Vol.18, No.5, Page 107- 113, 2024 https://doi.org/10.59628/jchm.v18.i5.1380 ISSN 2958-7476 JCHM

Sana'a University Journal of Medical and Health Sciences

Prevalence and risk factors for anemia during pregnancy in Sana'a city

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Abstract

Background: a common issue during pregnancy, which is defined as a decline in the ability of the blood to carry oxygen, mainly as a result of lower hemoglobin levels. There are two possible types of declines: absolute and relative. Iron deficiency is well known that the most common nutritional condition.
Objective: To ascertain the prevalence of anemia and its related risk factors among pregnant women in Sana'a, Yemen, a cross-sectional study was conducted.
Subjects and methods: Two hundred pregnant women aged between 17 and 40 years participated in this study. Calculations were made for sociodemographic characteristics, menstrual history, and haematological characteristics. Platelet counts were ascertained along with anemia proxies, such as hemoglobin (HB), hematocrit (HCT), mean corpuscular volume (MCV), packed cell volume (PCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC).
Results: The mean hemoglobin level among the pregnant females was 12.8 mg/dL, with 26% diagnosed with anemia (<11.9 mg/dL). Notably, 38% of patients exhibited PCV levels below the norm, while none in >46 PCV patients (above the normal level). The average RBC count was 4.5 cells x $10^6/\mu L$, ranging from 3.6 to 5.9 cells x $10^6/\mu L$, with none falling below the normal range for adult females. The mean MCV was 81.3 fl, with 34% displaying microcytic anemia (<80 fl). Additionally, the mean MCH was 28.3 p/cell, with 22% experiencing iron deficiency anemia and 8% showing elevated counts (>31 p/cell), suggestive of anemia due to low folic acid or vitamin B12 levels. The mean MCHC was 34.6 g/dl, with 18% having levels exceeding 36 g/dl, indicating anemia. Age played a significant role, with anemia being notably associated with those under 19 years of age, with an odds ratio of 2.8. Other significant associations included illiteracy (OR = 2.3, p =0.01), being in the third trimester (OR=2.1, p=0.04), multigravida status (OR=2.2, p=0.05), having a menstrual cycle longer than 5 days (OR=7.5, p <0.0001), and bleeding during pregnancy (OR=5.6, p<0.0001).
Conclusion: The prevalence of anemia during pregnancy among Yemeni pregnant women was moderate but significant. Multigravidy and third trimester were risk factors associated with a higher incidence of anemia during pregnancy. Other risk factors included women younger than 19 years, a longer menstrual cycle of >5 days, bleeding during pregnancy, and a low level of education.

Article Info

Keywords:
anemia, pregnancy, risk factors, hemoglobin, Sana'a, Yemen.

Article History:
Received:8-November-2024 ,
Revised:12-November-2024 ,
Accepted:11-December-2024 ,
Available online:30-December-2024

