Therefore, emphasis should be given to reduce the prevalence of anemia in RAW. In 2011, WHO estimated that anemia among RAW in Ethiopia was a mild public health problem with a prevalence of 19%, of whom 1.1% were severely anemic [12]. However, in this study, there was no severe anemia detected.

In this study, the overall prevalence of anemia among RAW was found to be 24.2%. This result is consistent with the EDHS report of 2016 (23%) [11], a study conducted in Sidama zone of Southern Ethiopia (21.3%) [25]. On the other hand, it is lower than other studies conducted in Coimbatore district, India (64.4%) [26], in urban slums of Lucknow city, India (69%) [27], in Bursa, Turkey (32.8%) [28], Tanzania (39.6%) [29], Bangladesh (41.3%) [30], in urban slum of Mumbai, India (49.5%) [31], and Nepal city (37.6%) [18]. Moreover, the prevalence of anemia in this study was higher than those of the studies conducted in Jimma, Ethiopia (16%) [32], 2011's WHO report for Ethiopia (19%) [12], in rural Tabas, Iran 13.8% [33], and Vietnam 19.7% [34]. The possible reason for the variation between our findings with aforementioned studies might be due to the difference in the study period, socioeconomic difference, and geographical location of the study area above sea level.

In this study, educational status was found to be significantly associated with the prevalence of anemia among study participants. RAW with no formal education were more likely to be anemic as compared to RAW having secondary and above educational status. The odds of to be anemic in this study was 2.28 times higher in women with no formal education than women attending secondary and above educational status. This is supported by studies conducted in Ethiopia [32, 35], that low educational status was a key predisposing factor of women to be anemic. The reason might be due to the fact that the provision of education enables people to earn or increase their earnings so as to get out of the poverty trap. It is important to bring sustainable and effective poverty reduction [36]. In fact, anemia by its nature related to nutritional deficiencies, and in turn, nutritional deficiency has been directly related to poverty which leads to the onset of anemia. Education also directly impacts health and nutritional status [36].

On the other hand, wealth index was not significantly associated with prevalence of anemia. The possible reason might be due to the fact that the principal component analysis uses arbitrary classification of wealth in which the number of components and variables to include is not well defined and choice of the variables to assess the wealth index may be the other reason. The choice of variables included can have an impact on the observed poor-rich difference in health outcomes. The other possible reason may be inclusion of variables which had low frequency [37].

Age category of the study participants was also found to be significantly associated with the prevalence of anemia. This study revealed that being in the age category of 36 and above is 2.64 times more likely to be anemic as compared to the age categories of 15–24 years. The reason might be due to the economic burden of the women because most of the study participants in this age group were divorced and widowed. This result is consistent with the studies conducted in nine administrative regions, Ethiopia [17] and in Tabas, Iran [33]. The reason might be due to the fact that women under these age categories suffer from undernutrition [38]. This undernutrition, in turn, leads to the development of anemia. However, other studies in Jimma, Ethiopia, and in an urban slum of Mumbai, India, showed that age category between 25 and 35 had a greater risk of developing anemia than other age groups [31, 32]. Age category also significantly associated with anemia in a study conducted in Nepal city, but they found that being in the young age category was a risk factor for anemia [18]. The possible reason for the increment of the risk of anemia in the age group of 36 and above may be related to reproductive history, pregnancy history-related conditions, and maternal workload that may contribute to the high prevalence of anemia among those age groups [17].

This study identified that household food insecurity level has been significantly associated with anemia. Women living in food-insecured household were 1.92 times at higher risk of developing anemia as compared to women living in food-secured household. This result is supported by a study conducted in Mexico showing that household food insecurity among adult women was significantly associated with anemia [39]. It is comparative with a study conducted in Bangladesh on the association between food insecurity and anemia among women of reproductive age. There was an association between food insecurity and prevalence of anemia [40]. Poor maternal nutrition is directly associated with mother's lack of resistance to infection and with maternal ill health during pregnancy and childbirth [41]. This vulnerability for infections leads to the development of anemia. The possible explanation for the association between food insecurity and anemia is that as mentioned earlier anemia is mainly related to nutritional deficiency. Food insecurity had a substantially higher risk of suffering from anemia as compared to their food-secure counterparts. Food insecurity can lead to anemia through the inadequate intake of micronutrients [40].

In our study, we did not assess the iron status of the study participants. Even though it was not assessed, the iron deficiency may be related to the food insecurity. The food insecurity directly results in the lack of necessary nutrients including iron deficiency. The iron deficiency in turn results in the development of iron deficiency anemia, in which the iron deficiency anemia contributes to the prevalence of anemia. Fortification of suitable food vehicles with absorbable forms of iron is a highly desirable approach to controlling iron deficiency. This control mechanism of iron deficiency is directly related to food security [40, 42].

In this study, prevalence of anemia among RAW was significantly associated with BMI. Being of BMI greater than 25 kg/m^2 is 73.7% less likely to be anemic when compared to BMI ranges from 18.5 to 24.9 kg/m^2 or normal BMI. Overweight was inversely associated with the prevalence of anemia. This is consistent with a study conducted in Andhra Pradesh, India, in which overweight and obese women have lower prevalence ratios for anemia [43], and a study conducted in Jiangsu Province, China, among adult women [44]. This protective effect can be related to the nature of the diet and lifestyle of the individual. That is because BMI is directly related to the nutritional status. This suggests that underweight is related to the nutritional deficiency and results in the reduced bioavailability of essential nutrients and finally leads to anemia. The prevalence of anemia showed a significant difference between underweight and overweight that underweight populations are at risk of developing anemia [45]. A study conducted in Bangladesh also reported that being undernourished was more likely to be anemic compared to normal overweight and obese nonpregnant reproductive-aged women [30].

5.1. Limitations and Strength of the Study

The strength of the study was its study population; that is, it was community-based study and assessment of associated factors which may be important to plan intervention methods to decrease the prevalence of anemia. When we come to the limitations, being cross-sectional was the limitation for this study because it is difficult to show cause–effect relationship by the cross-sectional study. The other limitation is that we have used only Hb for anemia definition. We did not assess other hematologic parameters, such as iron, vitamin B12, folate, CBC, and the RBC morphology. In addition to this, lack of data on malaria and inflammation were limitations of the study. The other limitation of this study was that we only used wet mount examination for stool examination; as a result, we could not quantify and measure the severity of parasite.

6. Conclusion

The prevalence of anemia in the study area was a moderate public health problem. In this study, low educational status, BMI above 25 kg/m^2, food insecurity, and age category of 36–49 years of the study participants were significantly associated with the prevalence of anemia. Therefore, it is better to design appropriate interventional strategies to reduce RAW anemia. These include information, education, and communication activities focused on RAW with no formal education, life-cycle-focused food security rather than targeted to only infants and young children or pregnant women and RAW, especially older-age groups need to visit health facilities and check themselves regularly for anemia. Further longitudinal studies with a large sample size including the assessment of all red blood cell indices, red cell morphology, serum micronutrient level, parasitic investigations with advanced methods, and subclinical infections need to be conducted in order to identify the cause–effect relationship of anemia with its contributing factors.

Ethical Approval

This study was conducted after ethical approval had been obtained from the School of Biomedical and Laboratory Sciences Research and Ethical Review Committee at the University of Gondar College of Medicine and Health Sciences. Permission was obtained from Sayint Adjibar Town Health Office.

Consent

The study participants were informed about the objective of the study, and a written informed consent was obtained from each study participant and from parents or guardians of study participants with age less than 16 years. They were assured about the confidentiality of their information. To assure the confidentiality of the study participants' information, anonymous typing and code system were used. Study participants who were diagnosed positive for intestinal parasite and anemia had been linked to the nearby health institution for standard treatment. Health and nutritional advice were given to all of the study participants.

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Glossary

Abbreviations

AOR:Adjusted odds ratio

BMI:Body mass index

CI:Confidence interval

COR:Crude odds ratio

EDHS:Ethiopian Demographic and Health Survey

Hb:Hemoglobin

RAW:Reproductive-aged women

RBC:Red blood cells

WHO:World Health Organization.

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Magnitude, Severity, and Associated Factors of Anemia among Under-Five Children Attending Hawassa University Teaching and Referral Hospital, Hawassa, Southern Ethiopia, 2016

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ABSTRAK (ENGLISH)

Background. Anemia is a widespread public health problem associated with increased risk of morbidity and mortality. Infants, under-5-year-old children, and pregnant women have greater susceptibility to anemia. The magnitude and associated risk factors for anemia vary in different settings. The study aimed to assess the magnitude, severity, and associated factors of anemia at Hawassa University Teaching and Referral hospital, Hawassa, southern Ethiopia. *Methods*. In a hospital-based cross-sectional study, a total of 422 under-five children were included. Sociodemographic data and other predisposing factors were collected by structured questionnaire. Venous blood samples were collected and analyzed for hemoglobin determination using a Cell-Dyn 1800 automated analyzer. Stool samples were collected and processed using direct wet mount and formol-ether concentration method to detect intestinal parasites. Data were entered and analyzed using SPSS version 20 statistical packages. Binary and multiple logistic regressions were computed to assess factors associated with anemia. p value less than 0.05 was taken as statistically significant. *Result*. The overall prevalence of anemia was found to be 41.7%. The mean hemoglobin level was 10.59 g/dl. Anemia was of mild, moderate, and severe type in 6.6%, 19%, and 16.1% of the children, respectively. Children in the age group 6–23 months (AOR = 2.04 (95% CI: 1.13, 3.69)), and mothers having no formal education (AOR = 1.73 (95% CI: 0.99, 3.02)) were identified as associated factors for anemia. *Conclusion*. The prevalence of anemia among the study subjects was 41.7% indicative of the fact that anemia is an important public health problem. It was associated with the child's age, residence, mother's education level, and intestinal parasite (*Ascaris lumbricoides*). It clearly indicates that there should be well integrated public health interventions to improve the health status that needs to be prioritized to prevent anemia among children under five years of age.

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DETAIL

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Screening for Anemia and Iron Deficiency in the Adult Portuguese Population

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ABSTRAK (ENGLISH)

Anemia and iron deficiency (ID) can impair quality of life and socioeconomic development. We evaluated the prevalence of anemia and ID in the adult Portuguese population in real-life contexts by gender, age, and pregnancy status. We performed a cross-sectional screening in adult individuals in mainland Portugal from 2013 to 2017. Participants completed a survey about demographics and signs or symptoms compatible with anemia, and ID and hemoglobin and ferritin concentrations were determined by point-of-care tests. We estimated and compared prevalence ratios (PR) of anemia and ID using Poisson regression with robust variance and the Wald chi-square test. We collected data from 11,030 individuals (26% men, 64% nonpregnant women, and 10% pregnant women). We found anemia in 51.8% (95% CI 50.1–53.4%) of nonpregnant women in fertile age, 46.6% (95% CI 44.7–48.6%) of nonpregnant women >51 years, 38.2% (95% CI 35.4–41.1%) of pregnant women, and 33.3% (95% CI

31.6–35.1%) of men. The prevalence of ID was 72.9% (95% CI 71.4–74.4%) in nonpregnant women in fertile age, 50.5% (95% CI 48.5–52.4%) in nonpregnant women >51 years, 94.8% (95% CI 93.3–96.0%) in pregnant women, and 28.9% (95% CI 27.3–30.6%) in men. We found significant associations between the prevalence of anemia or ID and nonpregnant women (PR: 1.50, 95% CI 1.42–1.59 or PR: 2.21, 95% CI 2.09–2.35, respectively), manifestation of signs or symptoms (PR: 1.19, 95% CI 1.53–1.23 or PR: 1.22, 95% CI 1.18–1.26), pregnant women (PR: 0.74, 95% CI 0.68–0.80 or PR: 1.30, 95% CI 1.27–1.33), and nonpregnant women ≤51 years (PR: 1.11, 95% CI 1.06–1.17 or PR: 1.42, 95% CI 1.36–1.48). In conclusion, anemia and ID represent moderate to severe public health problems, particularly among women in fertile age and in 3rd trimester, of pregnancy emphasizing the need to raise the public and health professionals' awareness of these problems and their prevention, diagnosis, and treatment.

TEKS LENGKAP

1. Introduction

Anemia, defined as a decreased hemoglobin concentration [1], is a major global public health problem affecting about one-quarter of the world's population [2]. In Europe, the World Health Organization (WHO) has estimated a prevalence of anemia of approximately 23% for children ≤5 years, 23% for nonpregnant women in fertile age, and 26% for pregnant women in 2011 [3]. In Portugal, recent studies have estimated a prevalence of anemia of 20% in the Portuguese general population, particularly affecting women (21%), pregnant women (54%), and adults aged ≥65 years (21%) [4, 5].

Anemia may result from several causes, such as micronutrient deficiencies (iron, folate, and vitamin B12), genetic disorders, or other conditions that may induce iron loss or decreased iron absorption (acute or chronic infection, inflammatory bowel disease, chronic heart failure, chronic kidney disease, neoplasm, and autoimmune disease) [3, 6, 7]. Iron deficiency (ID) is a major contributing factor of anemia in developed countries, generally caused by an insufficient dietary iron intake or by conditions causing hemorrhage or decreased iron absorption [3, 6–8]. Approximately, 50% of anemia cases can be explained by ID. However, this proportion can vary among different local conditions and population groups [3–5, 9–12]. ID is more likely to occur when the iron requirements are increased, such as during periods of rapid growth and increased erythropoiesis (children and adolescents), additional requirements (pregnancy), or due to menstrual bleeding and insufficient dietary iron intake (women in fertile age) [8, 11–13]. In contrast, the elderly population is particularly susceptible to anemia of chronic disease, which generally lacks a known underlying cause [6, 10]. Anemia of chronic disease is commonly associated with several prevalent conditions in the elderly population, such as chronic infections, inflammatory diseases (heart failure, chronic kidney disease, and immune diseases), and neoplasms [10]. Common causes of ID in the elderly population include disorders and/or acute or chronic hemorrhage through the gastrointestinal tract [8, 10].

Anemia and ID can have adverse health effects impairing quality of life [14, 15] and socioeconomic development [3, 16]. In children, ID anemia negatively affects motor and cognitive development, and, in adults, it is associated with fatigue, decreased physical performance, and lower productivity [3, 8, 12]. During pregnancy, ID anemia has been associated with low birth weight, premature delivery, and increased risk of perinatal mortality [3, 12, 13]. In the elderly population, anemia is associated with frailty, decreased cognitive function, and a global increase in morbidity and mortality [10]. ID, by itself, can have deleterious effects as the use of iron supplementation to correct ID without anemia has been associated with beneficial effects in women in fertile age or pregnancy [8].

The high prevalence and negative impact of anemia and ID in high-risk population groups make these conditions public health problems that must be taken into consideration [3–5, 7, 10]. However, the relevance and best strategies of screening and treating ID or ID anemia in different populations are still unclear [6, 8]. On the one hand, ID is a widespread problem in clinical practice, and several guidelines for the diagnosis and treatment of anemia or ID exist and vary between different medical specialties and populations [6, 7]. On the other hand, to increase the prevention or treatment of anemia and ID, additional studies are needed to characterize the local etiology, prevalence, and most affected population groups [3, 17]. Finally, epidemiological data on anemia and ID are sparse [4, 5, 9, 11, 18]. Therefore, we aimed to evaluate the prevalence of anemia and ID in different groups of the adult Portuguese population stratified by age, gender, and in the case of women, by pregnancy status. This study was conducted in real-life contexts, in which the participants were asked to complete a survey as well as screening tests for anemia and ID. Additionally, we aimed to raise awareness among the public, health professionals, and policy-makers about the extent of anemia and ID problem in Portugal and possible future interventions.

2. Materials and Methods

2.1. Study Design

This cross-sectional screening was promoted by the Anemia Working Group Portugal—*Associação Portuguesa para o Estudo da Anemia*—aiming to evaluate the prevalence of anemia and ID in different demographic groups of the adult Portuguese population. The screening was performed using a convenience sampling in real-life contexts, such as public locations and private entities frequented by the general population. The screening was carried out in several geographical locations in mainland Portugal from January 2013 to December 2017. The study was conducted by applying a survey as well as anemia and ID screening blood tests to the participants, in which hemoglobin and ferritin concentrations were determined by point-of-care tests.

The study received approval from the Portuguese National Data Protection Committee (CNPD, Lisbon, Portugal). All the participants voluntarily participated in this study and provided their oral consent after clarification about the scope of the screening.

2.2. Participants and Procedures

The study enrolled all adult individuals (≥18 years old) that, after an invitation to participate in the screening in several public locations, such as public or private health institutions, pharmacies, shopping centers, companies, and medical and healthcare congresses, they showed availability and interest to participate.

The participants were asked to answer a survey about anemia and ID. The survey included questions about demographic characteristics and the presence or absence of signs or symptoms compatible with the presence of anemia or ID. The last were collected using three categories: (1) fatigue in daily activities; (2) bleed easily, headaches, and dizziness; and (3) visible blood loss. If the participants answered positively to at least one question of these categories, they were considered as having a sign or symptom compatible with the presence of anemia or ID (see Figure S1 in the Supplementary Material for analysis of the survey's form).

Hemoglobin and ferritin concentrations were determined by point-of-care testing devices using capillary puncture performed by the research team. This team consisted of trained individuals in the survey methodology and the execution of point-of-care tests by capillary puncture, mostly health professionals (nurses and lab technicians). Hemoglobin and ferritin concentrations were determined using Cera-Chek Hb Plus (Ceragem Medisys, Chungnam, South Korea) and Vedalab Easy Reader (Vedalab, Alençon, France), respectively.

2.3. Definition of Anemia and Iron Deficiency

Anemia was defined as hemoglobin concentration <12.0 g/dL for nonpregnant women, <13.0 g/dL for men, <11.0 g/dL for pregnant women in the 1st or 3rd trimester, and <10.5 g/dL for pregnant women in the 2nd trimester, in accordance with the WHO [1] and the Portuguese Directorate-General for Health (DGS, Lisbon, Portugal) [19] guidelines.

ID was classified according to the ferritin concentration, which is positively correlated with the magnitude of the total body iron stores in the absence of inflammation [20]. Several ferritin cutoffs have been proposed in the literature for the diagnosis of ID in the general population, and there are no consensus criteria [7]. Ferritin concentrations <15 ng/mL are indicative of iron stores depletion in both genders [20]. In the presence of factors that affect ferritin levels such as age, inflammation, infection, or pregnancy, ferritin concentrations <30 ng/mL are also indicative of iron stores depletion [20]. The DGS indicates serum ferritin concentrations of 30 to 340 ng/mL as normal reference ranges in the general adult population and recommends that pregnant women should initiate oral iron therapy if their serum ferritin concentration is <70 ng/mL [19]. Therefore, in this study, ID was defined as a ferritin concentration <30 ng/mL in men and nonpregnant women and <70 ng/mL in pregnant women, regardless of the pregnancy trimester

[19].

2.4. Statistical Analysis

A convenience sampling of the general adult population was conducted at several public and private locations for five consecutive years in mainland Portugal. A sample size calculation was not performed. Participants were excluded from the analysis if they had missing data regarding any of the following variables: age, gender, hemoglobin concentration, ferritin concentration, or pregnancy trimester.

Data from the sample population were stratified by gender, age, and presence or absence of signs or symptoms of anemia or ID, to estimate and compare the prevalence of anemia or ID between groups. Female participants were stratified into nonpregnant women (age ≥18 years) and pregnant women in the 1st, 2nd, or 3rd trimester of gestation. Nonpregnant women in fertile age (18–44 years) and pregnant women were matched by the following age groups: 18–26, 27–35, and 36–44 years. To evaluate the relationship of menopause with the prevalence of anemia or ID, nonpregnant women were further stratified into the age groups ≤51 years and >51 years. Because the scope of the screening did not include the report of a clinical diagnosis of menopause (i.e., 12 consecutive months of amenorrhea without any other obvious pathological or physiological cause) and because menopause is an event that occurs at a median age of 51 years [21–24], we have used this cutoff to stratify women into pre- and postmenopause.

The normality of the data was assessed using the Kolmogorov–Smirnov test. Continuous variables were presented as mean (standard deviation), median (minimum–maximum), or median (1st quartile–3rd quartile), as applicable. Categorical variables were expressed as number and percentage. Each prevalence estimate of anemia or ID was expressed as a percentage with the respective 95% Clopper–Pearson confidence interval (CI). To assess the relationship between anemia or ID and different population groups or the presence of signs or symptoms of anemia or ID, crude prevalence ratios (PR) with their corresponding 95% CI were estimated using Poisson regression with robust variance. Pairwise comparisons of each PR versus the reference group were performed using the Wald chi-square test.

Statistical significance was reported for *p* value

3. Results

3.1. Sample Characterization

During the study period, between 2013 and 2017, we collected data from 11,384 participants that resulted from 135 events of anemia and ID screenings. We excluded 354 cases from the initial screening sample, corresponding to participants with age <18 years ($n = 86$) or participants' records that presented missing data ($n = 268$).

We included 11,030 adult participants with ages between 18 and 99 years, 25.8% ($n = 2845$) of men, 64.0% ($n = 7060$) of nonpregnant women, and 10.2% ($n = 1125$) of pregnant women. Their mean age was 40.90 (16.86), 45.94 (16.02), and 30.89 (4.84), respectively. Table 1 shows the summary statistics for demographic characteristics and hemoglobin and ferritin concentrations of the study participants.

Table 1

Summary of the demographic characteristics and concentrations of hemoglobin and ferritin of the study participants.

Group	Participants, $N = 11,030$			
n	Age, mean (SD) (years)	Hb, mean (SD) (g/dL)	Ferritin, median ($Q1$–$Q3$) (ng/mL)	Men
2845	40.90 (16.86)	13.62 (1.65)	50.82 (26.60–86.80)	Nonpregnant women
				Total

7060	45.94 (16.02)	12.01 (1.54)	21.28 (9.00–40.46)	≤51 years
4525	36.02 (9.04)	11.94 (1.53)	17.78 (9.00–33.46)	>51 years
2535	63.66 (8.91)	12.14 (1.55)	29.96 (14.28–56.00)	·
Pregnant women				
Total	1125	30.89 (4.84)	11.15 (1.41)	17.38 (9.00–30.94)
1st trimester	41	30.44 (5.26)	11.74 (1.40)	29.60 (9.00–45.49)
2nd trimester	633	30.67 (4.75)	11.16 (1.39)	20.44 (9.00–36.12)
3rd trimester	451	31.24 (4.90)	11.09 (1.44)	10.80 (9.00–23.94)
18–26 years	203	23.90 (2.08)	11.23 (1.51)	16.80 (9.00–29.12)
27–35 years	723	30.87 (2.51)	11.13 (1.40)	17.78 (9.00–31.78)
36–44 years	199	38.07 (1.89)	11.14 (1.36)	16.94 (9.00–30.94)
–				
Nonpregnant women in fertile age[a]				
Total	3500	32.54 (7.14)	11.96 (1.52)	16.94 (9.00–32.20)
18–26 years	870	23.24 (2.37)	11.95 (1.53)	14.10 (9.00–27.44)
27–35 years	1285	30.91 (2.61)	12.01 (1.47)	17.78 (9.00–32.62)
36–44 years	1345	40.13 (2.53)	11.92 (1.56)	17.78 (9.00–35.28)

Hb, hemoglobin; *N*, total number of participants; *n*, number of participants per group; *Q*1, 1st quartile; *Q*3, 3rd quartile; SD, standard deviation. [a]Subgroups of nonpregnant women matched to the same age groups of the pregnant women.

