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Prevalence and Associated Risk Factors for Anemia in Pregnant Women in White Nile State, Sudan: A Cross-Sectional Study

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Abstract

Introduction: Anemia during pregnancy can lead to several adverse maternal and perinatal outcomes. Despite preventive measures, anemia during pregnancy remains a threatening health problem, especially in sub-Saharan African countries.

Objective: We aimed to determine the prevalence of, and factors associated with, anemia among pregnant women at Rabak Maternity Hospital, Sudan.

Methods: We conducted a cross-sectional study involving pregnant women who presented to Rabak Maternity Hospital from September to December 2021. Questionnaires were completed via face-to-face interviews to gather both obstetric and socio-odemographic information (i.e., age, parity, history of miscarriage, education, level of antenatal care), and hemoglobin levels were estimated. A logistic regression analysis was performed.

Results: The median (interquartile range) of the age and parity of the 208 women enrolled in the study was 25 (21.0–30.0) years and 2 (1–4), respectively. Forty-five (21.6%) women did not use iron-folic acid during the index pregnancy. Eighty-eight (42.3%) women had anemia, and four (1.9%) had severe anemia. In the univariate analysis, age, parity, history of miscarriage, interpregnancy interval, education, and antenatal care level were shown not to be associated with anemia. A higher number of women with anemia did not use iron-folic acid during the index pregnancy than those without anemia (29/80 [33.0%] vs. 16/120 [13.3%], respectively, $p = .001$). Not taking iron-folic acid was found to be associated with anemia in the multivariate analysis (adjusted odds ratio = 3.19, 95% confidence interval = 1.60–6.63).

Conclusion: Anemia was found to be a major health problem among the pregnant women in this study. There is no clear evidence across the women with anemia that their anemia stems from lack of using iron-folic acid (in fact, some women used iron-folic acid and they were anemic). There is a possibility that using iron-folic acid may prevent anemia in this part of Sudan.

Keywords

anemia, pregnancy, prevalence, risk factors, iron-folic acid

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Introduction

Pregnant women, especially those in countries with less resources, are susceptible to having anemia, and several adverse maternal and perinatal outcomes are attributed to anemia and particularly the severe form of anemia (Black et al., 2013). The World Health Organization (WHO) defines anemia during pregnancy as a hemoglobin level of less than 11 g/dl (World Health Organization, 2011) and considers anemia a severe public health risk if the rate of anemia in the population is greater than or equal to 40% (*World Health Organization*, 2021). Of note, over half (56.0%) of pregnant women in low- and middle-income countries have anemia (Black et al., 2013).

Review of Literature

While around one quarter (24.1%) of pregnant women in South America have anemia, over half (57.0%) the pregnant women in sub-Sahara Africa (SSA) and 48% of pregnant

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women in South-East Asia have anemia (*World Health Organization*, 2021). A recent meta-analysis showed that the worldwide prevalence of anemia during pregnancy was 36.8% (Karami et al., 2022). Several factors, such as residence, education level, interpregnancy interval (IPI), not having antenatal care (ANC), not taking iron-folic acid, and malaria, are associated with a high risk of anemia during pregnancy (Adam et al., 2018; Geta et al., 2022), and numerous adverse maternal and perinatal adverse effects, such as preterm birth, low birth weight, maternal and perinatal mortality, and an increased risk of cesarean delivery, are attributed to anemia (Adam et al., 2016; Drukker et al., 2015; Figueiredo et al., 2018; Masukume et al., 2015; Patel et al., 2018).

It is thus essential to assess the prevalence of, and factors associated with, anemia during pregnancy in each setting in order to create a set of evidence-based interventions. As such, research needs to be conducted to assess the prevalence of anemia during pregnancy and the associated factors to inform researchers, physicians, and health planners and to offer information to the healthcare field as a whole. It is therefore important to determine the current prevalence and predictors of anemia in pregnant women so as to generate data that may help guide appropriate preventive/treatment protocols focused on the specific predictors of anemia.

