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Research article

Correlates of haemoglobin level in mothers of children under two years in Nanton district: A cross-sectional study from Ghana

Anthony Wemakor [a,*], Daniel Edem Kpewou [a], Khadidjah Wemah [b]

[a] Department of Nutritional Sciences, School of Allied Health Sciences, University for Development Studies, P O Box TL 1883, Tamale, Ghana
[b] Department of Global and International Health, School of Public Health, University for Development Studies, P O Box TL 1883, Tamale, Ghana

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ABSTRACT

Objectives: Anaemia, defined using haemoglobin level, is one of the most prevalent nutritional deficiency diseases among women of childbearing age. Whilst most studies of anaemia were conducted on pregnant women, data are lacking on the haemoglobin level and its correlates of mothers in Ghana. In this paper, we report data on the correlates of haemoglobin level among mothers in Nanton district, Northern Region, Ghana.

Method: A cross-sectional study design was used to study 420 mothers of children under 2 years selected randomly from the child welfare clinics (CWCs) of five health facilities in Nanton District, Ghana. Women were interviewed on their socio-demographic characteristics, dietary practices, reproductive history, and knowledge on anaemia using a structured questionnaire in health facilities. Haemoglobin values during pregnancy were retrieved from antenatal clinic files whilst finger-pricked blood test samples were obtained and used to determine haemoglobin levels during the survey. Multiple linear regression was used to identify the correlates of haemoglobin level of the mothers.

Results: The mean age (±SD) and parity of the subjects were 29.4 (±6.36) years, and 3.36 (±1.78) respectively. The mean haemoglobin (±SD) was 10.35 (±2.17) g/dl and 56.0% of the subjects had anaemia. Multivariable regression analysis identified 12 haemoglobin correlates, but based on standardized regression coefficients, the seven most important correlates of haemoglobin were: parity ($\beta = -0.396$), age ($\beta = 0.352$), having malaria infection postpartum ($\beta = -0.340$), frequency of fruit consumption (once weekly, $\beta = 0.322$), frequency of vegetable consumption (twice weekly, $\beta = 0.296$), overall index of anaemia knowledge (richest tertile, $\beta = 0.125$), and CWC attendance ($\beta = 0.110$). It is recommended to strengthen family planning and malaria prevention programmes, and to intensify education on fruit and vegetable consumption, and anaemia.

1. Introduction

Anaemia is defined as a reduced amount of haemoglobin (less than 12 g/dl) in the blood, a deficiency in the size or number of red blood cells, or the amount of haemoglobin red blood cells contain [1]. Iron forms an essential component of the haemoglobin molecule, which is the predominant oxygen transporter in the body [2]. The most common type of anaemia, iron deficiency anaemia, is usually caused by low iron intake or absorption and/or excessive iron loss [3,4]. Nutritional anaemia is the result of an inadequate intake of

* Corresponding author.
E-mail address: awemakor@uds.edu.gh (A. Wemakor).

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iron, protein, vitamin B12, folic acid, pyridoxine, ascorbic acid, and copper [1]. Mothers may develop low haemoglobin levels due to haemorrhage at childbirth [5], anaemia during pregnancy [6,7], poor dietary and supplemental iron intake and absorption, haemoglobinopathies, inflammation, infections, intestinal worms, and high parity [8].

Low haemoglobin level resulting in anaemia is associated with lower quality of life, depression, emotional instability, stress, and low cognitive performance [9,10]. The World Health Organization (WHO) recommends that newly delivered women receive iron supplementation with or without folic acid supplementation for 6–12 weeks after delivery in areas where gestational anaemia can reach public health level [11].

Studies among pregnant women in the Northern region of Ghana, where this study was conducted, revealed an anaemia prevalence of 50.8–70.0% [12–14] which makes the situation an alarming public health problem. Given the difficulty in resolving anaemia during pregnancy, most affected women will carry it into the postpartum period. Although anaemia is well studied among women at other physiological stages (especially during pregnancy), little is known about haemoglobin level and its determinants among mothers in northern Ghana. It is important to know haemoglobin level of mothers, and factors that influence it to aid in the prevention and management of anaemia. This study therefore aimed to investigate the haemoglobin level and its correlates among mothers in Nanton district of the Northern region of Ghana.