3.2. Prevalence of Anemia and Iron Deficiency

3.2.1. Health Institutions versus Other Public Locations

The prevalence and prevalence ratios of anemia and ID by the type of location of the participant are presented in Supplementary Table S2 (Supplementary Materials). We estimated an anemia prevalence of 56.7% (95% CI 55.2–58.1%) in participants from health institutions and 35.6% (95% CI 34.5–36.8%) in participants from other public locations. Furthermore, we found a significant association between having anemia and the type of institution of the participant. Compared with participants from other public locations, participants from health institutions were associated with a PR of anemia of 1.59 (95% CI 1.50–1.68, $p<0.001$).

Regarding ID, we estimated a prevalence of 59.6% (95% CI 58.2–61.0%) in participants from health institutions and 57.0% (95% CI 55.8–58.3%) in participants from other public locations. No significant association was found between the prevalence of ID and the type of institution of the participant.

3.2.2. Men versus Nonpregnant Women

The prevalence of anemia and ID by gender is presented in Figure 1. We estimated an anemia prevalence of 33.3% (95% CI 31.6–35.1%) in men and 50.0% (95% CI 48.9–51.2%) in nonpregnant women. Furthermore, we found a significant association between having anemia and gender. Compared with men, nonpregnant women were associated with a PR of anemia of 1.50 (95% CI 1.42–1.59, $p<0.001$).

[figure omitted; refer to PDF]

Regarding ID, we estimated a prevalence of 64.1% (95% CI 62.9–65.2%) in nonpregnant women and 28.9% (95% CI 27.3–30.6%) in men. Similar to anemia, nonpregnant women were associated with a significantly higher prevalence of ID compared with men (PR: 2.21, 95% CI 2.09–2.35; $p<0.001$).

3.2.3. Presence of Signs or Symptoms of Anemia or Iron Deficiency

Figure 2 shows the prevalence of signs or symptoms compatible with anemia or ID by the anemia or ID status in the study sample. Most of the participants with anemia (63.8%, 95% CI 62.4–65.1%) or with ID (62.9%, 95% CI 61.7–64.1%) presented signs or symptoms compatible with these conditions. Furthermore, we found a statistically significant association between the presence of signs or symptoms and the presence of anemia or ID. Participants with anemia were associated with a PR of 1.19 (95% CI 1.15–1.23, $p<0.001$) compared with those without anemia. Similarly, participants with ID had a statistically higher prevalence of signs or symptoms compared with participants without ID (PR: 1.22, 95% CI 1.18–1.26; $p<0.001$).

[figures omitted; refer to PDF]

3.2.4. Nonpregnant Women versus Pregnant Women

Table 2 shows the prevalence and the PR of anemia in nonpregnant women in fertile age and pregnant women stratified by age and pregnancy trimester. Overall, we found a prevalence of anemia of 51.8% (95% CI 50.1–53.4%) in nonpregnant women in fertile age and 38.2% (95% CI 35.4–41.1%) in pregnant women. Furthermore, we estimated a significant association between anemia and pregnancy status, in which pregnant women had a 0.74-fold lower prevalence of anemia compared to nonpregnant women in fertile age (Table 2). This significant lower PR of anemia in pregnant women versus nonpregnant women in fertile age was observed in all age groups (18–26 years, 27–35 years, and 36–44 years).

Table 2

Prevalence and prevalence ratio of anemia in nonpregnant and pregnant women stratified by age group and pregnancy trimester.

Group	Anemia

N	*n*	Prevalence, % (95% CI)	PR (95% CI)	Total
				NPW in fertile age[a]
3500	1812	51.8 (50.1–53.4)	1 (reference)	Pregnant women
1125	430	38.2 (35.4–41.1)	0.74 (0.68–0.80)***	1st trimester
41	11	26.8 (14.2–42.9)	0.52 (0.31–0.86)*	2nd trimester
633	200	31.6 (28.0–35.4)	0.61 (0.54–0.69)***	3rd trimester
451	219	48.6 (43.9–53.3)	0.94 (0.85–1.04)	·
18–26 years				
NPW in fertile age[a]	870	445	51.1 (47.8–54.5)	1 (reference)
Pregnant women	203	74	36.5 (29.8–43.5)	0.71 (0.59–0.86)**
1st trimester	10	0	0.0 (0.0–30.8)	-[b]
2nd trimester	117	33	28.2 (20.3–37.3)	0.55 (0.41–0.74)***
3rd trimester	76	41	53.9 (42.1–65.5)	1.06 (0.85–1.31)
–				
27–35 years				
NPW in fertile age[a]	1285	634	49.3 (46.6–52.1)	1 (reference)
Pregnant women	723	281	38.9 (35.3–42.5)	0.79 (0.71–0.88)***
1st trimester	23	10	43.5 (23.2–65.5)	0.88 (0.55–1.41)
2nd trimester	414	133	32.1 (27.6–36.9)	0.65 (0.56–0.76)***
3rd trimester	286	138	48.3 (42.3–54.2)	0.98 (0.86–1.12)
–				
36–44 years				
NPW in fertile age[a]	1345	733	54.5 (51.8–57.2)	1 (reference)

Pregnant women	199	75	37.7 (30.9–44.8)	0.69 (0.58–0.83)***
1st trimester	8	1	12.5 (0.3–52.7)	0.23 (0.04–1.44)
2nd trimester	102	34	33.3 (24.3–43.4)	0.61 (0.46–0.81)**
3rd trimester	89	40	44.9 (34.4–55.3)	0.83 (0.65–1.04)

CI, confidence interval; *N*, total number of participants; *n*, number of participants with anemia; NPW, nonpregnant women; PR, prevalence ratio. [a]Subgroups of nonpregnant women matched to the same age groups of the pregnant women. [b]Poisson regression was not performed because the prevalence equals zero. *p value <0.05, **p value <0.01, ***p value <0.001; Wald chi-square test.

When analyzing pregnant women by their pregnancy trimester, we recorded that almost half of the pregnant women in the 3rd trimester (48.6%, 95% CI 43.9–53.3%) had anemia compared to less than one-third of the pregnant women in the 1st (26.8%, 95% CI 14.2–42.9%) and 2nd trimesters (31.6%, 95% CI 28.0–35.4%). What stands out in Table 2 is the high prevalence of anemia in 3rd trimester pregnant women, which was not significantly different compared to nonpregnant women in fertile age in all groups. Conversely, pregnant women in the 1st and 2nd trimesters had a significant 48% and 39% decrease, respectively, in the overall prevalence of anemia compared to nonpregnant women in fertile age (Table 2).

Table 3 shows the prevalence and the PR of ID in nonpregnant women in fertile age (ferritin <30 ng/mL) and in pregnant women (ferritin <70 ng/mL) stratified by age and pregnancy trimester. In the total group, the prevalence of ID was 72.9% (95% CI 71.4–74.4%) in nonpregnant women in fertile age and 94.8% (95% CI 93.3–96.0%) in pregnant women. The most striking result to emerge from the data is that pregnant women in the 2nd and 3rd trimesters presented a prevalence of ID above 90%, regardless of the age group. The 3rd trimester pregnant women showed the highest prevalence, ranging from 97.8% (95% CI 92.1–99.7%) in the 36–44-year group to 98.7% (95% CI 92.9–100) in the 18–26-year group.

Table 3

Prevalence and prevalence ratio of iron deficiency in nonpregnant and pregnant women stratified by age group and pregnancy trimester.

Group	ID			
N	*n*	Prevalence, % (95% CI)	PR (95% CI)	Total
				NPW in fertile age[a]
3500	2553	72.9 (71.4–74.4)	1 (reference)	Pregnant women
1125	1066	94.8 (93.3–96.0)	1.30 (1.27–1.33)***	1st trimester
41	36	87.8 (73.8–95.9)	1.20 (1.07–1.35)**	2nd trimester
633	588	92.9 (90.6–94.8)	1.27 (1.24–1.31)***	3rd trimester
451	442	98.0 (96.2–99.1)	1.34 (1.31–1.38)***	·

18–26 years		3		
NPW in fertile age[a]	870	679	78.0 (75.1–80.8)	1 (reference)
Pregnant women	203	195	96.1 (92.4–98.3)	1.23 (1.18–1.29)***
1st trimester	10	10	100 (69.2–100)	1.28 (1.24–1.33)***
2nd trimester	117	110	94.0 (88.1–97.6)	1.21(1.14–1.28)***
3rd trimester	76	75	98.7 (92.9–100)	1.26 (1.21–1.32)***
–				
27–35 years				
NPW in fertile age[a]	1285	932	72.5 (70.0–75.0)	1 (reference)
Pregnant women	723	682	94.3 (92.4–95.9)	1.30 (1.25–1.35)***
1st trimester	23	19	82.6 (61.2–95.0)	1.14 (0.94–1.38)
2nd trimester	414	383	92.5 (89.5–94.9)	1.28 (1.22–1.33)***
3rd trimester	286	280	97.9 (95.5–99.2)	1.35 (1.30–1.40)***
–				
36–44 years				
NPW in fertile age[a]	1345	942	70.0 (67.5–72.5)	1 (reference)
Pregnant women	199	189	95.0 (91.0–97.6)	1.36 (1.30–1.42)***
1st trimester	8	7	87.5 (47.3–99.7)	1.25 (0.96–1.63)
2nd trimester	102	95	93.1 (86.4–97.2)	1.33 (1.25–1.42)***
3rd trimester	89	87	97.8 (92.1–99.7)	1.40 (1.33–1.46)***

CI; confidence interval; ID, iron deficiency; *N*, total number of participants; *n*, number of participants with iron deficiency; NPW, nonpregnant women; PR, prevalence ratio. [a]Subgroups of nonpregnant women matched to the same age groups of the pregnant women. **p value <0.01, ***p value <0.001; Wald chi-square test. Nonpregnant women ≤51 years versus >51 years.

Moreover, we found that pregnant women had a prevalence of ID that was 1.30-fold higher than nonpregnant women in fertile age in the total group (Table 3), suggesting that ID was associated with the pregnancy status. We found the highest PR for ID in 3rd trimester pregnant women, compared to nonpregnant women in fertile age in the total group (PR: 1.34, 95% CI 1.31–1.38; p<0.001) and the 36–44-year group (PR: 1.40, 95% CI 1.33–1.46; p<0.001).

We also aimed to compare the prevalence of anemia or ID between nonpregnant women in pre- and postmenopause, based on the stratification of nonpregnant women into the age groups ≤51 and >51 years. Figure 3 shows the prevalence of anemia and ID in these groups of nonpregnant women.

[figure omitted; refer to PDF]

We found a prevalence of anemia of 51.9% (95% CI 50.5–53.4%) in nonpregnant women ≤51 years and 46.6% (95% CI 44.7–48.6%) in nonpregnant women >51 years. Moreover, we found a significant association between these age groups and the prevalence of anemia, which showed an 11% increase in nonpregnant women ≤51 years compared to nonpregnant women >51 years (PR: 1.11, 95% CI 1.06–1.17; p<0.001).

We found similar results for ID. The prevalence of ID was 71.7% (95% CI 70.3–73.0%) in nonpregnant women ≤51 years and 50.5% (95% CI 48.5–52.4%) in nonpregnant women >51 years. We also found a significant association between these age groups and prevalence of ID, which showed a 42% increase in nonpregnant women ≤51 years compared to nonpregnant women >51 years (PR: 1.42, 95% CI 1.36–1.48; p<0.001). The results and discussion may be presented separately, or in one combined section, and may optionally be divided into headed subsections.

4. Discussion

In this study, we conducted a large-scale screening (*n*=11030) for anemia and ID in the adult Portuguese population between 2013 and 2017. This study was performed in real-life contexts both within and outside the clinical setting, allowing not only to obtain more prevalence data on population groups generally less accessible outside the clinical context, such as adult men, but also on high-risk groups within the population, such as pregnant women. Therefore, we analyzed the extent of anemia and ID, which has been poorly studied in different population groups, to increase the amount of epidemiological data available for healthcare planning.

We found anemia to be highly prevalent in the screened adult general population: 33% in men, 38% in pregnant women, 47% in nonpregnant women >51 years, and 52% in both in nonpregnant women in fertile age (18–44 years) and nonpregnant women <51 years. These prevalence estimates of anemia are above the ones previously reported in the WHO [3] and EMPIRE [4, 5] studies on the Portuguese general population. The prevalence of anemia was particularly high in nonpregnant women in fertile age, exceeding the estimated value for pregnant women, therefore contrasting with the estimates from WHO (19% nonpregnant versus 26% pregnant) [3] and the EMPIRE study (21% nonpregnant versus 54% pregnant) [4]. These differences may be explained not only by different study designs but also by differences in the demographic characteristics and the sample size used to estimate the prevalence of anemia. In the present study, we analyzed 3500 nonpregnant women in fertile age and 1125 pregnant women, whereas the EMPIRE study [4] analyzed 2245 and 59, respectively. Nevertheless, our findings are consistent with that of the EMPIRE study [4] because the reported prevalence estimates make anemia a moderate (20–39%) to severe (≥40%) public health problem in the population groups at higher risk, namely, the women in fertile age both nonpregnant or pregnant [2, 16].

In this study, we have reported a higher prevalence of cases with signs or symptoms compatible with anemia or ID in participants with anemia or with ID. Although the presence of anemia or ID has shown a significant association with the manifestation of compatible signs or symptoms, these are generally nonspecific and can result from several etiologies and comorbidities [6].

The ID was also found to be highly prevalent in the screened adult general population. Adult men showed the lowest prevalence of ID (29%), whereas nonpregnant women >51 years, nonpregnant women in fertile age, and pregnant women presented a prevalence of ID of 51%, 72%, and 95%, respectively. Similar to anemia, the prevalence estimates for ID are above those previously reported by the EMPIRE study [4], mainly for nonpregnant women in fertile age (38%) and pregnant women (63%). It should be highlighted that, despite being in line with the EMPIRE study, our results support a higher prevalence of both anemia and ID, which could be explained by the different study designs, as already mentioned, and also by the increased number of women participants in our study, including nonpregnant women of fertile age (*n*=3500) and ≤51 years (*n*=4525), as well as pregnant women (*n*=

1125).
We found significant associations between gender and the prevalence of anemia and ID when we compared men to nonpregnant women. When analyzing the proportion of cases with ID and anemia, we observed a prevalence of ID of 29% and a prevalence of anemia of 33% in men, and a prevalence of ID of 64% and prevalence of anemia of 50% in nonpregnant women. Because ID is the most common cause of anemia [3, 6], an increase in ID is expected to be accompanied by an increase in anemia [16]. On the contrary, depending on its etiology, ID includes both iron depletion stages without manifestation of anemia and more severe stages with progression to ID anemia [6]. In theory, if a given population presents a prevalence of ID anemia over 20%, a prevalence of some degree of ID around 50% is expected. If the prevalence of ID anemia exceeds 40%, then almost all population will present some degree of ID [16]. However, in this study, we estimated the overall prevalence of anemia, without further investigation of its underlying cause or the concomitant presence or absence of an ID, which limits the interpretations of the relative proportions of anemia and ID in men and nonpregnant women [16].
Nonpregnant women in fertile age presented a significantly increased prevalence of anemia compared to pregnant women, being this association significant. This finding may be explained by the increased prevention or surveillance of pregnant women in Portugal, being this population group usually targeted for additional clinical follow-up. Nonetheless, despite being normally followed early during pregnancy, iron deficiency is still underdiagnosed in Obstetrics and General and Family Medicine, in which ferritin levels are not mandatorily assessed. Furthermore, the application of the DGS guideline for the approach, diagnosis, and treatment of ID in adults [19] recommends pregnant women to initiate oral iron supplementation only when their serum ferritin concentration is <70 ng/mL. On the contrary, the difference between the prevalence of anemia in nonpregnant women and pregnant women should be scrutinized considering the pregnancy trimester. For instance, this difference can be explained by the suppression of menstrual blood loss during the 1st pregnancy trimester. Globally, we found that pregnant women in the 3rd trimester, when a significant increase in iron demand occurs, present the highest prevalence of anemia and ferritin concentrations <70 ng/mL, whereas pregnant women in the 1st trimester presented a lower prevalence of these conditions. We also found significant associations between ID and pregnancy status, and the variation of anemia and ID prevalence along the pregnancy trimesters was as expected. In pregnant women, the ferritin concentration increases in the initial gestation period in the 1st trimester and tends to progressively decrease during 32 weeks to about 50% concerning the prepregnancy levels, due to hemodilution and iron mobilization [25]. Therefore, variations in the ferritin concentration are influenced by the progressive increase of iron requirements during the 2nd and 3rd pregnancy trimesters, induced by growth, fetal-placental and maternal tissue development, and expansion of maternal red blood cell mass [19, 26]. As this expansion increases during the 2nd half of the 2nd trimester, the iron requirements reach their highest level during the last six to eight pregnancy weeks [26].
As for the strengths of this study, we highlight its implementation over a long period in a population-based sample in real-life contexts, in several public locations visited by the general population, the use of validated analytical tests for the determination of anemia and ID and the sample size. However, this study had some limitations that are intrinsic to screening methodologies. We have used a convenience sampling that depended on participants who were willing to participate, and no sample size calculations were performed to estimate the representativeness of the population groups. Thus, despite the considerable sample size, caution is needed when generalizing the results of this study to the different population groups since they have different availabilities to participate. Furthermore, the validity of self-reported data regarding signs or symptoms of anemia or ID and medical history is influenced by the participants' memory and intellectual capacities. Finally, other factors contributing to the prevalence of anemia and ID were not analyzed [16], such as diet, clinical follow-up, comorbidities, and adherence to iron supplementation, mainly in pregnant women.

5. Conclusions

We previously estimated prevalence levels of anemia or ID above 20% in the adult Portuguese general population. In this study, our findings provided additional evidence on the existence of a moderate to severe public health problem, particularly among adult women in fertile age and pregnant women in the 3rd trimester, claiming for a preventive intervention concerning a clarification in timing, duration, and trigger cutoff.

This screening provided a real-life picture allowing to raise awareness among the public, healthcare professionals, and policy-makers about the need for early and proactive diagnosis of anemia and ID. The implementation of future policies should promote further awareness and prevention of anemia and ID among the high-risk population groups, an active demand for healthcare, and better treatment strategies, to minimize the anemia and ID problem in Portugal.

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DETAIL

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Association between Helicobacter pylori Infection and Occurrence of Anemia among Pregnant Women Attending Antenatal Care in Kulito Health Center, Halaba Zone, South Ethiopia, 2018

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ABSTRAK (ENGLISH)

Background. Anemia in pregnancy is defined as a hemoglobin (Hb) concentration of less than 11 grams (gm)/deciliter (dl) in venous blood. Globally, it affects 1.62 billion people. In developing countries, anemia is a major cause of maternal and child morbidity and mortality. Globally, anemia contributes to 20% of all maternal deaths. Nearly 50% of the world’s population is estimated to be infected with *Helicobacter pylori* (HP). High prevalence of HP among pregnant women was also reported in developing countries than developed ones. The association between HP infection and occurrence of anemia is not well known in Ethiopia. Therefore, the aim of this study was to determine the association between anemia and *Helicobacter pylori* infection among pregnant women attending antenatal care follow-up in Kulito Health Center, Halaba Zone, South Ethiopia. *Methods*. Institution-based cross-sectional study was employed. Systematic random sampling procedure was employed to select 236 pregnant women who attended antenatal care at Kulito Health Center. An interviewer-administered questionnaire supplemented by laboratory tests was used to obtain the data. The collected data were analyzed by using SPSS version 20.0. *Results*. The prevalence of anemia among antenatal care attendant pregnant women of Kulito Health Center was 27.5% with 36 (15.2%) of mild, 29 (12.3%) of moderate, and no severe cases of anemia. The overall prevalence of HP infection among study participants was found to be 129 (54.7%) (95% CI: 47.9–61.4). Factors significantly associated with anemia were presence of HP infection (AOR = 3.064, 95% CI: 1.336 7.027), low interpregnancy gap (AOR = 2.863, 95% CI: 1.245–6.582), being on the third trimester (AOR = 6.457; 95% CI: 1.276–32.729), and mid-upper arm circumference (MUAC) level <21 cm (AOR = 2.595, 95% CI: 1.044–6.450). *Conclusion*. This study revealed that anemia and HP infection were highly prevalent among pregnant women attending the antenatal follow-up clinic in Kulito Health Center. HP infection, low interpregnancy gap, being on the third trimester, and MUAC less than 21 cm were the independent factors associated with anemia. *Recommendation*. Pregnant women should be aware that anemia is a problem that can be prevented by early prevention and treatment of HP infection and undernutrition, using family planning to widen the interpregnancy gap. Further experimental studies are warranted to determine the cause and effect of the association between anemia and HP infection.

TEKS LENGKAP

DETAIL

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The Trabecular Bone Score as a Predictor for Thalassemia-Induced Vertebral Fractures in Northeastern Thailand

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ABSTRAK (ENGLISH)

Introduction. Thalassemia bone disease is one of the disease-related complications in patients with thalassemia. Prevalence of fractures and the role of a trabecular bone score (TBS) as a predictive factor for fractures were evaluated in patients with thalassemia. *Methods*. A cross-sectional study was conducted in patients with thalassemia aged ≥18 years at Srinagarind Hospital, Khon Kaen University, Thailand. A lateral thoracolumbar radiograph and bone mineral density (BMD) at the lumbar spine and hip, as well as the TBS measured by dual-energy X-ray absorptiometry (DXA), were evaluated in all patients. *Results*. Among 86 patients, 14 patients were found to have radiographic vertebral fracture yielding a prevalence of 16.3%. All patients who had fractures were *β*-thalassemia/Hb E. Combined low BMD and TBS at lumbar spines and a presence of endocrinopathies were significantly associated with vertebral fractures. *Conclusions*. The prevalence of vertebral fractures in patients with thalassemia was not uncommon. A combined low BMD and TBS and a presence of endocrinopathies were associated with vertebral fractures. These findings suggested that BMD testing and TBS measurement have a clinical implication as a screening tool for evaluating the risk of vertebral fractures in thalassemic patients, particularly in *β*-thalassemia/Hb *E* who have endocrinopathies.

