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Prevalence and Associated Factors of Anemia Among Pregnant Women Residing at High Altitude in Yemen

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Abstract: Anemia continues to be a major health problem affecting the mother and her neonate in the developing countries. The present study was aimed to investigate the prevalence and risk factors of anemia among Yemeni pregnant women residing in Dhamar district 2400 meters above the sea level. This was a cross-sectional study aimed to investigate the prevalence and risk factors of anemia among Yemeni pregnant women residing in Dhamar district, 2400 meters above the sea level. A total of 420 pregnant women visiting the general Maternal and Child Center for antenatal care were randomly selected. A hemoglobin cutoff value of 12.3 g/dl was used for evaluating the prevalence of anemia, according to the recommendations of World Health Organization pertaining on altitude adjusted hemoglobin concentrations. The results found that the overall prevalence of anemia among the study population was 26.56%. Moderate-to-severe anemia accounted for almost one-quarter of the disease burden. Trimester of pregnancy and number of cesarean surgeries were retained by multivariate regression model as significant risk factors. Over first trimester, the prevalence risk for predicting anemia was more significantly associated with third trimester (APR = 3.00; 95% CI = 1.82, 4.94; P = 0.000) rather than second trimester of pregnancy (APR = 1.73; 95% CI = 1.01, 2.96; P = 0.047). The pregnant women undergone two or more cesarean surgeries were significantly at higher risk for anemia (APR = 1.63; 95% CI = 1.12, 2.38; P = 0.012). The present study revealed that anemia is still a public health problem among the pregnant women in Yemen. There is a need for intervening and controlling this jeopardy using effective programs and strategies.

Keywords: Anemia, Prevalence, Pregnancy, High Altitude, Yemen

1. Introduction

Anemia is a pathological condition in which the number of red blood cells or concentration of hemoglobin (Hb) is inadequate to cover all the physiological requirements for the human body. Its global burden is still enormous affecting all age groups of people, and it results in more than two billion cases worldwide with the highest prevalence among pregnant women and children [1-2].

In pregnant women, anemia is associated with short and long term negative health consequences. It affects the health and productivity of mothers, children, and community. Recent estimates suggest that anemia during pregnancy causes about 700,000 deaths worldwide annually [3]. The association of anemia with growth retardation and poor cognitive function of children, and work productivity are well documented [4-5]. These negative consequences may continue to affect the development of the country and cause low work and economy productivities which trap the community at risk of diseases in a circle of poverty and collapsed health facilities [6-7].

In the developing countries with low socioeconomic status, pregnant women suffer most from the adverse health

consequences of anemia in which the risk factors could be nutritional, clinical, and demographic factors. They are more prone to be affected with macro and micronutrient deficiencies, heavy menstruation, and blood loss associated with delivery, general inflammatory disorders, and infections [8].

The Republic of Yemen is one of the poorest and least developed countries in the world. It ranks 160 out of 188 countries in 2015 [9]. An estimated 42% of the people are poor, and 80% of the country's poor people live in rural areas and most of them depend on agriculture for their livelihoods [10]. Maternal mortality in Yemen are the highest among the Middle East Countries being 370 per 100,000 live births [11]. Furthermore, 25% of women are estimated to be malnourished [12]. Although the prevalence of anemia among pregnant women in Yemen has not yet been well documented nationwide, limited data indicates that prevalence of this burden among pregnant women [13]. Therefore this study aims to estimate the prevalence and associated factors of anemia among Yemeni pregnant women in Dhamar district using altitude adjusted hemoglobin cutoff.

2. Methodology

2.1. Study Area and Study Population

The study was performed in Dhamar district, which is one of 12 districts belonging to Dhamar governorate, Yemen. Dhamar district is located 100 km to the south of the capital Sana'a. The altitude is about 2400 meter above sea level with population of 173,000 in 2004 [14]. The district is enclosed the general Maternal and Child Center, which is the main maternity facility in Dhamar city and accessible to women from most part of the districts.

The sample size was determined based on single population proportion formula, with a 95% CI, 5% absolute Poisson and assuming that 30% of pregnant women are anemic. Pregnant women were randomly selected from RHC and total of 420 were successfully enrolled in this study.

2.2. Study Design

This was a cross- section study designed to assess the prevalence and associated risk factors of anemia among pregnant women attending antenatal or medical clinics at the general Maternal and Child Center in Dhamar district, Yemen, between December 2014 and June 2015.

The study design was planned with a 95% confidence level and 0.50 expected frequency. Data were collected using pretested questionnaire, which contains sociodemographic characteristics (age, residence, education, occupation household income and other), obstetric and gynecological history (trimester, gravidity, number of living children, number of cesarean surgery and others), and dietary habits (intake of meat, fruits, and using iron supplementation).

