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Prevalence of Anemia Among Pregnant Women Attending Antenatal Care in Dhamar Governorate, Yemen: A Cross-Sectional Study

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SUMMARY

Background: Anemia, a chronic condition affecting millions globally, poses greater risks to pregnant mothers, particularly in regions like Yemen. However, data on pregnancy-related anemia in Yemen is scarce. This study aimed to gauge anemia prevalence in Yemen's Dhamar governorate, identifying associated pregnancy-related risk factors.
Methods: Through a questionnaire-based cross-sectional study involving a total of 157 pregnant participants, data on sociodemographics (age, education, income) and health history (gestational age, parity, hemorrhage) were collected. Utilizing SPSS v25, frequencies, percentages, and binary logistic regression (OR, AOR) with 95% confidence intervals ($p<0.05$) were calculated.
Discussions: Results highlighted 17% of pregnant women in medical centers had anemia (43% of which are mild, 23% moderate, 33% severe). Significantly, rural residence and lower socioeconomic status were linked ($p=0.021$, 0.015) with AORs of 0.305 (CI: 0.111-0.835) and 3.86 (CI: 1.294-11.542).
Conclusion: In conclusion, anemia affects pregnant women, particularly those in rural areas with lower incomes. Addressing this requires targeted medical interventions to mitigate anemia's prevalence and impact during pregnancy.

Keywords: anemia, pregnant mothers, Hb, cross-sectional study

INTRODUCTION

Anemia can be defined as the reduction of hemoglobin (Hb) or red blood cells count (RBC) below normal range. Patients with anemia usually have undistinguishable symptoms like pallor, lethargy and tiredness, but others exhibit acute signs such as shortness of breath. The potential consequence is the gradual hypoxia status of many tissues in the body. The pattern of clinical signs depends on the underlying cause as well as the severity of anemia together with available comorbidities. Notably, clinical manifestations begin to develop whenever Hb drops below 7 g/dl [1]. However, WHO has detailed classification of the severity of anemia during pregnancy with 10.9-10 g/dl range is mild, 9.9-7 g/dl moderate and < 7 g/dl severe based on Hb concentration [2,3]. Globally, approximately 36.8% of pregnant women are anemic, and based on the severity of anemia, mild anemia was the highest (70.8%). Around half of the anemia in pregnancy was found in the third trimester (48.8%) [4]. In the developing world, many countries suffer from poor nutrition, recurrent infections together with multiple pregnancy cases which render women prone to anemia [5,6]. These factors are attributed to the low socio-economic status of those countries. Nevertheless, the most common type of anemia is iron deficiency anemia (75% of all cases) [7] followed by

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macronutrient (iron, folate and cyanocobalamin) [8] or micronutrient (vitamins A, B6, C, and E) deficiency [9]. The consequences of a mother having anemia during pregnancy include premature labor, abortions and low-weight birth baby, among others [10]. The risk goes also toward pregnant mother where preeclampsia was demonstrated in few cases and even morbidity in rare cases [11].

Numerous studies have consistently identified socioeconomic factors as significant risk factors for pregnancy anemia. Pregnant women from lower socioeconomic backgrounds, including those with lower education levels, lower income, and residing in rural areas, are at a higher risk of developing anemia during pregnancy due to limited access to nutritious food, healthcare facilities, and antenatal care [12,13].

Maternal nutritional status is another significant risk factor for pregnancy anemia. Pregnant women with inadequate intake of iron, folic acid, and essential nutrients are at an increased risk of developing anemia during pregnancy [14]. Additionally, women with pre-existing medical conditions such as sickle cell anemia or thalassemia are also at a higher risk of developing anemia during pregnancy. Furthermore, studies have shown that parity, gestational age, and maternal age are additional risk factors for pregnancy anemia. Women with higher parity, advanced maternal age, and later gestational age have been found to be at a higher risk of developing anemia during pregnancy [15].

The previous literature concerning prevalence of pregnancy anemia in Yemen is limited. Therefore, the goal of this study was to screen the prevalence of anemia in pregnant women attending antenatal care in Dhamar governorate, Yemen. The investigation of the attributing factors was also discussed.

