Research article

Prevalence of anemia and associated risk factors among pregnant women in an urban community at the North of Saudi Arabia

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Keywords

Anemia • Risk factors • Pregnant • Women

Summary

Background. *Anemia in pregnancy is common public health problem with poor outcome for both mother and child. This study, aimed to determine the prevalence of anemia and its associated factors among pregnant women in an urban community at the north of Saudi Arabia.*
Materials and methods. *A cross-sectional study was carried out among 390 pregnant attending for antenatal care in one of eight Primary Health Care (PHC) centers in Hail city, Saudi Arabia.*
Results. *Among participants, 133 (34.1%) were anemic (hemoglobin level < 11 g/dl). Out of which, 24.9% were mildly anemic, 9.2% were moderately anemic and none of the participant was found to be severely anemic. The prevalence of anemia increased significantly with low income (p = 0.026), bigger family size (p = 0.020), higher parity (p = 0.023), longer menstrual cycle > 5 days (p = 0.042), bleeding during pregnancy (p = 0.028), infrequent intake of meat (p = 0.020), the habit of drinking tea just after meals (p = 0.019), past history of anemia (p < 0.001), clinical anemia (pallor) (p < 0.001). On the other hand, increased BMI (p = 0.002) and frequent intake of food from restaurants (p = 0.008) were found to be negatively associated with anemia among pregnant women.*
Conclusion. *"In urban Hail region, Saudi Arabia, anemia among pregnant women was a moderate public health problem. Low income, bigger family size, higher parity, longer menstrual cycle > 5 days, bleeding during pregnancy, infrequent intake of meat, the habit of drinking tea just after meals, past history of anemia, and the sign of clinical anemia (pallor), were found to be significantly associated with anemia. These findings give insight to healthcare providers about the importance of early detection and management of anemia in early pregnancy. Further research utilizing prospective cohort design to study risk factors of anemia including rural areas, should be considered to support and extend the present study findings".*

Introduction

Anemia is a condition in which the number of red blood cells and consequently their oxygen-carrying capacity is insufficient to meet the body's physiologic needs. It is an indicator of both poor nutrition and poor health [1]. While some degree of dilutional anemia is very frequent and can be considered part of the normal physiology of pregnancy, iron deficiency anemia is likewise common during pregnancy but can have serious adverse health consequences for the mother and child [2].
Anemia in pregnancy is a worldwide health and social problem associated with mortality and morbidity in the mother and baby, including risk of miscarriages, stillbirths, prematurity, low birth weight, and severe neonatal complications needs admission to intensive care units [3-9].
World Health Organization (WHO), reported in 2015 that 38% of pregnant women have anemia globally, corresponding to 32 million pregnant women for the year 2011 [1]. Reducing anemia is recognized as an important component of the health of women and children, and the second global nutrition target for 2025 calls for a 50% reduction of anemia in women of reproductive age [3].
WHO, classified anemia among pregnant women in Saudi Arabia as severe public health problem with 40.0% prevalence at the national level [1].
A notable variation in anemia prevalence among pregnant women appears in studies carried out in different regions in Saudi Arabia [10-13]. This variation, implies the significance of carrying out a standardized regular national and local surveys to highlight temporal and spatial distribution of the problem, identify significant local risk factors and to evaluate the progress of prevention and control strategies. Hence, we aimed in this research to assess the prevalence of anemia among pregnant women in urban Hail region, the north of Saudi Arabia and to identify important risk factors associated with, in order to provide insights to policy-makers and administration to deal with the problem.

Methods

Setting

A cross-sectional study was carried out among pregnant women attending one of eight governmental Primary Health Care (PHC) centers in Hail city, at the north of Saudi Arabia during the period November 3, 2019 to June 25, 2020. PHC centers were selected at random

between 24 centers covering all neighborhoods of Hail city. Among other services provided by PHC centers, antenatal care is a main service provided free of charge.

Participants

The sample was selected using a two-stage sampling method. In the first stage; from the list of 24 PHC centers, one third of centers (eight centers) were selected systematically with the first one at random. In the second stage, women, who visited the selected PHC centers attending for antenatal care, were systematically randomly selected and invited to undergo an interview. Pregnant women were eligible if they were aged 18 years or over, with a singleton pregnancy, and no hematological disease.

Sample size

We assumed 50% prevalence of anemia among pregnant women (to maximize sample size), since we found a large variation in the prevalence of anemia among studies carried out in different regions in Saudi Arabia [10-13], then we assigned a 95% confidence level, and a 5% margin of error. Therefore, the sample size was calculated using Cochran's Sample Size Formula [14] to comprise 384 pregnant women.

