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Prevalence of Maternal Anemia in Pregnancy: The Effect of Maternal Hemoglobin Level on Pregnancy and Neonatal Outcome

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Abstract

Objective: The aim of our study is to assess the prevalence of anemia in pregnant women, and to evaluate the effect of severity of anemia on maternal and perinatal outcome. **Methods:** This retrospective cohort study was conducted at the Department of Obstetrics and Gynecology from hospital records. Study population of all pregnant women who had delivered in our hospital after twenty weeks gestation between July 2014 and December 2016. **Results:** A total of 2654 pregnant women fulfilled the inclusion criteria, 42% were anemic, 83.3% mild anemia group (I) which represents the majority of patients and 16.7% moderate to severe anemia group (II). The majority of cases were due to iron deficiency anemia 92.8%, while 7.2% were due to sickle cell trait, B-thalassemia intermedia, and other causes. The incidence of postpartum hemorrhage, cesarean delivery, and infections was significantly higher in group II compared to group I (5.4%, 40.3%, 3.8% Vs, 2.9%, 31.0%, 2.0%; $p = 0.007, 0.041, 0.043$ respectively). Low Apgar score, preterm labor, and low birth weight babies were significantly higher in group II compared to group I (11.8%, 12.9%, 11.3% Vs 8.7%, 9.0%, 7.4%; $p = 0.034, 0.046, 0.032$). **Conclusions:** This study clarified that anemia is prevalent among pregnant women particularly mild anemia. Early diagnosis and treatment from first trimester has an essential role in managing maternal anemia and it reflects directly on the perinatal outcome. Prematurity, low birth weight infants, and postpartum hemorrhage are the commonest maternal and neonatal complications.

Keywords

Anemia, Postpartum Hemorrhage, Perinatal Outcome

1. Introduction

Anemia is a condition in which red blood cells or their oxygen carrying capacity is insufficient to meet physiologic needs, which may vary according to age, sex, and pregnancy status [1]. In pregnancy, if hemoglobin level is less than 11 gm/dl in the first and third trimester, or less than 10.5 gm/dl in second trimester, the pregnant women considered anemic [2] [3]. World Health Organization reported that 18% of women from industrialized countries, and 35% to 75% (56% on average) of pregnant women in developing countries, are anemic [4].

Anemia is one of the most common medical disorders during pregnancy. It can cause serious adverse effects on the mother and the fetus with high risk for maternal mortality. [2]. The association of maternal anemia with pre-eclampsia and eclampsia as well as intrauterine growth restriction (IUGR), low birth weight, and increased risk of postpartum hemorrhage (PPH) [5], has been proposed [6]. Prematurity, low Apgar score and intrauterine fetal death are more common in anemic pregnant women compared to non anemic [7]. Mild anemia usually has no effect on pregnancy except that the mother may become anemic in subsequent pregnancies due to low iron stores; on the other hand severe anemia is associated with poor outcome as tachycardia, dyspnea and high cardiac output failure which may be fatal [8]. During pregnancy, iron requirements increases thus exacerbating the prevalence of anaemia, also there is a disproportionate increase in plasma volume more than red cell mass resulting in a physiological drop in hemoglobin level (Hb) in the mid trimester [9].

Anemia in pregnancy could be due to malnutrition, blood loss, infections, chronic diseases, parasites and chronic hemolysis, and several risk factors have been recognized as unhealthy lifestyle, multiple pregnancies, alcohol, smoking, and menstrual disorders [3]. Iron and folic acid deficiency are the two most prevalent causes of anemia in pregnancy [6] [10], with subsequent fetal complications as IUGR, low birth weight, and prematurity, while vitamin B12 deficiency is rare during pregnancy as it usually causes infertility [11].

Approximately 5% of the world's populations are carriers of inherited hemoglobin disorders. Affected women with hemoglobinopathies commonly desire pregnancy when they reach childbearing age because of advances in hematological management. Successful pregnancy is possible with coordinated obstetric and medical management, and over 332,000 affected births occur annually worldwide [12]. Kobak and colleagues reported for the first time the effects of sickle cell disease on pregnancy in 1941 [13]. Pregnant women with sickle cell disease are commonly associated with complications as bacterial infection, preterm delivery, pre-eclampsia, stillbirths, and increased the risk of maternal and perinatal mortality [14] [15].

The aim of our study is to assess the prevalence of anemia in pregnant women, and evaluate the effect of severity of anemia on maternal and perinatal outcomes. Furthermore, in order to assess the relationship between maternal hemoglobin level and neonatal measures.