2. Methodology

2.1. Study design, setting and participants

This facility-based, cross-sectional study was conducted among mothers in the Nanton district of the Northern Region of Ghana in the period September 2019 through June 2020. The Nanton District was created from the Savelugu/Nanton Municipality in 2017. The district has no district hospital. The main referral Hospital is the Savelugu Municipal Hospital. There are nine operational Community Health Planning Services (CHPS) zones and four (4) health centres. All the health centres provide both antenatal and postnatal services and hence were selected for this study. Participants were enrolled from the four (4) health centres in the district: Nanton, Tampion, Janjori-Kukuo and Zoggu Health Centres. All mothers aged 18–49 years, with children under two years, who attended CWCs of the selected health facilities were eligible to participate in the study. Mothers who had a recent episode of malaria, were sick at the time of the study or reported a history of blood transfusion in the past 3 months were excluded.

2.2. Sample size and sampling procedure

The single population proportion formula was used to determine an initial sample size of 384 based on an assumed prevalence of anaemia among postpartum women of 50% with a 95% confidence interval (1.96), and 5% margin of error. A total sample of 420 to was used for the study. The overall sample size was divided proportionally among the four health facilities. The number of women registered for CWC was divided by the sample size for the health facility to determine the sampling interval, and systematic random sampling was used to select the women, who were then interviewed whenever they reported for CWC.

2.3. Data collection

Interviews were conducted after explaining the objectives of the study to the participants and obtaining their informed consent. Each woman was interviewed separately in a designated office within the health facility by research data collection staff either in English or in the local dialect. A structured questionnaire was used to collect data on socio -demographic and -economic characteristics: age, marital status, education, religion, ethnicity, occupation and parity of the respondents, and dietary habits i.e., frequency of consumption of meat, fish, vegetables, and fruits within a week. Data were also collected on haemoglobin level in pregnancy, use of long-lasting insecticidal net (LLIN) the previous night, iron supplementation after birth, number of CWC visits, malaria infection after delivery and knowledge on anaemia. Overall anaemia knowledge index was constructed from the women's knowledge of four ways of preventing or resolving anaemia (i.e., dietary iron intake, iron-folic acid supplementation, treating infections and blood transfusion), and two benefits of iron (i.e., it is needed for i. blood production, and ii. growth and development of the foetus). For each correct answer, the women were given a score of "1" otherwise a score of "0". The overall score therefore ranged from 0 to 6 depending on the number of correct answers. The sums of the individual scores were determined, ranked in ascending order, and divided into 3 equal parts i.e., poorest tertile, middle tertile and richest tertile.

To determine the haemoglobin level of the mothers, finger-pricked blood test samples were obtained and evaluated using the URIT-12 Haemoglobinometer (URIT Medical Electronics Co., Ltd, China) by two experienced laboratory technicians hired by the project.

3. Data analysis

Data analysis was performed with Stata version 15 (Stata Corp, TX). Descriptive analysis of data summarized categorical data as frequencies and proportions, and continuous data as means and standard deviations. Multivariable linear regression modelling was used to determine the correlates of haemoglobin levels by estimating coefficients and their 95% confidence intervals. To assess the importance of each significant independent variable, standardized regression coefficients were also calculated. Multicollinearity among the independent variables was checked by calculating variance inflation factor. A variance inflation factor value of 10 or more was regarded as the presence of multicollinearity [15]. In all analyses, a p-value less than 0.05 was considered statistically significant.

3.1. Ethics approval and consent to participate

The study was carried out in accordance with the Helsinki Declaration. The Committee on Human Research, Publication and Ethics of the Kwame Nkrumah University of Science and Technology, School of Medical Sciences/Komfo Anokye Teaching Hospital, gave ethical approval for the conduct of the study (CHRPE/AP/102/21). Informed consent was obtained from participants, or from their husbands on their behalf after assent if they were formally uneducated.

4. Results

4.1. Socio-demographic and -economic characteristics of study participants

The general background (socio-demographic and -economic) characteristics of the participants are presented in Table 1. A total of 420 mothers were included in this study. The mean age (±SD) of the participants was 29.37 (±6.36) years, and the mean number of children was 3.36 (±1.78). Majority of the mothers (74.5%) had no formal education, were farmers (97.6%), and married (95.2%). Regarding ethnicity, 94.8% belonged to Dagomba, the largest ethnic group in the study area.