TEKS LENGKAP

1. Introduction

Thalassemia syndromes are a group of inherited anemias caused by genetic disorders of the globin genes. The mutations of globin genes have resulted in quantity and quality defects of globin chains. Presently, thalassemia syndromes are classified into 2 main subgroups according to the red blood cell transfusion requirements: (1) Transfusion-Dependent Thalassemia (TDT) and (2) Non-Transfusion-Dependent Thalassemia (NTDT) [1].

Thalassemia bone disease is one of the major disease-related complications in patients with thalassemia. Thalassemia-associated osteoporosis is the most common bone disease in patients with thalassemia. The prevalence varies from 40% to 60% in patients with TDT [2–4]. Evidence has shown that several contributing clinical risk factors are associated with thalassemia-induced osteoporosis including bone marrow expansion [5, 6], iron overload and iron chelation therapy [7–10], endocrine disorders [7, 11–15], vitamin deficiencies [16, 17], and low physical activity [18, 19]. Previous studies reported a wide-range of fracture prevalences in patients with thalassemia (12–51%) [20–22]. A high prevalence of fractures was found in patients with TDT and related to the presence of iron overload-associated endocrinopathy, i.e., hypogonadism, hypothyroidism, and diabetes [20, 21, 23].

The trabecular bone score (TBS) is a new tool to evaluate bone microarchitecture. The score is derived from dual-energy X-ray absorptiometry (DXA) images, measured at the lumbar spine. The TBS was designed to reflect bone quality, while the bone mineral density (BMD) is a proxy for bone quantity. The literature has shown a correlation between the BMD and TBS in the normal population and in patients with thalassemia [24]. The association of low BMD and fractures is well established in patients with thalassemia, but the association between TBS and fractures in these patients remains limited. Therefore, this study was designed to demonstrate the role of TBS as a clinical predictive factor for vertebral fractures in patients with thalassemia.

2. Patients and Methods

A cross-sectional study was conducted in patients with thalassemia who were aged 18 years or older at Srinagarind Hospital, Khon Kaen University, between January 2013 and January 2014. Medical history taking and physical examinations were performed by a physician in all patients. Clinical characteristics and laboratory data that the literature indicated as the potential risk factors for thalassemia bone disease and osteoporosis were collected. Endocrinopathies are defined as a presence at least one of the endocrine disorders including (1) diabetes mellitus, (2) hypothyroidism, and (3) hypogonadism. The diagnosis of endocrinopathies was based on medical history, physical examinations, and blood tests. Transfusion-dependent thalassemia (TDT) was defined as a group of patients requiring transfusion of red blood cells every 2–4 weeks to survive. Non-transfusion-dependent thalassemia (NTDT) was characterized as a group of patients who received occasional transfusion of red blood cells. Symptomatic and radiographic vertebral fractures were recognized. The radiographic vertebral fractures were evaluated by using lateral thoracic-lumbar X-ray radiographs, and the BMDs at the lumbar spine and hip were measured by using the DXA (Lunar prodigy model, GE Lunar). In this study, low BMD was defined as a Z-score from the DXA scanning of less than −2.0 SD. The TBS was derived from the evaluation of the experimental variogram, obtained from the grayscale DXA scan (Medimaps TBS iNsight) at the lumbar spine [25], and low TBS was defined as a TBS value less than 1.1 according to the previous study in patients with thalassemia [24]. The research protocol was approved by the Human Research Ethics Board of the Faculty of Medicine, Khon Kaen University.

2.1. Statistical Analyses

Continuous parameters were reported as mean and standard deviations (SD). Categorical parameters were reported as numbers and percentages. Univariate and multivariate logistic regression analyses were used to determine the associations between clinical factors and vertebral fractures. All statistical analyses were performed by the STATA program version 10 (StataCorp, College Station, TX). Statistical significance was considered as a p value <0.05.

3. Results

A total of 86 patients (52 females, 34 males) were enrolled. The radiographic vertebral fractures were found in 14 patients (16.3%). Baseline clinical characteristics are shown in Table 1. The mean age was 32.2 years. The mean lumbar spine BMD Z-score was 0.7, while the mean TBS was 1.2. A history of splenectomy was found in 39 patients (45.4%). Nearly half of the patients had a low BMD (36 patients, 42%), and low TBS was found in 7 patients (8%). None of the patients who had a low TBS had a normal BMD. All of the patients who had vertebral fractures were *ß*-thalassemia/Hb E. There were no fractures in patients with *a*-thalassemia.

Table 1

Baseline characteristics of 86 patients with thalassemia.

Characteristics	Transfusion-dependent thalassemia (TDT) ($n = 57$)	Non-transfusion-dependent thalassemia (NTDT) ($n = 29$)
Mean age (min-max), years	30.5 (18–60)	35.5 (18–58)
Mean pretransfused Hb (min-max), g/dL	7.2 (4.9–8.8)	7.6 (7.5–9.2)
Mean serum ferritin (min-max), ng/mL	2.690 (153–11,810)	1.651 (336–7,869)
Z-score BMD (min-max), g/cm^2	0.7 (0.4–1.0)	0.8 (0.5–1.0)

TBS score (min-max)	1.2 (0.8–1.5)	1.3 (0.8–1.4)
Gender, *n* (%)		
Female	38 (66.6)	14 (48.3)
Male	19 (33.4)	15 (51.7)
Splenectomy, *n* (%)		
No	22 (38.6)	25 (86.2)
Yes	35 (61.4)	4 (13.8)
Vertebral fractures, *n* (%)		
No	48 (84.2)	26 (89.6)
Yes	11 (15.8)	3 (10.4)
Low lumbar spine BMD, *n* (%)		
No	30 (52.6)	20 (68.9)
Yes	27 (47.4)	9 (31.1)
Low TBS, *n* (%)		
No	53(93)	26 (89.6)
Yes	4 (7)	3 (10.4)
Smoking, *n* (%)		
No	51 (89.4)	23 (79.3)
Yes	6 (10.6)	6 (20.7)
Menopause, *n* (%)		
No	46 (80.7)	25 (86.2)
Yes	11 (19.3)	4 (13.8)
Endocrinopathies, *n* (%)		

No	44 (77.2)	24 (82.7)
Yes	13 (22.8)	5 (17.3)
Phenotype group, *n* (%)		
β-thalassemia/Hb E	52 (91.2)	15 (51.7)
Homozygous *β*-thalassemia	3 (5.2)	0 (0)
Hb H disease	0 (0)	5 (17.2)
Hb H disease with Hb CS	0 (0)	5 (17.2)
EABart's disease*	2 (3.6)	4 (13.9)

Hb CS = hemoglobin constant spring; *compound heterozygous Hb H and heterozygous Hb *E*.

Univariate analyses of the clinical predictive factors for vertebral fractures in patients with thalassemia are shown in Table 2. Low BMD (odds ratio = 4.4, 95%CI: 1.2–15.5, p=0.02), low TBS (odds ratio = 9.2, 95%CI: 1.7–47, p=0.008), combined low BMD and TBS (odds ratio = 14, 95%CI: 2.2–86.5, p=0.005), a history of splenectomy (odds ratio = 5.7, 95%CI: 1.5–22.5, p=0.01), and endocrinopathies (odds ratio = 5.3, 95%CI: 1.5–18.3, p=0.007) were significantly associated with vertebral fractures.

Table 2

Univariate analysis of risk factors for vertebral fractures.

Variables	OR	95% CI	p value
Age	1.02	0.9–1.1	0.46
Female gender	0.8	0.2–2.5	0.7
Low TBS score	9.2	1.7–47	0.008
Low BMD	4.4	1.2–15.5	0.02
Combined low BMD and TBS	14	2.2–86.5	0.005
Smoking	3.2	0.8–12.6	0.09
Splenectomy	5.7	1.5–22.5	0.01
Hemoglobin <7 g/dl	0.8	0.2–2.8	0.7
Serum ferritin >1,000 ng/ml	1.0	0.3–3.6	0.9

Transfusion-dependent thalassemia	2.1	0.5–8.1	0.3
Menopause	3.4	0.9–12.4	0.06
Endocrinopathies	5.3	1.5–18.3	0.007

OR = odds ratio; 95% CI = 95% confidence interval.

The patients with combined low BMD and TBS had the highest prevalence of pathological fractures (67%, odds ratio = 14), followed by the patients with low TBS (57%, odds ratio = 9.2) and the patients with low BMD (20%, odds ratio = 4.4) (Figure 1). In multivariate analyses, combined low TBS and BMD (odds ratio = 4.8, 95%CI: 1.02–22.9, p=0.04) and a presence of endocrinopathies (odds ratio = 4.4, 95%CI: 1.02–19.2, p=0.04) remained significantly associated with vertebral fractures (Table 3).

[figure omitted; refer to PDF]

Table 3

Multivariate analysis of risk factors for vertebral fractures.

Variables	OR	95% CI	p value
Age	1.0	0.9–1.1	0.2
Endocrinopathies	4.4	1.02–19.2	0.04
Combined low BMD and TBS	4.8	1.02–22.9	0.04
Smoking	3.2	0.6–17.4	0.1
Splenectomy	3.4	0.6–18.5	0.1
Serum ferritin > 1,000 ng/ml	1.1	0.2–5.7	0.8

OR = odds ratio; 95% CI = 95% confidence interval.

4. Discussion

The prevalence of thalassemia-associated osteoporotic fractures in beta-thalassemia major and in the various thalassemia syndromes has not been well established This study demonstrated that the prevalence of vertebral fracture was 16.3% (14/86), which was comparable with a previous study by Engkakul et al., which reported that the prevalence of vertebral fracture was 13% in Thai patients with thalassemia [26] The prevalence of vertebral fractures in the present study, however, was slightly higher than that in a previous report from a large cohort study including 31 clinical centers in the United States, Canada, and the United Kingdom (16.3% vs. 10.6%) [21]. The discrepancy in prevalence among the studies might be explained by three main factors including (i) the differences in the diagnostic methods of vertebral fracture because in the previous study, fractures were assessed by the self-reported fracture history questionnaires, but in this cohort, vertebral fractures included both symptomatic and/or radiographic vertebral fractures; (ii) the enrolled subjects in this study were adult patients with a high iron burden, and about 20% of patients had iron-associated endocrinopathies. Advanced age, iron overload, and endocrine disorders were important risk factors for osteoporosis and fractures in this population; and (iii) the ethnic differences in fracture risk [27].

Vertebral body bones are composed of the cancellous bone more than the cortical bone. The previous study demonstrated that low bone density, reduced trabecular bone volume, and extensive iron deposition were predominant characteristics of bone abnormalities in thalassemia bone disease [28]. These findings supported that the vertebral fracture in patients with thalassemia was more likely to be caused by thalassemia disease. Indeed, the TBS represents that the bone strength may be useful for assessing the risk of vertebral fractures. The association between low TBS and vertebral fractures, however, was demonstrated in postmenopausal women and men with the chronic obstructive pulmonary disease, and there was no study in thalassemia patients [29–31].

It is well established that a low BMD is an important risk factor for fractures in patients with thalassemia; however, this study showed that a low TBS was also associated with fractures. The current study found that patients with low TBS had a higher risk of vertebral fractures compared with low BMD (OR 9.2 vs. 4.4, p value <0.008 vs. 0.02). Moreover, patients with a combined low BMD and TBS were statistically significantly associated with vertebral fractures (OR 41.4, p value = 0.007). These findings suggested that thalassemia bone disease might explain the defect of both bone quantity and bone quality; however, impairment of bone quality might be more of a contributing factor for developing fractures in these patients than the bone quantity. The findings from this cohort suggested that all thalassemia patients should be evaluated for the TBS together with BMD for predicting the risk of fractures. T-L X-ray radiography should be performed in high-risk patients who have a combined low BMD and low TBS to exclude vertebral fractures.

Previous studies reported that the endocrine disorders were significant contributing factors of osteoporosis and fractures in patients with thalassemia. Endocrinopathies in these patients, for example, hypothyroidism, diabetes mellitus, hypogonadism, and hypoparathyroidism, led to increased osteoclast activity and decreased osteoblasts resulting in osteoporosis [7, 11, 13–15]. Fung et al. showed that hypogonadism was associated with fractures in patients with thalassemia [23]. Moreover, male patients with endocrine disorders, especially hypogonadism and a history of previous fractures, were predictive factors for future fractures [21].

An interesting finding in this present cohort was that pathological fractures were found in patients with *β*-thalassemia/Hb *E* and there were no fractures in patients with *a*-thalassemia. This finding might be explained by the nature of the disease that patients with *β*-thalassemia have more severe ineffective erythropoiesis compared to patients with *a*-thalassemia. A majority of patients with *β*-thalassemia/Hb *E* in this study were transfusion-dependent thalassemia. Supporting this, a large cohort study showed that fractures were more prevalent in patients with TDT and increased with age [20, 22]. Menopause, age, smoking, iron overload, and TDT, however, were not significantly associated with vertebral fracture in this study due to the small number of fracture events.

A limitation of this study is that the small sample size of patients limits the power to demonstrate the statistical significance of the potential clinical risk factors for fractures. The receiver operating characteristic (ROC) curve was constructed, but the sample size and the number of vertebral fractures were small to find the optimal cut-off point for predicting vertebral fracture in these patients. A large longitudinal cohort study is needed to confirm the associations of other clinical risk factors and fractures. To the authors' knowledge, however, this was the first study that demonstrated the association between radiographic vertebral fractures and the TBS in patients with thalassemia.

In conclusion, a combined low BMD and TBS and a presence of endocrinopathies were significant risk factors for vertebral fractures in patients with thalassemia. These findings could have clinical implications for performing BMD and TBS measurements as screening tools to evaluate the risk of vertebral fractures in patients with thalassemia, particularly in those patients with *ß*-thalassemia who have iron overload and endocrinopathies.

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DETAIL

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Proportion of Immediate Postpartum Anaemia and Associated Factors among Postnatal Mothers in Northwest Ethiopia: A Cross-Sectional Study

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ABSTRAK (ENGLISH)

Background. Anaemia is a major global health problem, especially in developing countries. Postpartum anaemia hurts both maternal and newborn baby health. Anaemia in pregnancy is sufficiently emphasized; however, very little attention has been paid to postpartum anaemia in Ethiopia. Therefore, this study aimed to investigate the proportion of immediate postpartum anaemia and associated factors among postpartum mothers in Debre Markos Referral Hospital. *Methods*. Institutional-based cross-sectional study was conducted among 424 study participants from August 1st to October 30th, 2019. A systematic random sampling technique was employed to select the study participants. Data were collected through both face-to-face interview and maternal chart review by using a pretested questionnaire. Data were cleaned, coded, and entered using Epi Data version 4.6.0.0 and then exported to SPSS version 24 for analysis. First, binary logistic regression was applied to identify candidate variables for multivariable regression. Then, variables at p value <0.2 were entered into a multivariable logistic regression to control possible confounders. Finally, variables at p value <0.05 were considered as statistically significant. *Results*. The proportion of immediate postpartum anaemia was 24.3%. Frequency of antenatal care (ANC) visits <4 times [AOR = 2.40; 95% CI (1.29, 4.43)], antepartum haemorrhage (APH) [AOR = 5.08; 95% CI (1.91, 13.55)], postpartum haemorrhage (PPH) [AOR = 4.47; 95% CI (2.25, 8.88)], giving birth assisted by instruments (vacuum or forceps) [AOR = 3.99; 95% CI (1.42, 11.23)], poor adherence to iron and folic acid (IFA) [AOR = 2.52; 95% CI (1.06, 6.04)], and midupper arm circumference (MUAC) <23 cm [AOR = 3.25; 95% CI (1.87, 5.65)] were the predictors. *Conclusion*. The proportion of immediate postpartum anaemia was a moderate public health concern. ANC, APH, PPH, mode of delivery, adherence to IFA supplementation, and MUAC measurement were the factors affecting the magnitude of anaemia. Therefore, interventions that would address the above mentioned factors need to be implemented.

TEKS LENGKAP

1. Introduction

The postnatal period is a critical phase in the lives of mothers and newborn babies. Even though most maternal and infant deaths occur during this time, this is the most neglected period for the provision of quality of care, especially in low resource setting countries [1].

There is no consensus on the definition of postpartum anaemia. Nevertheless, as it can be inferred from the definition given by different scholars, postpartum anaemia (PPA) occurs when haemoglobin level <11 gm/dl at 1 week and <12 gm/dl at 8 weeks of the postpartum period [2, 3]. Accordingly, haemoglobin level 10–10.9 gm/dl is categorized as mild anaemia, 7–9.9 gm/dl and <7 gm/dl are categorized as moderate and severe anaemia, respectively [4]. Furthermore, even if there is no clear agreement as to the right time to determine the postpartum haemoglobin level, it is usually recommended to check on the first postpartum day [5, 6].

The prevalence of anaemia among postnatal mothers in developed countries ranges from 10% to 30% and in developing countries 50% to 80% [2, 6]. In Ethiopia despite of the 2020 anaemia reduction plan, postpartum anaemia among lactating women increased from 18% in 2011 to 28.6% in 2016 [7, 8]. Anaemia is an indirect cause of maternal morbidity and mortality which accounts for 2% of total maternal mortality in Ethiopia [8, 9]. Blood loss and anaemia were interrelated causes of maternal complications. Due to bleeding, postnatal mothers lose a significant amount of iron during labour and delivery [10, 11]. PPA is also strongly associated with poor quality of life, palpitation, increase maternal infection, fatigue, reduced cognitive ability, emotional instability, and postpartum depression. These outcomes may, in turn, result in poor mother-child bonding, inability to provide care and breastfeeding, or slow infant development [2, 12, 13].

The studies conducted in different parts of the world revealed that factors like young maternal age (<21 years) [14], low educational status of the mother [15], rural residence [16], cesarean mode delivery, episiotomy assisted delivery, prenatal anaemia [17–19], antepartum haemorrhage (APH), postpartum haemorrhage (PPH) [20], antenatal care (ANC) visit less than four [21], reactive (positive) in Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) test, malaria [15, 16, 22], and poor adherence of iron and folic acid (IFA) intake during pregnancy [15, 23–25] were some of the independent factors significantly associated with the occurrence of postpartum anaemia. The reduction of postpartum anaemia is a component of target 2 (50% anaemia reduction plan) of World Health Organizations’ (WHO) to achieve sustainable development goals.

Some studies were conducted in Ethiopia on anaemia during pregnancy, yet postpartum anaemia screening is the least emphasized illness in the postpartum period. Early diagnosis and identifying the possible risk factors are helpful to manage PPA on time before further complications developed. This study might provide insight into postpartum anaemia to health care providers to propose targeted screening and intervention measures for those whose haemoglobin level <11 gm/dl. Furthermore, researchers might also be benefited by using this result as baseline data to conduct further community-based studies covering a wide area. Several factors contribute to PPA and it can be difficult to generalize the causes for all mothers who reside in a different area. Therefore, this study was intended to assess the proportion and associated factors of anaemia among immediate postnatal mothers in Debre Markos Referral Hospital, Northwest Ethiopia.

2. Material and Methods

2.1. Study Setting, Design, and Period

This study was conducted in Debre Markos Referral Hospital which is located in East Gojjam Zone, Northwest Ethiopia, and 299 km far from Addis Ababa, the capital city of Ethiopia. This hospital serves more than 3.5 million people who reside in the town and neighbouring areas. In the maternity department, a total of 7 gynaecologists, 1 emergency surgeon, 1 MSc clinical midwife, 14 general practitioners, and 36 midwives work as health care providers. This department has 60 beds for inpatient clients to serve high-risk mothers, gynecologic case-patients, and postnatal mothers. The annual delivery report showed that 6017 mothers gave childbirth in this hospital. The study was conducted by using an institutional-based cross-sectional study design method and data was collected from August 1st to October 30th, 2019.

2.2. Source and Study Population

All postnatal mothers who gave birth in Debre Markos Referral Hospital and mothers who gave birth somewhere else but came to the hospital within 24 hours of the postpartum period were considered as source population. Mothers who fulfilled the criteria to be a source population and avail themselves during the data collection period were the study population.

2.3. Inclusion and Exclusion Criteria

All postnatal mothers who gave birth in Debre Markos Referral Hospital and mothers who gave birth somewhere else but arrived at the hospital within 24 hours during the data collection period were included in this study. Mothers who were anaemic before conception and/or during pregnancy were excluded in this study.

2.4. Sample Size Determination

Sample size calculation was based on single population proportion formula by using the following assumption: 50% proportion since there were no the same previous studies, 95% confidence level, and 5% margin of error, and then the calculated sample size was 385. Finally, by adding a 10% nonresponse rate, the final sample size was 424. Sample size determination by using the second objective (statistically significant factors) was calculated by Epi info version 7.2.1, and the maximum sample size was 312. Therefore, the sample calculated by the first objective was larger than the sample size determined by the second objective. Therefore, the final sample size for this study was 424.

2.5. Sampling Technique and Procedure

Systematic random sampling was employed to select the study participants. Based on 3 consecutive previous month's average number of delivery data (497), bed numbers in maternity unit (60), and sample size (424); interval was computed. Beds occupied by postnatal mothers were selected with a systematic random sampling technique every 8th bed interval. After written informed consent was taken, data were collected through interviews and chart reviews. Blood samples were collected and processed using the standard procedures for haemoglobin determination at 24 hours before mothers have discharged from the hospital.

2.6. Study Variables

2.6.1. Dependent Variable

Dependent variable is immediate postpartum anaemia.

2.6.2. Independent Variables

Sociodemographic related variables include age, maternal education level, maternal occupation, religion, residence, marital status, husband education level, husband occupation, and estimated average monthly income. *Obstetrical related variables* include parity, antepartum haemorrhage, multiple pregnancies, abortion, interpregnancy interval, antenatal care visit, frequency of antenatal care visit, gestational age at initial (first) ANC visit, place of delivery, mode of delivery, duration of second-stage labour, episiotomy, perineal tear, the weight of newborn, and postpartum haemorrhage. *Coexisting infections related variables* include helminths infestation, malaria infection, medical disease during pregnancy, HIV/AIDS, syphilis, and urinary tract infection. *Dietary and micronutrient uptake related variables* include hot drink (tea, coffee, or milk) when she has taken iron, meal frequency per day, adherence of IFA, and midupper arm circumference (MUAC).

2.7. Operational Definitions

Immediate postpartum period is the first 24 hours after childbirth [26].

Postpartum anaemia is when the haemoglobin level is less than 11 gm/dl at 24 hours of the postpartum period [19, 27].

Adherence of iron and folic acid supplementation means women who had taken iron folate supplements ≥90 days during the most recent pregnancy [8].