Data collection

Preparing for conducting the study, the authors visited the assigned PHC centers and met directors of those centers, introduced to the study objectives, showed the official letters of the regional health authority to facilitate the study conduction and the letter of ethical approval. All centers approached agreed to participate. Data were collected through face-to-face interviews with the eligible pregnant women during the study period with cautions against committing any selection or information bias during recruiting and interviewing eligible participants in the study. Other data, including anthropometric measurement and laboratory investigations, past medical history were taken from the booking file of the pregnant woman in the PHC center. One female researcher carried out all interviews with pregnant women who agreed to participate in the study and gave their consent. The interviews were carried out privately and taken about 15 minutes.

Data collection tool

Each participant was interviewed to complete the structured questionnaire which had been developed by the researchers based relevant literature to meet the objectives of the research [7, 10-13, 15, 16].

The questionnaire consisted of 4 sections. Sociodemographic aspect of the participants included in the 1st section.

In the second section, dietary and nutritional information relating to their intakes of iron-rich foods, iron absorption-inhibiting foods and eating habits were collected utilizing the Food Frequency Questionnaire (FFQ) format. Participants women were asked about their usual food consumption by querying the frequency at which the food items are usually consumed. There were four options in the category for frequency of intake, which were: (a) "at least once per day"; (b) "at least once per week"; (c) "at least once per month"; and (d) "rarely or never taken". Alongside with every option the number of times the food item usually consumed was asked for. Intake of supplements (iron, folic acid and B12) were also asked about as (Yes/No).

The 3rd section included obstetric, gynecological and medical history: menstrual history, parity, birth intervals, current or past diagnoses of medical conditions.

The last section, collected data from the pregnant woman booking file, including clinical examination, anthropometric measurements, laboratory hematological investigations in order to evaluate the anemic status of the pregnant woman.

A pilot study was done on 20 eligible pregnant women (not included in the final sample) was carried out before beginning of the study, consequently, the questionnaire was revised and modified to its final form. Face and content validity of the questionnaire were assessed by a panel of 4 experts in concern with anemia in pregnancy (obstetrician, nutritionist, family medicine and public health). The reliability was relatively high for the total items of the questionnaire (Cronbach's Alfa = 0.745) and for the subset of items describing the frequency food intake habits (Cronbach's Alfa = 0.699).

Data management and analysis

Data was entered, cleaned and analyzed using Epi info version 7 and SPSS version 23. Data was summarized using proportions for categorical data and mean and standard deviation for continuous data. The relationship was determined using chi square for categorical variables and T test or Anova test for continuous variables or nonparametric tests as applicable if the data were not normally distributed.

The hemoglobin level of < 11 g/dL was considered anemia. Anemia severity was considered according to WHO criteria for mild (10.0-10.9), moderate (7.0-9.9) and severe (< 7) [1].

Univariate and multivariable analysis was carried out using logistic regression analysis to find out factors that were associated with anemia in pregnancy. Pregnant women with proven anemia based on the hemoglobin level < 11 g/l (no = 0; yes = 1) were tested against predictor variables assumed to be associated with anemia as categorized in 4 domains, namely: (i) sociodemographic factors; (ii) dietary and nutrition factors; (iii) obstetric and menstrual factors; and (iv) medical factors found on clinical examination, anthropometric measurements, laboratory hematological investigations and personal history of anemia and important relevant medical conditions. Four adjusted multivariate logistic regression models were approached to capture predictor variables independently associated with anemia in pregnant women in each domain. An overall model combining the four models was also carried out. Variables of the final models were determined using a stepwise

backwards removal method, deleting variables with a p value above 0.25 in order to exclude the non-important variables from the model until the minimum adequate model was reached. Odds ratios (ORs) as well as their 95% confidence intervals (CIs) were calculated for the predictor variables in the analyses. All statistical tests were two-tailed and differences were considered to be statistically significant at a p-value ≤ 0.05.

Ethics

The study protocol was approved by the Bioethical Committee of the General Directorate of Health Affairs, Hail region, Saudi Arabia, with ethical approval number is: 2019-21. Agreed participants signed the study consent form.

Results

Sociodemographic and economic characteristics

Out of 400 pregnant women approached, 390 agreed to participate in the study and completed the interview, with a response rate (97.5%). Non-response was mainly due to the time factor.

