AUCTORES
Globalize your Research

Clinical Research and Clinical Trials

Hassan Abdulwahab Al-Shamahy *

Open Access

Research Article

Prevalence and Risk Factors for Anemia During Pregnancy in Sana'a City

Salwa'a Ahmed Ali Al-Jarrmozi [1], Amel Abdullah Almagrami [1,5], Khaled Abdulkarim Al-Moyed [1,3], Hassan Abdulwahab Al-Shamahy [1,2,3] *, Ahmed Mohammed Al-Haddad Ibrahim Ali Al-Arashi [6], Ohood Musleh Al-Dhuraibi [6], Yossera Mohammed al-Ghulaibi [6], Khadeja ali al-almohtadi [6], Elham Hussein Khalil [6], Fatima Mohammed Al-Sanabani [6], Amal Mohammed Al-Thahbi [6]

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

[2]Departement of Basic Sciences, Faculty of Dentistry, Sana'a University, Republic of Yemen.

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

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

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

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

***Corresponding Author:** Hassan A. Al-Shamahy, Hatay 1-Faculty of Medicine and Heath Sciences, Sana'a University.

Received date: November 09, 2024; **Accepted date:** November 29, 2024; **Published date:** December 24, 2024

Citation: Al-Jarrmozi SAA, Amel A. Almagrami, Al-Moyed KA, Al-Shamahy HA, Al-Haddad AM, et al, (2024), Prevalence and Risk Factors for Anemia During Pregnancy in Sana'a City, *Clinical Research and Clinical Trials*, 11(4); **DOI:10.31579/2693-4779/245**

Abstract:

Background: A common issue during pregnancy is anemia, which is defined as a decline 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. It is well known that the most prevalent nutritional condition is iron deficiency.

Objective: In order to ascertain the prevalence of anemia and related risk factors among pregnant women in Sana'a, Yemen, a cross-sectional study was conducted.

Subjects and methods: Two hundred pregnant women between the ages of 17 and 40 years participated in this study. Calculations were made for socio-demographic, 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 our 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 (above the normal level). The average RBC count stood at 4.5 cells x 106/µl, ranging from 3.6 to 5.9 cells x 106/µl, 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, exhibiting 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 (OR=2.2, p=0.05), having a menstrual cycle longer than 5 days (OR=7.5, p <0.0001), and experiencing bleeding during pregnancy (OR=5.6, p<0.0001).

Conclusion: The prevalence of anemia during pregnancy among Yemeni pregnant women was moderate, but at a significant rate. Multigravidy and the third trimester were associated risk factors with a higher incidence of anemia during pregnancy. Other risk factors were women younger than 19 years, a longer menstrual cycle >5 days, bleeding during pregnancy, and a low level of education.

Keywords: anemia; pregnancy; risk factors; hemoglobin; Sana'a; Yemen

Introduction

Pregnancy-related anemia is a common issue that is 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 by a

phenomenon known as "plethora gravidarum." The question of whether this "hydremia" is normal or indicative of a medical issue is still up for debate [1-3].

There is no published data regarding the prevalence of anemia among pregnant women in Yemen's various regions, nor is the prevalence of anemia among them known. Pregnant women's anemia rates can differ according to their socioeconomic level, access to healthcare, and eating habits, among other things. Pregnancy-related anemia is still a major public health concern in Arabic nations [2].

In pregnancy, anemia is defined as having 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 below 11 g/dL, hematocrit levels below 33% in the first or third trimester, or hemoglobin levels below 10.5 g/dL and hematocrit levels below 32% in the second trimester [3]. The risk of anemia rises with each stage of pregnancy. By CDC standards, 8 percent of American low-income pregnant women are anemic in the first trimester, 12 percent in the second, and 34 percent in the third [4].

The US Department of Health and Human Services (DHHS) states that a key predictor of reproductive health is the prevalence of third-trimester anemia. Black Americans had the highest prevalence rate (48.5%), followed by Asians, Native Hawaiians and 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 D:\ARTICLES\CRCT\Next articles from 167\CRCT-24-RA-245have long understood that the reason why 10% to 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, the iron shortage has been acknowledged as the most prevalent cause of anemia in pregnancy around the world. This anemia typically manifests in the third trimester, when the iron is most 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, and normocytic anemia if the cells are normal in size. A hemoglobin level of less than 130 to 140 g/L (13 to 14 g/dL) for men and less than 120 to 130 g/L (12 to 13 g/dL) for women is the basis for diagnosing anemia [8,9]. The reason must then be determined by additional testing [8,10].

This cross-sectional study was aimed to study the prevalence and associated risk factors of anemia in pregnancy among Yemeni women. Our results are anticipated to provide specific guidance for future studies and what needs to be addressed to fill in knowledge gaps at this time.

Subjects And Methods

Study design

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

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% [Ref-1].