METHODS

Study area and population study

This was a cross-sectional study designed to evaluate prevalence and risk factors associated with anemia among pregnant women in clinics and antenatal centers and medical hospitals of Dhamar city, Yemen. The study was carried out during the period between September and December 2021 in Dhamar city, one of the 12 directorates of Dhamar Governorate, Yemen. Dhamar city is located 100 km south of the capital, Sana'a. Altitude is about 2,400 meters above sea level. Population was 173,000 according to 2004 national statistics.

Sample size and inclusion/exclusion criteria

All pregnant mothers in any age, socioeconomic level or pregnancy trimester admitting to antenatal care or medical hospitals and accepted to participate were recruited to the current study. A total of 157 (response rate of 98%) pregnant women agreed to participate in the present study. Individuals with missing information or those who refused to measure Hb were excluded from this study to avoid inconsistency. Main methodology figure of the present study is provided in Fig 1.

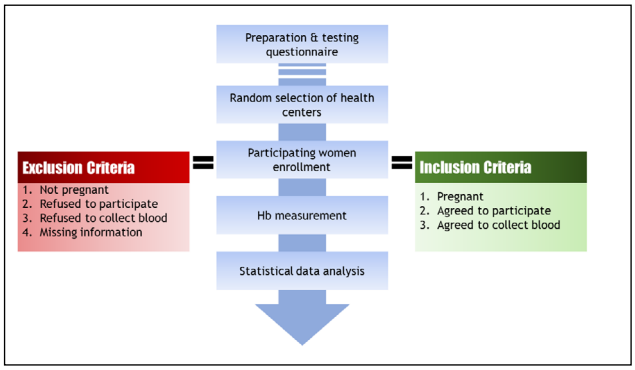

Figure 1. Flowchart showcasing the main steps in conducting this study along with inclusion and exclusion criteria

Recruitment and Data collection

The data of the present study was gathered through interviewing the pregnant women face to face after getting informed consent using structured and pre-tested questionnaire. The questionnaire was originally developed in English and then translated into Arabic (mother language). The tested and validated questionnaire contained a series of questions regarding sociodemographic characteristics (age, residence, education, family income) and health history (gestational age, number of springs, hemorrhage incidence) (detailed in Table 1). The Hb is the most prominent and the most important among the questionnaire questions. The questionnaire information were developed based on standard previous reports [16,17].

Descriptor	Definition
Urban	Within the borders of the city (otherwise rural)
Literate	secondary school or higher (otherwise illiterate)
Poor	Mean monthly income < $100 (otherwise good)
Malnourished	BMI < 18 (25 < BMI > 18 well-nourished)

Table 1. Definition of demographic descriptors and other risk factors

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Sample collection and processing

All participants enrolled in this study was asked for permission to withdraw a 5-ml blood sample. A qualified lab technician was responsible for blood collection. If not was directly used to measure Hb using a ready-to-use colorimetric kit (SPINREACT, Spain), the blood sample was stored in the refrigerator at 4°C.

Ethical approval

Prior to conducting this study, ethical clearance was obtained from the Biochemical Technology Program at Dhamar University (approval number FAS2021-18). In addition, a consent permission letter was submitted to the Ethical Review Committee of the university to obtain approval for the study protocol. This letter was then presented to the antenatal care centers and medical hospitals that participated in the study, in order to ensure that all participants provided informed consent before any data was collected. These measures were taken to ensure that the study followed ethical guidelines and protected the rights and welfare of the participants.

Statistical analysis

The dataset underwent a thorough cleaning and coding process before being inputted into statistical package for social sciences (SPSS® package, version 25) software for comprehensive analysis. The outcome variables were categorized into binary groups, with '1' indicating anemia and '0' representing the control group. Age, number of offspring and Hb variables were dichotomized also. To explore the relationships between the predictor variables and the outcomes, "Exploratory" binary logistic regression models were employed. Each independent variable was subjected to bivariate analysis to detect any associations with the dependent variable, using a significance threshold of $P < 0.05$. To adjust for potential confounders, multivariate logistic regression analysis was conducted, also at a significance level of $P < 0.05$. The strength of the associations was quantified using adjusted odds ratios (AOR) with 95% confidence intervals (95% CI), ensuring the interpretation of the findings was robust. All statistical procedures adhered to established analytical standards.