The mean age ± (standard deviation) of the participants was 29.9 ± (7.56) years, less than half of them 171 (43.8%) were in the age range of 25-34 years. A considerable number of the participants 153 (39.2%) were university educated, living in medium size families 2-5 members 232 (59.5%). The majority 288 (73.9%) reported having family income < 10.000 SR (2,666 US $) (Tab. I).

Tab.I. Background characteristics of participant pregnant women (n = 390).

Variable	N or mean (SD)	%
Sociodemographic aspect		
Woman age (years)		
< 25	109	27.9
25-34	171	43.8
≥ 35	110	28.2
Mean (SD)	29.9 (7.56)	
Median (range)	29 (18-49)	
Woman education		
No formal education	14	3.6
Primary/middle	34	8.7
High school	150	38.5
University/higher	192	49.2
Woman occupation		
House wife	304	77.9
Employed	86	22.1
Husband education		
No formal education	18	4.6
Primary/middle	40	10.3
High school	179	45.9
University/higher	153	39.2
Family income (SR)		
< 5,000	47	12.1
5,000-10,000	241	61.8
10,000-15,000	85	21.8
> 15,000	17	4.4
Family type		
Nuclear	381	97.7
Extended	9	2.3
Family size		
2-3	126	32.3
4-5	106	27.2
6-7	84	21.5
≥ 8	74	19.0
Obstetric and menstrual history		
Gravida		
1-2	122	31.3
3-4	107	27.4
≥ 5	161	41.3
Parity		
0	70	17.9
1-2	109	27.9
3-4	101	25.9
≥ 5	110	28.2
Mean (SD)	3.1 (2.47)	
Median (range)	3 (0-10)	

▶

Tab.I. Background characteristics of participant pregnant women (n = 390).

Variable	N or mean (SD)	%
Obstetric and menstrual history		
Number of children under 5 years		
0	103	26.4
1	152	39.0
≥ 2	135	34.6
Mean (SD)	1.1 (0.83)	
Median (range)	1 (0-4)	
Inter pregnancy space (years)		
Not applicable (primigravida)	127	32.6
< 2	161	41.3
≥ 2	102	26.2
Mean (SD)	(1.04)	
Median (range)	1 (0-6)	
Menstrual cycle duration (days)		
≤ 5	95	24.4
> 5	295	75.6
Mean (SD)	5.8 (0.75)	
Median (range)	6 (3-8)	
Menstrual cycles usually regular		
Yes	380	97.4
No	10	2.6
Menstrual cycles usually heavy		
Yes	20	5.10
No	370	94.9
Duration of pregnancy (trimester)		
First	124	31.8
Second	132	33.8
Third	134	34.4
Antenatal visits		
< 3	233	59.7
≥ 3	157	40.3
First antenatal visit		
During 1st trimester	274	70.3
During 2nd trimester	103	26.4
During 3rd trimester	13	3.3
Bleeding during pregnancy		
Yes	23	5.9
No	367	94.1
The pregnancy was planned for		
Yes	49	12.6
No	341	87.4
Medical history		
Chronic medical illness		
Yes	20	5.1
No	370	94.9
Any chronic bleeding condition		
Yes	32	8.2
No	358	91.8
Past history of anemia		
Yes	148	38.0
No	241	62.0
Dietary practice and supplements intake		
Iron supplement		
Yes	262	67.2
No	128	32.8
Folic acid supplement		
Yes	335	85.9
No	55	14.1
Meat intake		
Once or more weekly	73	18.7
Less than 4 times per month	303	77.7
Never/rare	14	3.6

Tab.I. Background characteristics of participant pregnant women (n = 390).

Variable	N or mean (SD)	%
Dietary practice and supplements intake		
Green leafy vegetables intake (per day)		
Infrequent	134	34.4
Once or more per day	256	65.6
Fresh fruits intake (per day)		
Infrequent	332	85.1
Once or more per day	14.9	14.9
Number of meals per day		
< 3	29	7.4
3	311	79.7
≥ 4	50	12.8
Habit of drinking tea immediately after meal		
Yes	212	54.4
No	178	45.6
Consuming food from restaurants		
Not consuming	10	2.6
Once per week	191	49.0
Tow times or more	189	48.5
Clinical examination/Laboratory workup		
BMI (kg/m²)		
< 25	107	27.5
25 - < 30	148	38.0
≥ 30	134	34.4
Clinical anemia		
Yes	109	27.9
No	281	72.1
Blood hemoglobin level (g/l)		
< 7.0	0	0.0
7.0-9.9	36	9.2
10.0-10.99	97	24.9
≥ 11	257	65.9
Mean (SD)		
Median (range)		
Laboratory anemia (WHO classification)		
Anemic (Hb < 11 g/dl)	133	34.1
Non-anemic (Hb ≥ 11 g/dl)	257	65.9

Obstetric and menstrual and medical history

Study participants have a mean parity (SD) of 3.1 (2.47), of them 110 (28.2%) were grand multipara (≥ 5 deliveries) and 70 (17.9%) were primigaravida. Menstrual cycles were usually regular among 380 (97.4%) with mean duration 4.8 (0.75) days. Participants described their menses as usually heavy were 20 (5.0%).