Sudan is the second largest country in Africa, and anemia during pregnancy is a significant health problem in the country (Adam et al., 2018). Most, if not all, previous reports on anemia during pregnancy have been conducted in central and eastern Sudan (Adam et al., 2009, 2012, 2018; Mubarak et al., 2014; Omer et al., 2017). However, there is no published data on anemia during pregnancy in Sudan's White Nile state.

Methods

Design

A cross-sectional study was conducted at the Rabak Maternity Hospital in Rabak, the capital of the White Nile state of Sudan, from September to December 2021.

Research Question

Research questions for study: (1) what was the prevalence of anemia, and (2) what are the factors associated with, anemia at Rabak Maternity Hospital in central Sudan.

Sample and Setting

Rabak is one of the main cities in Sudan. It lies 362 m above sea level, and its geographical coordinates are 13°9′0″ N and 32°44′0″ E (GPS coordinates of Rabak, Sudan, DMS, UTM, GeoHash - CountryCoordinate.com, n.d.).

Procedure

Pregnant women aged between 18 and 40 years with singleton pregnancies who had been in labor and gave birth at Rabak Maternity Hospital were enrolled in this study after they had provided their written informed consent. Women who were less than 28 weeks pregnant at the time of delivery or who had multiple pregnancies, hemorrhage, or systematic diseases, such as diabetes mellitus, thyroid disease, hypertension, and intrauterine fetal death, were excluded.

Systematic random sampling was used to select the pregnant women who fulfilled the inclusion criteria. According to the hospital records from 2021, 980 pregnant women attended the hospital over the 6-month period prior to the study. Accordingly, the sampling interval (≈ 4) was determined by dividing the expected number of deliveries (208) by the calculated sample size ($980/208 \approx 4$). The eligible women were therefore interviewed at four intervals until the required sample size (208) was reached.

After signing the written informed consent form and undergoing blood tests, all the women who were enrolled in the study completed a questionnaire in which their demographic data and clinical and obstetric histories were collected. These data included age, parity, education level, history of miscarriage, ANC level, IPI, and intake of iron-folic acid during the index pregnancy. The questionnaires were completed by two medical officers via face-to-face interviews. Weight and height were measured using standard procedures and used to compute the body mass index (BMI) of each participant. Subsequently, 2 ml of blood was drawn. Ethylenediaminetetraacetic acid was added, and the sample was analyzed to provide a complete blood count, which included hemoglobin. Testing was performed using an automated hematology analyzer in accordance with the manufacturer's instructions (Sysmex KX-21, Japan). Blood films for malaria were prepared from the maternal, placenta, and cord. The slides were Giemsa-stained and double-checked by an expert microscopist who was blinded to the participants' data.

Sample Size. The sample size (n) of 208 women was estimated with an assumed incidence of anemia of 20%; this percentage has previously been reported in a study in Khartoum, Sudan (Mubarak et al., 2014) using the single proportional formula $n = Z^2pq/d^2$, where $q = (1 - p)$, $Z1 - \alpha$ (95% confidence interval [CI]) = 1.96, and d (margin of error of 5%) = 0.05.

Analysis Plan

The data were analyzed using SPSS for Windows version 22 (IBM, Armonk, NY, USA). The data were checked for normality using the Shapiro–Wilk test, and the data were not normally distributed. The median (interquartile range [IQR]), frequency, and percentage were used to describe the participants' characteristics. After calculating the prevalence of anemia (number of women with anemia/total number of women enrolled), the chi- square test was used

Table 1. General Characteristics of Enrolled Pregnant Women (Number = 208) in Rabak Hospital, Sudan, 2021.