2. Patients and Methods

This retrospective cohort study was conducted at the Department of Obstetrics and Gynecology of Ibn Sina College Hospital. It consisted of a study population of all anemic pregnant women who had delivered in our hospital between July 2014 and December 2016. Anemia was defined according to WHO classification (mild: 10 - 10.9 gm/dl, moderate: 7 - 9.9 gm/dl, severe: < 7 gm/dl) [16]. This study was approved by the Hospital Research Ethics Committee and has been performed in accordance with the ethical standards as in Declaration of Helsinki (1964) and its later amendments.

Sample Size Justification

The required sample size has been calculated using the Med Calc statistical software VAT registration number is BE 0809 344 640. Med Calc Software is a corporate member of the American Statistical Association. Member of the International Association of Statistical Computing.

A previous study reported that the incidence of anemia in pregnant women was approximately 40.0%. From the reported data of that study, it is calculated that approximately 40.0% of women were anemic. So, it is estimated that a sample size of 2500 pregnant women from the hospital. A power of the study was 80% (type II error, 0.2) to detect a statistically significant difference of 3% between the anemic women using a two-sided chi-squared test with a confidence of 95% (two-sided type I error, of 0.05). This difference corresponds to a small effect size (w) of 0.07. The effect size (w) is calculated as follows (Chow *et al.*, 2003):

$$W = \sqrt{X^2 / N}$$

where χ^2 is the chi-squared statistic and N is the total sample size. *The sample size was at least* 2500 *pregnant women*.

Data collected retrospectively from anonymised hospital records; inclusion criteria include all pregnant women more than twenty weeks gestation, singleton pregnancy. Exclusion criteria include multiple pregnancies and patients who had pre-gestational systemic diseases such as, renal disease, diabetes mellitus, and hypertension. Data retrieved from files include socio-demographic profile of the mother as maternal age, anthropometric measurements [height, weight, body mass index (BMI)], smoking, women's educational and employment status. We collected data on obstetrics, and gynecology profile including gestational age (from the first day of last menstrual period), parity, medical supplementation during pregnancy, preterm labor (before completed 37 weeks), preeclampsia, mode of delivery, and post-partum hemorrhage. We also collected data on neonatal anthropometry (length, weight, and head circumference), Apgar score, and neonatal care unit admission.

3. Statistical Analysis

The collected data were coded, tabulated, and statistically analyzed using IBM

SPSS statistics (Statistical Package for Social Sciences) software version **22.0, IBM Corp., Chicago, USA, 2013.** Descriptive statistics were done for quantitative data as minimum & maximum of the range as well as mean ± SD (standard deviation) for quantitative parametric data, while it was done for qualitative data as number and percentage.

Inferential analyses for independent variables were done using Chi square test for differences between proportions and Fisher's exact test for variables with small expected numbers, while correlations were done using Pearson's correlation for numerical parametric data. T-test was used to compare between two groups if mean and S.D. was used. The level of significance was taken at P value < 0.050 is highly statistically significant, otherwise is non-significant. The p-value is a statistical measure for the probability that the results observed in a study could have occurred by chance.

4. Results

A total of 2654 pregnant women fulfilled the inclusion criteria, 42% were anemic and they were sub-classified into mild group 83.3% (929/1115) that represents the majority of patients and moderate to severe group 16.7% (186/1115) of total anemic women. According to the etiology of anemia, the majority of cases were due to iron deficiency anemia 92.8%, while 7.2% were due to sickle cell trait, B-thalassemia intermedia, and other causes. (Figure 1 and Figure 2) The socio-demographic characteristics of the study participants are illustrated in Table 1. There were no statistically significant differences between the two groups regarding BMI, educational level, smoking, and medical supplementation during pregnancy. It is observed that mild anemia was more prevalent among women below 30 years of age, while moderate to severe anemia was more prevalent above 30 years of age, and the mean maternal age was significantly higher in group II compared to group I (28.2 ± 4.01 Vs 27.6 ± 3.25 ; $p = 0.015$ respectively). The majority of anemic patients were unemployed 56.3% which was significantly higher in group II than group I, and 40.7% of anemic patients were illiterate.