RESULTS

Socio-demographic information

Based on the surveyed sample, a total of 157 pregnant mothers were enrolled in the current study. Of whom, about two-thirds (64.3%) was less than 30 years old while 35.7% was more than 30 years. About 53.5% of the participants reside in rural regions of Dhamar governorate. Approximately two-thirds (68.8%) of the pregnant women were literate. Demographic characteristics are summarized in Table 2.

Character	Frequency	Percent
Age		
< 30	101	64.3%
> 30	56	35.7%
Residence		
Rural	84	53.5%
Urban	73	46.5%
Educational level		
Illiterate	49	31.2%
Literate	108	68.8%
Offspring		
< 4	93	59.2%
> 4	64	40.8%
Gestational age		
< 18 weeks	72	45.9%
> 18 weeks	85	54.1%
Socioeconomic level		
Poor	101	64.3%
Good	56	35.7%

Table 2. Percentage of socio-demographic characteristics of the enrolled participants

Prevalence of anemia

Our results, as shown in Fig 2, indicated that the severity of anemia was distributed to the three main categories in the anemic pregnant mothers. The majority of anemic mothers had mild anemia (43.33%) while 23.33% had moderate anemia. Moreover, 33.33% of the anemic pregnant women had severe anemia. Collectively, the anemia in pregnancy as a whole constituted nearly 17% from all pregnant mothers.

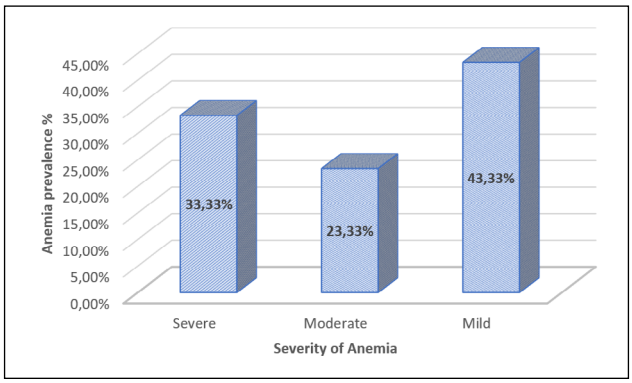

Figure 2. Distribution of anemia according to severity

Risk factors

AOR of 2.418 (95% CI = 0.699-8.365) between age and pregnancy anemia means that older women (above 30 years) have 2.418 times higher odds of developing anemia during pregnancy compared to younger women (below 30 years). However, the p-value of 0.163 suggests that this result could be due to chance and is not statistically significant. This means that more evidence is needed to confirm whether age is a significant risk factor for anemia during pregnancy. Women living in rural areas are much more likely to develop anemia during pregnancy than women living in urban areas, according to the odds ratio of 0.305 (95% CI = 0.111-0.835) with statistically significant outcome (p value = 0.021). We also obtained an AOR of 0.583 between education (illiterate and literate) and pregnancy anemia indicating a negative association between education and anemia in pregnancy, signifying that literate women may have a lower risk of developing anemia during pregnancy. However, the AOR of 0.583 is relatively small, indicating that the effect of education on the risk of anemia may not be substantial. Additionally, it is important to note that this association does not necessarily imply causation, and other factors such as access to healthcare and nutrition may also contribute to the risk of anemia in pregnancy. The present study also found an AOR of 0.613 (95% CI = 0.187-2.011) for the relationship between the number of offspring (less than 4 and 4 or more) and anemia during pregnancy. This denotes that there could be a negative association between the two variables, implying that women with four or more children may have lower odds of developing anemia during pregnancy than those with fewer than four children. Nonetheless, the p-value of 0.42 indicates that this association is not statistically significant. Upon investigating the association between gestational age and the risk of anemia during pregnancy, an AOR of 0.4 was obtained. This mirrors a negative association between gestational age and anemia in pregnancy, i.e. women who are further along in their pregnancy may be at a lower risk of developing anemia albeit this difference was not statistically significant. Nonetheless, the direction of the association indicates that gestational age may be an important factor to consider when assessing the risk of anemia in pregnancy. Based on the significant AOR of 3.865 (95% CI = 1.294-11.542) with a p-value of 0.015, it can be concluded that there is a strong positive association between socioeconomic level and pregnancy anemia. The finding indicates that pregnant women with a poor socioeconomic status are at a significantly higher risk of developing anemia compared to those with a good socioeconomic status. Therefore, efforts to improve socioeconomic conditions for pregnant women may be an effective preventative measure against pregnancy-related anemia. Similarly, the present study found that women who had less than three antenatal care visits might have a lower chance of developing anemia during pregnancy than those who had more than three visits, but this finding is not strong enough to say for sure (p value of 0.085). The odds of having anemia in pregnancy among those who are malnourished are 0.93 times the odds of having anemia in pregnancy among those who are not malnourished, after controlling for the effects of other variables in the statistical model. In other words, malnutrition appears to be negatively associated with anemia in pregnancy, but the effect is very small. The p-value of 0.894 indicates that the observed association between malnutrition and anemia in pregnancy is not statistically significant. Likewise, the same findings were obtained concerning twins, multigravida, smoking, hemorrhage and chronic diseases in which the causality was failed to be established nor statistical significance. The risk as well as logistic regression analysis are described in Table 3.