Variables		*Median*	*Interquartile range*
Age, years		25.0	21.0–30.0
Parity		2	1–4
Interpregnancy interval, months		7.5	12.0–24.0
Body mass index, kg/m^2		21.4	19.0–24.7
		Frequency	*Proportion*
	Primipara	60	28.0
Parity	Parous	148	71.2
	≥ Secondary	80	38.5
Education level	< Secondary	128	61.5
	No	170	81.7
History of miscarriage	Yes	38	18.3
	> Two visits	173	83.2
Antenatal care	≤ Two visits	35	16.8
	Yes	163	78.4
Taking iron-folic acid	No	45	21.6

to compare the proportions of women with anemia versus those without. Univariate analyses were performed with anemia as the dependent variable, and various sociodemographic and obstetric factors (age, parity, education, history of miscarriage, ANC level, IPI, BMI, and iron-folic acid intake) as the independent variables. Multicollinearity was evaluated if the variance inflation factor exceeded 4. Variables with a p-value < .2 were shifted to build the multivariable analysis. Additionally, a backward likelihood ratio was used to evaluate the independent effects of each covariate by controlling the effects of the other variables. The adjusted odds ratios (AORs) and 95% CI were also computed; a p-value less than .05 was considered statistically significant.

Results

General Characteristics

We initially screened 224 women for our study. Sixteen women were not included in analysis as they met the exclusion criteria. Among the 208 women selected, the median (IQR) of their age and parity was 25 (21.0–30.0) years and 2 (1–4), respectively. In total, 128 women (61.5%) had achieved less than a secondary education, 35 (16.8%) women had received two or fewer ANC visits, and 45 (21.6%) women did not use iron-folic acid during the index pregnancy (Table 1). All the maternal and umbilical cord blood films were negative for malaria, and four placentas were positive for *P. falciparum*. The use of iron-folic acid was significantly higher among the women who had two or more ANC visits compared to those who had two or fewer ANC visits (82.7% vs. 57.1%, respectively, $p = .003$).

Factors Associated With anemia

Hemoglobin testing showed that 88 (42.3%) women had anemia (hemoglobin < 11.0 g/dl), and four (1.9%) women had severe anemia (hemoglobin < 7.0 g/dl). Age, parity (or number of primiparas), a history of miscarriage, IPI, education, and level of ANC were not associated with anemia in the univariate analysis. Compared with the women without anemia, a higher number of women with anemia did not use iron-folic acid during the index pregnancy (29/80 [33.0%] vs. 16/120 [13.3%], respectively, $p = .001$; Table 1). Compared to the women without malaria, the four women whose placentas were positive for malaria had anemia (4/88 [4.54%] vs. 0/120 [0.008%], respectively, $p = .018$). Placental malaria was not included in the model because of the low number (4) of such cases, which would have distorted the model. The non-intake of iron-folic acid was associated with anemia in both the univariate and multivariate analysis (AOR = 3.19, 95% CI = 1.60–6.63; Tables 2 and 3).

Discussion

Our results showed that 42.3% of the pregnant women in our study had anemia. The prevalence of anemia in our setting was slightly lower than that among pregnant women in Khartoum in Sudan (65.0%) (Eltayeb et al., 2019) and lower than the pooled prevalence (53.0%) of anemia that we have previously reported in a meta-analysis of 16 studies representing 15,688 pregnant Sudanese women (Adam et al., 2018). Notwithstanding, the prevalence of anemia among the pregnant women in this study was higher than the pooled prevalence (26.4%) of anemia among the pregnant women observed in a meta-analysis in neighboring Ethiopia (Geta et al., 2022) and South Africa (31.0%) (Dorsamy et al., 2022). Similarly, the prevalence of anemia among pregnant women in our area of Sudan was higher than the pooled prevalence (35.6%) of anemia among pregnant women reported in a meta-analysis covering sub-Saharan Africa (SSA)(Fite et al., 2021), as well as the

Table 2. Univariate Analysis of the Factors Associated With Anemia in Rabak Hospital, Sudan, 2021.

