**A CROSS-SECTIONAL STUDY OF THE PREVALENCE AND RISK FACTORS OF ANAEMIA AMONGST PREGNANT WOMEN AT THE TAMALE TECHNICAL UNIVERSITY HOSPITAL.**

**ABSTRACT**

**Background:** Anaemia is a global public health problem affecting both developing and developed countries with major consequences on human health as well as social and economic development. It is a major cause of morbidity and mortality during pregnancy in developing countries. The study's goal is to determine the prevalence of anaemia and its risk factors among pregnant women receiving prenatal treatment at the Tamale Technical University Hospital.

**Methods:** The study design used in this research was a quantitative cross-sectional study among pregnant women who attended antenatal care at Tamale Technical University Hospital. A total of 183 consenting participants were sampled, with questionnaires and antenatal records books used as major instruments for data collection.

**Results:** Results of recent data analysis have shown that the prevalence of anemia among pregnant women at their current visits to the ANC of Tamale Technical University Hospital was found to be 59%. A Chi-square analysis revealed a strong correlation of clinical significance between the current hemoglobin level (Hb) and the educational level (P = 0.029), parity (P = 0.032), gestational age (P = 0.029), number of meals eaten per day (P = 0.013), and sleeping under a long-lasting insecticide net (P = 0.041).

**Conclusion:** Anaemia continues to be a significant public health concern during pregnancy, characterised by a high prevalence that may lead to detrimental maternal and newborn consequences. Identified key risk factors encompass inadequate dietary intake, low socioeconomic position, insufficient prenatal care, short birth intervals, and pre-existing medical problems, including malaria and infections. The study emphasises the significance of early diagnosis and focused therapies, such as nutritional supplementation (iron and folic acid), health education, and enhanced access to quality antenatal care services.

**Key Words: *Anaemia, Prevalence, pregnant women, risk factors***

**INTRODUCTION**

Anaemia remains a major public health issue in developing countries, with about two billion people being anemic worldwide. It has a worldwide prevalence of approximately 41.8% 1. Among the high-risk groups of anemia are patients who lose a lot of blood, individuals with nutritionally poor diets, and pregnant women 2. Some of the effects of anaemia in general are poor cognitive development, reduced physical work ability, and increased mortality, particularly during the prenatal period. According to 3, of all the anemia in pregnancy, iron deficiency accounts for 75%, followed by folic acid deficiency. Other causes of anemia are micronutrient deficiency such as vitamin A and vitamin B12, hemoglobinopathies like sickle cell disease and beta-thalassemia, parasite infestation including malaria, hookworm, and schistosomiasis, haemorrhage, and chronic diseases such as human deficiency virus (HIV) and diabetes mellitus 4. In developing countries, women are at an increased risk of anemia because they may be pregnant for more than half of their reproductive lives 5.

The major obstetric complications caused by anemia in pregnancy include prematurity, abortion, intrauterine fetal death, neonatal low birth weight, postnatal mortality, and morbidity 6. There is also a reduction in productivity in pregnant women affected by anemia, and this has a financial impact on families, communities, and societies 5. Due to the high prevalence of anemia in pregnancy, the government of Ghana through the Ghana health service and most other developing countries have put in place policies such as iron and folic acid supplementation, prevention of malaria by distribution of ITN and IPT to reduce the impact of anemia in this group. Also, with support from NGO’s and CBO’s focused on water, sanitation, and hygiene (WASH), priority has been given to the education of citizens on the relevance of clean and safe drinking water to the prevention of worm infestation, which can play a role in iron deficiency anemia 7. Data on anemia prevalence continues to be an important indicator in public health as anemia is linked to morbidity and mortality in the demographic groups that are often considered high-risk, such as pregnant women and children under five 8. Anemia prevalence studies can be used to track reproductive health progress. Despite efforts to reduce the burden of anemia, the prevalence of the disease remains high in underdeveloped countries. As a result, the purpose of this study is to identify risk factors for anemia among pregnant women seeking antenatal care (ANC) at the Tamale Technical University Hospital, a hospital that serves both rural and urban populations of the Sagnerigu District in Ghana's Northern region.

METHODS

Study design: This is a quantitative cross-sectional study conducted among pregnant women who attended antenatal care at the Tamale Technical University Hospital.

Setting: Tamale Technical University Hospital is located in the Sagnarigu Municipality in the Northern Region of Ghana. Sagnarigu District is a newly carved district of the Tamale Metropolis.