Nearly, equal proportions were in their first, second or third trimester (124; 31.8%, 132; 33.8% and 134; 34.4%) respectively. Among participants 23 (5.9%) reported having bleeding in their current pregnancy and only 49 (12.6%) reported that the current pregnancy was planned for.

Participants reported having a chronic medical illness were 20 (5.1%) and 32 (8.2%) reported having chronic bleeding conditions like hemorrhoids, while a considerable number 148 (38.0%) reported past history of anemia (Tab. I).

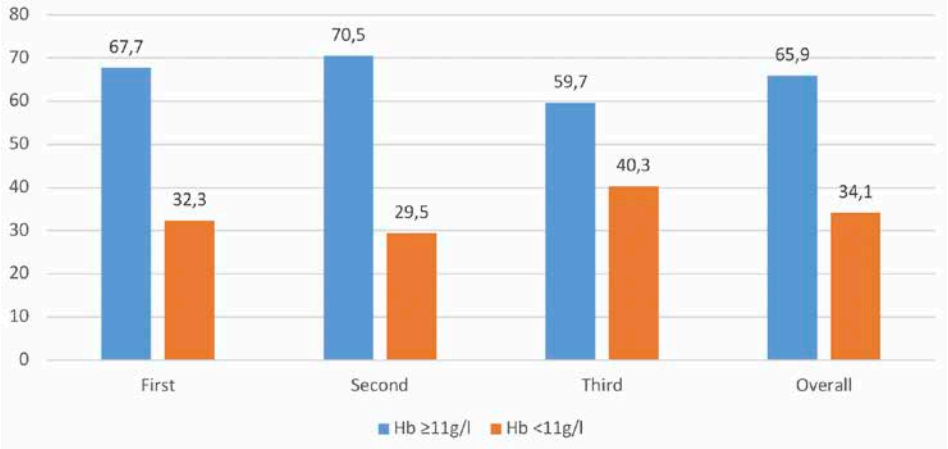
Dietary practice and supplements intake

While around two third of the participants 262 (67.2%) of the pregnant women take iron supplements, yet, most of them 335 (85.9%) take folic acid. Infrequent red meat consumption was reported; only 73 (18.7%) were consuming red meat weekly, while 303 (77.7%) take meat sometimes per month and 14 (3.6%) rarely or never consuming meat. Moreover, less than two third of the participants (256; 65.6%) reported consuming leafy green vegetables at least once daily, while few participants (58; 14.9%) reported consuming fresh fruits daily. More than half 212 (54.4%) of the participants reported the habit of taking tea immediately after meal. Most participants 311 (79.7%) were taking 3 meals per day, while 50 (12.8%) were taken 4 meals or more per day and few of them (29; 7.4%) who reported taking less than 3 meals. About half (191; 49.0%) of the participants reported having one main meal from restaurant per week, 189 (48.5%) taking two or more main meals from restaurants per week, while only very few participants 10 (2.6%) who did not consume restaurant food (Tab. I).

Prevalence and severity of anemia

The prevalence of anemia among the pregnant women in our study was 34.1% (95% CI: 29.5-39.1%). Among the anemic participants, 97 (72.9%) had mild anemia and 36

Fig. 1. Prevalence of anemia among pregnant women according to the pregnancy trimester.



(27.1%) had moderate anemia. None of the participants had severe anemia. The mean (±) SD hemoglobin concentration among the study participants was 11.6 ± (1.20). The prevalence of anemia with respect to the trimesters was 40 (32.3%), 39 (29.5%) and 54 (40.3%) for the 1st, 2nd and 3rd trimesters respectively (Fig. 1).

Factors associated with anemia

We carried out univariate (Tab. II) and multivariate (Tab. III) logistic regression analysis to determine factors associated with anemia among participants' pregnant women. We built 4 separate multivariate models predicting association of anemia with: (i) socio-demographic factors; (ii) dietary practice and supplement intake; (iii) obstetric and menstrual factors; and (iv) medical history and clinical examination variables. Subsequently, we built out an overall predicting model adjusting for all variables.