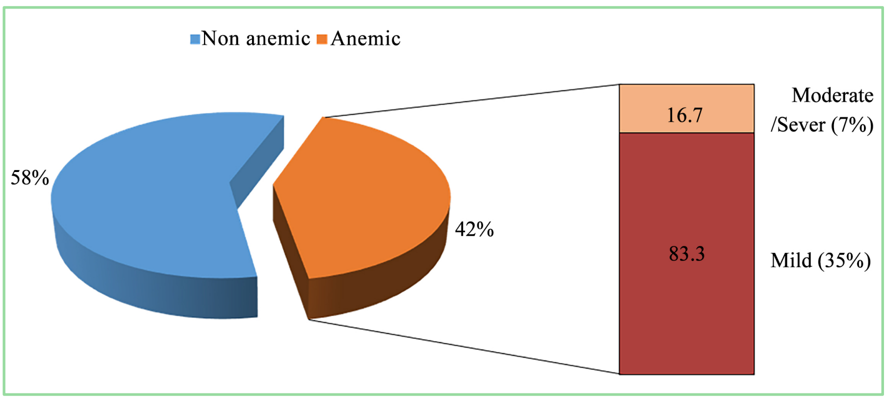

Figure 1. Incidence and severity of anemia in the studied patients.

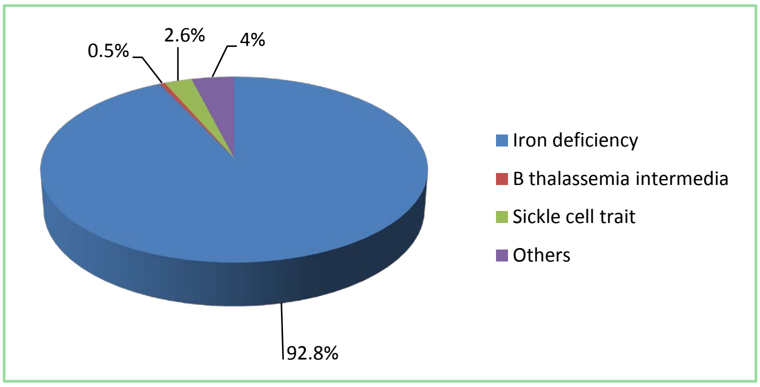

Figure 2. Causes of anemia in the studied patients.

Table 1. Socio-demographic characteristics of anemic women in both groups.

Parameter	Group I (mild) "n = 929"		Group II (moderate/severe) "n = 186"		P value
	No.	%	No.	%	
Maternal age					
Below 30	632	68	78	41.9	0.001*
Above 30	297	32	108	58.1	
Mean ± SD	27.6 ± 3.25		28.2 ± 4.01		0.015*
BMI					
Mean ± SD	24.3 ± 3.21		23.7 ± 4.09		0.107
Medical supplementation					
Multivitamin supplementation	223	24	35	18.8	
Iron supplementation	288	31	38	20.4	0.113
None	418	45	113	60.8	
Education					
Post high school	241	25.9	24	12.9	
Pre high school	301	32.4	95	36.0	0.107
illiterate	387	41.7	67	51.1	
Smoking	102	11	26	14	0.210
Booking					
Booked	642	69.1	119	64.0	0.207
Unbooked	287	30.9	67	36.0	
Employment Status					
Employed	427	46.0	60	32.3	0.005*
Housewife	502	54.0	126	67.7	

Data presented as numbers (%) or mean ± SD; *Significant (P < 0.05); BMI: body mass index.

As expected the mean hemoglobin level was significantly lower in group II compared to group I (8.77 ± 0.71 Vs 10.2 ± 1.8; $p = 0.001$ respectively), and anemia was more prevalent among multigravid women 60.1% which was significantly higher in group II compared to group I (66.1% Vs 59%; $p = 0.048$ respectively). Moreover the incidence of postpartum hemorrhage, cesarean delivery, and infections was significantly higher in group II compared to group I (5.4%, 40.3%, 3.8% Vs, 2.9%, 31.0%, 2.0%; $p = 0.007, 0.041, 0.043$ respectively) (Table 2).

Regarding perinatal outcome, low Apgar score, preterm labor, and low birth weight babies were significantly higher in group II compared to group I (11.8%, 12.9%, 11.3% Vs 8.7%, 9.0%, 7.4%; $p = 0.034, 0.046, 0.032$). On the other hand, there were no significant differences between both groups regarding IUGR, neonatal anemia, and neonatal mortality. Table 3 When maternal hemoglobin level was correlated with other parameters, we established a significant positive correlation between maternal hemoglobin level and low birth weight (r = 0.325, p = 0.016), low Apgar score (r = 0.333, p = 0.009), and neonatal hemoglobin level (r = 0.421, p = 0.001), in addition to another significant positive correlation between neonatal hemoglobin level and low birth weight (r = 0.32, p = 0.023).

Table 2. Obstetric characteristics of anemic women in both groups.