Target Population: The study comprised pregnant women who attended the Antenatal Care clinic at the Tamale Technical University Hospital during the data collection period and were willing to participate.

Inclusion Criteria: Pregnant women in the second and third trimester of pregnancy attending ANC. Pregnant women who consent to participate in the study.

Exclusion Criteria: Pregnant women in the first trimester of pregnancy. Pregnant women in the second and third trimester of pregnancy who fail to consent to participate in the study.

Sampling Technique and Size: The study participants were chosen using the convenience sampling approach. Pregnant women who came for routine ANC visits or who came for booking visits within the period of study were included in the study. The sample size was 183.

Data Collection tools and Procedures: A face-to-face interview using a pre-tested semi-structured questionnaire was conducted to obtain data about participant’s demographic and socio-economic characteristics and evaluate the prevalence of anemia in pregnancy among the clients of TaTU hospital; their hemoglobin levels (both booking values and current values) were recorded and asked respondents if they had been educated on anemia during the ANC visit.

Data Analysis:Quantitative data were analysed utilising SPSS version 20. Descriptive statistics were calculated for all pertinent variables. Descriptive analysis was conducted utilising means, proportions, and frequencies. Pearson’s chi-square test and odds ratio (OR) with associated 95% confidence intervals (CI) were calculated to determine the association between the independent and dependent variable (anaemia). A P-value of 0.05 was deemed statistically significant. Multivariate analysis was used to identify the independent factors contributing to anaemia during pregnancy.

**RESULTS**

Table 1: BACKGROUND CHARACTERISTICS OF RESPONDENTS

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Variable**  | **Frequency**  | **Percentage**  |
| **Ages**  | 16-20  | 10 | 10.9 |
|  | 21-30  | 120 | 65.6 |
|  | 31-40  | 41 | 22.4 |
|  | 41-50  | 2  | 1.1 |
| **Occupation**  | Government Worker  | 72 | 39.3 |
|  | Others  | 1 | 0.5 |
|  | Self-employed  | 93 | 50.8 |
|  | Student  | 14 | 7.7 |
|  | Unemployed  | 1 | 0.5 |
| **Religion**  | Christian  | 38 | 20.8 |
|  | Muslim  | 145 | 79.2 |
|  | Marriage Type  |   |   |
|  | Monogamous  | 148  | 80.9  |
|  | Polygamous  | 35 | 19.1 |
| **Educational level**  | None  | 25 | 13.7 |
|  | Primary  | 7 | 3.8 |
|  | JHS  | 22 | 12 |
|  | SHS  | 34 | 18.6  |
|  | Tertiary  | 95 | 51.9 |