DISCUSSION

In the present study, we found that the prevalence of anemia among the pregnant women to represent 17% while the remaining 83% were at normal Hb range. Of the 17%, the severity was distributed to 43.33%, 23.33%, and 33.33% among mild, moderate and severe anemia. This reflects the wide distribution of anemia among pregnancy in Dhamar city which requires health measures to limit the incidence and, at the same time, provide medical interventions to "normalize" the anemic pregnant mothers. This necessitate the interplay among many health sectors to leading to a comprehensive solution.

In Sana'a (the capital city), the prevalence of anemia among was 25%; of which 70.83% had mild anemia, 28.13% had moderate anemia, and only 1.04% had severe anemia [18]. Another study in the capital city found higher prevalence rate (40%) [19]. These data confirm health burden of anemia in pregnancy in Yemen albeit it is decreasing, 40% in 2017, 25% in 2020 and 17 in 2021. This may lead us to the generalizability of anemia nationwide in Yemen according to the present literature.

We also analyzed the potential risk factors leading to anemia among pregnant women. These involved demographic factors such as age, residence, educational level, number of offspring, socioeconomic level and gestational age. Among all these demographic factors, only two factors, namely, residence and socioeconomic level were statistically significant (p value 0.021, 0.015) with AOR and CI of 0.305 (0.111-0.835), 3.86 (1.294-11.542). There is evidence to suggest that limited access to nutrition and healthcare services in rural areas may contribute to a higher prevalence of anemia among pregnant women. Pregnant women in rural areas may have limited access to nutritious foods, healthcare facilities, and prenatal care, which can increase their risk of developing anemia. Additionally,

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Factor	Normal	Anemic	Odds ratio (95% CI)	Adjusted odds ratio (95% CI)	P-value
Age < 30 > 30	 80 48	 21 9	1.400 (.593-3.305)	 2.418 (0.699-8.365)	 0.163
Residence Rural Urban	 74 54	 11 19	.422 (.186-.960)	 0.305 (0.111-0.835)	 0.021
Education Illiterate Literate	 43 85	 7 23	.602 (.239-1.513)	 0.583 (0.187-1.814)	 0.351
Offspring < 4 > 4	 76 52	 18 12	1.026 (.456-2.310)	 0.613 (0.187-2.011)	 0.42
Gestational age < 18 weeks > 18 weeks	 62 65	 10 20	.524 (.227-1.208)	 0.4 (0.146-1.097)	 0.075
Socioeconomic level Poor Good	 78 49	 23 7	2.064 (.824-5.171)	 3.865 (1.294-11.542)	 0.015
Antenatal care visits < 3 times > 3 times	 97 30	 18 12	.464 (.201-1.072)	 0.423 (0.159-1.124)	 0.085
Malnutrition Yes No	 53 74	 10 20	.698 (.302-1.612)	 0.93 (0.32-2.705)	 0.894
Twins Yes No	 8 119	 1 29	.513 (.062-4.265)	 0.524 (0.053-5.197)	 0.581
Multigravida Yes No	 61 66	 14 16	.947 (.427-2.101)	 0.942 (0.33-2.689)	 0.911
Smoking Yes No	 13 114	 4 26	1.349 (.407-4.474)	 1.056 (0.249-4.474)	 0.941
Haemorrhage Yes No	 19 108	 2 28	.406 (.089-1.847)	 0.415 (0.077-2.235)	 0.306
Chronic diseases Yes No	 9 118	 3 27	1.457 (.369-5.744)	 1.98 (0.34-11.539)	 0.447