2.8. Data Collection Tools and Procedures

The questionnaire was developed after reviewing different pieces of literature [20, 21, 28] conducted in different parts of the world. First, the questionnaire was prepared in English and translated into a local language Amharic and then backto English to keep consistency. Two BSc midwives and one master midwife were recruited for data collection and supervision, respectively. After taking written informed consent, data were collected through both face-to-face interview and retrospective maternal chart review by using a semistructured pretested questionnaire. MUAC was measured via tape measures on the nondominant hand, mostly left hand. The result was interpreted to the United Nation International Children's Emergency Fund (UNICEF) and WHO recommendations of cutoff point <23 cm as undernourished and ≥23 cm as well nourished. About 1-2 milliliter of venous blood was collected from each study participant aseptically for haemoglobin estimation. Then, haemoglobin was determined using automated blood analyzer Cell-Dyne 1800 (Abbot Laboratories Diagnostic Division, USA) by experienced laboratory technologist. Finally, the level of haemoglobin was collected and attached to their respective charts. At the end, anaemic mothers were managed with iron and folate or transfused blood based on their haemoglobin levels and advised on iron-rich diets intake.

2.9. Data Quality Control

The training was provided for both data collectors and a supervisor. The questionnaire was pretested at Debre Berhan referral hospital with 5% of the sample size. Completeness, clarity, and appropriateness of the questionnaire were modified accordingly after the pretest. Completeness of data was checked daily.

2.10. Data Processing and Analysis

Collected data were checked for completeness, consistency, clarity, and missed values. Then, it was cleaned, coded, and entered using Epi Data version 4.6.0.0 and then exported to SPSS (Statistical Package for Social Science) version 24 for analysis. Descriptive analysis: frequency, proportion, mean, median, and standard deviation were computed and presented with texts, tables, and graphs. The normality assumption was checked with a histogram and box plot. Multicollinearity and chi-square assumptions were done. Then, binary logistic regression was performed and variables at p value <0.2 were entered into a multivariable logistic regression to control possible confounders. Crude and adjusted odds ratios with 95% confidence interval were computed. Finally, variables at p value <0.05 were considered as statistically significant.

3. Results

3.1. Sociodemographic Characteristics

Four hundred twenty-four immediate postnatal mothers were involved in this study. The mean age of the study population was 27.79 years with a standard deviation of ±5.12. Based on the age category, 241 (56.8%) study participants were with the age range of 25–34 years. More than one-third (35%) of mothers were unable to read and write and two hundred seventy-seven (65.3%) of mothers were housewives by their occupation. Almost all (95.5%) were orthodox Christian religion followers. More than half (55.7%) of the participants were from urban areas. More than one-third (40.9%) of husbands were farmers. Most of the participants' husband might be predominantly involved in farming activities and urban farming is also a common practice these days. Regarding estimated average monthly income, 158 (39.2%) of the respondents' income was within the range of 1000–3000 birr with a median income of 3500 birr and IQR ± 3500 birr. (Table 1).

Table 1

Sociodemographic related characteristics of postnatal mothers in Debre Markos Referral Hospital, Northwest Ethiopia, 2019 ($n = 424$).

Variables	Category	Frequency	Percent (%)
Age	15–24	121	28.6
25–34	241	56.8	35–49
62	14.6	-	

Maternal education status	Unable to read and write	148	35.0
Able to read and write	49	11.6	Primary class completed
55	13.0	Secondary class completed	81
19.1	Diploma and above	90	21.3
–			
Occupation of respondent	Housewife	277	65.3
Government employee	73	17.2	Private employee
25	5.9	Merchant	38
9	Others*	11	2.6
–			
Religion	Orthodox	405	95.5
Muslim	14	3.3	Protestant
5	1.2	-	
Residence	Rural	188	44.3
Urban	236	55.7	·
Marital status	Married	408	96.2
Unmarried	16	3.8	·
Husband education level	Unable to read and write	133	32.3
Able to read and write	31	7.5	Primary class completed
55	13.4	Secondary class completed	80

19.4	Diploma and above	113	27.4
–			
Husband occupation	Government employee	104	25.5
Private employee	68	16.7	Merchant
49	12	Farmer	167
40.9	Others*	20	4.9
–			
Monthly income (ET birr)	<1000	18	4.5
1000–3000	158	39.2	3001–5000
102	25.3	≥5001	125

*Others represent daily labourers and students for both occupation of study participants (mothers) and husbands.

3.2. Obstetrical Related Factors

Among the total 424 study participants, 218 (51.5%) were primipara mothers. Fifty-six (25%) of the mothers had a short interpregnancy interval which was less than two years. A majority (88.4%) of the study participants had antenatal care follow-up during the most recent pregnancy. From those, more than half (60.6%) of the mothers had ≥4 ANC visits, and two hundred fifty-nine (69.1%) of them started the follow-up before 16 weeks of gestation. Of the total study participants, 27 (6.4%) of them had an antepartum haemorrhage in the latest pregnancy. Almost all (95.0%) of the study participants gave birth in health institutions and more than half (52.6%) of the study participants gave childbirth through cesarean section, and 89.5% of the operations were emergency/unplanned. (Table 2).

Table 2

Obstetrical related characteristics of postnatal mothers in Debre Markos Referral Hospital, Northwest Ethiopia, 2019 (*n*=424).

Variables	Category	Frequency	Percent (%)
Parity	Primipara	218	51.5
Para 2–4	171	40.2	Grand multiparous
35	8.3	·	
History of abortion	Yes	71	31.6
No	154	68.4	·

Interpregnancy interval in years	<2	56	25.0
≥2	168	75.0	·
Attend ANC during this pregnancy	Yes	375	88.4
No	49	11.6	·
GA when ANC visit initiated in weeks	<16	259	69.1
16–24	69	18.4	25–30
45	12.0	31–34	2
0.5	-		
Frequency of ANC visits (times)	<4	148	39.4
≥4	227	60.6	·
Antepartum haemorrhage	Yes	27	6.4
No	397	93.6	·
Multiple pregnancies	Yes	23	5.4
No	401	94.6	·
Place of birth	Health institution	403	95.0
Home	21	5.0	·
Mode of delivery	SVD	176	41.5
IAVD	25	5.9	C/S
223	52.6	-	
Type of C/S	Elective	25	10.5
Emergency	198	89.5	·
Manual removal of placenta	Yes	20	4.7
No	404	95.3	·

Episiotomy	Yes	19	4.5
No	405	95.5	·
Prolonged second stage	Yes	32	7.5
No	392	92.5	·
Perineal tear	Yes	41	9.7
No	383	90.3	·
Weight of newborn in gram	<2500	72	17.0
2500–3999	348	82.1	≥4000
4	0.9	-	
Postpartum haemorrhage	Yes	60	14.2

ANC: antenatal care, GA: gestational age, IAVD: instrumental assisted vaginal delivery, SVD: spontaneous vaginal delivery, and C/S: cesarean section.

3.3. Coexisting Infection-Related Factors

One hundred twelve (26.5%) of the respondents had clinically confirmed medical and parasitic illness before or/and during the latest pregnancy. Among these, preeclampsia was the most frequent complaint (33.60%), whereas tuberculosis was the least one (2.64%). (Figure 1).

[figure omitted; refer to PDF]

3.4. Dietary and Micronutrients Utilization Related Factors

Three hundred sixty-eight of the study participants were started on IFA tablets during the most recent pregnancy. Among these, 176 (51.5%) were started before 16 weeks of gestation, whereas 45.9% and 2.6% were started during second- and third-trimester pregnancy, respectively. Among those mothers who took IFA tablets, only 93 (27.3%) of them had good adherence. Among IFA tablets supplied mothers, 135 (39.5%) participants drank hot drink when they took iron. More than two-thirds of 322 (76.1%) of the mothers ate three or fewer times per day during pregnancy. Close to half (46%) of the mothers' midupper arm circumference was less than 23 cm. (Table 3).

Table 3

Dietary and micronutrient uptake characteristics of postnatal mothers in Debre Markos Referral Hospital, Northwest Ethiopia, 2019 ($n = 424$).

Variables	Category	Frequency	Percent (%)
IFA tablet took during pregnancy	Yes	368	86.8
No	56	13.2	·
GA when IFA tablet started	<16 weeks	176	51.5

20–24 weeks	90	26.3	26–30 weeks
67	19.6	30–34 weeks	9
2.6	-		
Adherence to iron and folic acid supplementation	Poor adherence	248	72.7
Good adherence	93	27.3	·
Hot drink while taking iron	Yes	135	39.5
No	207	60.5	·
Frequency of meal per day	≤3	322	76.1
>3	101	23.9	·
Midupper arm circumference in centimeter (cm)	<23	195	46.0

IFA: iron and folic acid, GA: gestational age.

3.5. Proportion and Associated Factors of Immediate Postpartum Anaemia

3.5.1. The Proportion of Immediate Postpartum Anaemia

Postpartum anaemia was observed among 103 (24.3%) mothers. Postpartum haemoglobin concentrations of study participants ranged from 6.70 gm/dl to 17.50 gm/dl with a mean value of 12.4 gm/dl and SD ± 1.88 gm/dl. From the total 24.3% anaemic mothers, 13.4%, 10.2%, and 0.7% of them were categorized as mild, moderate, and severe anaemia, respectively (Figure 2).

[figure omitted; refer to PDF]

3.5.2. Associated Factors of Postpartum Anaemia

In binary logistic regression analysis, maternal educational level (being unable to read and write and able to read and write), rural residence, home delivery, preterm delivery, and less frequent meal per day were variables associated with immediate PPA with p value <0.2, but all these variables were eliminated by backward multivariate regression. In multivariable logistic regression, antenatal care visit <4 times, antepartum haemorrhage, instrumental delivery, postpartum haemorrhage, poor adherence to IFA supplementation, and MUAC <23 cm were independent variables significantly associated with p value <0.05.

The odds of postpartum anaemia were higher among postnatal women who had <4 antenatal care visits [AOR = 2.40; 95% CI (1.29, 4.43)]. The higher likelihood of postpartum anaemia was observed among postnatal women who were experienced APH and PPH compared to their counterparts [AOR = 5.08; 95% CI (1.91, 13.55)] and [AOR = 4.47; 95% CI (2.25, 8.88)], respectively. Mothers who gave birth by instrumental assisted vaginal delivery were almost 4 times more likely to be anaemic compared to those who gave birth through spontaneous vaginal delivery [AOR = 3.99; 95% CI (1.42, 11.23)]. Mothers who poorly adhere to IFA supplementation were 2.5 times more likely to develop postpartum anaemia compared to those who had good adherence [AOR = 2.52; 95% CI (1.06, 6.04)]. Increased odds of anaemia were noted among postpartum women with MUAC measurements of <23 cm [AOR = 3.25; 95% CI (1.87, 5.65)] (Table 4).

Table 4

Logistic regression showing factors associated with immediate postpartum anaemia among postnatal mothers in

Debre Markos Referral Hospital, Northwest Ethiopia, 2019 (*n*=424).

Independent variables	Postpartum anaemia		COR 95% CI	AOR 95%CI
Yes	No	Maternal education status		
		Unable to read and write	55	93
5.32 (2.48–11.44)	2.00 (0.81–4.88)	Able to read and write	14	35
3.60 (1.43–9.09)	2.05 (0.71–5.87)	Primary school class	10	45
2.00 (0.76–5.23)	1.66 (0.57–4.80)	Secondary school class	15	66
2.04 (0.85–4.98)	1.09 (0.40–2.99)	Diploma and above	9	81
1	1	-		
Residence				
Rural	59	129	2.00 (1.27–3.13)	0.63 (0.31–1.29)
Urban	44	192	1	1
–				
Frequency of ANC visits				
	46	102	3.10 (1.84–5.25)	2.40 (1.29–4.43)*
≥4 times	29	198	1	1
–				
Antepartum haemorrhage				

Yes	17	10	6.15 (2.71–13.9)	5.08 (1.91–13.55)*
No	86	311	1	1
–				
GA at delivery				
Preterm	31	58	1.96 (1.18–3.25)	1.41 (0.73–2.71)
Term	69	255	1	1
–				
Place of birth				
Health institution	92	311	1	1
Home	11	10	3.72 (1.61–9.00)	1.92 (0.60–6.19)
–				
Mode of delivery				
SVD	39	137	1	1
IAVD	13	12	3.81 (1.57–8.77)	3.99 (1.42–11.23)*
Cesarean section	51	172	1.04 (0.65–1.67)	1.06 (0.59–1.88)
–				
Postpartum haemorrhage				
Yes	36	24	6.65 (3.72–11.89)	4.47 (2.25–8.88)*
No	67	297	1	1
–				
Adherence of IFA supplementation				
Poor adherence	53	195	2.88 (1.31–6.33)	2.52 (1.06–6.04)*
Good adherence	8	85	1	1
–				

Frequency of meal per day				
≤3	87	235	1.97 (1.09–3.54)	1.21 (0.59–2.48)
>3	16	85	1	1
–				
Midupper arm circumference				
	71	124	3.53 (2.12–5.66)	3.25 (1.87–5.65)*
≥23 cm	32	197	1	1

GA: gestational age; SVD: spontaneous vaginal delivery; IAVD: instrumental assisted vaginal delivery; IFA: iron and folic acid; AOR: adjusted odds ratio; COR: crude odds ratio; 1: reference and *significantly associated with p value <0.05.

4. Discussion

This study assessed the proportion and factors associated with immediate postpartum anaemia among postnatal mothers at 24-hour postpartum period in Debre Markos Referral Hospital. The proportion of immediate postpartum anaemia was 24.3%.

This value was in line with the study done in Germany (22%), Jimma (28.7%), Costal Karnataka (26.5%), and Mekelle (24.2%), respectively [20, 21, 24, 29]. But, haemoglobin cutoff points to define anaemia and the time (postpartum period) to diagnose anaemia were different.

The magnitude of immediate postpartum anaemia in this study was lower than the study done in Uganda (30%) [17]; Madrid, Spain (29%) [30]; Mancha Centro hospital, Spain (45%) [28]; Tamil Nadu, India (47.3%) [23]; Pakistan (47.9%) [15]; and Myanmar 73.8% [27]. The possible reason for this variation might be due to anaemic mothers in preconception and pregnancy period being excluded from this study, use of different cutoff points to define postpartum anaemia, and difference in postpartum time of screening. Due to a lack of consensus on the definition of PPA, different scholars use different cutoff points, like Hgb

However, this proportion was higher than the Amhara region DHS data report (17.2%) [6]; the study was done in Kenya (16.4%) [8] and Ghana (16%) [31]. The variations might be because the above studies cover a wide range of areas and include all breastfeeding mothers who were far from the immediate postpartum period or close to 6-week and 6-month postpartum period. This shows that when the time of the postpartum period extends, mothers will have enough time to recover from anaemia or haemoglobin level will be increased [32].

Independent factors significantly associated with immediate postpartum anaemia were frequency of ANC visits <4 times in the most recent pregnancy, having antepartum haemorrhage during most recent pregnancy, instrumental assisted vaginal delivery, having the experience of primary postpartum haemorrhage during the most recent birth, poor adherence to IFA supplementation during the latest pregnancy, and MUAC <23 cm at the time of interview.

A majority (88.4%) of the study participants had ANC follow-up and 39% of them had <4 times of visits. The odds of postnatal mothers who had <4 times of antenatal care visits were about 2.4-fold higher to develop postpartum anaemia than those who had ≥4 ANC visits. This finding was supported by the studies conducted in Jimma, Tigray, and Ethiopia DHS data [21, 33, 34]. The possible explanations are as follows: mothers who had <4 ANC visits might not get enough IFA supplements, have poor adherence to IFA supplementation, and not screened/detected the risk factors early and treat on time.

Among all study participants, 27 (6.4%) of them had an antepartum haemorrhage. Mothers who had antepartum haemorrhage were 5 times more likely to be anaemic in the immediate postpartum period, compared to their counterparts. This finding was consistent with the finding from Germany [20]. The possible explanation might be due to the loss of iron stores during pregnancy and blood loss during delivery could be the complications of APH.

The odds of anaemia among postpartum mothers who experienced massive postpartum blood loss were 4.5 times higher than the odds of anaemia among postnatal mothers who did not develop postpartum haemorrhage. The similar findings were reported in Germany, Saudi Arabia, and Tamil Nadu, India [14, 20, 35]. Excessive bleeding after birth decreases the red blood cell component called haemoglobin. In every milliliter blood loss, a half milligram of iron will be reduced in the blood [11].

Mothers who gave birth by instrumental (vacuum or forceps) assisted mode of delivery were almost 4 times more likely to be anaemic in the postpartum period when compared to those who gave birth through spontaneous vaginal delivery. This finding agreed with the studies done in Spain (two studies) and Saudi Arabia [11, 18, 35]. It might be due to the fact that instrumental assisted vaginal delivery increases the risk of episiotomy, spontaneous perineal, or/and cervical tear, and this tear may be also extended to the uterus. Clinicians are usually misdiagnosing the tears and repairing after mothers bleed a lot.

The odds of PPA were 2.5-fold higher among postpartum mothers who had poor adherence to IFA supplementation compared to their counterparts. This finding was in agreement with the studies carried out in Uganda, Pakistan, and Tanzania [15, 23, 25]. The possible explanation might be due to the depleting of stored maternal iron since physiologic requirements of iron during pregnancy and labour are high. Therefore, not taking IFA based on the right order could reduce iron store and results in anaemia even with minimal blood loss during childbirth.

Increased odds of anaemia were noted among postnatal mothers whose MUAC measurements <23 cm compared to those whose MUAC measurements ≥23 cm. This study is supported by the study done in Jimma, Myanmar, and Tanzania [21, 25, 36]. The most likely explanation might be iron deficiency anaemia usually related to nutritional deficiency. MUAC measurement <23 cm indicates that poor muscle mass lacks adequate energy intake. Haemoglobin concentration and maternal MUAC had a linear relationship which was also another explanation [16].

4.1. Limitation of the Study

Since the interview was about the past nine months' activity of mothers, recall bias was one of the limitations. Besides, environmental and behavioural factors were not assessed. The study was facility based and difficult to generalize for the entire community. As the study design was a cross-sectional, a causal relationship could not be established.

5. Conclusions

The proportion of postpartum anaemia was a moderate public health problem in Debre Markos Referral Hospital. Antepartum haemorrhage, instrumental assisted vaginal delivery, frequency of antenatal care visit <4 times, postpartum haemorrhage, poor adherence to IFA supplementation, and MUAC less than 23 cm were independent factors significantly associated with immediate postpartum anaemia. Therefore, interventions that would address the abovementioned factors need to be implemented, and further researches that will address this study limitation should be also considered.

Ethical Approval

Ethical approval was obtained from the University of Gondar, College of Medicine and Health Science, School of Midwifery Ethical Clearance Committee. A permission letter was obtained from the Debre Markos Referral Hospital administrator before the starting of the study. Each study participant was informed about the benefits and objectives of the study.

Consent

Written informed consent was obtained from all the study participants. The willingness nature of participation and the right to refuse or withdraw at any time was emphasized. Confidentiality was maintained during and after data collection.

Disclosure

The funder had no role in the study design, analysis, interpretation, writing, or decision to publish this manuscript.

Authors' Contributions

All the authors contributed in conception and design, data entry, analysis, interpretation, writing of the report, and critically revising the paper. They approved the version to be published and agreed to be accountable for all aspects of the work.

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Glossary

Abbreviations

ANC:Antenatal care

AOR:Adjusted odds ratio

APH:Antepartum haemorrhage

COR:Cruds odds ratio

CS:Cesarean section

DHS:Demographic health survey

GA:Gestation age

HIV:Human immune virus

IAVD:Instrumental assisted vaginal delivery

IFA:Iron and folic acid

MUAC:Midupper arm circumference

OR:Odds ratio

PPA:Postpartum anaemia

PPH:Postpartum haemorrhage

SPSS:Statistical package for social science

SVD:Spontaneous vaginal delivery

TB:Tuberculosis

VDRL:Venereal disease research history

WHO:World Health Organization.

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Determinants of Anemia in Pregnancy: Findings from the Ethiopian Health and Demographic Survey

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ABSTRAK (ENGLISH)

In Ethiopia, anemia during pregnancy is a major public health problem and affects both the mother's and their child's health. There is a scarcity of community-based evidence on determinants of anemia among pregnant women in the country. Therefore, this study aimed to assess the determinants of anemia among pregnant women in Ethiopia. *Method*. This study was based on the 2016 Ethiopian Demographic Health Survey (EDHS) that used a two-stage stratified cluster sampling technique. A cross-sectional study was conducted among 3080 pregnant women. Data analysis was done using STATA v.14. Variables with P value <0.05 in the bivariate analysis were candidates for the multivariable analysis to identify independent determinants of anemia among pregnant mothers. Odds ratios (OR) were calculated at 95% confidence interval (CI). *Results*. The overall prevalence of anemia among pregnant women was 41% of which 20% were moderately anemic, 18%, mildly anemic, and 3%, severely anemic. The following were significantly associated with anemia during pregnancy: an age of 30–39 years, receiving no education (AOR = 2.19; 95% CI 1.45, 2.49), belonging to the poorest wealth quintile (AOR = 1.29; 95% CI 1.22, 1.60), being a Muslim (AOR = 1.59; 95% CI 1.69, 2.65), number of house members being 4–6 (AOR = 1.44; 95% CI 1.05, 1.97), number of under-five children being two (AOR = 1.47; 95% CI 1.10, 1.97), head of the household being a female (AOR = 2.02; 95% CI 1.61, 2.54), current pregnancy wanted later (AOR = 1.75; 95% CI 1.23, 1.63), no terminated pregnancy (AOR = 1.49; 95% CI 1.15, 1.93), and an age of 13–17 years at the first sexual intercourse (AOR = 1.97; 95% CI 1.291, 3.00). *Conclusions*. The study revealed that more than one-third of the pregnant women in Ethiopia were found anemic. Its prevalence varied among regions in which the highest (62.7%) and the lowest (11.9%) were from Somali and Addis Ababa, respectively. Hence, efforts should be made by concerned bodies to intervene in terms of the identified risk factors.