Variables		Women with anemia (number = 88)	Women without anemia (number = 120)	OR (95% CI)	*p*
Median (interquartile range)					
Age, years		25 (21.0–29.0)	25 (21.0–31.0)	0.96 (0.91–1.01)	.134
Parity		3 (2–4)	2 (1–4)	1.01 (0.89–1.15)	.836
Interpregnancy interval, months		12 (7.0–24.0)	12 (8.0–26.0)	1.01 (0.82–1.22)	.987
Body mass index		21.3 (18.9–24.6)	19.1 (21.8–25.2)	0.97 (0.92–1.03)	.448
Frequency (proportion)					
	Primipara	22 (25.0)	38 (31.7)	0.71 (0.38–1.33)	
Parity	Parous	66 (75.0)	82 (68.3)	Reference	.315
	≥ Secondary	33 (37.5)	47 (39.2)	Reference	
Education level	< Secondary	55 (62.5)	73 (60.8)	1.07 (0.60–1.89	.807
	No	70 (79.5)	100 (83.3)	Reference	
History of miscarriage	Yes	18 (20.5)	20 (16.7)	1.28 (0.63–2.60)	.486
	> Two visits	75 (85.2)	98 (81.7)	Reference	
Antenatal care	≤ Two visits	13 (14.8)	22 (18.3)	0.77 (0.36–1.63)	.498
	Yes	59 (67.0)	104 (86.7)	Reference	
Taking iron-folic acid	No	29 (33.0)	16 (13.3)	3.19 (1.60–6.63)	.001

Table 3. Adjusted Logistic Regression for Factors Associated With Anemia in Rabak Hospital, Sudan, 2021.

Variables		Odds ratio (95.0% confidence interval)	*p*
Age		0.96 (0.91–1.01)	.110
Taking iron-folic acid	Yes	Reference	
	No	3.27 (1.63–6.56)	.001

global pooled prevalence of anemia reported in a meta-analysis of 52 studies comprising 1,244,747 pregnant women (Karami et al., 2022). Our results therefore confirmed that anemia in our setting has severe public health significance, as defined by the WHO, which considers anemia prevalence ≥40% to be of severe health significance (*World Health Organization*, 2021).

Our study revealed that pregnant women who did not take iron-folic acid were at a 3.27 times higher risk of anemia. This correlates with the results of our previous report, where pregnant women in Khartoum who did not use iron-folic acid were at 2.5 times higher risk of having anemia (Abdullahi et al., 2014). Moreover, a recent meta-analysis showed that pregnant women in Ethiopia who did not take iron-folic acid were at a higher risk of anemia (relative risk = 1.53) (Geta et al., 2022). Likewise, a meta-analysis of 25 studies in SSA comprising 15,061 pregnant women showed that women who took no iron-folic acid supplements were 1.82 times more likely to have anemia (Fite et al., 2021). Furthermore, both our present study and another recent study (Mulugeta, 2022) showed that iron-folic acid adherence was associated with ANC visits. Notwithstanding, in our study, 67.0% of the women with a history of taking iron-folic acid had anemia. Although we did not assess the levels of other vitamins and trace elements, deficiencies in other vitamins and/or trace elements could explain the anemia among the women who were using iron-folic acid. Other factors (e.g., infections, food intake) could also have caused anemia in these women. In our study, four women had both placental malaria and anemia. Several studies inside Sudan (Adam et al., 2018) and in SSA (Dorsamy et al., 2022; Fite et al., 2021) have shown that malaria is the main cause of anemia during pregnancy.

In our study, age, parity, education, IPI, and BMI were not associated with anemia among our participants, which corresponds with the results of our earlier study (Eltayeb et al., 2019) showing that age, parity, and BMI were not associated with anemia among pregnant women in Khartoum. Moreover, the results of our previous meta-analysis (Adam et al., 2018) revealed that neither age nor parity were associated with anemia in pregnant women in Sudan, which aligns with the results of our current study. However, in their meta-analysis of 60 studies in neighboring Ethiopia, Geta et al. (Geta et al., 2022) determined that family size, residence, level education, IPI, and not having ANC visits were associated with anemia during pregnancy. It is worth mentioning that caution should be applied when comparing our results with those of later studies. First, the difference in the sociodemographic characteristics should be considered. Second, there may be differences in the prevalence rates of malaria, HIV, and others infections, such worm infestations, between the different settings (Dorsamy et al., 2022; Fite et al., 2021).