Table 3. Multivariate binary logistic regression analysis of determinants of anemia among pregnant women

rural populations may have limited access to education about healthy behaviors during pregnancy, such as the importance of consuming a balanced diet and taking iron and folic acid supplements. These factors may contribute to a higher prevalence of anemia in rural regions compared to urban areas. Therefore, interventions to improve access to healthcare, nutrition, and education in rural areas may help to reduce the prevalence of anemia among pregnant women [20]. A low socioeconomic level is associated with an increased risk of anemia during pregnancy due to various factors. Women from lower socioeconomic backgrounds may have limited access to nutritious food, healthcare facilities, and antenatal care, which are crucial for maintaining maternal health and reducing the risk of anemia during pregnancy. Poor maternal nutrition is a significant risk factor for anemia during pregnancy, and women from lower socioeconomic backgrounds may not have access to the resources needed to maintain a balanced diet. Moreover, women from lower socioeconomic backgrounds may not be able to afford transportation to antenatal care visits or may have work obligations that prevent them from attending. Limited access to education about healthy

behaviors during pregnancy may also contribute to a higher prevalence of anemia in this population [21]. On the other hand, the clinical factors examined were antenatal care visits, malnutrition, twins, multigravida, smoking and chronic diseases. However, none of these factors was a significantly associated with the incidence of pregnancy anemia.

Globally, anemia is a prevalent health concern among pregnant women, with varying prevalence rates across different regions and countries. A systematic review and meta-analysis of 39 studies from low- and middle-income countries reported an overall prevalence rate of 38.2% among pregnant women, with the highest prevalence in South Asia (49.2%) and the lowest in Latin America and the Caribbean (18.7%). A separate study in Ethiopia found an overall prevalence rate of 58.9%. Anemia during pregnancy can result in adverse outcomes for both the mother and the fetus, such as preterm birth, low birth weight, and maternal mortality. Therefore, it is crucial to address this issue through interventions such as iron and folic acid supplementation, improving maternal nutrition, and managing underlying medical conditions [22,23]. Since WHO has accepted the lower normal limit of Hb in pregnancy to 11 g/dl, all values below this range is considered to be anemic [24].

Indeed, many reports assessed the prevalence of anemia during pregnancy in different geographic areas correlating wide factors with fluctuating outcomes. For example, an Ethiopian study found that 16.88% of pregnant women in the community were anemic (hemoglobin level < 11 g/dl). Multivariable analysis revealed that several factors were significantly associated with anemia. These included a history of malaria attack within the year prior to the study, a history of excessive menstrual bleeding, unplanned pregnancy, and a meal frequency of three times or less. These findings highlight the importance of addressing modifiable risk factors such as malaria prevention, menstrual health, family planning, and adequate nutrition to reduce the burden of anemia during pregnancy [25]. Our findings were in good agreement with this study with respect to anemia prevalence (16.88% versus 17% in our study).

Similarly, unmatched case-control study conducted in Jigjiga Somali region and East Ethiopia in 2019. This study has identified three significant predictors of anemia in pregnant women. The first predictor is an inadequate intake of red meat, with those who consume red meat 1-2 times a month or not at all being at a higher risk of anemia. The second predictor is insufficient consumption of green vegetables, with those who consume green vegetables 1-2 times a week or 1-2 times a month being at a higher risk of anemia. Finally, a mid-upper arm circumference (MUAC) of less than 23 cm was found to be strongly associated with anemia. These findings are statistically significant with p values < 0.05 and highlight the importance of consuming a balanced diet during pregnancy to prevent anemia and ensure a healthy pregnancy [26].

Other researchers conducted a prospective study of 300 pregnant women in India and found that 67% of them were anemic. The study found that maternal age, education, socioeconomic status, and hemoglobin level were significantly associated with anemia during pregnancy. The p-values for these associations were less than 0.05. Parity, occupation, and gestational age were not found to be significant risk factors for anemia during pregnancy [10].