Data collection

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

Statistical analysis

By using Epi Info statistical program version 6 (CDC, Atlanta, USA), the analysis of the data was performed. Expressing the quantitative data as mean values, or standard deviation (SD), when the data was normally distributed. Expressing the qualitative data as percentages. Also risk factors were calculated by 2X2 tables to get odds ratio, confidence interval, chi square and p value to determine the associated risk factors of anemia among our pregnant women.

Ethical consideration

Ethical authorization 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's goals and informed consent was taken from all participants before sampling.

Fields And Laboratory Works

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

Results

The mean age of our patients was 25.6 years with SD equal to 5.9 years and ages ranged from 17-40 years. Most of pregnant women were in the age group of 20-30 years (60%), followed by the group of >30 years (28%), while <19 years was less frequent (Table 1).

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

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 all pregnant women (Table 2).

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.

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

Table 3 displays the PCV levels of pregnant women. Among the 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).

PCV	Number (%)
Less than 36	76 (38)
36-46	124 (62)
>46	0 (0.0)
Total	200 (100)
Mean	36.8
SD	3.8
Median	36.9
Mode	32.4
Min-Max	29.3-45

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

Normal levels of PCV in adult females range from 36% to 46%. Table 4 illustrates the red blood cell counts of adult pregnant female patients (cells x 10^6/µL). The average RBC count was 4.5 cells x 10^6/µL with a standard deviation of 0.48, ranging from 3.6 to 5.9 cells x 10^6/µL. A normal RBC count in adult females would be around 3.5 to 5.1 x cell x10^6/µL.

RBC (cell x 10^6/µL)	Number (%)
Less than 3.5	0 (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 4: Red blood cell counts of pregnant women included in the study in Sana'a city, who were tested for anemia (10^6/µL)

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/µL, accounting for 86% of the cases.

Table 5 shows the MCV level of 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 of the patients had <80 fl of the MCV (34%) (microcytic anemia).

MCV/fl	Number (%)
Less than 80	68 (34)
80-84	64 (30)
85-89	72 (36)
>89	0 (0.0)
Total	200 (100)
Mean	81.3
SD	5.9
Median	82.3
Mode	81.8
Min-Max	61.4-88.8

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

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

Table 6 shows the MCH level 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.

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

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

Table 7 shows the average MCHC 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 recorded MCHC levels between 32-36 g/dL, while 6% had levels below 32 g/dL, and 18% had levels exceeding 36 g/dL. Values outside the specified range indicated the presence of 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 lab. Levels outside this range can indicate anemia.

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

Table 8 shows that the average platelet count among the patients was 270 cells per microliter (μL), with a standard deviation of 72 cells per μL, ranging from 141 to 489 cells per μL. Among the participants, 2% exhibited platelet counts below 150 cells per μL, indicating thrombocytopenia, while another 2% showed elevated platelet counts, suggesting thrombocytosis.

platelet count per microliter x103	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

A normal platelet count ranges from 150,000 to 450,000 platelets per microliter of blood. Having more than 450,000 platelets is a condition called thrombocytosis; having less than 150,000 is known as thrombocytopenia.

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

Table 9 shows anemia associated risk factors for pregnant women attending tertiary hospitals in Sana'a city.

Characters	Anemia Number (%)	OR	CI	X^2	*p*
Age groups (years)					
Less than 19 (n=36)	16 (44.4)	2.8	1.3-6	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
M**ultigravida** (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	<0.0001
Bleeding during pregnancy (n=25)	15 (60)	5.6	2.3-13.4	17.2	<0.0001

Primigravida is a woman who is pregnant for the first time. Multigravida is a woman who is or has been pregnant for at least a second time.

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

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.

Discussion

Anemia raises the risk of both maternal and newborn morbidity and mortality, as well as physical and psychological co-morbidity in mothers [11]. Yemen has the greatest 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, lifestyle, 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 greatest prevalence (41.7%) [12,13].

The current investigation found that multigravida and the third trimester were risk factors for an increased incidence of anemia in pregnancy. This finding was comparable to the risk factor in four studies [14-16], which found that multigravida/multiparous >3 was a risk factor in four studies 14-16]19], and nulliparous [17,18] was one of the risk factors to increase the incidence of anemia in pregnancy. This could occur from a pregnant woman's iron levels being 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 up a lot of iron, therefore having too many pregnancies too close apart will lead to an 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 the maternal stores to meet this requirement, women are generally seen to have low iron stores, possibly due to the monthly blood loss during menstruation [26]. Once these reserves are depleted, the mother will develop 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, iron deficiency anemia's consequences and iron depletion can be avoided.