TEKS LENGKAP

DETAIL

Subjek:	Socioeconomic factors; Hemoglobin; Anemia; Womens health; Regression analysis; Obstetrics; Iron; Sociodemographics; Variables; Pregnancy; Data analysis; Toilet facilities; Drinking water; Illiteracy; Rural areas; Mothers; Households
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Leucocytosis and Asymptomatic Urinary Tract Infections in Sickle Cell Patients at a Tertiary Hospital in Zambia

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ABSTRAK (ENGLISH)

Sickle cell anaemia (SCA) is an inherited disease resulting from mutations in the *β*-globin chain of adult haemoglobin that results in the formation of homozygous sickle haemoglobin. It is associated with several complications including an altered blood picture and damage in multiple organs, including the kidneys. Kidney disease is seen in most patients with SCA and may affect glomerular and/or tubular function, thereby putting these patients at risk of urinary tract infections. However, there is a paucity of data on the prevalence of urinary tract infections (UTIs) among SCA patients in Zambia. This study aimed to determine the prevalence of UTIs and haematological and kidney function profiles among SCA patients at the University Teaching Hospitals, Lusaka, Zambia. This was a cross-sectional study conducted between April and July 2019 involving 78 SCA patients who presented at the UTH. Blood and midstream urine samples were collected from each participant using the standard specimen collection procedures. Full blood counts and kidney function tests were determined using Sysmex XT-4000i haematology analyser and the Pentra C200 by Horiba, respectively. Bacterial profiles of the urine samples were determined using conventional microbiological methods. We found that all the measured patients' haemoglobin (Hb) levels fell below the WHO-recommended reference range with a minimum of 5 g/dl, a maximum of 10.5 g/dl, and a mean of 8 ± 1 g/dl. Fifty percent of the participants had moderate anaemia, while the other 50% had severe anaemia. The minimum WBC count of the participants was 0.02×10^9/L with a maximum of 23.36×10^9/L and a mean of $13.48 \pm 3.87 \times 10^9$/L. Using the one-way analysis of variance test, we found no significant difference in mean WBC count and Hb concentration across various age-group categories that we defined. Bacteriuria was found in 25% of participants. The most common bacterial isolates were *Staphylococcus aureus* (32%) and coagulase-negative *Staphylococci* (32%). *Klebsiella pneumoniae* was 16%. We found no significant association between bacterial isolates and white blood cell count, age groups, sex, and anaemia severity p=0.41. None of the participants were diagnosed with kidney disease. There was a high prevalence of asymptomatic UTIs among SCA patients at UTH, which, when coupled with the marked leukocytosis and anaemia, may negatively impact the clinical outcome of the patients. Therefore, we recommend close monitoring of sickle cell patients in Zambia for such conditions to improve patients' outcomes.

TEKS LENGKAP

1. Introduction

Sickle cell anaemia (SCA) is an inherited disease resulting from mutations in the *β*-globin chain of adult haemoglobin that results in the formation of homozygous sickle haemoglobin (HbSS). In SCA, red blood cells deform into a sickle shape and damage cell membranes [1]. The disease is associated with significant and costly long-term complications and reduced life expectancy [1–3]. It is also generally associated with higher mortality in both children and adults [4, 5]. Estimates suggest that every year approximately 300,000 infants are born with sickle cell anaemia and that this number could rise to 400,000 by 2050 [6]. Although the burden of SCA is truly global, more than 75% of the global burden of SCA occurs in sub-Saharan Africa [6]. The fundamental pathological processes in SCA include blood vessel occlusion, erythrocyte sickling, and recurrent infections due to immune compromise [7–9].

The disease is associated with various complications ranging from an altered blood picture to complications such as leukocytosis, increased platelets, and decreased hematocrit and haemoglobin [10] and multiple organ disorders, including those of the kidney. Kidney disease is seen in most patients with SCA and may affect glomerular and/or tubular function [11]. Abnormalities in the function of the kidney are believed to increase the asymptomatic bacteriuria rate, which leads to UTIs in SCA patients. It is for this reason that sickle cell anaemia has some effect on the type and distribution of UTI-causing bacteria. These UTIs are either symptomatic with bacteriuria and associated with symptoms such as dysuria, pyuria, and frequent urination or asymptomatic (no acute symptoms) with bacteriuria [12]. The classical definition of asymptomatic urinary tract infection also called asymptomatic bacteriuria is the isolation of a specified quantitative count of bacteria in an appropriately collected urine specimen obtained from a person without symptoms or signs referable to urinary infection. While that for acute uncomplicated urinary tract infection is symptomatic bladder infection characterised by frequency, urgency, dysuria, or suprapubic pain in a woman with a normal genitourinary tract, and it is associated with both genetic and behavioural determinants [13]. Delay in detecting and thereby institution of appropriate treatment may lead to the formation of scars and subsequent renal impairment in sickle cell anaemia (SCA) individuals which may lead to precipitation of crisis and fatal septicaemia [14].

However, there is a paucity of data on the prevalence of both symptomatic and asymptomatic urinary tract infections among SCA patients in Zambia. Therefore, this study aimed to determine the prevalence of UTIs and haematological and kidney function profiles among SCA patients at the University Teaching Hospitals, Lusaka, Zambia.

2. Materials and Methods

2.1. Study Design

The study was a cross-sectional study conducted at the University Teaching Hospital (UTH) in Lusaka, Zambia.

2.2. Study Population

The study included both male and female participants of all age groups with sickle cell anaemia who visited the UTH sickle cell clinic between April and July 2019. All patients with a history suggestive of recurrent UTI were excluded from the study.

2.3. Sample Collection

A qualified or trained clinical personnel collected blood samples via a vein puncture from each patient for blood cell counts and kidney function tests. Each patient was asked to submit midstream urine in sterile containers for urine culture after being given instructions on how to collect the sample by the attending health personnel. The urine samples were cultured within 2 hours upon receipt. Otherwise, they would be stored at 4°C in a refrigerator for up to 24 hours maximum before culture.

2.4. Diagnosis of Sickle Cell Anaemia

Sickle cell anaemia was diagnosed by first running the haemoglobin solubility test. Specimens that showed precipitation in high-molarity-buffered phosphate solution in this test were then confirmed for sickle cell anaemia using gel haemoglobin electrophoresis on the Helena SAS-1 plus and Helena SAS-2 Auto-stainer (Helena Bioscience, Europe).

2.5. Full Blood Count and Kidney Function

The Sysmex XT-4000i (Sysmex, Japan) haematology analyser was used to carry out haematological analysis while kidney function was assessed by determining the serum creatinine levels using the Pentra C200 by Horiba (Horiba, Japan). We used creatinine to assess kidney function because studies have shown that serum creatinine above specific cutoff points reliably identifies patients with acute kidney injury or chronic kidney disease [15–17]. All quality control procedures were followed before running the specimens.

2.6. Urine Culture

The urine samples were inoculated on blood and Cysteine Lactose Electrolyte Deficient (CLED) agars. Briefly, a well-calibrated loop of 1 μL was dipped in a vertical position in the urine sample, and the loop was used to inoculate the plates using the streak plate method. The urine sample was streaked onto the agar plates by holding the loop at 45° angle to the agar plate. The agar plates were then incubated at 37°C for 24 hrs. The plates of blood agar were incubated in 5–10% CO_2 atmosphere. After 48 hrs of incubation, the urine cultures were classified as negative (if there was no bacterial growth), positive (if there was a pure bacterial growth of one colony type), and contaminated (if there was a mixed growth of more than three types of bacterial colonies). The samples were classified as contaminated when polymorphic bacterial growth was observed and as insignificant when bacterial growth was lower than 10^3 colony-forming unit (CFU)/mL and significant when monomorphic bacterial growth was higher than 10^5 CFU/mL [18]. Biochemical identification of isolates was made on culture-positive samples. These tests were performed based on the morphology of the isolated bacteria and the results of the microscopic examination of the Gram-stained smear. The *Enterobacteriaceae* were differentiated using triple sugar iron, Simmon's citrate, urease, lysine iron , motility, and indole tests. Pure colonies were used for the inoculation of test media and were incubated for 18 to 24 hours at 37°C. For Gram-positive isolates, the catalase test was used to distinguish *Staphylococcus* species from *Streptococcus* species. Furthermore, the coagulase test (Biomérieux, Slider Staph plus) was used to differentiate *Staphylococcus aureus* from the other *Staphylococci*.

2.7. Data Analysis

Data were entered in Excel and analysed using Python 3.7 for Mac. Age characteristics, anaemia prevalence and severity, WBC count categories, and UTI prevalence were analysed using descriptive statistics and presented as means, frequencies, percentages, and graphs. Data were checked for normality using the Shapiro–Wilk test and log-transformed to a nearly normal distribution. A one-way analysis of variance (ANOVA) was used to compare the mean difference of haematological parameters across our defined age group categories. Logistic regression analysis was used to examine the relationship between bacteria isolation and age groups, sex, anaemia severity, and white blood cell categories, and a p value of <0.05 was used to indicate statistical significance.

2.8. Ethical Consideration

Ethical approval for the study was obtained from the University of Zambia Health Sciences Research Ethics Committee (UNZAHSREC) (Protocol ID: 20190217067). Informed consent was obtained from the adults while assent for the children to take part in the study was obtained from their guardians.

3. Results

3.1. Demographic Characteristics

The study consisted of 78 participants out of which 45 (58%) were females and 33 (42%) were males. The minimum age was 2 years old and the maximum age was 28 years old, with a mean age of 11.4 ± 6.1 years. Participants were divided into age group categories, as shown in Figure 1 below. Sixty-six (86%) were on folic acid and deltaprim, while 11 (14%) were on folic acid only treatment.

[figure omitted; refer to PDF]

3.2. Prevalence of Kidney Disease in SCA Patients

Minimum creatinine concentration of the participants was 19 μmol/l and maximum 75 μmol/l with the mean of 38.23 ± 12.3 μmol/l. All participants had creatinine levels below 110 μmol/l.

3.3. Haematological Parameters in SCA Patients of Different Age Groups

All patients had Hb levels below the WHO-recommended reference range (11 g/dl for females and 13 g/dl for males) [19] with a minimum of 5 g/dl, maximum of 10.5 g/dl, and a mean of 8 ± 1 g/dl. We found that 50% of the participants had moderate anaemia, whereas the other 50% had severe anaemia with none having mild anaemia. We classified the severity of anaemia based on the World Health Organisation guidelines [19].

Using ANOVA, we showed that there was no significant difference in mean Hb concentration across age groups, $F(4.67) = 1.316$, $p = 0.273$. The minimum WBC count of the participants was 0.02×10^9/L with a maximum of 23.36×10^9/L and a mean of $13.48 \pm 3.87 \times 10^9$/L. Ninety percent (90%) had high WBC count (10×10^9/L), 7% normal count (between 4×10^9/L and 10×10^9/L), and 3% had low WBC count (below 4×10^9/L Table 1). There was no significant difference in mean WBC counts across age groups using ANOVA, F (4.67) = 0.19, p=0.466.

Table 1

Percentage of white blood cell categories.

WBC count	Percentage (%) of participants
Low	3
Normal	7
High	90

3.4. Asymptomatic UTIs in Different Age Groups of SCA Patients

Out of 72 urine specimens cultured, we found growth of bacteria in 18 (25%) specimens, whereas the other 54 (75%) specimens had no growth (Figure 2). The most common bacterial isolates were *Staphylococcus aureus* (32%) and coagulase-negative *Staphylococci* (32%). *Klebsiella pneumoniae* was 16%, *Enterococcus* 5%, *Streptococcus* 5%, *Pseudomonas* species 5%, and *Proteus mirabilis* were 5%.

[figure omitted; refer to PDF]

We performed logistic regression analysis to examine the relationship between bacterial isolation and white blood cell count categories using age groups, sex, and anaemia severity as possible confounders. Here, our results revealed a nonstatistically significant p=0.41 relationship between bacterial isolation and all the variables.

4. Discussion

We found that all participants had normal kidney function. The low and normal serum creatinine levels that we found might have been due to hyperfiltration of creatinine that is reported in most young SCA patients [11]. In patients with SCA, the glomerular filtration rate (GFR) begins to decline in the second decade of life [20]. This may, in part, explain why we found normal serum creatinine levels as most of our study participants were in their first decade of life. Others have reported kidney disease in SCA, albeit at very low prevalence of 6% [21]. The difference can be attributed to the sample population that was used in the study in Jamaica which only included participants who were in their fourth decade of life. However, the normal creatinine levels found in our study were similar to the creatinine levels that were found in a study that was done in Saudi Arabia which concluded that serum creatinine might remain low or within the low-normal range in SCA patients despite the reduced creatinine clearance [22]. The serum creatinine can remain within the normal range because it only begins to decline after the GFR has reduced to about 50 ml/min, and many years are taken to reach this GFR.

All the participants had haemoglobin levels below normal concentration. The low haemoglobin levels might have been due to haemolysis of red cells consequent to the damaged red cell membrane. In SCA, the haemolysis of red cells is intravascular or extravascular. Intravascular haemolysis results from the lysis of complement sensitive red cells and haemoglobin lost during sickling-induced membrane damage [23]. Extravascular haemolysis occurs by phagocytosis of red cells that have undergone sickling and physical entrapment of compromised red cells. The low haemoglobin levels in SCA patients that we found in this study was similar to the findings in a study that was done in Nigeria in which the mean haemoglobin level of 103 SCA patient participants was 7.93 ± 1.47 g/dl [24]. Here also, the shortened red cell survival and lowered erythropoietin response that is associated with SCA have a bearing towards the development of anaemia in SCA [10].

We found a high WBC count in the majority of the participants similar to other reports [24, 25]. Recurrent infection is a known predisposing factor to sickle cell disease crises and is associated with leukocytosis [26]. High WBC count has also been associated with severe anaemia [24]. Therefore, the high WBC count reported here might in part explain the presence of moderate to severe anaemia in all of the participants in the study. The findings corroborate with the findings of a study that was done in Saudi Arabia in which SCD participants who had high WBC count were also diagnosed with severe anaemia [25]. The high WBC count is a serious concern for sickle cell patients as it is associated with shortness of breath, tiredness, swelling in hands/feet, and back pain [25]. High WBC counts have also been found to be a risk factor for early SCD-related death [5], clinically overt stroke [27, 28], silent cerebral infarction [29], and acute chest syndrome [30].

The proportion of SCA patients with asymptomatic UTIs (25%) that we found was higher than those reported in Nigeria (6%); [31] and in Jamaica (5.3%) [32]. Since the prevalence of asymptomatic UTIs increases with age, these results are expected as the participants in our study were older than those of the Jamaican and Nigerian studies whose participants were between the ages of 2–12 years.

We found that the aetiologic pathogens associated with UTIs in our study included *Klebsiella* spp, *Staphylococcus aureus*, *Streptococci*, *Enterococcus* spp, *Pseudomonas*, *Proteus mirabilis*, and *E. coli* which are the major causes of UTIs worldwide. Additionally, organisms such as *Staphylococcus aureus*, *Streptococcus*, and *Proteus* have a broad representation as causative agents of UTIs in developing countries due to poor environment and personal hygiene [31]. Therefore, environmental factors and poor hygiene cannot be ruled out as contributing factors towards our report of *Staphylococcus aureus* (24%), *Streptococcus* (4%), and *Proteus* (4%) in the urine of SCA patients. Furthermore, impairment of the immune system in SCA also contributes towards the presence of asymptomatic bacteriuria, including infections with *Proteus* and *Staphylococcus species* [31]. With all these findings of our study, we recommend that the Zambia ministry of health introduces a newborn screening for sickle cell program using techniques such as dry blood spots [33]. The introduction of such a program may help improve the quality of life of sickle cell patients as they will be able to receive proper health care from childhood.

4.1. Limitations

There is a possibility that some participants have early kidney malfunction, which may not be detected by the use of serum creatinine [34]. Serum creatinine is considered a late marker of kidney injury since a rise in creatinine can only occur after about 50% of kidney function is lost [35].

5. Conclusion

There is a need for close monitoring of sickle cell patients in Zambia as there is a high prevalence (25%) of asymptomatic UTIs, and the majority of them (90%) has a high WBC count which impacts negatively on the clinical outcome of the patients. Also, we recommend the introduction of newborn screening for SCA so that the patients can receive the right treatment from the time they are still young.

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DETAIL

Subjek:	Patients; Urogenital system; Urinary tract diseases; Hemoglobin; Kidney diseases; Urinary tract infections; Bacteria; Urine; Age groups; Sickle cell anemia; Blood; Males; Hematology; Variance analysis; Creatinine
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Determinants of Anemia among HIV-Positive Children on Highly Active Antiretroviral Therapy Attending Hospitals of North Wollo Zone, Amhara Region, Ethiopia, 2019: A Case-Control Study

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ABSTRAK (ENGLISH)

Introduction. Anemia is one of the most commonly observed hematological abnormalities and an independent poor prognostic marker of HIV disease. The rate of progression and mortality in this subgroup of patients is high compared to nonanemic patients. WHO estimates that over two billion people are anemic worldwide and young children bear the world's highest prevalence rate of anemia. In Ethiopia, there is limited information about the determinant factors associated with anemia among HIV positive children. Thus, this study aimed to determine the determinant factors of anemia among HIV-infected children on HAART. *Objective*. The main purpose of this study was to assess the determinants of anemia among children on highly active antiretroviral therapy attending hospitals of North Wollo Zone, Amhara Region, Ethiopia. *Methods*. A case-control study was conducted on 350 HIV-infected children on HAART attending Hospitals of North Wollo Zone, from February 1 to March 30, 2019. The study participants were selected with a consecutive sampling technique. An adapted, interviewer-administered, and pretested questionnaire and chart review were employed to collect the data. Besides, blood and stool samples were investigated to determine hematologic indices and malaria and to investigate intestinal parasites, respectively. Data were analyzed by using the SPSS version 24 statistical software and bivariate and multivariate logistic regression was used to identify predictors. *Results*. A total of 350 HIV positive children (117 cases and 234 controls) were included in this study with an overall response rate of 100%. On multivariate analysis, variables which have spastically significant association with anemia were as follows: had amebiasis (AOR = 7.29, 1.22–43.56), had history of opportunistic infections (AOR = 9.63, 1.94–47.85), had malaria infection (malaria pf) (AOR = 4.37, 1.16–16.42), eating nondiversified food (AOR = 10.39, 2.25–48.0), WGT-Age *Z* score value between −2_−3 (AOR = 9.80, 2.46–39.14), level of adherence (AOR = 2.31, 1.92, 7.77), and being from a rural area (AOR = 8.8, 2.07–37.79). *Conclusion*. In this study, having parasitic infections, having a history of opportunistic infections, being malnourished, having poor adherence to ART, caregivers living in the rural area, and eating nondiversified foods were significantly associated with hemoglobin status. Therefore, intervention aimed at prevention, early diagnosis, and treatment of anemia is essential in these patients.

TEKS LENGKAP

DETAIL

Subjek:	Infections; Anemia; Human immunodeficiency virus--HIV; Iron; Hospitals; Variables; Public health; Acquired immune deficiency syndrome--AIDS; Antiretroviral drugs; Hematology; Drug therapy
Lokasi:	Ethiopia; Africa
Perusahaan / organisasi:	Nama: World Health Organization; NAICS: 923120

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Etiologies and Treatment Burden in Adult Patients with Pure Red Cell Aplasia: A Single-Center Experience and Review of Literature

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ABSTRAK (ENGLISH)

Background. Pure red cell aplasia (PRCA) is less common blood disorder; the causes and the treatments of PRCA are varied. *Methods*. We conducted a retrospective study during January 2010–December 2017, to explore the etiologies and to evaluate the response and treatment burden in adult patients with PRCA. *Results*. Of 32 PRCA patients, median age was 57 years (18–90 years). Median hemoglobin level and reticulocyte count at the time of diagnosis were 5.6 g/dL (3.3–7.3 g/dL) and 0.3% (0.1–0.7%), respectively. Median time to hematologic recovery was 12 weeks (3–72 weeks), and median number of red blood cell transfusion (RBC) was 20 units (4–100 units). Causes of PRCA were erythropoiesis-stimulating agent (ESA) (47%), parvovirus B19 infection (19%), thymoma (13%), zidovudine (6%), primary autoimmune PRCA (6%), Kaposi's sarcoma (3%), systemic lupus erythematosus (3%), and ABO-mismatched stem cell transplantation (3%). Only 9 out of 24 treated patients achieved hematologic response within 8 weeks of treatment. Intravenous immunoglobulin therapy provided 100% response rate in patients with parvovirus B19-associated PRCA and primary autoimmune PRCA. Low response rate was found in patients receiving immunosuppressants and chemotherapy for the treatment of ESA and thymoma-associated PRCA, respectively. *Conclusions*. Treatment outcome of PRCA depended upon the causes and the types of treatment, and the burden of RBC transfusion was very high in patients with ESA and thymoma-associated PRCA.

TEKS LENGKAP

1. Introduction

Pure red cell aplasia (PRCA) is a rare but devastating blood disorder presenting with normocytic anemia, severe reticulocytopenia, and markedly decreased number of erythroid precursors from the bone marrow (BM). Acquired PRCA may be caused by parvovirus B19, human immunodeficiency virus (HIV), thymoma, solid tumor, lymphoproliferative disorder, antierythropoietin (EPO) antibody, systemic lupus erythematosus (SLE), rheumatoid arthritis (RA), pregnancy, and major ABO-mismatched stem cell transplantation or primary autoimmune PRCA [1, 2]. In addition, isoniazide (INH), azathioprine (AZA), mycophenolate mofetil (MMF), tacrolimus (FK-506), zidovudine (AZT), lamivudine (3TC), and allopurinol are also reported as the cause of drug-mediated PRCA. Treatment of PRCA depends on the etiologies, and immunosuppressive therapies remain the mainstay of treatment for antibody-mediated PRCA. Nevertheless, the responses of primary or secondary immune-mediated PRCA to immunosuppressive therapies widely vary according to the protocols. Response rate of corticosteroids (Cs) and cyclophosphamide (Cy) were quite low, ranging from 30–60% and 20–40%, respectively. However, cyclosporin A (CSA) induces higher response rate, approximately 65–85% of cases [1–3]. Other armamentaria for PRCA treatments are intravenous immunoglobulin (IvIg), antithymocyte globulin (ATG), and anti-CD20 (Mabthera); however, the treatment outcomes are scarce. PRCA patients require frequent red blood cell transfusion (RBCT) while awaiting for resolution of PRCA. Since there were few studies or case series which described the causes of adult patients with PRCA in Asian countries [4–8], we, therefore, conducted this retrospective study to explore the etiologies of PRCA and to evaluate the treatment response and the burden of treatment in adult patients diagnosed with PRCA.

2. Materials and Methods

We enrolled adult patients diagnosed with PRCA during January 2010 to December 2017 at Ramathibodi Hospital. The diagnosis of PRCA is defined as anemia with severe reticulocytopenia and the number of erythroid progenitor cells in BM

3. Study Design and End Points

3.1. Primary End Points

The objectives of the study were to identify the causes of PRCA and to analyze the rate of hematologic response in adult PRCA patients receiving various regimens of immunosuppressant or other treatments. Hematologic response was defined as an increase in hemoglobin level, reticulocyte count>1% and becoming RBC transfusion independent. Treatment failure was defined as no hematologic response within 8 weeks after treatment with immunosuppressive or other therapies.

3.2. Secondary End Points

To evaluate the treatment burden in adult patients diagnosed with PRCA.