4.2. Dietary habits of participants

We examined the frequency of consumption of selected food groups that influence the level of haemoglobin. More than half (56.5%) and 98.1% of the participants reported consuming vegetables and fish respectively at least thrice weekly, Table 2. Only a small percentage of the subjects, 2.1% and 1.2% consumed fruits twice a week and meat (at least thrice a week) respectively.

4.3. Correlates of haemoglobin level

The mean number of CWC visits was 3.74 (±2.28), and majority (93.1%) of the participants did not use LLIN the night before the survey, Table 3. After delivery, approximately one-third (32.4%) of the participants had malaria and 16.0% received iron supplementation. The mean haemoglobin level [mean (±SD)] of the women increased from 10.24 (±1.39) g/dl in pregnancy to 10.35 (±2.17) g/dl at the time of the survey, and anaemia prevalence decreased from 77.4% in pregnancy to 55.9% at the time of the study.

The multivariable linear regression model was statistically significant ($F_{(21,\ 398)} = 35.81$; $p < 0.001$), and explained 64% of the variation in the haemoglobin level of the mothers (Adjusted R-squared = 0.64), Table 4. The values of the variance inflation factor for the independent variables were less than 5 suggesting that multicollinearity did not occur between the independent variables. The model identified age, educational status, marital status, number of children, number of CWC visits, mode of delivery, frequency of meat consumption, frequency of vegetable consumption, frequency of fruits consumption, iron supplementation after delivery, having malaria after delivery and overall knowledge of anaemia to be associated with the haemoglobin level of the mothers, Table 4. The other variables in the model were not significantly related to the haemoglobin level of the women. Based on the standardized regression coefficients, the seven most important haemoglobin correlates among the 12 significant variables were parity, age, having malaria infection postpartum, frequency of fruit consumption, frequency of vegetable consumption, overall anaemia knowledge index, and frequency of CWC visits. For a one standard deviation unit increase in parity and age of the women, the mean haemoglobin decreased by 0.40 ($\beta = -0.396$) and increased by 0.35 ($\beta = 0.352$) standard deviation units respectively, adjusting for the other variables in the model. The mean haemoglobin of those who had malaria was 0.34 standard deviation units lower compared to those who did not have malaria ($\beta = -0.340$). The mean haemoglobin of the women who consumed fruits once weekly compared to those who did not consume

Table 1
Socio-demographic characteristics of study subjects.

Variable	Frequency (Percent)/Mean (±Standard Deviation)
Mean age (years)	29.37 (±6.36)
Educational status	
Without formal education	313 (74.5)
Received formal education	107 (25.5)
Religion	
Christian	15 (3.6)
Islam	405 (96.4)
Marital status	
Divorced	20 (4.8)
Married	400 (95.2)
Mean number of children	3.36 (±1.78)
Main occupation	
Farming	410 (97.6)
Petty trading	10 (2.4)
Ethnicity	
Dagomba	398 (94.8)
Others	22 (5.2)

Table 2
Frequency of intake of vegetables, fruits, fish, and meat by the respondents.

Variable	Frequency	Percent
Frequency of vegetable consumption		
None	77	18.3
Twice a week	106	25.2
Thrice a week	109	26.0
More than thrice a week	128	30.5
Frequency of fruit consumption		
None	265	63.1
Once a week	146	34.8
Twice a week	9	2.1
Frequency of meat consumption		
None	274	65.2
Once a week	126	30.0
Twice a week	15	3.6
At least thrice a week	5	1.2
Frequency of fish consumption		
None	8	1.9
Thrice a week	6	1.4
More than thrice a week	406	96.7

Table 3
Haemoglobin level and other factors of mothers.