In model (i) lower family income < 10,000 SR (aOR = 1.81, 95% CI: 1.08-3.03, p = 0.026), and big family size > 7 members compared to small families < 4 members (aOR = 2.05, 95% CI: 1.12-3.74, p = 0.020), were

Tab. II. Univariate association between anemia in pregnant women and covariates according to sociodemographic, nutrition, reproductive and medical aspects (n = 390).

Term	Anemia*	Odds ratio	95% CI	P-value
Sociodemographic aspect				
Age in years				
< 25	34 (31.2)	1		
25-34	58 (33.9)	1.13	0.68-1.89	0.636
≥ 35	41 (37.3)	1.31	0.75-2.30	0.344
Woman education				
No formal education	4 (28.6)	1		
Elementary education	16 (47.1)	2.22	0.58-8.49	0.243
High school	48 (32.0)	1.18	0.35-3.94	0.792
University/higher	65 (33.9)	1.28	0.39-4.24	0.687
Occupation				
House wife	112 (36.8)	1	0.32-0.96	0.033
Employed	21 (24.4)	0.55		
Husband education				
No formal education	8 (44.4)	1		
Elemental (primary & middle school)	12 (30.0)	0.54	0.17-1.69	0.287
High school	59 (33.0)	0.62	0.23-1.64	0.331
University/higher	54 (35.3)	0.68	0.25-1.83	0.447
Family income (SR)				
< 10,000 SR	107 (37.2)	1.73	1.04-2.86	0.034
≥ 10,000	26 (25.5)	1		
Family size				
2-3	37 (29.4)	1		
4-5	36 (34.0)	1.24	0.7-2.16	0.453
6-7	27 (32.1)	1.14	0.63-2.07	0.668
> 7	33 (44.6)	1.94	1.07-3.52	0.030

Tab. II. Univariate association between anemia in pregnant women and covariates according to sociodemographic, nutrition, reproductive and medical aspects (n = 390).

Term	Anemia*	Odds ratio	95% CI	P-value
Dietary practice and supplements intake				
Iron supplementation				
Yes	92 (35.1)	0.87	0.56-1.37	0.547
No	41 (32.0)	1		
Folic acid supplementation				
Yes	116 (34.6)	0.85	0.46-1.56	0.590
No	17 (30.9)	1		
Frequency of taking meat				
At least once per week	15 (20.5)	1		
Less than 4 times per month	112 (37.0)	2.27	1.23-4.19	0.009
Rare/never	6 (42.9)	2.90	0.87-9.64	0.082
Vegetable intake (per day)				
Once or more per day	92 (35.4)	1		
Infrequent	41 (31.5)	0.84	0.54-1.32	0.450
Fresh fruits intake (per day)				
Once or more per day	16 (27.6)	1		
Infrequent	117 (35.2)	1.43	0.77-2.65	0.258
Frequency of intake of food from restaurants per week (number)	Range (0-5)	0.7028	0.55-0.90	0.005
Reproductive health variables(obstetric and menstrual history)				
Number of pregnancies (gravida)				
1-2	36 (29.5)	1		
3-4	38 (35.5)	1.32	0.76-2.29	0.333
≥ 5	59 (36.6)	1.38	0.83-2.29	0.209
Number of deliveries (parity)				
1-2	35 (32.1)	1		
3-4	30 (29.7)	0.89	0.50-1.61	0.706
≥ 5	45 40.9)	1.46	0.84-2.55	0.177
Inter pregnancy interval				
Not applicable (primigravida)	43 (33.9)	1		
< 2 years	47 (29.2)	0.81	0.49-1.33	0.397
≥ 2 years	43 (42.2)	1.42	0.83-2.44	0.198
Menstrual cycle length (days)				
≤ 5	26 (27.4)	1		
> 5	107 (36.3)	1.51	0.91-2.51	0.113
Menstrual cycle usually regular				
Yes	132 (34.7)	1		
No	1 (10.0)	0.21	0.03-1.66	0.139
Menstrual cycle usually heavy				
Yes	10 (50.0)	1		
No	123 (33.2)	0.50	0.20-1.23	0.130
Trimester of pregnancy				
1st	40 (32.3)	1		
2nd	39 (29.5)	0.89	0.52-1.50	0.639
3rd	54 (40.3)	1.42	0.85-2.36	0.181
Antenatal care visits				
1-2 visits	76 (32.6)	1		
≥ 3	57 (36.3)	1.18	0.77-1.80	0.451
Month of the first antenatal care visit	Range (1-8)	1.12	1.00-1.26	0.050
Medical history/clinical examination/laboratory workup				
Chronic Illness				
Yes	10 (50.0)	1		
No	123 (33.2)	0.50	0.20-1.23	0.130
Hemorrhoid				
Yes	16 (50.0)	2.06	1.00-4.26	0.050
No	1			
BMI (kg/m²)				
< 25	45 (42.1)	1		
25-29.99	53 (35.8)	0.77	0.46-1.28	0.312
≥ 30	35 (26.1)	0.49	0.28-0.84	0.010
Clinical pallor				
Yes	104 (95.4)	1		
No	29 (10.3)	0.006	0.00-0.02	< 0.001