4. Results

A total of 32 patients were identified, and median age was 57 years (range: 18–90 years). Median hemoglobin (Hb) level and reticulocyte count at the time of diagnosis were 5.6 g/dL (3.3–7.3 g/dL) and 0.3% (0.1–0.7%), respectively. The causes of PRCA were erythropoiesis-stimulating agent (ESA) (15 patients), parvovirus B19 infection (6 patients), thymoma (4 patients), AZT (2 patients), Kaposi's sarcoma (1 patient), SLE (1 patient), ABO-mismatched stem cell transplantation (1 patient), and primary autoimmune PRCA (2 patients). Twenty-four patients (75%) received treatment, the remaining 8 patients, all of whom were diagnosed with ESA-induced PRCA and received only supportive treatment with RBCT. In the entire study population, the median time to achieve hematologic recovery were 12 weeks (3–72 weeks), and the median number of RBCT was 20 units (4–100 units). Hematologic response within 8 weeks of treatment was achieved in 9 out of 24 patients (38%) (Table 1). Of 9 patients, 7 received IvIg therapy, five had parvovius B19, and two had primary autoimmune PRCA. The remaining 2 patients diagnosed with HIV achieved hematologic response after cessation of AZT. Treatment failure was found in 15 out of 24 treated patients.

Table 1

Causes and treatment outcomes of adult patients with PRCA.

Cause of PRCA/gender	Median time to develop PRCA from diagnosis/treatment (Mo)	Treatment (*N*)	Response rate within 2 Mo (%)	Median number of PRCT	Time to hematologic recovery (wk)	Relapse rate (%)
Erythropoietin/F:M = 9 : 6	10 (5–21)	Immunosuppressant (*N* = 4)	0	27 (8–50)	52 (40–64)	0
Other therapies (*N* = 4)	0	14 (8–32)	13 (12–14)	0	Supportive treatment (*N* = 8)	—
40 (34–52)	68 (52–72)	0	-			
Parvovirus B19 infection:						(i) HIV infection/F: M = 0 : 3
6 (0–10)	IvIg (*N* = 3)	100	4 (2–6)	3 (3–4)	0	(ii) Kidney transplantation/F: M = 1 : 2
4 (1–5)	IvIg (*N* = 3)	100	4 (4–5)	4 (3–12)	0	
Thymoma/F:M = 3 : 1	3.5 (0–36)	Thymectomy (*N* = 1, type B3)	0	100	—	—
Chemotherapy and immunosuppressive therapy (*N* = 3, type *B*1 = 2, *B*3 = 1)	0	30 (20–50)	31 (28–34)	0	Thymectomy /chemotherapy (*N* = 0)	—
—	—	—	-			
Zidovudine (AZT)/F:M = 1 : 1	84 (48–120)	Cessation of AZT (*N* = 2)	100	30 (10–50)	3.5 (3–4)	0
–						

Primary autoimmune PRCA/F:M = 2 : 0	—	IvIg (*N*=2)	100	8 (6–10)	5 (4–6)	50
–						
Systemic lupus nephritis/F:M = 1 : 0	156	Cellcept/danazol/pred/Mabthera	0	30	132	0
–						
Kaposi sarcoma/F:M = 0 : 1	60	Chemotherapy	0	6	12	0
–						
Transplant (ABO mismatch)/F:M = 1 : 0	4	Cyclosporin A/rEPO/Andrmedian olic/Velcade	0	75	104	0

In the group of ESA-induced PRCA, all 15 patients previously received epoetin alfa therapy after developing anemia associated with chronic kidney disease (CKD) stages 3–5 (13 patients), myelodysplastic syndrome (1 patient), and anemia of inflammation (1 patient). Twelve out of fifteen patients (80%) were treated with biosimilar epoetin alfa products. A bone marrow study was performed in all patients, whereas antibody to anti-EPO was performed in 10 out of 15 patients. The median time to development of PRCA after treatment with ESA was 10 months (5–21 months). Of 15 patients with ESA-induced PRCA, 3, 1, 1, 1, and 1 were treated with combined immunosuppressive therapies, kidney transplantation, oxymetholone, Mabthera, and IvIg, respectively. The remaining 8 patients received only RBCT. Three patients receiving combined immunosuppressive therapy (CSA/prednisolone ± cyclophosphamide) did not achieve response, and the hemoglobin levels were improved and became nontransfusion-dependent after treatment with immunosuppressants for 13–16 months. In contrast, the Hb level was recovered in patients treated with IvIg, Mabthera, or kidney transplantation at 12–13 weeks of therapy, but there was no response in patients treated with oxymetholone. Patients receiving kidney transplant was previously treated with 3-month period of combined immunosuppressive therapy (prednisolone, CSA, and cyclophosphamide) for PRCA, but did not achieve hematologic response. Four out of eight ESA-induced PRCA patients receiving supportive therapy achieved spontaneous hematologic recovery after 1 year (12–18 months), and the remaining 4 patients had been followed up by our hematologists for 4–5 months before returning to their nephrologists for long term follow-up at other hospitals. The median number of RBCT in patients with ESA-induced PRCA was 30 units (8–52 units); 41 (12–52 units) and 23 units (8–50 units) of RBCT were given in patients receiving supportive therapy and specific therapies, respectively.

Three CKD patients with ESA-induced PRCA who achieved spontaneous hematologic recovery were successfully rechallenged erythropoietin beta therapy for treatment of their anemia from CKD. Erythropoietin beta was resumed after their first diagnosis of PRCA for 5 years (1 patient) and 2 years (2 patients), and all 3 patients were not retested anti-EPO antibodies before starting erythropoietin beta therapy. Hb levels increased from 7.5–8.2 g/dL to 9.5–11.5 g/dL after erythropoietin beta therapy, and there was no evidence of recurrent PRCA after initiating this treatment for 13–20 months.

In the group of parvovirus B19-induced PRCA, 3 patients had HIV infection with CD4 cell count ranging from 18–217 cell/mm^3, and the remaining 3 patients were kidney transplant recipients. Two and one HIV patients had parvovirus B19 infection at the time of diagnosis of HIV infection and at 10 months of antiretroviral therapy, respectively. Giant pronormoblast was found in the BM tissues of all patients, and parvovirus B19 viremia was detected in 5 out of 6 patients. IvIg was given in all 6 patients, and the rate of response was 100% with a median time to response of 3.5 weeks (3–12 weeks). The median number of RBCT in these patients was 4 units (2–6 units).

The causes of PRCA in the other 3 HIV patients were AZT induced (2 patients) and Kaposi's sarcoma (1 patient). The CD4 cell count in HIV patients with AZT and Kaposi's sarcoma-induced PRCA were 199–271 and 450 cell/mm^3, respectively. Chemotherapy has yielded hematologic response at 3 months of therapy in one patient with Kaposi's sarcoma. In patients with AZT-induced PRCA, they achieved hematologic response after cessation of AZT for 3–4 weeks. One of two patients who developed AZT-induced PRCA was initially diagnosed with parvovirus B19 infection because her BM examination demonstrated erythroid progenitor cells <5% with few giant pronormoblast and her long duration of AZT treatment (10 years) without prior hematologic problem. However, further investigation revealed no evidence of parvovirus B19 viremia, and the patient did not respond to initial IvIg therapy. BM study was reperformed at 2 months of IvIg therapy and again found decreased erythroid progenitor cells. We decided to discontinue AZT, and surprisingly her Hb was improved and became nontransfusion-dependent within 4 weeks.

In patients diagnosed with malignant thymoma (4 patients), 2 patients had PRCA at the time of diagnosis of thymoma, while one patient developed PRCA after progressive disease (7 months after diagnosis of thymoma) and the another one had PRCA at the time of disease relapse (3 years). Three and one patients were treated with six cycles of chemotherapy alone and thymectomy alone, respectively. Combined immunosuppressive therapy was given in 3 patients with unresectable tumors who did not achieve hematologic recovery after completion of 6 cycles of chemotherapy, and only 2 patients achieved hematologic response after treatment with CSA with corticosteroids, and the response was seen at 7 and 8.5 months after starting chemotherapy. The remaining 2 patients had progressive disease and died from disease progression (1 patient) and *E.coli* septicemia (1 patient). The median number of RBCT in thymoma-induced PRCA was 50 units (20–100 units).

There were 2 middle-aged female patients diagnosed with primary autoimmune PRCA in this study. They were treated with IvIg and achieved hematologic response within 4–6 weeks. The median number of RBCT was 8 units (6–10 units). Relapsed PRCA was observed in 1 patient at 2 years of IvIg therapy, and she was treated with IvIg combined with CSA therapy and achieved a second hematologic response at 4 weeks after treatment. CSA therapy was continued for 3 years after achieving second hematologic response.

5. Discussion

We found only 32 patients diagnosed with PRCA during the study period which occurred in a small number of patients. The most common causes of PRCA were ESA-induced antibody-mediated PRCA and parvovirus B19 infection. Except AZT-induced PRCA, there was no occurrence of INH, AZA, MMF, FK-506, 3TC, antiepileptic drug, or allopurinol-induced PRCA in this study [1]. PRCA from hematologic malignancies was also not found. ESA-induced PRCA was frequently seen in the study since there were many brands of erythropoietin available in our country, and the issues that the physicians should be considered before choosing the type of erythropoietin therapy were the structure of erythropoietin (epoetin molecules differing in the carbohydrate structure), pharmacokinetic, pharmacodynamics, potency, immunogenicity, safety, purity, and also the coated rubber stoppers [9]. Although the incidence of ESA-induced PRCA was very low, the complication and the treatment burden in patients developed PRCA were extremely high, and all patients with ESA-induced PRCA required multiple red cell transfusions while waiting for achieving a hematologic recovery. In this study, the spontaneous hematologic recovery was found in ESA- and AZT-induced PRCA; however, a longer time to achieve hematologic recovery was seen in patients with ESA-induced PRCA. The patients receiving immunosuppressant or other therapies for treatment of ESA-induced PRCA required RBCT lesser than those receiving only supportive therapy, even the treatment failure was found in our patients receiving combined immunosuppressants. Mabthera® or IvIg® induced rapid hematologic recovery in these patients; therefore, Mabthera or IvIg might be the treatment options for ESA-induced PRCA. Nevertheless, the number of ESA-induced PRCA patients receiving treatment in the study was very small to address the initial treatment for ESA-induced PRCA. All HIV patients with parvovirus B19 infection had CD4 cell counts <250 cell/mm^3 which the result was similar to the previous study [10]. PRCA from parvovirus B19 infection in both HIV and non-HIV patients had a very good response to IvIg therapy. However, the response of treatment with chemotherapy in patients with thymoma-associated PRCA was very low. All thymoma patients needed to be treated PRCA with immunosuppressive therapy after completion of chemotherapy which induced hematologic response in 67% of cases. According to a previous study, the response rate of thymectomy for thymoma-associated PRCA was very low, whereas the authors described the treatment with antithymocyte globulin (ATG) plus CSA was shown to be an effective immunosuppressant against thymoma-induced PRCA [11]. In this study, only 2 patients were diagnosed with primary autoimmune PRCA, and they achieved hematologic response from IvIg therapy, while the study from Japan illustrated that CSA induced 75% of CR/PR in idiopathic PRCA patients [7].

6. Conclusions

PRCA was an uncommon blood disorder which the common causes of PRCA in the study were ESA, parvovirus B19 infection, and thymoma. Favorable treatment response occurred in groups of parvovirus B 19 infection, drug-(non-ESA-) induced PRCA, and idiopathic PRCA. However, unfavorable outcome was found in groups of ESA and thymoma-induced PRCA, even receiving immunosuppressants or chemotherapy, respectively.

Ethical Approval

This retrospective study was approved by the Local Ethics Committee on Human Rights related to research involving human subjects at Ramathibodi Hospital, Mahidol University.

Authors' Contributions

PN designed and carried out the experiment, analyzed the data, and wrote the manuscript. WK reviewed histological results of the bone marrow. SB carried out the experiment and edited the manuscript. PC and PW carried out the experiment.

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DETAIL

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An Analysis of Societal Determinant of Anemia among Adolescent Girls in Azad Jammu and Kashmir, Pakistan

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ABSTRAK (ENGLISH)

Societal determinants of health are of recognized importance for understanding the causal association of society and health of an individual. Iron deficiency anemia (IDA) is a challenging public health problem across the globe instigating from a broader sociocultural background. It is more prevalent among pregnant women, children under the age of five years, and adolescent girls. Adolescent girls are vulnerable to develop IDA because of additional nutritional demand of the body needed for growth spurt, blood loss due to onset of menarche, malnourishment, and poor dietary iron intake. In this study, we explore the societal determinants of anemia among adolescent girls in

Azad Jammu and Kashmir (AJK), Pakistan. A cross-sectional study was conducted in the Muzaffarabad division of AJK on randomly selected 626 adolescent girls. The data were collected using a pretested self-administered interview schedule comprising mainly closed-ended questions with a few open-ended questions. Descriptive statistics was computed for describing the data, and bivariate regression and logistic regression were used to determine the association of anemia with its societal determinants. Multiple linear regression is used to determine the relationship of different determinants (independent variables) with the hemoglobin level (dependent variable) of the respondents. The prevalence of anemia among adolescent girls is 47.9%, of which 47.7% have mild anemia, 51.7% have moderate anemia, and 5.7% have severe anemia, which reveals that anemia is a severe public health problem among adolescent girls in the study area. The findings aver that anemia occurrence was significantly associated with the respondent's and her parental education, economic well-being, prevalence of communicable diseases, menstrual disorder, exercise habits, meals regularity, and type of sewerage system.

TEKS LENGKAP

1. Introduction

Anemia is a widespread public health problem across the globe that accounts for majority of nutritional problems and is principally caused by iron deficiency [1]. Its prevalence is substantially higher among the people residing in the developing countries (89%) because of low socioeconomic status and impoverished access to health care [2–4]. Anemia affects around 2 billion of the world's population, with consequences not only on the human health but also on the social and economic development [3, 4]. In South Asian countries, anemia is a problem of moderate (20.0–39.9%) or a severe (≥40%) significance from public health perspective among preschool children as well as in pregnant and nonpregnant women [5, 6].

Anemia falls into sever public health category in Pakistan, which is equally prevalent among pregnant women (50%, 41 to 58) and nonpregnant women (51%, 43 to 59) [7, 8]. In Azad Jammu and Kashmir (AJK), anemia prevalence is 41.0%, whereas 25% nonpregnant and 32% pregnant women are iron deficient [7]. Recent studies reported that anemia is the most prevalent micronutrient deficiency among adolescent girls in Pakistan [9–11]. The nutritional interventions taken during the adolescent period before females get married and enter motherhood can be helpful to avoid anemia among women of reproductive age (WRA).

Adolescence is the period of aging between 10 and 19 years [12], during which body needs for both macronutrient and micronutrient are considerably high because of peak pubertal development, growth spurt, and physical activity. The daily iron need increases twofolds to threefolds during adolescence for both boys and girls, and after the menarche, iron need continues to remain high among adolescent girls because of blood loss during menstruation [13], which increases the risk of nutritional anemia among them. Nutritional anemia has negative irreversible consequences on the growth, cognitive development, working capability, immune system that can lead to infections, and reproductive years of life [14, 15].

Numerous studies conducted across the globe highlighted that anemia is a public health problem among adolescent girls [9–11, 14–16]. In Pakistan, studies conducted on anemia among the adolescent girls [9–11] are not only few but also did not address societal determinants and the impact of these factors on anemia prevalence. Medical treatment is not the only driver of health of an individual, instead societal factors play a vital role in keeping a person healthy [17, 18]. Anemia instigates from a broader sociocultural background, whereby societal determinants are of recognized importance for understanding the causal association of society and this ailment. Furthermore, these studies were conducted on different age ranges of adolescent girls, and they were not of standard age category (10 and 19 years).

The present study is aimed to estimate the prevalence of anemia among adolescent girls (aged 10 to 19 years) in the Muzaffarabad division of AJK and to determine societal factors associated with it. The outcomes of the study can be helpful for devising effective interventions for improving nutritional status of adolescent girls to prevent occurrence of anemia and its mental, physical, and reproductive health consequences.

2. Materials and Methods

2.1. Study Design

A cross-sectional study was conducted for assessing anemia prevalence and its societal factors among adolescent school girls. The study and its ethical clearance were approved by the board of advanced studies and research of International Islamic University. Informed consent of the respondents and their parents was also obtained before interview. The purpose of the study was orally explained to the respondents and their mothers. Confidentiality of the information and privacy of the respondents were also maintained.

2.2. Study Area

The study was conducted in the Muzaffarabad division, Azad Jammu and Kashmir (AJK), Pakistan, which comprises mountainous topography. AJK has three divisions and 10 districts [19, 20], and Muzaffarabad division was randomly selected for this study. The government and private-sector jobs, small businesses, livestock, tourism, horticulture, and collection of medicinal herbs are the main sources of livelihood. The region is badly affected by natural and manmade hazards. Because of limited job opportunities in the government and private sectors, a majority of people are working in Pakistan and abroad. Natural disasters and the firing across the line of control between Pakistani and Indian army has badly affected infrastructure, tourism, and hence the economic well-being of the people. Poverty and inadequate health facilities at far flung areas, insufficient diet, unawareness about anemia, and its health consequences make the female population vulnerable to iron deficiency anemia (IDA).

2.3. Sample Size and Sampling Procedure

The sample size was computed using the projected population of Muzaffarabad division for females aged 10 to 49 years in 2015 based on 1998 census. The population of female aging 10 to 15 years was $N = 342150$. The following formula [21] was used to compute the sample size:(1)$n=\frac{\chi^2 NP(1-P)}{d^2(N-1)+\chi^2 P(1-P)}$.

The sample size of female aged 10 to 49 years was 1529 by considering the parameters $\chi^2=3.841$, $P=0.50$ (population proportion), $d=0.025$ (marginal error), and $N = 342150$. The final sample size of adolescent girls (10 to 19 years) was 626, which were 40.95% of the sample size of 10 to 49 years. The respondents were selected using multistage stratified proportionate random sampling technique. Among the three divisions of AJK, Muzaffarabad division was randomly selected. The two districts of Muzaffarabad division, Hattian Bala and Muzaffarabad, were then randomly selected. In the next stage, 4 and 8 union councils of Hattian Bala and Muzaffarabad districts were randomly selected, respectively. There were 8 and 16 union councils in the Hattian and Muzaffarabad districts, respectively, and we selected 50% of them from each district. The houses having at least one adolescent were randomly selected in each union council based on the proportional allocation. Adolescents who were either married or were suffering from known chronic illness were excluded from the study.

2.4. Data Collection

Data were collected using a pretested interview schedule, which comprised questions related to socioeconomic, demographic, cultural, and nutritional variables. To ensure data quality, prefield activities such as proper question ordering, time and relevancy of questions, training and field supervision, and pretesting were performed before data collection. Mechanical weighing scale with a height rod was used for measuring weight and height of the respondents. The weight was measured in kilograms (kg) and height in centimeters (cm), which was then converted into meters (m). Hemoglobin (Hb) level of the respondents was measured using a precalibrated instrument (HemoCue Hb 301 analyzer manufactured by Ängelholm, Sweden). Microcuvettes were used for taking capillary blood, which were then inserted into the HemoCue Hb analyzer for determining the Hb level. For adolescent girls aged 10–11 years, Hb ≤8.0 g/dL, 8.1 to 10.9 g/dL, 11 to 11.4 g/dL, and ≥11.5 g/dL was taken as severe, moderate, mild anemic, and normal, respectively, whereas for girls aged ≥12 years, Hb less ≤8.0 g/dL, 8.1 to 10.9 g/dL, 11 to 1.9 g/dL, and ≥12 g/dL was taken as severe, moderate, mild anemic, and normal, respectively [5]. Hb levels were adjusted for the altitude of residence of the respondents [5, 22].

2.5. Data Analysis

Data were checked, coded, cleaned, and entered in Statistical Package of Social Sciences (SPSS) version 14. The independent variables are the societal determinants of anemia, whereas the dependent variables include anemia determined based on the Hb level. Univariate analysis was performed to compute descriptive statistics for societal determinants of anemia and anemia prevalence. Chi-square test and odds ratio (OR) were used to explore the association of anemia with its societal determinants. Binary logistic regression was used for computing OR. The results were considered statistically significant for significance level ≤0.05. Multiple linear regression (MLR) was used to find the relationships of different socioeconomic, demographic, cultural, and nutritional variables (independent variables) with hemoglobin level (dependent variable) of the respondents. MLR was first used by Pearson in 1908 for assessing the association of more than one independent variable and a dependent variable [23]. MLR model is indicated using the following equation:(2)$\hat{Y}=b_o+\sum_{i=1}^{p} b_i X_i$,where $\hat{Y}$ is the predicted value of the dependent variable, p is the order of polynomial, *X*'s represent the independent variables, and b_o is the value of $\hat{Y}$, when all *X*'s are zero and *b*'s are the regression coefficients. Before using MLR, critical assumptions are satisfied for ensuring validity of the model. Normality assumption is checked by normal probability-probability (P-P) plot of regression standardized residuals, and homoscedasticity assumption is examined by constructing the scatterplot of standardized residual predicted values against the standardized residuals [24]. A random spread suggests that variance of residual is constant at each point of the model, which validates the assumption homoscedasticity [25, 26]. Collinearity assumption is tested using collinearity statistics tolerance and variance inflation factor (VIF). The assumption of collinearity is satisfied if tolerance >0.1 and VIF should be <10 [24]. The Durbin–Watson statistic is used for testing the assumption that residuals are uncorrelated, and Cook's distance is used to check the assumption that there are no influential cases biasing the model. After satisfying MLR assumptions, stepwise regression technique, which combines advantages of forward and backward selection [27], is used for data analysis. Stepwise regression uses an automatic procedure for the selection of predictive variables [27]. This technique initially starts from no variable and adds a predictor variable whose addition is a good fit for the model, and the procedure is repeated till further inclusion of variables do not improve the model significantly.

3. Results

3.1. Descriptive and Bivariate Analysis

Table 1 shows the distribution of adolescent girls according to anemia severity determined based on the hemoglobin level. A little more than half (52.1%) respondents were nonanemic, and 47.9% were suffering from anemia, which indicates that anemia is a severe health problem among adolescent girls from the public health perspective. The prevalence of mild, moderate, and severe anemia is 20.4%, 24.8%, and 2.7%, respectively. The mean ± standard deviation (SD) of the hemoglobin level for the nonanemic girls was 13.13 ± 0.90 grams/deciliter (g/dL), and for those suffering from mild anemia was 11.44 ± 0.31 g/dL, moderate anemia 10.03 ± 0.81 g/dL, and severe anemia 7.18 ± 5.09 g/dL. The mean hemoglobin level among all the adolescent girls was 11.86 ± 1.69 g/dL.

Table 1

Prevalence of anemia and mean hemoglobin level.