Other risk variables included in the current study included low educational attainment, bleeding during pregnancy, longer menstrual cycles than five days, and women under the age of 19. These findings are in line with the risk factors for anemia among pregnant women that have been reported in other studies, which include women under the age of 25 [17], 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 characteristics have also been associated with the incidence of iron deficiency anemia during pregnancy [31]. Anemia is a measure of socioeconomic hardship since it is inversely connected with household socioeconomic level, especially in emerging countries [32].

In Malaysia, the prevalence of anemia during pregnancy varied from 19.3% to 57.4%, with iron deficiency anemia specifically ranging from 20.8% to 21.2% [21]. This level of anemia in pregnant women is similar to rates seen in countries with lower economic statuses. For instance, in Ethiopia, the pooled prevalence of anemia among expectant mothers was 31.66% [11], while in Sudan it stood at 53.0% [33]. In contrast, in Iran, a similarly developing nation, the prevalence of anemia among pregnant women was notably lower at 13.6% [34].

The study that is mentioned indicates that anemia is still a major issue for Yemeni pregnant mothers. Prenatal or antenatal anemia screening should be customized for each pregnant lady [19,35]. Two studies suggest that during pregnancy and for three months after delivery, health education programs at Primary Health Care Centers should address the need of adhering to iron supplementation guidelines and consuming an appropriate amount of iron-rich dietary sources 30, [36].

As part of the normal prenatal care for all pregnant women, the government and nongovernmental organizations ought to prioritize providing iron and folic acid supplements. In order to avoid repeated pregnancies, long-acting family planning methods must be used in all Yemeni locations where anemia is more common. Health extension providers ought to encourage community-based awareness initiatives and prenatal checkups. To fully understand the causes of anemia in pregnant women, further research must be done across the nation.

Conclusions

Among Yemeni pregnant 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 under the age of 19, a menstrual cycle longer than five days, bleeding during pregnancy, and poor levels of education were additional risk factors.

Acknowledgements

For their collaboration and support, we thank and appreciate all the medical staff at maternal clinics in Sana'a, Yemen.

Conflict of Interest

This work does not include any conflicts of interest.

Author's Contributions

Salwa'a Ahmed Ali Al-Jarrmozi, the first author of the study, under the supervision of Dr. Hassan A. Al-Shamahy. The other authors contributed to data analysis, writing, review, and final approval of the work.