1. INTRODUCTION

Pregnancy-related anemia is a common issue defined as a loss in the blood's ability to carry oxygen, mainly as a result of lower hemoglobin levels. There are two possible types of declines: absolute and relative. As most pregnancies result in a higher increase in plasma volume than red blood cell mass, it is commonly known that this causes "physiologic anemia." For decades, these physiological alterations have been described as a phenomenon known as "plethora gravidarum." The question of whether this "hydremia" is normal or indicative of a medical issue is still debate [1, 2, 3] There are no published data regarding the prevalence of anemia among pregnant women in various regions of Yemen, nor is the prevalence of anemia among them known. Pregnant women's anemia rates can differ according to their socioeconomic status, access to healthcare, and eating habits, among other factors. Pregnancy-related anemia remains a major public health concern in Arabic nations[2]. In pregnancy, anemia is defined as a hematocrit of less than 33% or a hemoglobin level of less than 11 g/dL at any one time, according to the World Health Organization (WHO) [1]. Pregnancy-related anemia is defined by the US Centers for Disease Control and Prevention as hemoglobin levels < 11 g/dL, hematocrit levels < 33% in the first or third trimester, or hemoglobin levels < 10.5 g/dL and hematocrit levels < 32% in the second trimester [3]. The risk of anemia increases at each stage of pregnancy. According to the CDC standards, 8 percent of low-income American pregnant women are anemic in the first trimester, 12 percent in the second trimester, and 34 percent in the third [4]. The US Department of Health and Human Services (DHHS) states that the prevalence of third-trimester anemia is a key predictor of reproductive health. Black Americans had the highest prevalence rate (48.5%), followed by Asians, Native Hawaiians, other Pacific Islanders (29%), Whites (27.5%), American Indians and Alaska Natives (33.9%), Hispanics and Latinas (30.1%), and Hispanics and Latinas [4, 5]. Physicians have long understood that the reason why 10–70% of pregnant women reported in studies conducted in the early 20th century had hemoglobin levels below 7 g/dL was not due to hydremia alone. Due to the frequent discovery of hypochromia, microcytosis, and anisocytosis in blood smears of pregnant women with anemia and the repair of such anomalies following the administration of iron supplements, the 1950s established a substantial role for iron deficiency in pregnancy anemia [6] Since then, iron shortage has been acknowledged as the most prevalent cause of anemia in pregnancy worldwide. This anemia typically manifests in the third trimester, when iron is maximally collected to support erythropoiesis in the developing baby [7]. The size and quantity of hemoglobin in each red blood cell can also be used to categorize anemia. It is known as microcytic anemia if the cells are small, macrocytic anemia if they are large, or normocytic anemia if the cells are normal in size. A hemoglobin level of less than 130–140 g/L (13–14 g/dL) for men and less than 120–130 g/L (12–13 g/dL) for women is the basis for diagnosing anemia [8, 9]. The reason for this must be determined by additional testing [8, 10]. This cross-sectional study aimed to investigate the prevalence and associated risk factors of anemia during pregnancy among Yemeni women. Our results are anticipated to provide specific guidance for future studies and what needs to be addressed to fill knowledge gaps at this time.

2. SUBJECTS AND METHODS

2.1. Study design

This cross-sectional active laboratory study was conducted in maternal clinics in Sana'a, Yemen, from December 2023 until the end of February 2024.

2.2. Sample size

A sample size of 200 was calculated using the following parameters: confidence level = 95%, margin of error = 6.22%, and frequency of anemia among pregnant women = 28% [1].

2.3. Data collection

Individual data were collected using a pre-designed questionnaire, including demographic data, pregnancy data, risk factors for anemia, clinical data, and laboratory results.

2.4. Statistical analysis

Data analysis was performed using Epi Info statistical program version 6 (CDC, Atlanta, USA). Quantitative data are expressed as mean values or standard deviation (SD) when the data are normally distributed. Qualitative data are expressed as percentages. Risk factors were calculated by 2 X 2 tables to obtain the odds ratio, confidence interval, chi square, and p-value to determine the associated risk factors of anemia among our pregnant women.

2.5. Ethical consideration

Ethical approval for the study was obtained from the Research Review Committee of the Faculty of Medicine and Health Sciences. All participants received an explanation of the study goals, and informed consent was obtained from all participants before sampling.

3. FIELDS AND LABORATORY WORKS

From December 2023 until the end of February 2024, a cross-sectional study centered in selected maternity clinics in tertiary hospitals in Sana'a City was conducted, enrolling 200 pregnant females. Direct interviews and review of medical records were used to gather sociodemographic and clinical data. Each participant provided a venous blood sample to determine blood markers including hemoglobin (HB), packed cell volume (PCV), red blood cell (RBCs) count, hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC).