Anemia severity	Number	Frequency (%)	Hemoglobin level
Mean ± SD	Normal	326	52.1
13.13 ± 0.90	Mild	128	20.4
11.44 ± 0.31	Moderate	155	24.8
10.03 ± 0.71	Severe	17	2.7
7.18 ± 0.59	Total	626	100

In Table 2, results of descriptive and bivariate analysis to reveal the individual characteristics and their association with the prevalence of anemia among adolescent girls are presented. The results aver that respondent's education, menstruation duration, heavy blood loss during menstruation, communicable diseases, healthcare utilization, meals regularity, and exercise habits were significantly associated with anemia among adolescent girls. Regarding educational attainment, majority of girls (33.1%) were students of 6th to 8th standard, followed by 29.7% of 9th to 10th standard, 28.4% were above 10th standard, 8.1% of 1 to 5th standard, and only 0.6% were illiterate. This reveals that almost 100% girls were enrolled in the schools for pursuing their education. The prevalence of anemia was lowest among the girls who had 10+ years of schooling. Majority of girls (36.6) had longer menstrual duration (5+days): 36.4 had 4 to 5 days and 10.7% had 2 to 3 days, whereas 16.9 had no menstrual period. The odds of occurrence of anemia were 1.68 and 2.49 times among girls who had menstrual periods for 4 to 5 and 5+days, respectively, compared with those who had no menstruation. Chi-square value 20.15 at a significance level <0.0001 reveals significantly high association between menstrual duration and anemia among girls. Heavy blood loss during periods was significantly associated with higher odds of anemia. The prevalence of communicable diseases among girls was 22% and was significantly associated with anemia (chi-square=27.7 at significance level <0.0001). The visits for utilizing health care revealed significant association with the occurrence of anemia among girls. The odds of anemia are 3.35 times more among girls who did not utilize healthcare services compared with those who availed health care often. The prevalence of anemia was high among girls who were using food supplements. The utilization of food supplements was small among respondents, and those girls were using them who were already anemic. The current age; BMI; knowledge about balanced diet; utilization of iron supplements; and knowledge about anemia, its causes, and preventive measures did not reveal any significant association with anemia among girls.

Table 2

Descriptive and bivariate analyses to reveal the individual characteristics and their association with prevalence of anemia among adolescent girls.

Variable	Category	Nonanemic	Anemic	Total	Chi-square	pvalue	Odds ratio
number (%)	number (%)	number (%)	Current age (years)	10 to 13	90 (56.6)	69 (43.4)	159 (25.4)
2.14	0.34	Reference	14 to 16	124 (49.2)	128 (50.8)	252 (40.3)	1.35
17 to 19	112 (52.1)	103 (47.9)	215 (34.3)	1.20	·		
Educational attainment (years)	Zero	1 (75.0)	3 (25.0)	4 (0.6)	9.42	0.05	2.04
1 to 5	26 (51.0)	25 (49.0)	51 (8.1)	1.42	6 to 8	110 (53.1)	97 (46.9)
207 (33.1)	1.30	9 to 10	83 (44.6)	103 (54.4)	186 (29.7)	1.83	10+

106 (59.6)	72 (40.4)	178 (28.4)	Reference	-			
BMI (kg/m^2)	Underweight	75 (53.2)	66 (46.8)	141 (22.5)	1.19	0.76	Reference
Normal	226 (51.1)	216 (49.9)	442 (70.6)	1.09	Overweight	19 (55.9)	15 (44.1)
34 (5.4)	0.90	Obese	6 (66.7)	3 (33.3)	9 (1.4)	0.57	·
Menstrual period duration	No	66 (64.7)	36 (35.5)	102 (16.3)	20.15	<0.0001	Reference
2 to 3 days	44 (65.7)	23 (34.3)	67 (10.7)	0.96	4 to 5 days	119 (52.2)	109 (47.8)
228 (36.4)	1.68	5+ days	97 (42.4)	132 (57.6)	229 (36.6)	2.49	·
Heavy blood loss during menstruation	Yes	56 (40.6)	82 (59.5)	138 (22.0)	9.38	0.002	1.48
No	270 (55.3)	218 (44.7)	488 (78.0)	Reference	-		
Communicable diseases	Yes	70 (36.5)	122 (63.5)	192 (30.7)	27.7	<0.0001	2.51
No	256 (59.0)	178 (41.0)	434 (69.3)	Reference	-		
Healthcare utilization	Not at all	14 (32.6)	29 (67.4)	43 (6.9)	10.79	0.005	3.35
Sometimes	244 (51.6)	229 (48.4)	473 (75.6)	1.52	Often	68 (61.8)	42 (38.2)
110 (17.6)	Reference	-					
Knowledge about balanced diet	Poor	133 (52.8)	119 (47.2)	252 (40.3)	0.08	0.77	0.95
Good	193 (51.6)	181 (48.4)	374 (49.7)	Reference	-		

Take meals regularly	Yes	267 (55.7)	212 (44.3)	479 (76.5)	10.98	0.001	Reference
No	59 (40.1)	88 (59.9)	147 (23.5)	1.88	-		
Use of iron supplements	Yes	20 (57.1)	15 (42.9)	35 (5.6)	0.38	0.54	Reference
No	306 (51.8)	258 (48.2)	591 (94.4)	1.12	-		
Use of food supplements	Yes	16 (36.4)	28 (63.6)	44 (7.0)	4.68	0.03	Reference
No	310 (53.3)	272 (46.7)	582 (93.0)	0.50	-		
Knowledge about anemia	Poor	60 (49.2)	62 (50.8)	122 (19.5)	0.51	0.48	1.15
Good	266 (52.8)	238 (74.2)	504 (80.5)	Reference	-		
Knowledge about anemia causes	Poor	139 (54.3)	117 (45.7)	256 (40.6)	0.86	0.36	0.86
Good	187 (50.5)	183 (49.5)	370 (59.1)	Reference	-		
Knowledge about preventive measures	Poor	93 (55.4)	75 (44.6)	168 (26.8)	0.99	0.32	0.84
Good	233 (50.9)	225 (49.1)	458 (73.2)	Reference	-		
Exercise habits	Not at all	139 (44.8)	171 (55.2)	310 (49.5)	14.55	0.001	1.15
Sometimes	30 (68.2)	14 (31.8)	44 (7.0)	0.64	Often	157 (57.7)	115 (42.3)

Table 3 presents the results of descriptive and bivariate analyses to reveal the parental and community factors of anemia and their association with occurrence of anemia among adolescent girls. Regarding the parental education, both father's and mother's education were significantly associated with anemia among girls. The odds of occurrence of anemia were 61% less for the girls whose parents had more than 12 years of education. The economic well-being of respondents determined based on the father's, mother's, and family monthly income revealed significant association with anemia among girls. The odds of anemia were 2%, 39%, 54%, and 86% less for the adolescent girls whose father's monthly income was 20001 to 50000, 50001 to 100000, and 100000+ Pakistani rupees, respectively, compared with girls whose fathers were not earning. The odds of occurrence anemia were high for girls whose mothers had low-paid jobs; however, the odds of occurrence of anemia were less for girls, whose mother had high-paid jobs compared with housewives. The family monthly income was also associated with lowers odds of anemia occurrence among girls. The parental professions were significantly associated with anemia among girls. The findings aver that anemia was noticeably low among adolescent girls of government employees. Household structure was marginally associated with anemia among girls; however, provision of proper latrine facility at home did not reveal significant association with anemia among girls, but there was significant association of the provision of the sewerage system with anemia. The open sewerage system was significantly associated with anemia (chi-square 7.09 and significance level 0.008) among girls.

Table 3

Descriptive and bivariate analyses to reveal the parental and societal determinants of anemia and their association with the prevalence of anemia among adolescent girls.

Variables	Category	Nonanemic	Anemic	Total	Chi-square	pvalue	OR
Number (%)	Number (%)	Number (%)	Father's education	Zero	38 (48.7)	40 (51.3)	78 (12.5)
15.10	0.004	Reference	1 to 5	37 (47.4)	41 (52.6)	78 (12.5)	1.05
6 to 8	45 (46.4)	52 (51.3)	97 (15.5)	1.10	9 to 12	143 (50.4)	141 (49.6)
284 (45.4)	0.94	12+	63 (70.8)	26 (29.2)	89 (14.2)	0.39	·
Mother's education	Zero	89 (45.9)	105 (54.1)	194 (31.0)	13.43	0.009	Reference
1 to 5	43 (47.3)	48 (52.7)	91 (14.5)	0.95	6 to 8	57 (60.0)	38 (40.0)
95 (15.2)	0.57	9 to 12	93 (51.1)	89 (48.9)	182 (29.1)	0.81	12+
44 (68.7)	20 (31.3)	64 (10.2)	0.39	-			
Father's monthly income	No income	33 (43.4)	43 (56.6)	76 (12.1)	19.84	0.001	Reference
Up to 20000	88 (44.0)	112 (56.0)	200 (31.9)	0.98	20001 to 50000	138 (55.9)	109 (44.1)

247 (39.5)	0.61	50001 to 100000	50 (60.2)	33 (39.8)	83 (13.3)	0.46	100000+
17 (85.0)	3 (15.0)	20 (3.2)	0.14	-			
Mother's monthly income	No income	254 (50.3)	251 (49.7)	505 (80.3)	15.94	0.003	Reference
Up to 10000	22 (46.8)	25 (53.2)	47 (7.5)	1.15	10001 to 20000	11 (45.8)	13 (54.2)
24 (3.8)	1.20	20001 to 50000	29 (74.4)	10 (25.6)	39 (6.2)	0.35	50000+
10 (90.9)	1 (9.1)	11 (1.8)	0.10	-			
Family monthly income	Up to 20000	69 (39.9)	104 (60.1)	173 (27.6)	28.27	<0.0001	Reference
20001 to 50000	125 (49.4)	128 (50.6)	253 (40.4)	0.68	50001 to 100000	95 (63.3)	55 (36.7)
150 (24.0)	0.38	100000+	37 (74.0)	13 (26.0)	50 (8.0)	0.23	
Father's profession	Government service	132 (57.1)	99 (42.9)	231 (36.9)	18.52	0.001	Reference
Private service	58 (40.6)	85 (59.4)	143 (22.8)	1.95	Business man	64 (57.7)	47 (4.3)
111 (17.7)	0.95	Skilled laborer	32 (66.7)	16 (33.3)	48 (7.7)	0.47	Others
40 (43.0)	53 (57.0)	93 (14.9)	1.77	-			
Mother's profession	House wife	246 (50.2)	244 (49.8)	490 (78.3)	18.45	0.001	3.19
Government service	45 (76.3)	14 (23.7)	59 (9.4)	Reference	Private service	8 (44.4)	10 (55.6)
18 (2.9)	4.02	Self employed	13 (37.1)	22 (62.9)	35 (5.6)	5.44	Others
14 (58.3)	10 (41.7)	24 (3.8)	2.33	-			

Family size	Up to 4	22 (47.8)	24 (52.2)	46 (7.3)	4.54	0.10	Reference
5 to 8	219 (55.3)	177 (44.7)	396 (63.3)	0.74	8+	85 (46.2)	99 (53.8)
374 (29.4)	1.07	-					
Preferred baby gender of parents	Son	64 (47.4)	71 (52.6)	135 (21.6)	2.14	0.34	Reference
Daughter	70 (56.5)	54 (43.5)	124 (19.8)	0.70	Does not matter	192 (52.3)	175 (47.7)
367 (58.6)	0.82	-					
Preference in food intake	Male	26 (43.3)	34 (56.7)	60 (9.6)	2.03	0.36	Reference
Female	96 (53.0)	85 (47.0)	181 (28.9)	0.68	Both	204 (53.0)	181 (47.0)
385 (61.5)	0.68	-					
Household structure	RCC	198 (52.9)	176 (47.1)	374 (59.7)	7.51	0.06	Reference
Mud	5 (26.3)	14 (73.7)	19 (3.0)	3.15	Wooden	5 (83.3)	1 (16.7)
6 (1.0)	0.23	Shelter	118 (52.0)	109 (48.0)	227 (36.3)	1.04	·
Latrine facility	Yes	304 (52.3)	277 (47.7)	581 (92.8)	0.20	0.66	Reference
No	22 (48.9)	23 (51.1)	45 (7.2)	1.15	·		
Sewerage system	Open	38 (39.6)	58 (60.4)	96 (15.3)	7.09	0.008	Reference

3.2. Multiple Linear Regression Analysis

Multiple linear regression (MLR) analysis is used to model the relationship of societal determinates (independent variables) and hemoglobin level (dependent variable) of the adolescent girls. Before performing MLR, we tested several assumptions to ensure reliability and validity of analyzed results. Only those independent variables were included in MLR analysis, which were significantly associated (p value ≤0.05) with dependent variables and obey the assumption of linearity. The assumption of normality is tested by looking at the P-P plots of residuals (Figure 1). It is

evident from the figure that data points lie very close to the diagonal line, which indicates that residuals are normally distributed. The homoscedasticity assumption is examined by constructing the scatterplot of standardized residual predicted values against the standardized residuals [24]. The random array of dots (Figure 2) suggests that variation in residuals is similar at each point of the model, which validates the assumption of homoscedasticity.
[figure omitted; refer to PDF]
[figure omitted; refer to PDF]
The collinearity assumption is tested using two collinearity statistics tolerance and variance inflation factor (VIF). Tolerance <1 and VIF <2 indicate that data are not multicollinear. We used Durbin–Watson statistic for testing the assumption that residuals are uncorrelated (independent). The Durbin–Watson statistic varies between 0 and 4, and a value close to 2 renders the validity of the analysis. In this study, the value is 1.95 (very close to 2), which indicates that values of residuals are independent. Cook's distance is used to test the assumption that there are no influential cases biasing the MLR model. The Cook's distance >1 is an indicator of significant outlier, which can pose undue influence on the model that should be removed. In this study, Cook's distance is very less than 1 for each respondent; hence, there are no influential cases biasing the MLR model.
After testing assumptions, we used stepwise regression technique, which combines advantages of forward and backward selection [27] for MLR analysis. Stepwise regression uses automatic procedure for the selection of predictive variables, which are best fit for the MLR model and exclude the variables which do improve the model significantly [27]. In Table 4, results of the model summary and analysis of variance (ANOVA) are presented. The model summary (first part of the table) reveals the strength of the association between the MLR model and the dependent variable. The value of R is 0.36, which specifies a linear correlation between observed and predicted values of the hemoglobin level. The value of R^2 (R square) is 0.131; this means that the model explains 13.1% variance in the hemoglobin level. In Table 5, the results to evaluate the contribution of each independent variable to predict the hemoglobin of the adolescent girls are shown.
Table 4
Model summary and ANOVA statistics.

Model summary					
R		R^2	Standard error of estimates		Durbin–Watson
0.36		0.13	1.36		1.95
–					
ANOVA statistics					
Model	Sum of squares	df	Mean square	*F*-measure	Significance
–					
Regression	234.57	6	38.05	15.54	<0.0005
Residual	1557.29	619	2.53	Total	1791.86

Table 5
Association of socioeconomic and environmental variables with anemia severity.

Model	Unstandardized coefficients		Significance
B	Standard error	Constant	11.23
0.44	<0.0005	Communicable diseases (X_1)	−0.67
0.14	<0.0005	Duration of menstruation (X_2)	−0.32
0.67	<0.0005	Family monthly income (X_3)	0.25
0.07	<0.0005	Exercise habits (X_4)	0.21
0.66	0.002	Meals regularity (X_5)	0.40
0.15	0.008	Respondent education (X_6)	0.07

Excluded variables are father's education, mother's education, father's profession, father's monthly income, mother's monthly income, heavy blood loss, and healthcare utilization.

(3)Hemoglobin=11.123−0.666X1−0.324X2−0.252X3−0.208X4+0.400X5+0.065X6.

The regression equation for predicting the hemoglobin level of adolescent girls from the independent variable is constructed using unstandardized coefficients (*B*) as detailed in the second column of Table 5.

In this model, communicable diseases and duration of menstruation have a significantly negative impact, whereas family monthly income, exercise habits, meals regularity, and respondent's education have a significantly positive impact on the hemoglobin level of the adolescent girls.

4. Discussion

Anemia in Pakistan is equally prevalent among both pregnant and nonpregnant women [7, 8]. Identifying subpopulations such as adolescent girls who are at high risk of anemia can assist to develop appropriate and effective interventions for preventing anemia during reproductive period. Anemia is the most prevalent micronutrient deficiency among adolescent girls in Pakistan [9–11]. In this study, we analyzed the societal determinants of anemia among adolescent girls to understand the causal association of society and this ailment. The findings of this study aver that anemia is severe public health problem among adolescent girls (47.9%) according to the WHO classification for public health significance. The prevalence of anemia among adolescent girls is relatively higher than that in the study [9] and is considerably low compared with that in the studies [10, 11] conducted in Pakistan.

The results of descriptive and bivariate analysis reveal that individual, parental, and community-based societal factors play a pivotal role in identifying girls at most risk of anemia. Individual determinants such education, duration of menstruation, heavy blood loss during menstruation, communicable diseases, healthcare utilization, meals regularity, and exercise habits showed a significant association with anemia among adolescent girls. The findings are in line with numerous studies conducted in Pakistan [25, 28–30]. Educated female can utilize adequate medical care and have appropriate knowledge about nutritional diet and personal hygiene [25].

Parental, household, and community factors are associated with anemia [25, 31–41]. The findings of our study elucidated that prevalence of anemia was smaller among girls whose parents had attained more than 12 years of education. The children of educated parents consume iron-rich food, utilize adequate healthcare facilities, and manage hygienic household environment, which can be associated with reduction in anemia among adolescent girls. The findings are consistent with the studies [31, 32], which reported that children of highly educated parents have lesser predisposition to develop anemia. Economic well-being of girls determined based on the father's, mother's, and family monthly revealed that all the independent variables are significantly associated with the prevalence of anemia among girls. The likelihood of anemia reduced substantially for the adolescent girls whose parental or family earnings were higher than those which had low income. The results are in good agreement with numerous studies conducted in different parts of the world and in Pakistan that economic well-being is a determinant factor of anemia among females [25, 33–38]. Our study highlighted that girls of government employees and businessmen are less vulnerable to develop anemia. The prevalence of anemia was low among girls whose mothers were government employees compared with that of anemia among girls whose mothers were with other professions. Similar results are reported by Kulkarni et al. [39] that occurrence of anemia is low among adolescent girls whose mothers are in service or doing business compared with housewives or laborers. Anemia prevalence was low among girls whose fathers are government employees, businessmen, or skilled laborers. This finding is concordant with the study conducted by Teji et al. [40] that nutritional status and occurrence of anemia among adolescent girls are directly associated with father's occupation. Poor household and environmental conditions are associated with anemia [41]. House structure and availability proper toilet were not associated with anemia among girls; however, anemia prevalence was comparatively more among girls residing in mud houses and do not have proper latrine at home. Higher prevalence of anemia was observed among girls residing in areas having an open sewerage system. The societal determinants (predictors) that contributed to predict the hemoglobin level of adolescent girls in the MLR model are communicable diseases, menstrual duration, family monthly income, exercise habits, meals regularity, and respondent education. Strong association of anemia and communicable diseases was noted among adolescent girls. This finding highlights that prevention and treatment of communicable diseases is the matter of deep concern among adolescent girls in the study population. The results are congruent with the findings of Batool [25] that communicable diseases are contributing factor of the decreased hemoglobin concentration among Pakistani women. Menstrual disorders not only affect daily activities and quality of life but are also the major cause of anemia among adolescent girls [28–30]. Numerous studies highlighted that family monthly income [25, 33–38], exercise [42, 43], meals regularity [25], and respondent education [25] are the societal determinants of anemia in female.

5. Conclusion

The present study explored the societal determinants of anemia among adolescent girls in Azad Kashmir, Pakistan. The findings documented that anemia is a severe public health problem among adolescent girls according to the United Nation's public health significance. Our findings confirm that anemia is a multifactor health problem that instigates from a broader background. Anemia among adolescent girls can be the predisposing factor of this health issue among women of reproductive age in Pakistan. Appropriate interventions intruded during adolescence can provide the best prospect to reduce anemia among women in Pakistan and to meet global target of 50% reduction in anemia among them by 2025. Respondent and her parental education and better socioeconomic status are directly linked to utilization of diverse and nutritious foods, utilization of adequate health care, better household, and environmental conditions, which can have important implications for preventing anemia. The intervention strategies should focus on prevention and early treatment of communicable disease and menstrual disorder, provision of nutritional education, creating awareness about meals regularity, and exercise habits for alleviating hemoglobin level among adolescent girls.

Authors' Contributions

Nazneen Habib conceived and designed the study, acquired data, performed data analysis, and wrote the manuscript. Saif-ur-Rehamn Saif Abbasi performed critical revision of materials/analysis tools, final proof reading, and English editing. Wajid Aziz performed data preprocessing, data analysis, data interpretation, and manuscript revision. All the authors read and approved the manuscript.

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DETAIL

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Effect of Interleukin and Hepcidin in Anemia of Chronic Diseases

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ABSTRAK (ENGLISH)

Background. Anemia of chronic disease (ACD) also termed as the anemia of inflammation has been found to be associated with inflammations, chronic infections, and cancers, particularly in old age. Recent studies revealed that interleukin-6 (IL-6), a proinflammatory cytokine, and hepcidin, an antimicrobial hepatic peptide, play a key role in ACD pathogenesis. *Patients and Methods.* The study included 40 subjects with chronic diseases and 40 normal subjects of the same age group. Red cell indices, levels of IL-6 and hepcidin, and iron profile were measured in all participants using Bayer ADVIA 120, VITROS 5600, Integrated System/2008, and ELISA assay, respectively. *Results*. The level of hemoglobin was considerably less in patients of chronic diseases referred to as “cases” than the normal subjects or “controls” (8.7 ± 1.5 vs. 13.2 ± 0.9). Red blood corpuscle (RBC) count, hematocrit (HCT) level, serum iron, mean corpuscular hemoglobin concentration (MCHC), and serum total iron-binding capacity (TIBC) were found to be significantly lower in the cases as compared to controls ($p<0.001$). Serum IL-6 and hepcidin levels were substantially higher in the cases than in the controls ($p<0.001$ and $p<0.02$, respectively). *Conclusion*. This study detected a significant increase in serum IL-6 and hepcidin levels in patients with ACD than the controls. These findings offer an insight into the role played by both cytokine and peptide in the pathogenesis of ACD and thus provide a rationale for future use of novel drugs inhibiting their effects on iron metabolism.

TEKS LENGKAP

DETAIL

Subjek:	Laboratories; Homeostasis; Hemoglobin; Anemia; Iron; Cytokines; Chronic illnesses; Tumor necrosis factor-TNF; Inflammation; Bone marrow; Metabolism; Older people; Peptides; Hematology
Lokasi:	United States--US; Egypt
Perusahaan / organisasi:	Nama: Cairo University; NAICS: 611310
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Assessment of Hematological Parameters in Malaria, among Adult Patients Attending the Bamenda Regional Hospital

Nlinwe, Nfor Omarine
; Tang, Bertilla Nange

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ABSTRAK (ENGLISH)

Malaria, which is responsible for a substantial amount of deaths in endemic countries, has been shown to have both direct and indirect effects on the hematological parameters. Notwithstanding, some hematological parameters among populations living in malaria endemic regions have not been described consistently, as a standard for measuring malaria burden. Based on the above fact, this study was designed to assess some hematological changes and their diagnostic values in malaria infected patients. A total of 160 malaria positive adult patients, together with 81 healthy control adults were recruited for the study. For the malaria positive group, the female to male ratio was 1.38 : 1. Specifically, 74.38%, 10.00%, and 15.62% of those in the malaria positive group had mild, moderate, and severe parasitaemia, respectively. Leukemia, anemia, and thrombocytopenia were found to be significantly associated with malaria and were all estimated to be specific for the diagnosis of malaria. Anemia was, however, estimated to be both sensitive and specific for malaria diagnosis. Therefore, anemia offers the most diagnostic value in the malaria infected patients of this study.