Strengths and Limitations

Several factors were included as covariates in our study. However, due to funding constraints, we were not able to

assess the women's ferritin, folic acid, or vitamin B12 levels to determine the prevalent types of anemia. Furthermore, inflammatory factors, such as C-reactive protein and food intake, were not assessed.

Implications for Practice

Overall, the findings of our study have significant implications for improving anemia screening and monitoring. Notably, iron-folic acid intake by pregnant women could reduce their rates of anemia.

Conclusion

Anemia was found to be a major health problem among the pregnant women in this study. There is no clear evidence across the women with anemia that their anemia stems from lack of using iron-folic acid (in fact, some women used iron-folic acid and they were anemic). There is a possibility that using iron-folic acid may prevent anemia in this part of Sudan.

Author Contributions

Both authors conceived the study; supervised the work, guided the analysis, and critically reviewed the manuscript; prepared the analysis plan, performed the data analysis, and wrote the first draft of the paper. Both authors reviewed and approved the final manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics Approval

This study received ethical clearance from the ethical committee of the Faculty of Medicine at El Imam El Mahdi University, Kosti, Sudan (#2021, 08). Women signed an informed consent. Methods were performed in accordance with the Declaration of Helsinki.

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References

Abdullahi, H., Gasim, G. I., Saeed, A., Imam, A. M., & Adam, I. (2014). Antenatal iron and folic acid supplementation use by pregnant women in Khartoum, Sudan. *BMC Research Notes*, *7*(1), 498. https://doi.org/10.1186/1756-0500-7-498

Adam, I., Adam, G. K., Mohmmed, A. A., Salih, M. M., Ibrahuim, S. A., & Ryan, C. A. (2009). Placental malaria and lack of prenatal care in an area of unstable malaria transmission in eastern Sudan. *Journal of Parasitology*, *95*(3), 751–752. https://doi.org/10.1645/GE-1912.1

Adam, I., & Abdelaziem, A. A. (2016). Anemia during pregnancy. In: P. Erkekoglu & B. Kocer-Gumusel (Eds.) *Nutritional deficiency*. ISBN 978-953-51-2438-2; Print ISBN 978-953-51-2437-5; https://doi.org/10.5772/63211

Adam, I., Ehassan, E. M., Mohmmed, A. A., Salih, M. M., & Elbashir, M. I. (2012). Decreased susceptibility to placental malaria in anaemic women in an area with unstable malaria transmission in central Sudan. *Pathogens and Global Health*, *106*(2), 118. https://doi.org/10.1179/2047773212Y.0000000011

Adam, I., Ibrahim, Y., & Elhardello, O. (2018). Prevalence, types and determinants of anemia among pregnant women in Sudan: A systematic review and meta-analysis. *BMC Hematology*, *18*(1), 31. https://doi.org/10.1186/s12878-018-0124-1

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., … & Uauy, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, *382*(9890), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Dorsamy, V., Bagwandeen, C., & Moodley, J. (2022). The prevalence, risk factors and outcomes of anaemia in South African pregnant women: a systematic review and meta-analysis. *Systematic Reviews*, *11*(1). Syst Rev. https://doi.org/10.1186/S13643-022-01884-W

Drukker, L., Hants, Y., Farkash, R., Ruchlemer, R., Samueloff, A., & Grisaru-Granovsky, S. (2015). Iron deficiency anemia at admission for labor and delivery is associated with an increased risk for cesarean section and adverse maternal and neonatal outcomes. *Transfusion*, *55*(12), 2799–2806. https://doi.org/10.1111/trf.13252