4. RESULTS

The mean age of our patients was 25.6 years with an SD of 5.9 years and ages ranged from 17-40 to years. Most of the pregnant women were age group–20-30 years (60%), followed by those aged >30 years (28%), while those aged <19 years were less frequent (Table 1). The mean hemoglobin level of our pregnant females was 12.8 mg/dL, the standard deviation level was 1.5 mg/dL and the level ranged from 9.0 to 15.6 mg/dL. Anemia (<11.9 mg/dL) was reported in 26% of the pregnant women (Table 2). Table 3 displays the PCV levels of the pregnant women. Among these patients, 38% exhibited PCV levels below the normal range, 62% fell within the 36–46 PCV range, and none had PCV levels exceeding 46 (above the normal range). Table 4 illustrates the red blood cell counts of the adult pregnant female patients (cells × $10^6/\mu L$). The average RBC count was 4.5 cells x $10^6/\mu L$ with a standard deviation of 0.48, ranging from 3.6 to 5.9 cells x$10^6/\mu L$. Notably, none of our patients exhibited values below the normal range for adult females. The majority of pregnant women patients fell within the range of 3.5-5.1 cells x $10^6/\mu$ L, accounting for 86% of the cases. Table 5 shows the MCV levels in the pregnant women. The mean MCV was 81.3 fl with SD equal to 5.9 fl, and the MCV ranged from 61.4 fl to 88.8 fl. Third, MCV <80 fl of the MCV (34%) (microcytic anemia). Table6 shows the MCH levels of adult patients. The mean MCH of our patients was 28.3 p/cell, with an SD of 2.8 p/cell and ranged from 19.9 to 32.6 p/cell. Pregnant women had less than 27 p/cell (22%), indicating iron deficiency anemia, while 8% had more than 31 p/cell, indicating anemia due to low levels of folic acid or vitamin B12. Table 7 shows that the average MCHC level among our patients was 34.6 g/dL, with a standard deviation of 2.01 g/dL, ranging from 25.2 to 39 g/dL. Approximately 76% of the patients had MCHC levels between 32-36 g/dL, 6% had levels below 32 g/dL, and 18% had levels exceeding 36 g/dL. Values outside the specified range indicate the presence of anemia. Table 8 shows that the average platelet count among the patients was 270 cells per microliter (μ L), with a standard deviation of 72 cells per μ L, ranging from 141 to 489 cells per μ L. Among the participants, 2% exhibited platelet counts below 150 cells per μ L, indicating thrombocytopenia, while another 2% showed elevated platelet counts, suggesting thrombocytosis. Table 9 shows anemia associated risk factors for pregnant women attending tertiary hospitals in Sana'a city. Considering age as associated factors, there was significant association between anemia occurrence and age less than 19 years in which odds ratio for less than 19 years group was 2.8, CI=1.3- 6, $X^2 = 7.7$ and p=0.005. Also there was significant association between anemia and illiterate group in which OR was 2.3, CI=1.2 - 4.5, $X^2 = 5.8$ and p =0.01. Considering gestation stages, there was significant association between anemia and third trimester in which odds ratio for association was 2.1, CI=1.1 – 4.4, $X^2 = 3.9$ and p=0.04. Considering gravidity, there was significant association between anemia and Multigravida in which odds ratio for association was 2.2, CI=1.1 – 3.1, $X^2 = 3.9$ and p=0.05. There was significant association between anemia and Longer menstrual cycle > 5 days in which the anemia rate was 48.1%, with associated OR equal to 7.5, CI=3.6 -15.5, $X^2 = 37$ and p <0.0001. Considering presence of Bleeding during pregnancy, there was significant association with anemia in which odds ratio for association was 5.6, CI=2.3 – 13.4, $X^2 = 17.2$ and p<0.0001.

5. DISCUSSION

Anemia increases the risk of both maternal and newborn morbidity and mortality, as well as physical and psychological co-morbidity in mothers [11]. Yemen has the highest prevalence of anemia among pregnant women (26%) according to the current study's data; however, there is a considerable range in Yemen. Pregnancy-related anemia is more prevalent than one may realize; this broad range in prevalence may be caused by cultural diversity in socioeconomic conditions, lifestyles, and health-seeking practices. According to a recent systematic review and meta-analysis, the prevalence of anemia during pregnancy was found to be 36.8% (95% CI: 31.5%-42.4%) worldwide, with Africa having the highest prevalence (41.7%) [12, 13]. The current investigation found that multigravida and third trimester were risk factors for an increased incidence of anemia during pregnancy. This finding was comparable to the risk factors in four studies [14, 15, 16], which found that multigravida/multiparous >3 was a risk factor in four studies [14, 16, 17], and nulliparous [18, 19] was one of the risk factors for increasing the incidence of anemia in pregnancy. This could be because the iron levels of pregnant women are depleted by several pregnancies [20]. A Malaysian study [21] found that the percentage of anemia was higher in grand multigravida women (66.7%). According to Okafor et al. and Isah et al., multiparity is a significant risk factor associated with iron-deficiency anemia [22, 23]. Pregnancy