TEKS LENGKAP

DETAIL

Subjek:	Laboratories; Infections; Malaria; Hemoglobin; Anemia; Neutrophils; Parasites; Microscopy; Lymphocytes; Blood platelets; Thrombocytopenia; Automation; Ethics; Erythrocytes; Blood; Pediatrics; Hematology; Adults; Tropical diseases
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Owaidah, T., Al-Numair, N., Al-Suliman, A., Zolaly, M., Hasanato, R., Zahrani, F. A., . . . Sajid, M. R. (2020). Iron deficiency and iron deficiency anemia are common epidemiological conditions in saudi arabia: Report of the national epidemiological survey. Anemia, 2020 doi:https://doi.org/10.1155/2020/6642568

Iron deficiency is the most prevalent nutritional deficiency worldwide. According to an estimate by the World Health Organization, up to 27% of the world's population experience iron deficiency anemia (IDA). Studies conducted in the Middle East, including Saudi Arabia, have suggested that IDA is the most common cause of anemia, especially among females. This study aimed to determine the prevalence of IDA and iron deficiency (ID) among apparently healthy young university students from four regions in Saudi Arabia. Students were asked to complete a simple survey questionnaire; blood samples were then collected and analyzed after obtaining informed consent. A total of 981 students completed the survey, with 11% of the participants reporting symptoms of anemia; 34% of participants were diagnosed with IDA and 6% reported a diagnosis of hemoglobinopathy. Blood analysis confirmed the prevalence of ID and IDA in 28.6% and 10.7% of the participants, respectively; those with ID and IDA were mostly females (88.5% and 94%, resp.). Thalassemia trait and sickle cell trait were detected in 1.3% and 7% of participants, respectively. Our findings from a national survey among young university in Saudi Arabia indicate a high prevalence of ID and IDA.

Darmawati, D., Siregar, T. N., Kamil, H., & Tahlil, T. (2020). Barriers to health workers in iron deficiency anemia prevention among indonesian pregnant women. Anemia, 2020 doi:https://doi.org/10.1155/2020/8597174

Background. Anemia is a global maternal health problem that commonly occurs in developing countries. During pregnancy, a woman will receive antenatal services to check her condition and prevent complications. This study aimed to explore barriers towards achieving eradication of iron deficiency anemia among pregnant women in Aceh Besar District, Indonesia. Methods. This qualitative study was conducted on 18 health workers who were recruited through a purposive sampling method. Data were collected through in-depth interviews using open-ended questions to gain insight about participants' experiences in managing iron deficiency anemia among pregnant women. Data analysis was conducted by an inductive content analysis method to evaluate, encode, and analyze the interview's result. Result. Three main themes emerged: (1) facilities, infrastructures, and supplement support; (2) sociocultural factors; and (3) health provider competency deficits and no developing guidelines. Conclusion. Our findings provide understanding that there are many obstacles and barriers encountered by health workers in iron deficiency anemia prevention management. Thus, the management of anemia must be supported by a skilled health worker and quality facilities. Health workers and pregnant women must work together to achieve optimal management of anemia prevention.

Berhanu, S. D., Elias, T. B., Gizachew, A. B., Geleta, T. A., Ayalew, A. F., Addis, A. G., . . . Lidya, Z. S. (2020). Determinants of anemia among pregnant women at public hospitals in west shewa, central ethiopia: A case-control study. Anemia, 2020 doi:https://doi.org/10.1155/2020/2865734

Introduction. Anemia is highly dominant among pregnant women due to the need for iron for women themselves and their fetuses. Nearly half a billion globally and around one-third in Ethiopia of pregnant women were affected by anemia which has both health and economic impact. Therefore, this study aimed to identify the determinants of anemia among pregnant women attending antenatal care at public hospitals in the West Shewa zone, Oromia regional state, Central Ethiopia, 2019. Methods. An unmatched case-control study was conducted at public hospitals in the West Shewa zone, Ethiopia, from February to April 2019. A consecutive sampling was used to select study participants. Data were collected by a structured questionnaire, and the collected data were entered into Epi Info version 7 and SPSS version 23 for analyses. Descriptive statistics such as tables, graphs, and proportions were used to present the data. Binary and multiple logistic regression analyses were computed to identify the determinants of anemia. Adjusted odds ratio (AOR) with 95% confidence interval (CI) and p value 5 (AOR = 2.95, 95% CI: 1.34–6.50), peptic ulcer diseases (PUD) (AOR = 2.85, 95% CI: 1.14–7.13), having the previous history of abortion (AOR = 2.84, 95% CI: 1.08–7.47), birth interval <2 years (AOR = 2.61, 95% CI: 1.20–5.70), antepartum hemorrhage (APH) (AOR = 6.05, 95% CI: 1.95–18.81), and not using latrine (AOR = 3.45, 95% CI: 1.30–9.24) were the identified determinants of anemia. Conclusions. Family size, PUD, abortion, birth interval, APH, and unable to use latrine were the determinants of anemia among pregnant women. Therefore, the intervention on anemia prevention should consider the promotion of family planning methods and counseling on latrine utilization.

Ropo, E. O., Babalola, B. T., & Akinyemi, O. (2020). Statistical modeling of determinants of anemia prevalence among children aged 6–59 months in nigeria: A cross-sectional study. Anemia, 2020 doi:https://doi.org/10.1155/2020/4891965

Objective. Childhood anemia remains a significant public health challenge in developing countries, and it has negative consequences on the growth of the children. Therefore, it is essential to identify the determinants of childhood anemia, as these will help in formulating appropriate health policies in order to meet the United Nations MDG goal. This study aims to assess and model the determinants of the prevalence of anemia among children aged 6–59 months in Nigeria. To accomplish the aims of the study, the authors applied single-level and multilevel binary logistic regression models. Methods. To measure the relative impact of individual and household-level factors for childhood anemia among children aged 6–59 months, this study undertakes data from Nigeria Demographic and Health Surveys with both binary logistic and multilevel logistic regression models. The fit of the model was assessed by Hosmer–Lemeshow goodness-of-fit, variance inflation factor, and likelihood ratio tests. Results. The study established that about 67.01% of the children were anemic and identified sex of children, mother's education, religion, household wealth status, total children ever born, age of children, place of residence, and region to have a statistical significant effect on the prevalence of anemia. The adjusted odds ratio (aOR) for anemia was 0.56 (95% CI = 0.50, 0.63) in children aged from 24 to 42 months and 0.40 (95% CI = 0.36, 0.45) in children aged from 43 to 59 months. Also, children who reside in certain geographical-political zones of Nigeria are associated with increased childhood anemia. Conclusion. This study has highlighted the high prevalence of childhood anemia in Nigeria and indicated the need to improve mothers' education and regional variations. Findings from this study can help policymakers and public health institutions to map out programs targeting these regions as a measure of tackling the prevalence of anemia among the Nigerian populace.

Gari, W., Tsegaye, A., & Ketema, T. (2020). Magnitude of anemia and its associated factors among pregnant women attending antenatal care at najo general hospital, northwest ethiopia. Anemia, 2020 doi:https://doi.org/10.1155/2020/8851997

Anemia is one of the major causes of morbidity for pregnant women in resource-limited regions. Yet robust research-based evidence on this vital public health problem in remote areas where the problem could be massive is quite limited in Ethiopia, one of the developing countries. Thus, this study is aimed to assess the magnitude of anemia and its associated risk factors among pregnant women attending one of the health facilities in Ethiopia. A facility-based cross-sectional study design was employed in 2019. A total of 384 pregnant women attending the antenatal care (ANC) unit of Najo General Hospital, Northwest Ethiopia, were included in the study. Their sociodemographic characteristics, and medical, obstetric, and gynecological history were collected using pretested interview questionnaires. Blood samples were collected from each participant for the determination of malaria parasite and hemoglobin (Hb) level. In addition, stool samples were collected for examination of intestinal parasites. Data were analyzed using Statistical Package for Social Science (SPSS) software version 25. The overall magnitude of anemia among pregnant women was 37.8% (95% CI, 32.8%–42.3%). The proportion of mild anemia, moderate anemia, and severe anemia was 24%, 11%, and 2.3%, respectively. Some variables such as absence of malaria infection (AOR: 0.195, 95% CI: 0.066–0.576), lack of history of abortion (AOR: 0.469, 95% CI: 0.265–0.830), and absence of history of anemia (AOR: 0.227, 95% CI: 0.134–0.385) were identified as protective variables of anemia during pregnancy, while urban residence (AOR: 1.753, 95% CI: 1.013–3.034) was unexpectedly found as a predisposing factor. Despite the higher number of anemic pregnant women observed in the current study, pregnancy-associated anemia is moderate public health importance in the study area.

Raden Tina, D. J., Madjid, T. H., Handono, B., Sukandar, H., Irianti, S., Gumilang, L., . . . Setiabudiawan, B. (2020). First trimester ferritin is superior over soluble transferrin receptor and hepcidin in predicting anemia in the third

trimester: Result from a cohort study in indonesia. Anemia, 2020 doi:https://doi.org/10.1155/2020/8880045

Introduction. Anemia in the third trimester has been identified as a risk factor for maternal and fetal morbidity that might lead to mortality. Due to its high cost, finding the best marker to predict anemia became more important to allow early prevention. Only one of ferritin, hepcidin, or soluble transferrin receptors can be picked for the prediction of anemia in the third trimester especially in low-resource setting. Objective. This study aimed at defining the best marker among ferritin, hepcidin, or soluble transferrin receptor (sTfR) in the first trimester for prediction of anemia in the third trimester. Materials, Methods, and Setting. This diagnostic study was nested on the cohort study of vitamin D and its impact during pregnancy in Indonesia. Singleton pregnant mothers with normal fetus were recruited in the first trimester from four cities in West Java, Indonesia. The 304 pregnant women were screened for hepcidin, ferritin, and sTfR level in the sera. All biomarkers were measured by ELISA. Complete blood count (CBC) was done by impedance method measurement (SysmexR). Only subjects with complete data were included in analysis for diagnostic study to compare the three markers by finding the best receiver operating curve (RoC), likelihood ratio (LR), and risk estimate (RR). Result. One-hundred and eighty-one pregnant women were eligible for analysis. The result of this study showed that the serum ferritin level in the first trimester was the best marker to predict anemia in the third trimester of pregnancy. Hepcidin and sTfR performed poorly. A new cutoff point of ferritin level ≤27.23 ng/ml yielded the best ROC with 67% area under curve (95% CI 60%–75%, p<0.0001, Youden index J 0.28), specificity 86.29% (95% CI 79.0%–91.8%), LR (+) 3.07 (95% CI 1.8–5.3), and RR 2.48 (95% CI 1.67–3.68). These last figures were better than the previously used cutoff point of ferritin level below 30 ng/ml. Conclusion. This study provided evidence that the serum ferritin level ≤27.23 ng/ml in the first trimester was the best marker to predict anemia in the third trimester. It was valuably useful for secondary screening of anemia in pregnancy, targeting subjects who may need rigorous approach for iron deficiency treatment in the prevention of anemia in pregnancy.

Melat, B. Z., Shaka, M. F., Adane, T. A., & Solomon, H. T. (2020). Anemia and its determinants among male and female adolescents in southern ethiopia: A comparative cross-sectional study. Anemia, 2020 doi:https://doi.org/10.1155/2020/3906129

Background. Adolescent anemia is a major public health problem worldwide. Adolescents (10–19 years) are at an increased risk of developing anemia due to increased iron demand during puberty, menstrual losses, limited dietary iron intake, and faulty dietary habits. Objective. To assess the prevalence of anemia and associated factors among male and female adolescent students in Dilla Town, Gedeo Zone, Southern Ethiopia, May 2018. Methods. A school-based comparative cross-sectional study was employed among 742 school adolescents. Basic characteristics, anthropometric measurements, haemoglobin measurement, and others were collected. Data were analyzed using SPSS version 20 software, and descriptive statistics were computed for all variables. Bivariate and multivariable logistic regression analyses using binary logistic regression were done, the results were interpreted by using AOR with their corresponding 95% CI, and statistically significant difference was declared at p<0.05Result. Out of the total 742 respondents, 377 (50.8%) were males and 365 (49.2%) were females. The overall prevalence of anemia was 21.1%, and the prevalence of anemia was 22.5% among male adolescents and 19.7% among females. Male adolescent students within the early adolescence age group (10–13 yrs) (AOR 0.27, 95% CI, 0.08–0.87), those consuming fibre-rich foods daily (AOR 0.11, 95% CI, 0.02–0.61), and those having no intestinal parasites (AOR 0.04, 95% CI, 0.02–0.09) were less likely to be anemic. Similarly, female adolescent students not having intestinal parasites (AOR 0.05, 95% CI, 0.01–0.11) were less likely to develop anemia while those from malaria endemic area (AOR 2.57, 95% CI, 1.13–5.83) were identified to be more anemic. Conclusion. This study identified that anemia was a moderate public health significance in the study area, and the prevalence of anemia was slightly higher among male than female adolescents. Age category, frequency of eating fibre-rich foods, and positive intestinal parasite tests were factors contributing for anemia among male adolescents while presence of intestinal parasite and malaria endemicity were the determinants of anemia among female adolescents.

Fentie, K., Wakayo, T., & Gizaw, G. (2020). Prevalence of anemia and associated factors among secondary school adolescent girls in jimma town, oromia regional state, southwest ethiopia. Anemia, 2020 doi:https://doi.org/10.1155/2020/5043646

Background. Anemia defined as a low blood hemoglobin concentration is public health importance. The adolescence age group is the most neglected in public health and nutrition research as priorities are usually given to pregnant women, lactating mothers, and their children less than 2 years. Current Ethiopian Food and Nutrition policy included adolescent girls in the most at-risk group for nutritional demands; however, only a few published studies have assessed a deficiency of anemia and associated factors to tackle the intergenerational cycle of malnutrition. Objective. To assess the prevalence of anemia and associated factors among high school adolescent girls in Jimma town. Methods. Data were collected from 528 secondary school adolescent girls by a school-based cross-sectional study design in Jimma town from 1/1/2019 to 1/2/2019, southwest Ethiopia. A multistage sampling technique was used to select the study participants. A portable battery-operated HemoCue Hb 301+ analyzer was used to measure the hemoglobin level, and then reading was classified as normal Hb ≥ 12 g\dl and anemic if the hemoglobin value <12 g/dl based on the WHO 2011 recommended cutoff points after adjustments to altitude was made. Bivariate analysis at p value ≤0.25 was considered as a candidate for multivariable logistic regression. Multivariable logistic regression was done to control for confounders and to identify factors independently associated with anemia. Level of statistical significance was declared at p<0.05. Results. A total of 528 adolescent girls were included in the study yielding a response rate of 95.8%. The prevalence of anemia was found to be 26.7%, 95% CI (22.7, 30.50). In multivariate logistic regression analysis, those living separately from their family (AOR = 4.430, 95% CI (2.20, 8.90)), low dietary diversity score (AOR = 3.57, 95% CI (1.88, 6.75)), menstrual bleeding more than 5 days (AOR = 2.25, 95% CI (1.17, 4.33)), and low economic status (AOR = 2.16, 95% CI (1.17, 4.33)) were positively associated factors with anemia and only having at least a secondary school in mother's educational status AOR = 0.43, 95% CI (0.18, 0.97) was negatively associated with anemia in the study area. Conclusion. Prevalence of anemia among school adolescent girls was moderate public health importance according to the World Health Organization prevalence estimation of anemia. The living condition of the adolescent girls, dietary diversity score, duration of menses, and low economic status were positive predictor variables, whereas mothers who are being secondary school and above was a protective factor for anemia. Therefore, iron-rich and diversified food consumption should be given attention.

F O Galiba, A. T., Itoua, C., Ehourossika, C., Ngakegni, N. Y., Buambo, G., N S B Potokoue, M., & Dokekias, A. E. (2020). Pregnancy outcomes among patients with sickle cell disease in brazzaville. Anemia, 2020 doi:https://doi.org/10.1155/2020/1989134

Introduction. Sickle cell disease (SCD) is one of the most common genetic diseases in the world. It combines, in its homozygous form, chronic hemolytic anemia, vasoocclusive complications, and susceptibility to infections. It is well known that the combination of pregnancy and sickle cell disease promotes the occurrence of complications that are sometimes fatal for the mother and/or the fetus. Objective. The objective of the current study was to compare pregnancy outcomes among women with SCD with those of women without the diagnosis of SCD. Materials and methods. It was a case-control study carried out in four maternity hospitals in Brazzaville in 2 years (July 2017–June 2019). It concerned 65 parturients with SS homozygous SCD. The mode of childbirth and maternal and perinatal morbidity and mortality were compared with those of 130 non-sickle cell pregnant women. Results. The average age was 27 years for SCD women and 31 years for non-SCD women. The average gestational age at delivery was 35 weeks for SCD women and 38 weeks for non-SCD women. From the logistic regression analysis using the comparison group as the reference group, there was excessive risk in SCD compared to non-SCD of infection (29.3% vs. 4.6%, OR = 21.7, 95% CI 7.6–62.7]; p=0.001), cesarean (63% vs. 35.4%, OR = 3.1, 95% CI 1.6–5.7]; p=0.001), prematurity (75.4% vs. 30.8%, OR = 8, 95% CI 3.0–23.2]; p=0.001), low birth weight (52.3% vs. 16.1%, OR = 4.7, 95% CI 2.4–9.4]; p=0.001), neonatal requiring admission to the intensive care unit (40.3% vs. 17.5%, OR = 3.2, 95% CI 1.6–6.3]; p=0.01), and neonatal death (21.5% vs. 4.8%, OR = 4.3, 95% CI 1.5–12.2]; p=0.01). Conclusion. The risk of pregnancy in patients with homozygous sickle cell anemia remains high, on both the maternal and fetal sides.

Al-Saqladi, A., Maddi, D. M., & Al-Sadeeq, A. (2020). Blood transfusion frequency and indications in yemeni children with sickle cell disease. Anemia, 2020 doi:https://doi.org/10.1155/2020/7080264

Background. Blood transfusion is an essential component in the care of patients with sickle cell disease (SCD), but it might be associated with serious acute and delayed complications. This study was aimed to describe red cell transfusion patterns and indications among hospitalized SCD children in a low-resource setting. Patients and Methods. A retrospective, descriptive study of all children (≤16 years) with SCD who received blood transfusion therapy during their hospital admissions in the pediatric department at Al-Sadaqa Teaching Hospital in Aden, Yemen, for a period of one year. Results. Out of 217 hospitalized children with SCD, 169 (77.9%) were transfused and received 275 RBC transfusion episodes. The mean age of transfused children was 6.9 ± 4.6 years and 103 (60.9%) were males, with a male/female ratio of 1.6 : 1 (p=0.004). Hemoglobin (Hb) levels were significantly lower in the transfused than in the nontransfused (Hb 5.5 ± 1.5 vs. 7.7 ± 1.5 g/dL, p=0.03). Pretransfusion Hb levels were ˂7.0 g/dL in 86.2% and ˂5.0 g/dL in 39.3% of patients. Single transfusion was given to 122 (72.2%) and 5 or more transfusions in 9 (4.15%) of patients on different occasions. Simple (top-up) transfusion was used in all transfusion events. Commonest indications for transfusion were anemic crises (41.1%), vasoocclusive crises (VOC) (13.8%), VOC with anemic event (11.3%), acute chest syndrome (8.7%), and stroke (7.3%). Conclusion. Intermittent blood transfusion remains a common practice for the management of children with acute SCD complications. Main indications were acute anemic crises, severe pain crises, ACS, and stroke. In limited resource settings, such as Yemen, conservative transfusion policy appears to be appropriate.

Woldu, B., Enawgaw, B., Asrie, F., Shiferaw, E., Getaneh, Z., & Melku, M. (2020). Prevalence and associated factors of anemia among reproductive-aged women in sayint adjibar town, northeast ethiopia: Community-based cross-sectional study. Anemia, 2020 doi:https://doi.org/10.1155/2020/8683946

Background. Globally, anemia affects one-fourth of the world population including 30% of nonpregnant reproductive-aged women. It has a number of causes including micronutrient deficiencies and chronic infections, inherited or acquired disorders of hemoglobin synthesis and red blood cell production, or survival alterations. The aim of this study was to assess the prevalence and associated factors of anemia among reproductive-aged women in Sayint Adjibar town, South Wollo Zone, Northeast Ethiopia. Methods. A community-based cross-sectional study was conducted from February to April among 359 reproductive-aged women (RAW). Systematic random sampling technique was implemented to select study participants. Sociodemographic, socioeconomic, and reproductive histories of study participants were collected using the structured and pretested questionnaire. Capillary blood and stool samples were collected from each study participant for hemoglobin and parasitological analysis, respectively. Data were entered into Epi Info version 7 and transferred to SPSS version 20 for analysis. Both bivariable and multivariable binary logistic regression models were fitted to identify associated factors of anemia. p value <0.05 was considered as statistically significant. Result. The median age of the study participants was 25 years. The overall prevalence of anemia was 24.2%. Among those anemic individuals, 49 (56.3%) were mildly anemic. Age category 36–49 years (AOR = 2.64; 95% CI: 1.05, 6.60), no formal educational status (AOR = 2.28; 95% CI: 1.06, 4.92), food insecurity (AOR = 1.92; 95% CI: 1.01–3.65), and body mass index of above 25 kg/m2 (AOR = 0.27; 95% CI: 0.08–0.87) were found to be statistically significant with anemia. Conclusion. The prevalence of anemia in this study was found as a moderate public health problem. The prevalence was significantly associated with women who had no formal education and were of older age group and those women living with household food insecurity and with higher body mass index. Therefore, it is better to design appropriate interventional strategies to reduce reproductive-aged women anemia. These include information, education, and communication activities focused on reproductive-aged women with no formal education and life-cycle-focused food security rather than targeted to only infants and young children or pregnant women.

Gebereselassie, Y., BirhanSelassie, M., Menjetta, T., Alemu, J., & Tsegaye, A. (2020). Magnitude, severity, and associated factors of anemia among under-five children attending hawassa university teaching and referral hospital, hawassa, southern ethiopia, 2016. Anemia, 2020 doi:https://doi.org/10.1155/2020/7580104