* Hemoglobin < 11 g/dl.

Tab. III. Models of Logistic Multivariate Analysis Predicting associations between anemia in pregnant women and covariates in sociodemographic, nutrition, reproductive, medical and overall domains (n = 390).

Characteristics	Anemia* n (%)	Adjusted OR (95% CI)	P-value
Model 1: Sociodemographic Domain **Final -2*Log-Likelihood: 490.40; Likelihood Ratio = 10.13; p = 0.038**			
Family income (SR)			
< 10,000	107 (37.2)	1.81 (1.08-3.03)	0.026
≥ 10,000	26 (25.5)	1	
Family size			
2-3	37 (29.2)	1	
4-5	36 (34.0)	1.32 (0.75-2.32)	0.331
6-7	27 (32.1)	1.32 (0.71-2.44)	0.376
> 7	33 (44.6)	2.05 (1.12-3.74)	0.020
Model 2: Dietary practice and supplements intake Domain **Final -2*Log-Likelihood: 478.83; Likelihood Ratio = 21.71; p < 0.001**			
Number of meals per day (number)	Range (1-4)	0.69 (0.45-1.05)	0.081
Drinking tea after meals			
Yes	81 (38.2)	1.91 (1.21-3.03)	0.019
No	52 (29.2)	1	
Intake of meat per week			
At least once	15 (20.2)	1	
Infrequent/rare/never	118 (37.2)	2.09 (1.13-3.90)	0.020
Meals from restaurants per week (number)	Range (0-5)	0.71 (0.55-0.92)	0.008
Model 3: Reproductive profile Domain (obstetric and menstrual history) **Final -2*Log-Likelihood: 486.46; Likelihood Ratio = 14.08; p = 0.007**			
Parity (number)	Range (0-10)	1.10 (1.1.01-1.98)	0.023
Menstrual cycle duration (days)			
≤ 5	26 (27.4)	1	
> 5	107 (36.3)	1.78 (1.02-3.12)	0.042
Menstrual cycle heavy			
Yes	10 (50.0)	2.34 (0.93-5.91)	0.071
No	123 (33.2)	1	
Bleeding during pregnancy			
Yes	11 (47.8)	2.43 (0.97-6.09)	0.058
No	122 (33.2)	1	
Model 4: Medical history and clinical examination Domain **Final -2*Log-Likelihood: 199.26; Likelihood Ratio = 300.44; p < 0.001**			
Past history of anemia			
Yes	70 (47.3)	4.10 (1.91-8.81)	< 0.001
No	63 (26.1)	1	
Clinical anemia (pallor)			
Yes	104 (95.4)	207.36 (73.38-585.96)	< 0.001
No	29 (10.3)		
BMI (kg/m²)	Range (17.73-42.15)	0.90 (0.84-0.96)	0.002
Model 5: Overall Model **Final -2*Log-Likelihood: 199.26; Likelihood Ratio = 300.44; p < 0.001**			
Family income (SR)			
< 10,000	107 (37.2)	2.33 (0.89-6.09)	0.084
≥ 10,000	26 (25.5)	1	
Parity (number)	Range (0-10)	1.13 (0.96-1.34)	0.152
Past history of anemia			
Yes	70 (47.3)	3.32 (1.48-7.44)	0.004
No	63 (26.1)	1	
Bleeding during pregnancy			
Yes	11 (47.8)	4.25 (1.17-15.47)	0.028
No	122 (33.2)	1	
Clinical anemia (pallor)			
- Yes	104 (95.4)	216.32 (75.54-619.48)	< 0.001
- No	29 (10.3)	1	
BMI (kg/m²)	Range (17.73-42.15)	0.90 (0.83-0.96)	0.002