Anemia during pregnancy and the degree of anemia was defined according to the World Health Organization (WHO) criteria [1]. Altitude adjustments of Hb (1.3g/dl) for altitude 2400 meter was used to develop the cutoff of anemia and the

severity of anemia based on the WHO report on Hb concentration for the diagnosis of anemia and assessment of severity [1]. A pregnant woman with Hb less than 12.3g/dl is considered anemic. The degree of anemia was determined as mild (Hb = 10.3- 12.2 g/dl), moderate (Hb = 8.3- 10.2 g/dl) and severe anemia (Hb < 8.3 g/dl).

Exclusion criteria was including those who are too sick, cases of dysfunctional uterine bleeding, any other diagnosed diseases especially hemoglobinopaties, renal and liver disease, history of multiple pregnancy and those not willing to participate in the study.

An ethical committee approval has been obtained for the study protocol. Informed consents were obtained from the respondents prior to the data collection.

2.3. Sample Collection and Processing

Blood sample was collected from each pregnant woman after completing the interview by trained laboratory nurses. Hb was detected using Beckman Coulter AcT 3 diff haematology analyzer from Beckman Coulter (Fullerton, CA, USA) [15].

2.4. Data Analysis

Data were analyzed using Statistical Package for Social Science (SPSS) version 23. Anemia (Hb < 12.3g/dl) was analyzed as the dependent factor dichotomously (0 = Hb $\geq$ 12.3 g/dl, 1 = <Hb 12.3g/dl). The potential risk factor of anemia were age, age at marriage, residence, education, family income, dietary habits trimesters, gravidity, number of living children and number of cesarean surgeries. The prevalence ratio (PR) of anemia was developed using Poisson regression analysis [16]. Univariate analysis was used to assess the association of the potential risk factors with anemia. Potential factors that showed an association with anemia at a P value of $\leq$ 0.2 was used to adjust the multivariate model. The adjusted PR was then calculated. This study used a P value of $\leq$ 0.05 as the level of significance.

3. Results

3.1. Socio-demographic Characteristics of the Participants

Table 1. Socio-demographic characteristics of pregnant women in Dhamar district, Yemen (No = 420).

Characteristics	Frequency (%)
Maternal age	
16 – 24	210 (50.0)
25 – 34	168 (40.0)
$\geq$ 35	42 (10.0)
BMI (kg/m^2)	
$\leq$ 24.9	264 (62.9)
> 25	156 (37.1)
Age at marriage	
$\leq$15	86 (20.5)
>15	334 (79.5)
Residence	
Urban	238 (56.7)
Rural	182 (43.3)

Characteristics	Frequency (%)
Education	
≥ 6 years formal education	178 (42.6)
No formal education	240 (57.4)
Occupation	
Government employee	13 (3.1)
Housewife	407 (96.9)
Household income	
≥ USD 200/month	137 (32.6)
< USD 200/month	283 (67.4)

As shown in Table 1, 420 pregnant women participated in this survey. About 50% of them were in the age 16-24. The majority of the pregnant women were housewives (96.9%), and most of them were urban (56.7%), with no formal education (57.4%). On the other hand most of the participated were with house hold income less than 200USD (67.4%).

3.2. Obstetric Characteristics of the Participants

The obstetric characteristics of pregnant women are revealed in Table 2. Of the 418 participants, 114 (27.3%) were reported to be in the first trimester, 162 (38.7%) in the second trimester, and 142 (34%) in the third trimester. One third of the respondent had no living children, 50% had less than four children, and 11% had five or more at the time of study. Half of the pregnant women 204 (48.8%) said they had one to two antenatal care visits during the present pregnancy. Multi caesarean surgery were reported in 57 (13.6%) of the participants.

Table 2. *Obstetric characteristics of pregnant women (No = 420).*

Characteristics	Frequency (%)
Trimester of pregnancy	
First trimester	114 (27.3)
Second trimester	162 (38.7)
Third trimester	142 (34.0)
Gravidity	
Primigravidae	107 (25.5)
Multigravidae	313 (74.5)
Number of living children	
Nil	129 (30.7)
1 – 2	155 (36.9)
3 – 4	90 (21.4)
≥ 5	46 (11.0)
ANC frequency during current pregnancy	
1 – 2	204 (48.8)
3 – 4	147 (35.2)
≥ 5	67 (16.0)
Number of cesarean surgery	
0 – 1	363 (86.4)
≥ 2	57 (13.6)

3.3. Dietary Habits of Pregnant Women

The dietary habits and iron supplementation are shown in Table 3. Daily eating of meat and fruits were only reported between 15% and 26% of the participants. However half of the participants eat vegetable every day. Of 420 pregnant women 60.5% of them were using Iron supplementation on the time of this study. Majority of the participants were not reporting to be a physically active.