Parameter	Group 1 (mild) "n = 929"		Group II (moderate/severe) "n = 186"		P value
	No.	%	No.	%	
Hemoglobin					
Mean ± SD	10.2 + 1.8		8.77 ± 0.71		0.001*
Gestational age (weeks)					
Mean + SD	37.9 + 2.50		37.2 + 3.84		0.083
Labor					
Pre-term labor	84	9.0	24	12.9	0.046*
Term labor	845	91.0	162	87.1	
Parity					
Primigravida	381	41.0	63	33.9	0.048*
Multigravida	548	59.0	123	66.1	
Delivery					
Cesarean section	288	31.0	75	40.3	0.041*
Vaginal	641	69.0	111	59.7	
Pre-eclampsia	57	6.1	14	7.5	0.107
Post partum hemorrhage.	27	2.9	10	5.4	0.007*
Infection (chorioamnitis-wound infection)	19	2.0	7	3.8	0.043*

Data presented as n (%) or mean ± SD, *Significant ($P < 0.05$).

Table 3. Maternal anemia and perinatal outcome.

Parameter	Group 1 (mild) "n = 929"		Group II (moderate/severe) "n = 186"		P value
	No.	%	No.	%	
Prematurity	84	9.0	24	12.9	0.046*
IUGR	65	7.0	20	10.8	0.107
Low Apgar score (1 minute)	81	8.7	22	11.8	0.034*

Continued

Mean ± SD	6.65 ± 2.01		5.21 ± 1.72		0.025*
Low Birth weight < 2500 gm	69	7.4	21	11.3	0.032*
Meconium stained liquor	102	11.0	16	8.6	0.211
NICU admission	98	10.5	25	13.4	0.336
Respiratory distress	50	51.0	15	60.0	
Prematurity	27	27.6	7	28.0	
Others	21	21.4	3	12.0	
Neonatal mortality	5	0.5	3	1.6	0.098
Neonatal anemia	84	9.0	23	12.4	0.211
Birth weight Mean ± SD	2960 ± 365.2		2750 ± 422.5		0.011*
Length	48.0 ± 3.92		46.8 ± 4.22		0.322
Head circumference	37.0 ± 2.2		36.4 ± 3.0		0.265

Data presented as numbers(%) or mean ± SD; *Significant ($P < 0.05$); IUGR: intrauterine growth restriction; NICU: neonatal intensive care unit.

5. Discussion

Anemia during pregnancy is a leading public health problem especially in poor and developing countries, it affects 30% - 60% of pregnant women [17]. In 5% - 10% of cases anemia is severe and associated with adverse effects on pregnancy outcome [18]. The main causes of anemia involve nutrient deficiencies, infections, bleeding disorders and inherited disorders as hemoglobinopathies [19]. The prevalence of anemia depends upon socioeconomic status, parity, associated medical problems and regular antenatal care. The extent to which the maternal hemoglobin concentration affects the fetal outcome is still uncertain [20]. Two large studies published by Murphy *et al.* and Garn *et al.* included over one million pregnancies, they showed that unfavorable pregnancy outcomes are more frequent among anemic mothers [10] [21].

In our study anemia was prevalent in 42% of pregnant women, 83.3% mild anemia while 16.7% moderate to severe anemia. Many studies showed the prevalence of anemia in pregnancy with different percentages as Hussein *et al.* they evaluated 1721 pregnant women in Tanzania, anemia was prevalent in 68% out of which 5.8% was of moderate to severe anemia [22]. Koura *et al.* stated that prevalence of maternal anemia at delivery was 39.5%, in Benin [23]. Nair *et al.* in another study showed that 35% of pregnant Indian women had moderate to severe anemia, while Levy *et al.* showed that 14% - 62% of women in developing countries, and 16% - 29% in developed countries are suffering from anemia [24] [25].

With consideration to the etiology of anemia among pregnant women, in the present study iron deficiency anemia was the most prevalent type 92.8%, Sickle cell trait 2.6%, and B-thalassemia intermedia 0.5% and anemia due to chronic hemorrhage 4% as ante-partum hemorrhage, piles, and parasitism. In the same context, we also observed that 60.8% in group II and 45% in group I pregnant women did not have any medical supplementation at antenatal care in the form of multivitamin or iron supplementation. Therefore, once anemia is recognized, the possibility of iron deficiency should be considered [26]. Abbaspour *et al.* reported that up to 50% of women even in developed countries have poor iron residual supplies, and are at risk of developing anemia if became pregnant [27]. Beck *et al.* in UK found that 40% of women aged 19 - 34 years had iron levels below the recommended levels [28]. We found 2.6% of anemic women sickle cell carriers while Al Qahtani *et al.* reported 1.1% sickle cell disease among pregnant Saudi women, 0.5% maternal deaths, and fetal growth restriction and stillbirths accounted for 65.6% of the perinatal mortality [14].