Table 2: BACKGROUND CHARACTERTICS AND THEIR RESPECTIVE ANEMIA STATUSES AND PERCENTAGES

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   |   | Status  |  |   | Total | p value  |
|  |   | Anaemic  | Non anaemic  |   |
| Age group  | 16-20  | 10.09%  |  | 10.70%  | 10.80%  | 0.400  |
|   | 21-30  | 64.80%  |  | 66.70%  | 65.8%  |   |
|   | 31-40  | 24.10%  |  | 20.00%  | 22.40%  |   |
|   | 41-50  | 0.90%  |  | 0.90% | 1.00%  |   |
| Level of education reached  | Junior High School  | 11.1% |  | 17.00%  | 11.50%  | 0.029  |
|   | None  | 45.8% |  | 11.10%  | 28.45%  |   |
|   | Primary  | 23.6% |  | 0.00% | 3.80%  |   |
|   | Senior High School  | 10.2% |  | 9.30%  | 18.00%  |   |
|   | Tertiary  | 9.3% |  | 62.60%  | 36.40%  |   |
| Occupation  | Government Worker  | 22.00%  |  | 21.70%  | 21.30%  | 0.306  |
|   | Others  | 1.70%  |  |  | 1.10%  |   |
|   | Self-employed  | 46.00%  |  | 33.00%  | 41.00%  |   |
|   | Student  | 27.10%  |  | 24.00%  | 25.70%  |   |
|   | Unemployed  | 3.40%  |  | 21.30%  | 10.90%  |   |
| Occupation of spouse  | Government Worker  | 42.6%  |  | 34.70%  | 39.30%  | 0.980  |
|   | Self-employed  | 48.1%  |  | 57.30%  | 51.90%  |   |
|   | Student  | 7.50%  |  | 8.00%  | 7.70%  |   |
|  | Unemployed | 0.9% |  |  | 0.5% |  |
|  | Others | 0.9% |  |  | 0.5% |  |
| Mother’s level of education  | Junior High School  | 10.2%  |  | 10.70%  | 10.40%  | 0.08 |
|   | None  | 44.4%  |  | 53.30%  | 48.10%  |   |
|   | Senior High School  | 11.0% |  | 12.00%  | 11.50%  |   |
|   | Tertiary  | 27.9%  |  |  24.0% | 27.30%  |   |
|  | Primary- | 6.5% |  |  | 2.7% |  |
| How many children do you have?  | 0  | 48.1%  |  | 54.70%  | 47.00%  | 0.032  |
|   | 1  | 18.50%  |  | 32.00%  | 22.40%  |   |
|   | 2  | 20.4%  |  | 8.00%  | 15.30%  |   |
|   | 3  |  | 9.30%  | 13.30%  | 10.40%  |   |
|   | 4  |  | 3.70%  | 5.3%  | 3.80%  |   |
|  | 5 |  | 0.00% | 1.3% | 1.00% |  |
| How many wives does your husband have?  | 1  |  | 85.2%  | 74.70%  | 80.90%  | 0.633  |
|   | 2  |  | 13.0%  | 18.70%  | 15.30%  |   |
|   | 3  |  | 1.8%  | 5.30%  | 3.30%  |   |
|  | 4 |  | 0.0% | 1.30% | 0.5% |  |
| Spouse’s level of education  | Junior School  | High  | 0.9%  | 8.00%  | 3.80%  | 0.348  |
|   | None  |  | 3.7%  | 2.7%  | 6.60%  |   |
|   | Primary  |  | 20.4%  | 12.0%  | 3.30%  |   |
|   | Senior School  | High  | 11.1%  | 0.00% | 28.90%  |   |
|   | Tertiary  |  | 53.7%  | 35.70%  | 57.40%  |   |
| Religion  | Christian  |  | 22.00%  | 20.00%  | 21.30%  | 0.439 |
|   | Muslim  |  | 78.00%  | 80.00%  | 78.70%  |   |
| Religion of spouse  | Christian  |  | 22.00%  | 20.00%  | 21.30%  | 0.439 |
|   | Muslim  |  | 78.00%  | 80.00%  | 78.70%  |   |
| Father’s level of education  | Junior School  | High  | 3.7%  | 5.30%  | 3.80%  | 0.420  |
|   | None  |  | 17.6%  | 28.00%  | 21.90%  |   |
|   | Primary  |  | 16.7%  | 0.00%  | 8.70%  |   |
|   | Senior School  | High  | 20.3%  | 32.00%  | 25.10%  |   |
|   | Tertiary  |  | 41.7%  | 38.7%  | 40.40%  |   |

##

## 4.2 PREVALENCE OF ANEMIA STUDY PARTICIPANTS

The study showed that 71 women out of the 183 had been told by their health care provider at some point in time during the current pregnancy that they were anemic. This represents 38.8% of the total. Out of these 71 women, 4 happen to have had a blood transfusion during the pregnancy, with 1 woman having been transfused once and 3 women receiving two blood transfusions.

The hemoglobin values at both the booking and current ANC visits were recorded. At booking, the lowest value recorded was 6.0g/dl, the lowest being 16.1. At delivery, 58.0% of pregnant women were anaemic. Using the WHO classification of anemia, 30.6% of women had moderate anemia, 25.8% had mild anemia, and 1.6 had severe anemia.

At their current visit, 59% of women were found to be anemic: 30.1% with moderate anemia, 27.3% with mild anemia, and 1.6% with severe anemia. Hence, the prevalence of anemia at booking was 58% and 59% at the current visit.

This is summarised in tables 3 and 4.