Table 3. *Dietary habits of pregnant women (No = 420).*

Characteristics	Frequency (%)
Eating meats every day	
Yes	63 (15.0)
No	357 (85.0)
Eating fruits every day	
Yes	110 (26.2)
No	310 (73.8)
Eating vegetables every day	
Yes	211 (50.2)
No	209 (49.8)
Using iron supplementation	
Yes	254 (60.5)
No	166 (39.5)
Physical work	
Yes	97 (23.1)
No	323 (76.9)

3.4. Prevalence and Degree of Anemia Among Pregnant Women
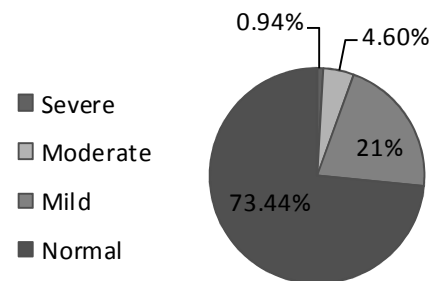

Figure 1. *Prevalence and degree of anemia among pregnant women.*

Prevalence and degree of anemia among pregnant women is shown in Figure 1. Among the 420 study participants, the overall prevalence of anemia (Hb < 12.3 g/dl), was estimated to be 26.56%. The degree of anemia among pregnant women was estimated based on the classification of WHO for the severity and degree of anemia in pregnancy plus the altitude adjusted value 1.3g/dl: mild anemia (Hb = 10.3- 12.2 g/dl), moderate anemia (Hb = 8.3- 10.2 g/dl), and severe anemia (Hb < 8.3 g/dl). The result of this study indicated 21% mild anemia, 4.6% moderate anemia, and 0.94% severe anemia among pregnant women.

3.5. Factors Associated with Anemia Among Pregnant Women

The association of relevant variables with anemia is presented in Table 4. Univariate analysis indicated that the third trimester (PR = 3.05; 95%CI = 1.83, 5.09; P = 0.000), the second trimester (PR = 1.83; 95% CI = 1.06, 3.16; P = 0.030), the cesarean surgery ≥ 2 PR = 1.56; 95% CI = 1.07, 2.26; P = 0.020) and those were not used to eat fruits (PR = 1.54; 95% CI = 1.01, 2.34; P = 0.046) and vegetables every day (PR = 1.50; 95% CI = 1.09, 2.08; P = 0.014) showed association with the prevalence of anemia. Logistic regression analysis confirmed that third trimester (APR = 3.00; 95% CI = 1.82, 4.94; P = 0.000), second trimester (APR = 1.73; 95% CI = 1.01, 2.96; P = 0.047), and cesarean surgery ≥ 2 (APR = 1.63; 95% CI = 1.12, 2.38; P = 0.012) were significant risk factors for prevalence of anemia among pregnant women in this study.

Table 4. *Factors associated with anemia among pregnant women in Dhamar district, Yemen (No = 420).*

Variables	Anemia (Hb < 12.3 g/dl)			
	Prevalence (%)	PR (95% CI)	APR (95% CI)	*P*
Age at marriage				
≤15	86 (20.5)	0.95 (0.64, 1.42)		0.800
>15	334 (79.5)	1		
Maternal age*				
≥ 35	35.7	1.39 (0.87, 2.21)	1.10 (0.60, 2.08)	0.167, 0.775
25 – 34	25.6	0.96 (0.71, 1.41)	0.92 (0.60, 1.40)	0.979, 0.599
16 – 24	25.7	1	1	
Residence				
Rural	43.3	1.13 (0.83, 1.56)		0.439
Urban	46.7	1		
Education*				
No formal education	29.6	1.28 (0.92, 1.80)	1.09 (0.79, 1.52)	0.140, 0.599
≥ 6 years formal education	23.0	1		
Household income*				
< USD 200/month	29.7	1.45 (1.00, 2.12)	1.34 (0.92, 1.94)	0.052, 0.125
≥ USD 200/month	20.4	1		
Trimester of pregnancy**				
Third trimester	40.1	3.05 (1.83, 5.09)	3.00 (1.82, 4.94)	< 0.001, < 0.001
Second trimester	24.1	1.83 (1.06, 3.16)	1.73 (1.01, 2.96)	0.030, 0.047
First trimester	13.2	1		
Number of living children*				
≥ 5	34.8	1.48 (0.88, 2.39)	1.00 (0.52, 1.90)	0.148, 0.989
3 – 4	27.8	1.16 (0.72, 1.2)	1.22 (0.65, 1.94)	0.531, 0.680
1 – 2	25.8	1.07 (0.72, 1.61)	0.96 (0.64, 1.45)	0.731, 0.859
Nil	24.0	1		
Gravidity				
Multigravidae	74.5)	1.13 (0.77, 1.65)		0.526
Primigravidae	107	1		
Number of cesarean surgery**				
≥ 2	38.6	1.56 (1.07, 2.26)	1.63 (1.12, 2.38)	0.020, 0.012
0 – 1	24.8	1		
Eating meat every day				
No	85	1.06 (0.67, 1.67)		0.806
Yes	15	1		
Eating fruits every day*				
No	29.4	1.54 (1.01, 2.34)	1.22 (0.72, 1.74)	0.046, 0.617
Yes	19.1	1		
Eating vegetables every day**				
No	32.1	1.50 (1.09, 2.08)	1.40 (.99, 1.99)	0.014, 0.057
Yes	21.3	1		
Using iron supplementation				
No	39.5	1.15 (0.83, 1.61)		0.402
Yes	60.5	1		