Variable	Frequency (Percent)/Mean (±Standard Deviation)
Used LLIN the previous night	29 (6.9)
Mean number of CWC visits	3.74 (±2.28)
Received iron supplementation after birth	67 (16.0)
Had malaria after delivery	136 (32.4)
Mean haemoglobin in pregnancy (g/dl)	10.24 (±1.39)
Mean haemoglobin at the time of survey (g/dl)	10.36 (±2.18)
Experienced anaemia in pregnancy	325 (77.4)
Experienced anaemia at the time of survey	235 (55.9)

it was 0.32 standard deviation units higher ($\beta = 0.322$), and 0.30 higher ($\beta = 0.296$) for those who consumed vegetables at least twice weekly to those who did not consume it, after adjusting for other variables in the model. Regarding the overall anaemia knowledge index and CWC visits, the mean haemoglobin of women classified into the richest tertile of anaemia knowledge was higher than that for those in the poorest tertile ($\beta = 0.125$) and a standard deviation unit increase in the frequency of CWC visits led to an increase in haemoglobin in standard deviation units ($\beta = 0.110$).

5. Discussion

This study assessed the correlates of haemoglobin levels among mothers in the Nanton district of the Northern region of Ghana. The mean haemoglobin level among the study population [10.36 (±2.18) g/dl] was lower than the minimum recommended haemoglobin threshold for the study population [3,4], and falls within the anaemic category. This is corroborated with the high prevalence of anaemia (56.0%) recorded among the study participants. The prevalence of anaemia found in our study is higher than the 16.0%, 24.3%, 34.2%, and 43% found among mothers in Hohoe, Ghana [16], Northwest Ethiopia [17], Tanzania [18] and Ethiopia [19] respectively. Moreover, our prevalence was higher than the prevalence for mothers elsewhere; 26.5% in India [20] and 29% in southern Italy [21]. The higher anaemia rates observed among the participants of this study compared to other studies may be due to low intake of iron-rich foods and poor uptake of iron-folic acid (IFA) supplementation in the postpartum period in the study area. The varying anaemia prevalence rates reported in the various studies may be due to differences in socio-economic circumstances, cultural practices, preventive health practices, cut-offs for postpartum anaemia, and diagnostic tests across the study areas. These prevalence rates however clearly suggest that anaemia in mothers remains an important issue of public health importance.

Multivariable analyses show that, the seven most important correlates of haemoglobin among the 12 significant variables were parity, age, having malaria infection postpartum, weekly frequency of fruit consumption, weekly frequency of vegetable consumption, overall anaemia knowledge index and frequency of CWC visits. Our data show that the haemoglobin level decreases with increasing parity, which is consistent with other findings [18,21–23]. Mremi et al [18] found that low parity is protective of anaemia and in a study by Åkesson et al [23], iron status was found to decrease with increasing parity. Among the possible reasons for this observation, the nutritional demand of pregnancy, especially the iron requirements by the foetus, is noted, as about 500–600 mg of iron are lost per pregnancy [24].

Maternal age is associated with improved haemoglobin level suggesting that, the older the women are, the higher their likelihood of having improved socio-economic conditions, increased access to iron-rich foods and/or increased uptake of iron-folic acid

Table 4
Multiple regression analysis of the correlates of haemoglobin level of mothers.

Variable	Unstandardized Coefficient	95% Confidence Interval of Unstandardized Coefficient	Standard error of the mean	P	Standardized Coefficient	Variance Inflation Factor
Age (years)	0.12	0.08, 0.16	0.020	<0.001	0.352	4.08
Formal education						
No						
Yes	0.35	0.02, 0.67	0.166	0.039	0.069	1.28
Religion						
Christian						
Islam	0.01	−0.74, 0.76	0.382	0.987	<0.001	1.22
Marital status						
Divorced	−0.94	−1.57, −0.32	0.319	0.003	−0.092	1.12
Married						
Occupation						
Farming						
Petty trading	−0.56	−1.56, 0.44	0.509	0.273	−0.039	1.46
Ethnicity						
Dagomba						
Others	0.22	−0.40, 0.84	0.317	0.487	0.022	1.21
Parity	−0.48	−0.63, −0.34	0.073	<0.001	−0.396	4.11
Use of LLIN the night before survey						
No						
Yes	0.08	−0.48, 0.63	0.282	0.780	0.009	1.24
Number of CWC visits	0.10	0.04, 0.17	0.032	0.001	0.110	1.29
Mode of delivery						
Caesarean section						
Vaginal delivery	−0.96	−1.69, −0.22	0.373	0.011	−0.081	1.17
Pregnancy anaemia						
No						
Yes	−0.22	−0.67, 0.23	0.228	0.333	−0.029	1.06
Frequency of weekly meat consumption						
None						
At least once	0.47	0.13, 0.81	0.173	0.007	0.102	1.65
Frequency of weekly vegetable consumption						
None						
Twice weekly	0.48	0.07, 0.89	0.208	0.022	0.296	1.99
Thrice weekly	0.53	0.08, 0.99	0.231	0.022	0.107	2.49
More than 3 times weekly	1.40	0.93, 1.88	0.241	<0.001	0.010	2.98
Weekly frequency of fruits consumption						
None						
Once	1.47	1.15, 1.79	0.162	<0.001	0.322	1.45
Twice	2.45	1.46, 3.44	0.502	<0.001	0.163	1.28
Received iron supplementation after deliver						
No						
Yes	0.51	0.10, 0.92	0.208	0.014	0.086	1.40
Had malaria after delivery						
No						
Yes	−1.58	−1.91, −1.25	0.167	<0.001	−0.340	1.49
Overall anaemia knowledge index						
Poorest tertile						
Middle tertile	0.28	−0.02, 0.58	0.154	0.072	0.052	1.20
Richest tertile	0.97	0.46, 1.49	0.262	<0.001	0.125	1.30
$F_{(21,\ 398)} = 35.81$; $p < 0.001$; Adjusted R squared = 0.64						