Table 3: ANEMIA-STATUS, FREQUENCY AND PERCENTAGE

|  |  |
| --- | --- |
| Anemia status Frequency  | Percent  |
|   | Anaemic  | 108 | 59.0  |
|  | Non anaemic  | 75 | 41.0  |
| Total  | 183 | 100.0  |

Figure 1: ANEMIA-STATUS AND FREQUENCY

Table 4: ANEMIA GRADES AND THEIR RESPECTIVE FREQUENCY AND

PERCENTAGE

|  |  |  |
| --- | --- | --- |
| **Hemoglobin (g/dl)**  | **Frequency**  | **Percentage**  |
| ***Booking Visit***  |   |   |
| >10.9 (non anaemic)  | 77 | 42.0 |
| 10.0-10.9 (mild anemia)  | 47 | 25.8  |
| 9.9-7.0 (moderate anemia)  | 56 | 30.6 |
| <7.0 (severe anemia)  | 3 | 1.6  |
|  |  |  |
| ***Current Visit***  |   |   |
| >10.9 (non-anaemic)  | 75 | 41.0  |
| 10.0-10.9 (mild anemia)  | 50  | 27.3 |
| 9.9-7.0 (moderate anemia)  | 55  | 30.1  |
| <7.0 (severe anemia)  | 3 | 1.6  |
|  |  |  |

An enquiry into why severely anemic pregnant women did not seek medical services revealed that they were unaware of the medical treatments available near their houses, and lacked knowledge about the anemia's negative effects, while others lacked family support. Reasons supporting this fact include the high rate of women presenting in a decompensated state or when labour has begun.

Figure 2: BOOKING VISIT AND ANEMIA-STATUS

Figure 3: CURRENT VISIT AND ANEMIA-STATUS

**DISCUSSION**

**Prevalence of anaemia during pregnancy**

Worldwide, the prevalence of anaemia during pregnancy has been estimated at 41.8%, 9,10. In developing countries, the prevalence of anaemia during pregnancy is 60.0% 11. In Africa 57.1% of pregnant women are anaemic 10. According to the 2014 Ghana Demographic and Health Survey (GDHS), the prevalence of anaemia among pregnant women in Ghana was 63%, indicating a significant burden of the disease 12. At the end of the research study, the prevalence of anaemia among pregnant women at their current visits to the ANC of the Tamale Technical University Hospital was found to be 59% (27.3% had mild anemia, 30.1% had moderate anemia, and 1.6% had severe anemia). This correlates with a study undertaken in seven communities in four districts in the Ashanti Region of Ghana which showed that anemia was present in 56.5% of pregnant women 13 and 57.1% in another study done in the Sankyere West district 14. The prevalence also correlates with the prevalence of 62.6% in New Halfa Teaching Hospital, eastern Sudan 15,16.

However, the recorded prevalence was slightly higher than the 50.8 percent in a Wemakor study conducted in Tamale Teaching Hospital in 2019 and 41.5 percent in Savelugu Municipal Hospital in Savelugu 10,17.

When comparing the recorded prevalence to the national prevalence, which was estimated to be 54.29% 10, the study showed that the prevalence of anemia among pregnant women was marginally higher than the national prevalence. However, the prevalence of anemia in pregnancy in Africa, which was 67.6% 10,18, was higher. The disparities could be due to various causes of anemia, dietary variances, study methods, or the different times these investigations were conducted. This could also be due to socio-cultural characteristics of the respondents which included for example, a high percentage did not use any vector control for malaria prevention, and more people took only three or a smaller number of meals per day. All these factors including the obstetric factors like multiparity, could likely be a reason for the high prevalence of anemia. From the study, it is evident that the prevalence of anemia is very high in the Tamale Technical University hospital.

**Risk factors associated with anaemia during pregnancy**

**Relationship between maternal age and anaemia**: The odds of anaemia were observed to rise as maternal age advances. Pregnant women aged 21-30 years were significantly more anaemic compared to those mothers below 21 years old. This result is in agreement with the previous studies such as in Kisumu District of Kenya 19, Ethiopia 20, Tanzania 21 and Egypt 22 which found that late pregnancy is significantly increased risk of developing anaemia. It is generally believed that anaemia in pregnancy increases with rising parity and maternal age. Besides the general body weakness with advanced maternal age, older women are expected to be multigravidae. Multigravida may induce anaemia by reducing maternal iron reserves at every pregnancy and by causing blood loss at each delivery 23.

**Association between marital status and anaemia**: Even though it was not statistically significant in multivariate logistic regression (but significant in bivariate analysis), single pregnant women had significantly higher proportion of anaemia compared to the married women. This result is in agreement with other previous studies in Northern Nigeria 24 and Brasil 25 which found that women without a partner is significantly increased risk of developing anaemia. This can be due to the fact that married women are in a better position to get emotional, physical and economic support from their husbands. Women without a partner usually tend to have greater financial difficulties. The low socioeconomic status of the women may have a significant impact on their nutritional status and health seeking behaviour.