References

1. WHO: (2022)? Iron deficiency anaemia: assessment, prevention, and control. A guide for programme managers. WHO, Geneva?
2. El-Kholy AA, El Kholy EA, Al Abdulathim MA, *et al*. (2023). Prevalence and associated factors of anemia among pregnant women and the impact of clinical pharmacist counseling on their awareness level: a cross sectional study. Saudi Pharm J., 31(8):101699.
3. Lee AI, Okam MM: (2011). Anemia in pregnancy. Hematol Oncol Clin North Am., 25(2):241-259.
4. Zhang X, Beckles GL, Chou CF, *et al*. (2013). Socioeconomic disparity in use of eye care services among US adults with age-related eye diseases: National Health Interview Survey, 2002 and 2008. JAMA Ophthalmol., 131(9):1198-1206.
5. Sifakis S, Pharmakides G. (2000). Anemia in pregnancy. Ann N Y Acad Sci., 900:125-136.
6. Frenkel P, Yardley A. (2000). Clinical and laboratory features and sequelae of deficiency of folic acid (folate) and vitamin B12 (cobalamin) in pregnancy and gynecology. Hematol/Oncol Clin North Am., 14(5):1079-1100.
7. Rao R, Georgieff MK. (2002). Perinatal aspects of iron metabolism. Acta Paediatr Suppl. 91(438):124-129.
8. Janz TG, Johnson RL, Rubenstein SD. (2013). Anemia in the emergency department: evaluation and treatment. Emergency Medicine Practice; 15 (11): 1-15.
9. Smith RE. (2010). The clinical and economic burden of anemia. Am J Manag Care; 16: 59-66.
10. Rhodes CE, Varacallo M. (2019). Physiology, Oxygen Transport". NCBI Bookshelf;
11. Kassa GM, Muche AA, Berhe AK, Fekadu GA. (2017). Prevalence and determinants of anemia among pregnant women in Ethiopia; a systematic review and meta-analysis. BMC Hematol., 17:17.
12. Karami M, Chaleshgar M, Salari N, Akbari H, Mohammadi M. (2022). Global prevalence of anemia in pregnant women: a comprehensive systematic review and meta-analysis. Matern Child Health J., 26:1473-1487.
13. Mekonnen FA, Ambaw YA, Neri GT. (2018). Socio-economic determinants of anemia in pregnancy in North Shoa Zone, Ethiopia. PLoS One., 13:0202734.
14. Alreshidi MA, Haridi HK. (2021). Prevalence of anemia and associated risk factors among pregnant women in an urban community at the North of Saudi Arabia. J Prev Med Hyg., 62:653-663.
15. Baradwan S, Alyousef A, Turkistani A. (2018). Associations between iron deficiency anemia and clinical features among pregnant women: a prospective cohort study. J Blood Med., 9:163-169.
16. Salih S, Alqahtani H, Almalki A, *et al.* (2015). Anemia and dietary habits among pregnant women in Jazan, Saudi Arabia. Br J Med Med Res., 10:1-8.
17. Mahfouz A, el Said M, Alakija W, *et al.* (1994). Anemia among pregnant women in the Asir region, Saudi Arabia: an epidemiologic study. Southeast Asian J Trop Med Public Health., 25:84-87.
18. Mahfouz AA, el-Said MM, Alakija W, *et al.* (1994). Anemia among pregnant women in the Asir region, Saudi Arabia: an epidemiologic study. Southeast Asian J Trop Med Public Health., 25:84-87.
19. Hafez K, Dorgham S, Sayed A. 2014). Profile of high-risk pregnancy among Saudi women in Taif-KSA. World J Med Sci., 11:90-97.
20. Dewey KG, Cohen RJ. Does birth spacing affect maternal or child nutritional status? A systematic literature reviews. Matern Child Nutr. 2007, 3:151-173.
21. Abd Rahman R, Idris IB, Isa ZM, Rahman RA, Mahdy ZA. (2022). The prevalence and risk factors of iron deficiency anemia among pregnant women in Malaysia: A Systematic Review. Front Nutr., 15(9):847693.
22. Okafor M, Okpokam C, Antai B, Usanga A: (2017). Iron status of pregnant women in rural and urban communities of Cross River State, South-South Nigeria. Nig J Physiolog Sci., 31:121-125.
23. Isah HS, Fleming AF, Ujah IA, Ekwempu CC: Anaemia and iron status of pregnant and non-pregnant women in the guinea savanna of Nigeria. Ann Trop Med Parasitol. 1985, 79:485-493.
24. Al-Farsi YM, Brooks DR, Werler MM, Cabral HJ, Al-Shafei MA, Wallenburg HC. (2011). Effect of high parity on occurrence of anemia in pregnancy: a cohort study. BMC Pregnancy Childbirth., 11:7.
25. Zavaleta N, Caulfield LE, Garcia T. (2000). Changes in iron status during pregnancy in Peruvian women receiving prenatal iron and folic acid supplements with or without zinc. Am J Clin Nutr., 71:956-61.
26. Ofojekwu N, Nnanna U, Okolie E, *et al.* (2013). Hemoglobin and serum iron concentrations in menstruating nulliparous women in Jos, Nigeria. Lab Med., 44:121-124.
27. Ribot B, Aranda N, Viteri F, Hernández-Martínez C, Canals J, Arija V. (2012). Depleted iron stores without anaemia early in pregnancy carries increased risk of lower birth weight even when supplemented daily with moderate iron. Hum Reprod., 27:1260-1266.
28. Percy L, Mansour D, Fraser I. (2017). Iron deficiency and iron deficiency anaemia in women. Best Pract Res Clin Obstet Gynaecol., 40:55-67.
29. Abdelhafez M, El-Soadaa S. (2012). Prevalence and risk factors of anemia among a sample of pregnant females attending primary health care centers in Makkah, Saudi Arabia. Pakistan J Nutri., 11:1113-1120.
30. Rasheed P, Koura MR, Al-Dabal BK, Makki SM. (2008). Anemia in pregnancy: a study among attendees of primary health care centers. Ann Saudi Med., 28:449-452.
31. Obasi O, Nwachukwu N. (2013). Comparative iron related anaemia at pregnancy in Ebonyi state, South-east Nigeria. J Med Sci., 13:425.
32. Ndukwu U, Dienye O. (2012). Prevalence and socio-demographic factors associated with anaemia in pregnancy in a primary health centre in Rivers State, Nigeria. Afr J Primary Health Care Family Med., 4:1-7.
33. Adam I, Ibrahim Y, Elhardello O. (2018). Prevalence, types and determinants of anemia among pregnant women in Sudan: a systematic review and meta-analysis. BMC Hematol., 18:1-8.
34. Barooti E, Rezazadehkermani M, Sadeghirad B, *et al.* (2010). Prevalence of iron deficiency anemia among Iranian pregnant women; a systematic review and meta-analysis. J Reprod Infertil., 11:17-24.
35. Fallatah AM, Bifari AE, Alshehri HZ, *et al.* (2020). Anemia and cost-effectiveness of complete blood count testing among pregnant women at King Abdulaziz University Hospital: a single tertiary center experience. Cureus., 12:10493.

36. Mahfouz AA, El-Said MM, Alakija W, *et al.* (1994). Anemia among pregnant women in the Asir region, Saudi Arabia: an epidemiologic study. Southeast Asian J Trop Med Public Health., 25:84-87.

DOI:10.31579/2693-4779/245