PR: prevalence ratio; *APR: adjusted prevalence ratio;* CI: confidence interval; P: level of significance
*Potential association (P ≤ 0.20), **Significant association (P < 0.05)

4. Discussion

This the first study to reveal the prevalence of anemia among pregnant women in Dhamar district Yemen, using a cutoff level of Hb <12.3 g/dl. Gratification for using the Hb level <12.3 g/dl as a cutoff for anemia in the study's subjects was based on the relation between Hb concentration and altitude oxygen concentration. Following the WHO recommendation [1], this study adjusted the cutoffs by adding 1.3 g/dL for the altitude of 2400 meter.

The overall prevalence of anemia among pregnant women involved in this study is 26.56%. This prevalence according to WHO classification of the public health importance of anemia is a moderate public health problem [17]. The prevalence shown in this study was comparable with the results reported from neighboring countries which indicated that prevalence of anemia among pregnant women in Oman 34%, Qatar 28%, Syrian Arab Republic 30%, Iraq 31%, Jordan 27%,%, Lebanon 27%, Libya 28%, United Arab Emirates 26%, Ethiopia 23%, Sri Lanka 26% and Iran, Islamic Rep 26% [13, 17]. On the other hand, the prevalence of anemia in the present study was lower than that reported in Tanzania (58.2%), Yemen (58.09%), Sudan (57.745), Guinea-Bissau (57.7%),

Senegal (57.58%), Vanuatu (57.3%), Cambodia (57.1%) and Angola (57.07%) [13].

The present study specifies that out of all pregnant women involved in this study 21% had mild anemia, 4.6% had moderate anemia, and 0.94% had severe anemia. These findings are also similar to the findings from other studies [18- 20].

Anemia occurs at all stages of the life cycle but its risk is higher in state of pregnancy. Anemia in pregnancy is related to different socio-demographic factors. In different studies, age, educational status, economic position, gravidity, miscarriage and gestational age were the major risk factors for anemia in pregnancy [21- 22]. Investigating the possible risk factors associated with anemia among the participants revealed that trimesters were important variables, which have shown a significant association with anemia. The risk of developing anemia was higher in third and second trimester. This finding is consistent with a study conducted in Saudi Arabia, India and Malaysia [23- 25]. This could be explained by the fact that there is an increase in hemodilution as a result of increase in estrogen level towards the end of gestational age [26]. Furthermore physiological requirements for iron in pregnancy are three times higher than in non-pregnant menstruating women and iron requirement increases as pregnancy advances. In addition to Iron 20% of women show a physiological drop in vitamin B12 levels during pregnancy, with lowest levels reached at third trimester [27].

Pregnant women who underwent two or more cesarean surgeries were found to have an increased risk of anemia during the present pregnancy. In fact cesarean sections are not without complications and consequences. A study in three London hospitals revealed that women who have caesarean sections run a 4-fold risk of suffering serious complications, including hemorrhage, infection and rupture of the uterus [28]. Retrospective review of almost 1000 cesareans, estimated blood loss of greater than 1000 ml was recorded in 9.2% of cesarean births, with 1% of women requiring a blood transfusion [29]. Bleeding during cesarean surgery leads to depletion of iron stores and reduction of erythropoiesis and therefore the Hb level falls.

5. Conclusions

This is the first cross-section study carried out among Yemeni pregnant women in Dhamar district. The prevalence of anemia among the study population is found to be 26.7%. Trimester of current pregnancy and multiple cesarean deliveries associated significantly with the disease. Using effective programs and strategies is imperative for improving the maternal health in this poor community. Further large national survey is recommended to estimate the magnitude of this public problem and to ascertain the causes and predisposing factors.

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