It is suggested that women in low socioeconomic classes are likely to be poorly educated and often have financial constraints. Such women are likely to find it difficult to access and afford good health services. Women with low socioeconomic status tend to consume diets that are low in micronutrients, animal proteins and vitamins but high in carbohydrate and phytates which interfere with intestinal uptake of iron and other trace minerals such as zinc and calcium 26. They are therefore more likely to suffer the adverse effects of poor/inadequate nutrition, acute/chronic infections and worm infestations associated with anaemia. This indicates that economic empowerment of women would play a very important role in reducing the prevalence of anaemia in our community.

**Association between participant’s employment and anaemia**: The proportion of anaemia was significantly more among employed and self-employed participants compared to the others. This finding is in line with studies conducted in Pakistan 27(Baig-Ansari et al., 2014) and Brasil 25. This was not unexpected, where women often need to work outside the home because of low family income.

**CONCLUSION**

The prevalence of anemia among ANC attendees at the TaTU was high and of a serious public health concern per WHO classification. This was due to the high illiteracy rate among women and unemployment. Women who did not sleep under a long-lasting treated net or use any other form of vector control were at a higher risk of developing anemia. It was noted that anemia among the women increased with the gestational period, gravidity, and parity.

Reference

1. Chathuranga G, Balasuriya T, Perera R. Anaemia among Female Undergraduates Residing in the Hostels of University of Sri Jayewardenepura, Sri Lanka. *Anemia*. 2014;2014:526308. doi:10.1155/2014/526308

2. Samia AEAH, Hanan AEES, Heba AFI. Knowledge, Attitude and Practice Regarding Prevention of Iron Deficiency Anemia among Pregnant Women in Tabuk Region. *Int J Pharm Res Allied Sci*. 2019;8(2):87-97. www.ijpras.com

3. Kejela G, Wakgari A, Tesfaye T, et al. Prevalence of anemia and its associated factors among pregnant women attending antenatal care follow up at Wollega University referral hospital, Western Ethiopia. *Contracept Reprod Med*. 2020;5:26. doi:10.1186/s40834-020-00130-9

4. Di Renzo GC, Spano F, Giardina I, Brillo E, Clerici G, Roura LC. Iron deficiency anemia in pregnancy. *Womens Health (Lond Engl)*. 2015;11(6):891-900. doi:10.2217/whe.15.35

5. Cappellini MD, Musallam KM, Taher AT. Iron deficiency anaemia revisited. *J Intern Med*. 2020;287(2):153-170. doi:10.1111/joim.13004

6. Ahmed S, Mamun MA Al, Mahmud N, et al. Prevalence and Associated Factors of Anemia among Pregnant Women Receiving Antenatal Care (ANC) at Fatima Hospital in Jashore, Bangladesh: A Cross-Sectional Study. *Food Nutr Sci*. 2019;10(09):1056-1071. doi:10.4236/fns.2019.109076

7. Jolly SP, Roy Chowdhury T, Sarker TT, Afsana K. Water, sanitation and hygiene (WASH) practices and deworming improve nutritional status and anemia of unmarried adolescent girls in rural Bangladesh. *J Heal Popul Nutr*. 2023;42(1):127. doi:10.1186/s41043-023-00453-8

8. Tettegah E, Hormenu T, Ebu-Enyan NI. Risk factors associated with anaemia among pregnant women in the Adaklu District, Ghana. *Front Glob Women’s Heal*. 2023;4(February):1-10. doi:10.3389/fgwh.2023.1140867

9. MacLean B, Sholzberg M, Weyand AC, Lim J, Tang G, Richards T. Identification of women and girls with iron deficiency in the reproductive years. *Int J Gynecol Obstet*. 2023;162(S2):58-67. doi:10.1002/ijgo.14948

10. McLean E, Cogswell M, Egli I, Wojdyla D, De Benoist B. Worldwide prevalence of anaemia, WHO Vitamin and Mineral Nutrition Information System, 1993-2005. *Public Health Nutr*. 2009;12(4):444-454. doi:10.1017/S1368980008002401