requires a lot of iron; therefore, having too many pregnancies too close apart will lead to iron deficiency [24]. Pregnant women have a three to four times higher need for iron than non-pregnant women do [25]. Although iron can be mobilized from maternal stores to meet this requirement, women are generally seen to have low iron stores, possibly due to monthly blood loss during menstruation [26]. Once these reserves are depleted, the mother develops an iron shortage [27]. A reduction in the rate at which hemoglobin is produced as a result of an iron deficit can lead to iron-deficiency anemia [28]. Reducing the total number of pregnancies and increasing the time between pregnancies can help control iron deficiency anemia in women. By reducing a woman's need for iron through family planning and child spacing, the consequences of iron-deficiency anemia and iron depletion can be avoided. Other risk variables included in the current study included low educational attainment, bleeding during pregnancy, menstrual cycles longer than five days, and women under the age of [17]. These findings are in line with the risk factors for anemia among pregnant women reported in other studies, which include women under the age of[18, 25], low income[14] , a menstrual cycle longer than five days [14], bleeding during pregnancy [14], infrequent meat consumption [14], low level of education [29], and decreased consumption of iron-rich foods [30]. Low socioeconomic status has also been associated with the incidence of iron-deficiency anemia during pregnancy [31]. Anemia is a measure of socioeconomic hardship since it is inversely related to household socioeconomic level, especially in emerging countries [32]. In Malaysia, the prevalence of anemia during pregnancy varies from 19.3% to 57.4%, with iron-deficiency anemia ranging from 20.8% to 21.2% [21]. This level of anemia in pregnant women is similar to that observed in countries with a lower economic status. For instance, in Ethiopia, the pooled prevalence of anemia among expectant mothers was 31.66% 11, while in Sudan it was 53.0% [33]. In contrast, in Iran, a similarly developing nation, the prevalence of anemia among pregnant women was notably lower 13.6% [34]. This study indicates that anemia remains a major issue for pregnant Yemeni mothers. Prenatal or antenatal anemia screening should be customized for each pregnant lady [17, 35]. Two studies suggested that during pregnancy and for three months after delivery, health education programs at Primary Health Care Centers should address the need to adhere to iron supplementation guidelines and consume an appropriate amount of iron-rich dietary sources [30, 36]. As part of the normal prenatal care for all pregnant women, the government and non-governmental organizations ought to prioritize providing iron and folic acid supplements. To avoid repeated pregnancies, long-acting family planning methods must be used in all Yemeni locations, where anemia is more common. Health extension providers should encourage community-based awareness initiatives and prenatal check-ups. To fully understand the causes of anemia in pregnant women, further research must be conducted nationwide.

6. CONCLUSIONS

Among pregnant Yemeni women, anemia during pregnancy was significantly more common. Pregnancy-related anemia was found to be associated with risk variables, such as multigravidity and the third trimester. Women aged < 19 years, a menstrual cycle longer than five days, bleeding during pregnancy, and poor levels of education were additional risk factors.

ACKNOWLEDGEMENTS

We thank the medical staff at the maternal clinics in Sana'a, Yemen, for their collaboration and support.

CONFLICT OF INTEREST

This work does not include any conflicts of interest.

Table 1. Age distribution of pregnant women included in the study in Sana'a city, tested for anemia

Age groups (years)	Number (%)
Less than 19	36 (18)
20-25	60 (30)
26-30	60 (30)
>30	44 (22)
Total	200 (100)
Mean age	25.6 years
SD	5.9 years
Median	26 years
Mode	18 years
Min-Max	17-40 years

Table 2. Hemoglobin level in pregnant women included in the study in Sana'a city, who were tested for anemia

Hb (mg/dL)	Number (%)
Less than 11.9	52 (26)
12-14	104 (52)
≥14.1	44 (22)
Total	250 (100)
Mean	12.8
SD	1.5
Median	13
Mode	11.9
Min-Max	9.0-15.6

The normal Hb level in adult females is 11.9 to 15 mg/dl. Normal levels of PCV in adult females range from 36% to 46%. The normal RBC count in adult females would be around 3.5 - 5.1 x cell x$10^6/\mu L$. MCV/fl = Mean corpuscular volume/fl Below 80 fl (femtoliters), they are likely to develop or have microcytic anemia. Alternatively, if their MCV levels are greater than 100 fl, they could experience macrocytic anemia.