According to the age group, we found that 68% of mild anemic pregnant women were below thirty years of age, on the other side 58.1% of moderate to severe anemic pregnant women were above thirty years of age. This is in agreement with previous studies done in UAE by Ahmed *et al.* they found out that anemia was more common (59.6%) among women ≤ 30 years of age, likewise another study done in Ethiopia by Kefiyalew *et al.* [29] [30].

Although, the majority of patients were booked but anemia was frequent among them 68.2%, which could be attributed to different timing of booking in relation to three trimesters of pregnancy. On contrary to our results Nwizi *et al.* concluded that Women who booked late for antenatal care had a higher risk for anemia [31]. We evaluated the prevalence of anemia in relation to gravidity, we reported higher frequency of anemia in multigravida women 60.1% in comparison to primigravida women 39.9%, this is consistent with previous study done by Zama *et al.* in Nigeria and they concluded that multiparity was one of the etiological factors of anemia in pregnancy [32].

The association between maternal anemia in pregnancy and adverse perinatal outcome was evaluated in the current study, our data concluded that there was increased risk of premature delivery, LBW babies, PPH. Our results showed that LBW was 8% in anemic pregnant women, and it was significantly higher in group II compared to group I in (11.3% Vs 7.4%, $P = 0.032$ respectively). On the other hand Hussein *et al.* Koura *et al.* and Nair *et al.* reported 14% 11.3%, 27 prevalence of LBW among anemic mothers. [22] [23] [24]. Moreover, *Lone et al.* concluded that low birth weight babies were 9 times more common in anemic pregnant women compared to non anemic in 626 pregnant women [7]. We also documented a significant positive correlation between maternal Hb and low birth weight which is in line with previous studies [33] [34]. On the other side other studies failed to find such relationship [35] [36] [37] [38].

Prematurity was present in 9.6% of our cases, which was significantly higher in group II compared to group I in (12.9% Vs 9%, $P = 0.046$ respectively). In agreement with our results Karaflahin *et al.* and Hussein *et al.* reported 9.9% and 17% preterm delivery in anemic group [39] [22]. Lone *et al.* studied 626 pregnant women and found that preterm delivery was 4.1 times more common in anemic pregnant women compared to non anemic [7]. On the other hand, *Levy* *et al.* in their retrospective study, they evaluated the preterm birth and birth weights of anemic pregnant women and found no association [25]. Bondevik *et al.* studied 1400 pregnant women and concluded that low birth weight and preterm birth rates were significantly higher when the maternal hematocrit under 24%. [40] Another study in India stated that severity of anemia is associated with preterm delivery as well as low birth weight with high rate of fetal mortality [41].

As regard Apgar score, we reported 9.2% low one minute Apgar score in anemic women, and neonatal mortality was 0.7%, which is consistent with Lone *et al.* reported that neonates of anemic women had 1.8 times increased risk having low Apgar scores at 1 minute [7]. When pregnant women were treated with iron in Niger, Apgar scores were significantly higher in those infants whose mothers received iron [42].

PPH is one of the most serious complications in anemic pregnant women, our data revealed 3.3% among all anemic women (2.9% in mild cases and 5.4% in moderate and severe cases) this is in agreement with previous studies concluded that anemia during pregnancy is associated with increased risk of PPH [5] [43]. Nair *et al.* in a recent study observed a 17-fold increased risk of PPH among pregnant women with moderate-severe anemia [24]. In consideration with the mode of delivery, the incidence of cesarean delivery was 31% in group I Vs 40.3% in group II, which was significant. Likewise Karaflahin *et al.* found that normal delivery was 69.8% in severe anemic mothers, while Normal delivery rate of mild cases was 72.5% [39].

6. Study Limitation

Our study had some limitations particularly the overlapping etiological factors of anemia in some cases which was considered by accurate interpretation of data, and sometimes the course of anemia was not clarified if it was gradual or sudden which required complete data about maternal hemoglobin level throughout three trimesters of gestation. This study raises interesting issues requiring further investigations for infants born to anemic mothers for the next months for better assessment of anemia and development of infants.

7. Conclusion

This study clarified that anemia is prevalent among pregnant women particularly mild anemia. Early diagnosis and treatment at regular antenatal care from first trimester has an essential role in managing maternal anemia and it reflects directly on the perinatal outcome. Prematurity, low birth weight infants, and postpartum hemorrhage are the commonest maternal and neonatal complications.

Declaration of Funding

This study was not funded.

Conflict of Interest

The authors declare that they have no conflict of interest.

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