11. Agan T, Ekabua JE, Udoh AE, Ekanem EI, Efiok EE, Mgbekem MA. Prevalence of anemia in women with asymptomatic malaria parasitemia at first antenatal care visit at the University of Calabar Teaching Hospital, Calabar, Nigeria. *Int J Womens Health*. 2010;2(1):229-233. doi:10.2147/ijwh.s11887

12. GSS, GHS. Ghana Dermographic and Helath Survey 2014. *Ghana Stat Serv*. Published online 2014:1-55. https://dhsprogram.com/pubs/pdf/sr224/sr224.pdf

13. Ayensu J, Annan R, Lutterodt H, Edusei A, Peng LS. Prevalence of anaemia and low intake of dietary nutrients in pregnant women living in rural and urban areas in the Ashanti region of Ghana. *PLoS One*. 2020;15(1):e0226026. doi:10.1371/journal.pone.0226026

14. Glover-Amengor M, Owusu WB, Akanmori B. Determinants of anaemia in pregnancy in sekyere west district, ghana. *Ghana Med J*. 2005;39(3):102-107.

15. Adam I, Salih Y, Hamdan HZ. Association of Maternal Anemia and Cesarean Delivery: A Systematic Review and Meta-Analysis. *J Clin Med*. 2023;12(2). doi:10.3390/jcm12020490

16. Adam I, Khamis AH, Elbashir MI. Prevalence and risk factors for anaemia in pregnant women of eastern Sudan. *Trans R Soc Trop Med Hyg*. 2005;99(10):739-743. doi:10.1016/j.trstmh.2005.02.008

17. Wemakor A. Prevalence and determinants of anaemia in pregnant women receiving antenatal care at a tertiary referral hospital in Northern Ghana. *BMC Pregnancy Childbirth*. 2019;19(1):495. doi:10.1186/s12884-019-2644-5

18. Stephen G, Mgongo M, Hussein Hashim T, Katanga J, Stray-Pedersen B, Msuya SE. Anaemia in Pregnancy: Prevalence, Risk Factors, and Adverse Perinatal Outcomes in Northern Tanzania. *Anemia*. 2018;2018:1846280. doi:10.1155/2018/1846280

19. Nyabuti Ondimu K. Severe anaemia during pregnancy in Kisumu District of Kenya: prevalence and risk factors. *Int J Health Care Qual Assur*. 2000;13(5):230-235. doi:10.1108/09526860010372812

20. Samson KLI, Fischer JAJ, Roche ML. Iron Status, Anemia, and Iron Interventions and Their Associations with Cognitive and Academic Performance in Adolescents: A Systematic Review. *Nutrients*. 2022;14(1). doi:10.3390/nu14010224

21. Hinderaker SG, Olsen BE, Bergsjø P, Lie RT, Gasheka P, Kvåle G. Anemia in pregnancy in the highlands of Tanzania. *Acta Obstet Gynecol Scand*. 2001;80(1):18-26. doi:https://doi.org/10.1034/j.1600-0412.2001.800104.x

22. Morsy N, Alhady S. Nutritional status and socio-economic conditions influencing prevalence of anaemia in pregnant women. *Int J Sci Technol Res*. 2014;3(7):54-60. www.ijstr.org

23. Adinma JIBD, Ikechebelu JI, Onyejimbe UN, Amilo G, Adinma E. Influence of Antenatal Care on the Haematocrit Value of Pregnant Nigerian Igbo Women. *Trop J Obstet Gynaecol*. 2002;19(2):68-70-70.

24. Nwizu EN, Iliyasu Z, Ibrahim SA, Galadanci HS. Socio-demographic and maternal factors in anaemia in pregnancy at booking in Kano, northern Nigeria. *Afr J Reprod Health*. 2011;15(4):33-41.

25. Fançony C, Soares Â, Lavinha J, Barros H, Brito M. Iron deficiency anaemia among 6-to-36-month children from northern Angola. *BMC Pediatr*. 2020;20(1):298. doi:10.1186/s12887-020-02185-8

26. Vanderjagt DJ, Brock HS, Melah GS, El-Nafaty AU, Crossey MJ, Glew RH. Nutritional factors associated with anaemia in pregnant women in northern Nigeria. *J Health Popul Nutr*. 2007;25(1):75-81.

27. Baig-Ansari N, Badruddin SH, Karmaliani R, et al. Anemia prevalence and risk factors in pregnant women in an urban area of Pakistan. *Food Nutr Bull*. 2008;29(2):132-139. doi:10.1177/156482650802900207