supplementation.

It was observed that, the women who had malaria, had on average lower haemoglobin level compared to those who did not. Malaria is a significant cause of anaemia [25], which results from accelerated obliteration of normal erythrocytes, variable dyserythropoiesis, and obligatory destruction of parasitized erythrocytes [26–28]. Most of the women did not use LLIN the night before the survey, suggesting that they do not use it regularly and are exposed to mosquito bites, considering that malaria is endemic in Ghana. The LLIN is an important public health intervention to prevent malaria, but compliance with usage is an issue [29–31].

The frequency of vegetable and fruit consumption was related to the haemoglobin level of the women, with women who consumed them weekly having a better haemoglobin status than those who did not. This finding is corroborated by other studies, for example, the

reanalysis of the Ghana Demographic and Health Survey data show that, non-pregnant women who consumed less than 5 servings of fruits or vegetable per day had significantly higher odds of anaemia compared with those who consumed more than 5 servings per day [32]. The protective effect of fruits and vegetable consumption on anaemia is directly linked to the high non-haeme iron content, and indirectly linked to the relatively high ascorbic acid content which contributes to greater bioavailability of iron by functioning as a stimulating agent [33]. To a lesser extent, the consumption of fruits and vegetables also contributes to folate intake correcting its deficiency, which is involved in anaemia pathophysiology.

We also found that, overall anaemia knowledge index and frequency of CWC visits are associated with haemoglobin in the women. Poor anaemia knowledge of pregnant women was found in a previous study to be related to anaemia in Northern Ghana [12]. It can be anticipated that, knowledge on the causes and preventive strategies of anaemia of women would help them reduce exposure to potential causes of anaemia and empower them to utilize the preventive strategies to reduce the odds of getting anaemia. In this study, an increase in the number of CWC visits translates into better haemoglobin status. Child welfare clinic attendance is protective of anaemia as the education received on anaemia and other essential health and nutrition topics could contribute to positive haemoglobin status.

5.1. Strengths and limitations

This study has two notable strengths. Firstly, most of the studies on anaemia in women were conducted on pregnant women, but this study reports data on haemoglobin level and its correlates of mothers, and secondly, a high proportion of the variation in haemoglobin level was explained by the statistical model. Regarding limitations, while the project carried out haemoglobin estimation of the mothers during the study, the haemoglobin values in pregnancy were retrieved from their antenatal care booklets, and association not causation was studied. Given the strengths and limitations, we believe that the results provide useful data on the haemoglobin level and its correlates of mothers in Ghana.

6. Conclusion

A high proportion of mothers were found to have anaemia in the Nanton District reemphasising that anaemia is still a public health problem in mothers. We found that educational status, parity, iron-folic acid supplementation, anaemia knowledge, and malaria infection are important correlates of the haemoglobin level of mothers. It is recommended to strengthen family planning, and malaria prevention programmes and to intensify education on fruit and vegetable consumption and anaemia.

Authors' contributions

A. Wemakor: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

K. Wemah: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

D. E. Kpewou: Analyzed and interpreted the data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e16021.

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