Table 3. Packed cell volume level of pregnant women included in the study in Sana'a city, who were tested for anemia

PCV	Number (%)
Less than 36	76 (38)
36-46	124 (62)
>46	0 (0)
Total	200 (100)
Mean	36.8
SD	3.8
Median	36.9
Mode	32.4
Min-Max	29.3-45

Table 4. Red blood cell counts of pregnant women included in the study in Sana'a city, who were tested for anemia ($10^6/\mu$ L)

RBC (cell x $10^6/\mu L$)	Number (%)
Less than 3.5	0 (0)
3.5–5.1	172 (86)
>5.1	28 (14)
Total	200 (100)
Mean	4.5
SD	0.48
Median	4.5
Mode	4.4
Min–Max	3.6–5.9

Table 5. MCV level of pregnant women included in the study in Sana'a city, who were tested for anemia

MCV (fL)	Number (%)
Less than 80	68 (34)
80–84	64 (30)
85–89	72 (36)
>89	0 (0)
Total	200 (100)
Mean	81.3
SD	5.9
Median	82.3
Mode	81.8
Min–Max	61.4–88.8

Table 6. MCH level of pregnant women included in the study in Sana'a city, who were tested for anemia

MCH (pg)	Number (%)
Less than 27	44 (22)
27–28	32 (16)
29–31	108 (54)
>31	16 (8)
Total	200 (100)
Mean	28.3
SD	2.8
Median	29.4
Mode	26.6
Min–Max	19.9–32.6

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

Table 7. MCHC level of pregnant women included in the study in Sana'a city, who were tested for anemia

MCHC g/dl	Number (%)
Less than 32	12 (6)
32-36	152 (76)
>36	36 (18)
Total	200 (100)
Mean	34.6
SD	2.01
Median	34.7
Mode	34.6
Min-Max	25.2-39

A typical MCHC result is 32-36 grams/deciliter (g/dL), although this may vary depending on the laboratory. Levels outside this range can indicate anemia.

Table 8. Platelets counts of pregnant women included in the study in Sana'a city, who were tested for anemia

platelet count per microliter x 10^3	Number (%)
Less than 150	4 (2)
150-450	192 (96)
>450	4 (2)
Total	200 (100)
Mean	270
SD	72
Median	251
Mode	269
Min-Max	141-489

Normal platelet count ranges from 150,000 to 450,000 platelets per microliter of blood. Having more than 450,000 platelets is a condition with more than 150,000 is known as thrombocytopenia.

The primigravida is a woman who is pregnant for the first time. A multigravida is a woman who is or has been pregnant for at least a second time.

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Table 9. Anemia-associated risk factors among pregnant women at a tertiary hospital in Sana'a city (n=200).

Characteristics	Anemia Number (%)	OR	CI	X^2	*p*-value
Age groups (years)					
Less than 19 (n=36)	16 (44.4)	2.8	1.3–6.0	7.7	0.005
20–25 (n=60)	21 (35)	1.8	0.97–3.6	3.6	0.057
26–30 (n=60)	9 (15)	0.3	0.17–0.88	5.4	0.02
>30 (n=44)	6 (13.6)	0.37	0.14–0.95	4.5	0.03
Education					
Illiterate (n=55)	21 (38.2)	2.3	1.2–4.5	5.8	0.01
Primary-secondary school (n=104)	25 (24)	0.8	0.4–1.5	0.43	0.51
University (n=41)	6 (14.6)	0.42	0.16–1.1	3.5	0.06
Gestation stage					
First trimester (n=59)	11 (18.6)	0.5	0.2–1.1	2.3	0.12
Second trimester (n=102)	26 (25.4)	0.9	0.5–1.7	0.02	0.8
Third trimester (n=39)	15 (38.5)	2.1	1.0–4.4	3.9	0.04
Gravidity					
Primigravida (n=49)	8 (16.3)	0.4	0.2–1.6	3.1	0.07
Multigravida (n=151)	44 (29.1)	2.2	1.1–3.1	3.9	0.05
Longer menstrual cycle >5 days (n=81)	39 (48.1)	7.5	3.6–15.5	37.0	<0.0001
Bleeding during pregnancy (n=25)	15 (60)	5.6	2.3–13.4	17.2	<0.0001

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