* Hemoglobin < 11 g/dl.

independently predicted anemia among pregnant women.
In model (ii) infrequent intake of meat (aOR = 2.09, 95% CI: 1.13-3.90, p = 0.020) and the habit of drinking tea immediately after meals (aOR = 1.91, 95% CI: 1.21-3.03, p = 0.019), were independently associated with anemia, whereas, intake of restaurant meals (aOR = 0.71, 95% CI: 0.55-0.91, p = 0.008) possessed a protective effect.
In bivariate analysis we found that the intake of restaurant food was found to be associated with socio-economic factors as, women's higher education (p < 0.001), employment (p = 0.001) and higher family income (p = 0.002) (not included in Tables).
In model (iii), higher parity (aOR = 1.10, 95% CI: 1.01-1.98, p = 0.023), menstrual cycle > 5 days (aOR = 1.78, 95% CI: 1.02-3.12, p = 0.042) were independently associated with anemia.
In model (iv) past history of anemia (aOR = 4.10, 95% CI: 1.91-8.81, p < 0.001), clinical anemia manifested by pallor (aOR = 207, 95% CI: 73.38-585.96, p < 0.001) was independently associated with anemia, while increasing BMI (kg/m^2) was a protective independent factor (aOR = 0.90, 95% CI: 0.84-0.96, p = 0.002). In bivariate analysis BMI was found to be associated with women's employment (p = 0.008), lower education less than high school (p = 0.013), but not associated with income (p = 0.105) (not included in Tables).
The overall model (v) revealed a significant independent positive association of anemia among pregnant women with the past history of anemia (aOR = 3.32, 95% CI: 1.48-7.44, p = 0.004), the reported bleeding during pregnancy (aOR = 4.25, 95% CI: 1.17-15.47, p = 0.28) and pallor on clinical examination (aOR = 216.32, 95% CI: 75.54-619.48, p < 0.001). In linear regression analysis, clinical pallor explained 50% of the variance of laboratory anemia in terms of hemoglobin < 11 g/dl (r^2 = 0.50; F statistic = 391.44, p < 0.001)
On the other hand, increased BMI (kg/m^2) significantly appeared as a protective factor for anemia development in pregnancy with lower likelihood of association (aOR = 0.9, 95% CI: 0.83-0.96, p = 0.002).

Discussion

Despite, anemia in pregnant women at the national level in Saudi Arabia (40.0% prevalence) is classified by WHO as severe public health problem [1], yet, the estimated prevalence in our study (34.1%) indicates that the problem in urban Hail is of moderate public health importance based on the same WHO classification [1]. This prevalence is also lower than the global prevalence (38.2%) and of Eastern Mediterranean countries (38.9%) [1].
Compared to the prevalence reported in other regions in Saudi Arabia, the estimate for urban Hail is slightly higher than the prevalence reported in Asir region (31.9%) [12], but lower than the prevalence reported in Makkah (39.0%) [10], Al-Khobar (41.3%) [13] and much lower than the prevalence reported from Al-Ahsa (73.3%) [11].
In our analysis, most of the identified significant risk factors of anemia among pregnant women in urban Hail, were similar to risk factors reported in many national, regional and worldwide studies. Some socio-demographic and economic characteristics were found to be significant risk factors having an independent association with anemia in pregnancy, in particular lower family income and bigger family size. Pregnant women with lower family incomes (< 10,000 SR) were about two folds more likely to be anemic compared to those with higher income. Furthermore, family size was steadily and independently associated with anemia in pregnancy. The pregnant woman who lives in a family with 7 members or more, were more than two folds likely have the risk to be anemic. This association between anemia in pregnancy and low family income and living in beg sized families was documented in previous studies [7, 15-18], which might indicate a less food security and low dietary diversity.
Our study highlighted the importance of nutritional factors as important risk factors associated with in anemia in pregnancy. Consumption of meat was a factor which showed significant association with anemia in pregnancy. Pregnant women with the habit of eating meat less than once per week were 2.1 times at higher risk of developing anemia than pregnant mothers who ate meat one or more times per week. This finding is consistent with other studies in which pregnant women who frequently eat red meat had higher hemoglobin concentrations [15, 16, 19, 20]. Red meat is an important dietary source of heme iron [21].
Consistent with other studies [15, 19], the habit of drinking tea just after meal in our study was independently associated with increased risk of anemia in pregnancy. Phenolic compounds found in tea, coffee, and other beverages are a main inhibitor of non-heme iron absorption [21].
Interestingly, results in our study revealed a protective effect of frequent intake of food from restaurants, a habit many Saudi families do. For every one meal taken per week, there was a decrease by 29% likelihood of developing anemia among pregnant woman. A possible explanation is the dietary diversity with meat and other animal proteins are a usual main component of this meal, which is a good source of iron and proteins [21].
In our study, increased parity was independently associated with anemia in pregnant women. Women with higher parity pregnancies had a higher risk of anemia in pregnancy compared to those who had had fewer pregnancies A 10% more increase in anemia prevalence for every increase in parity by one (OR = 1.10, 95% CI: 1.1.01-1.98). Other research indicated that frequent pregnancies are associated with anemia in pregnancy [15, 20, 22, 23] giving no chance to restore the depleted iron stores [18, 22, 24, 25].
Consistent with other studies [26, 27], participants in our study with pre-pregnancy longer menstrual cycles (> 5 days), were more likely to have anemia in pregnancy compared to women with less cycles duration (OR = 1.73; 95% CI: 1.02-3.12).
Bleeding during pregnancy was also another predictive factor for anemia in pregnancy in our study. Participants who reported antepartum bleeding were four times more