Moreover, another study performed in Bangladesh found that the overall prevalence of anemia among pregnant women was 58.9%, with 36.3% being mildly anemic, 62.4% being moderately anemic, and 1.3% being severely anemic. Binary logistic regression analysis revealed that several factors were significantly associated with anemia among pregnant women. These factors include monthly family income between 11,000-20,000 Taka, joint family size, gestational age in the third trimester, birth spacing less than 2 years, excessive blood loss during previous surgery, consumption of 1-4 food groups in the past 24 hours, and not regularly having breakfast. These findings highlight the importance of addressing these factors in order to prevent anemia among pregnant women [27]. It seems that the data of anemia prevalence in East Asia (India and Bangladesh) regions correlate well with each other. Furthermore, East African regions (primarily Ethiopia) outputted similar findings, i.e. the major determinant was the geographic area, climate and their consequences on lifestyle and other environmental factors [28].

Limitation

The low sample size which is attributed to the war-torn mode of the general population. Moreover, the present study suffer from selection bias since Khat-chewing habit is greatly widespread even in women which could be a confounding factor since Khat's polyphenols chelate iron and prevent its intestinal absorption [7]. Also, Strong seasonal variation exists in the prevalence of moderate to severe anemia among pregnant women. During the dry season, the prevalence is lower (around 8.7%), while it increases significantly during the rainy season (reaching 41.2%) [29]. This could be another influencing factor that we did not examine.

CONCLUSION

This study found that anemia is prevalent among pregnant women in Dhamar governorate, Yemen, with 17% of pregnant women admitted to medical centers and health care centers having anemia. The severity of anemia varied, with 43% being mild, 23% moderate, and 33% severe cases. Residence in a rural area and having a lower socioeconomic level were identified as

significant risk factors for anemia during pregnancy. These findings underscore the need for appropriate medical interventions to reduce the prevalence and incidence of anemia during pregnancy, particularly among pregnant women living in rural areas and those with low income.

Facing pregnancy anemia is multifaceted and require different interventions, nutritional, healthcare and socioeconomic support. Nutritional interventions include encouraging iron, multivitamins (vitamin B9 and vitamin B12 for erythropoiesis and vitamin C for increase iron absorption) continuous intake and conducting awareness campaigns to educate pregnant women about the importance of proper nutrition during pregnancy. Healthcare intervention involve strengthening antenatal care services by ensuring regular check-ups for pregnant women. ANC visits provide opportunities for early detection and management of anemia, training healthcare providers, and improve data collection and reporting systems to monitor anemia prevalence and track progress. Lastly, addressing socioeconomic factors that contribute to anemia, such as poverty, low education levels, and inadequate food security besides the bad habits such as Khat-chewing (Tea consumption is linked to iron-deficiency anemia through inhibiting iron absorption [30,31]) are deeply necessary.

CONFLICT OF INTEREST

None declared.

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ABBREVIATIONS

AOR	adjusted odds ratio
CI	confidence intervals
Hb	hemoglobin
OR	odds ratio
RBCs	red blood cells
WHO	World Health Organization

AUTHOR CONTRIBUTIONS

All authors participated in study conception and design, data acquisition, analysis and interpretation, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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APPENDIX

Questionnaire:

Degree and Prevalence of Anemia among Pregnant Women in Dhamar City hospitals

1-Age, year(العمر)	<20	20-29	30-39	≥40
2-Residence (الإقامة)	(ريف)Rural		(مدينة)Urban	
3- Level of education (مستوى التعليم)	a. No educated غير متعلمة	b. Primary School اساسية	c. Secondary School ثانوية	d. University جامعيه

4-Number off springs عدد الاولاد	0-1	2-3	4-5	More than five

5-Gestational age عمر الحمل	a-First trimester الأشهر الثلثة الاولي	b-Second trimester الأشهر الثلثة الثانية	d-Third trimester الأشهر الثلثة الاخيرة

6-Socioeconomic level المستوى المعيشي	a-Good level مستوى جيد	b-Medium level مستوى متوسط	c-Bad level مستوى سيء

7-Antenatal care visits زيارات رعاية ما قبل الولادة	a-0-1visit	b-2-3Visits	C.4-5Visits	d. More than 5 Visits

8-Risk factors عوامل الخطر	Yes	No
a- Twins توأمان		
b. Multigravida		
C .Bad habits عادات سيئة		
d Smoking التدخين		
e. Hemorrhage النزيف		
f. Chronic diseases امراض مزمنة		

9-Level of hemoglobin (Hb):.....