Eltayeb, R., Rayis, D. A., Sharif, M. E., Ahmed, A. B. A., Elhardello, O., & Adam, I. (2019). The prevalence of serum magnesium and iron deficiency anaemia among Sudanese women in early pregnancy: A cross-sectional study. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *113*(1), 31–35. https://doi.org/10.1093/trstmh/try109

Figueiredo, A. C. M. G., Gomes-Filho, I. S., Silva, R. B., Pereira, P. P. S., Mata, F. A. F. D., Lyrio, A. O., Souza, E. S., Cruz, S. S., & Pereira, M. G. (2018). Maternal anemia and low birth weight: A systematic review and meta-analysis. *Nutrients*, *10*(5), 601. https://doi.org/10.3390/nu10050601

Fite, M. B., Assefa, N., & Mengiste, B. (2021). Prevalence and determinants of anemia among pregnant women in sub-Saharan Africa: a systematic review and meta-analysis. *Archives of Public Health 79*(1). Arch Public Health. https://doi.org/10.1186/S13690-021-00711-3

Geta, T. G., Gebremedhin, S., & Omigbodun, A. O. (2022). Prevalence and predictors of anemia among pregnant women in Ethiopia: Systematic review and meta-analysis. *PloS one*, *17*(7). https://doi.org/10.1371/JOURNAL.PONE.0267005

GPS coordinates of Rabak, Sudan, DMS, UTM, GeoHash - CountryCoordinate.com (n.d.). Available at: https://www.countrycoordinate.com/city-rabak-sudan/ (accessed 9 October 2022)

Karami, M., Chaleshgar, M., Salari, N., Akbari, H., & Mohammadi, M. (2022). Global prevalence of anemia in pregnant women: A comprehensive systematic review and meta-analysis. *Maternal and Child Health Journal*, *26*(7), 1473–1487. https://doi.org/10.1007/S10995-022-03450-1

Masukume, G., Khashan, A. S., Kenny, L. C., Baker, P. N., Nelson, G., & SCOPE Consortium (2015). Risk factors and birth outcomes of anaemia in early pregnancy in a nulliparous cohort.

PLOS ONE, *10*(4), e0122729. https://doi.org/10.1371/journal.pone.0122729

Mubarak, N., Gasim, G. I., Khalafalla, K. E., Ali, N. I., & Adam, I. (2014). Helicobacter pylori, anemia, iron deficiency and thrombocytopenia among pregnant women at Khartoum, Sudan. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *108*(6), 380–384. https://doi.org/10.1093/trstmh/tru044

Mulugeta, S. S. (2022). Geographical disparities and determinants of adherence to iron folate supplementation among pregnant women in Ethiopia: spatial and multilevel analysis of the Ethiopian Mini Demographic and Health Survey of 2019. *BMJ Open*, *12*(9). https://doi.org/10.1136/BMJOPEN-2022-061900

Omer, S. A., Idress, H. E., Adam, I., Abdelrahim, M., Noureldein, A. N., Abdelrazig, A. M., Elhassan, M. O., & Sulaiman, S. M. (2017). Placental malaria and its effect on pregnancy outcomes in Sudanese women from Blue Nile state. *Malaria Journal*, *16*(1), 374. https://doi.org/10.1186/s12936-017-2028-0

Patel, A., Prakash, A. A., Das, P. K., Gupta, S., Pusdekar, Y. V., & Hibberd, P. L. (2018). Maternal anemia and underweight as determinants of pregnancy outcomes: Cohort study in eastern rural Maharashtra, India. *BMJ Open*, *8*(8), e021623. https://doi.org/10.1136/bmjopen-2018-021623

World Health Organization (2011). the Global Prevalence of Anaemia in 2011. *WHO Report*: 48. https://doi.org/10.1017/S1368980008002401.

World Health Organization (2021). *GHO | By category | Anaemia in pregnant women - Estimates by country*. World Health Organization.