likely to be anemic (OR = 4.25; 95% CI: 1.17-15.47). A logically explained when a considerable blood loss occurs. This finding was also reported in previous studies. Participants who reported past history of anemia before pregnancy were four times more likely to be anemic during pregnancy, which is consistent with other studies [28].

In our study, the odds of anemia, decreased with obesity. This finding is consistent with the results of other studies [29-31]. A systematic review carried out in 2011 revealed that obese women tend to have a higher hemoglobin and ferritin concentrations [22].

Pallor on clinical examination as a sign of anemia was highly indicative of anemia (aOR = 216.32, 95% CI: 75.54-619.48, $p < 0.001$). In linear regression analysis, clinical pallor explained 50% of the variance of laboratory anemia in terms of hemoglobin < 11 g/dl ($r^2 = 0.5$; F statistic = 391.44, $p < 0.001$). Pallor documented in other studies [9, 32, 33] as a sensitive indicator of anemia in pregnant women.

Limitations

Our study encountered some limitation: (i) measurements were taken from booking files of the pregnant women in the PHC centers, so that we cannot ensure a standardized measurement of hemoglobin and anthropometric measurements. However, all laboratory testing machines and scales are the same in all PHC centers and regularly calibrated by the same quality control staff; (ii) the cross-sectional nature of the study cannot determine the direction of cause and effect relationship; (iii) social desirability and recall bias are major concerns in any interview survey as participants were requested to give dietary information and monthly income and past events.

Conclusions

"In urban Hail region, Saudi Arabia, anemia among pregnant women was a moderate public health problem. Low income, bigger family size, higher parity, longer menstrual cycle > 5 days, bleeding during pregnancy, infrequent intake of meat, the habit of drinking tea just after meals, past history of anemia, and the sign of clinical anemia (pallor), were found to be significantly associated with anemia. These findings give insight to healthcare providers about the importance of early detection and management of anemia in early pregnancy. Further research utilizing prospective cohort design to study risk factors of anemia including rural areas, should be considered to support and extend the present study findings".

Ethics approval and consent to participate

The protocol of the study was reviewed and approved by the Regional Bioethics Committee of the General Directorate of Health Affairs, Hail region, with the approval number 2019/21 dated October 6, 2019. Agreed participants signed the study consent form. Participants were guaranteed anonymity confidentiality of the responses and voluntary participation and they can withdraw for any reason and any time, without any implications.

Availability of data and materials

Available from the corresponding author on reasonable request.

Acknowledgements

Funding sources: this research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

We thank directors and healthcare staff in PHC centers, Hail City, Saudi Arabia for facilitating the study. We also thank the participant pregnant women for their agreement, patience and allowing the time to carry out the interview with them.

Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

MA conceived the study idea, participated in development of the data collection tool, carried out all interviews and participated in interpretation of the study results.

HH adapted the study idea, designed the data collection tool, carried out data analysis & interpretation of results and wrote the manuscript.

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Received on January 17, 2021. Accepted on March 8, 2021.

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How to cite this article: Alreshidi MA, Haridi HK. Prevalence of anemia and associated risk factors among pregnant women in an urban community at the North of Saudi Arabia. J Prev Med Hyg 2021;62:E653-E663. https://doi.org/10.15167/2421-4248/jpmh2021.62.3.1880