

Factors associated with hemoglobin level of children 6-23 months of age in Wa Municipality of Ghana

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Research article

Keywords: Children, nutritional knowledge, anemia, hemoglobin, antenatal care, Wa Municipality

Posted Date: August 19th, 2019

DOI: <https://doi.org/10.21203/rs.2.13114/v1>

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Abstract

Background: Childhood anemia (hemoglobin <11.0g/dl) remains a key public health concern in sub-Saharan Africa including Ghana. Anemia in early childhood has consequences on the cognitive development and growth of children. We determined the factors associated with hemoglobin (Hb) level of children 6-23 months of age in the Wa Municipality of Ghana.

Methods: A cross-sectional study was used involving 278 mother-child pairs selected from households using multi-stage sampling technique. Socio-demographic characteristics, nutritional knowledge on child feeding practices and antenatal care (ANC) attendance data were collected using questionnaires. Hb level was measured using an automated Huma Count 5L analyzer. Factors associated with Hb level was determined using linear regression modelling.

Results: More than half (53.0%) of the children were females and aged more than one year (60.4%). The mean Hb was 8.5 ± 1.5 g/dl and prevalence of anemia (Hb <11.0 g/dl) was 95.0%. There was strong evidence for increased Hb level among children whose mothers had high nutritional knowledge ($\beta=0.61$, $p<0.005$) and those whose mothers attended ANC for at least four (4) times during pregnancy ($\beta=0.42$, $p=0.04$). We found some evidence for an association between sex of child ($\beta=0.34$, $p=0.06$), household wealth ($\beta= -0.75$, $p=0.06$) and Hb level.

Conclusion: Anemia in children less than two years was high in the Wa Municipality. High maternal nutritional knowledge on child feeding and more ANC attendance were associated with increased hemoglobin level of children. We recommend that maternal education on child feeding practices during ANCs should be intensified by health workers.

Background

Anemia is a disorder that occurs when there is insufficient circulating red blood cells (RBC) or inadequate red cell hemoglobin (Hb) or tissue oxygenation [1]. Globally, childhood anemia remains a major public health challenge. Anemia burden extremely affects young children and women of childbearing age, especially pregnant women. Around the world, 43% of children under five years are anemic [1]. In sub-Saharan Africa (SSA), about 83.5 million people are anemic [2]. Anemia and vitamin A deficiency are persistent nutritional problems of public health interest affecting young children in Ghana [3–5]. Anemia in pregnancy increases maternal and infant morbidity and mortality; impairs cognitive and physical development of children; and reduces physical stamina and work output. It impairs children's mental, physical, social development and it is related to their poor academic performances [6].

Anemia is caused by multiple nutritional and non-nutritional factors [7]. Nutritional anemia is attributable to iron, vitamin A, folate, vitamin B12, ascorbic acid and zinc deficiencies [7]. Iron deficiency anemia (IDA) is more pronounced in pregnancy and during infancy, when iron requirements are higher [8]. Other causes of anemia include malaria, helminthic infections, chronic infections like Human Immune Virus (HIV), tuberculosis, and genetic disorders such as thalassemia and sickle cell [9]. Nutrient deficiencies important

to anemia may be due to inadequate dietary intake, poor bioavailability or a combination [9]. Typically, complementary foods in developing countries are known to be inadequate in micronutrients including those essential for preventing anemia in children [10]. The complementary foods commonly consumed in these countries are mainly cereal based and contain inhibitory factors such as polyphenols, tannins and phytates that reduce bioavailability of essential micronutrients such as iron and zinc [11].

Population level approaches to prevent anemia include malaria control, helminth infection prevention and control, reducing overall infectious disease burden, and dietary interventions [9]. There have been attempts to minimize the burden of anemia among children in Ghana. Most of these interventions include dietary modification and diversification, access to and use of mosquito treated bed nets and nutrition education programs such as growth monitoring and promotion at Child Welfare Clinics (CWC). Despite these interventions, childhood anemia still persists in many parts of Ghana with major regional variation [4]. Data on child hemoglobin levels and potential risk factors could be useful in identifying most vulnerable areas requiring attention. Thus, we determined the factors associated with hemoglobin level of children 6–23 months of age in the Wa Municipality, Upper West Region, Ghana.

Methods

Study area

The study was conducted in Wa Municipality, Upper West Region, Ghana. The Municipality has a population of 123,744. Wa serves as both the capital town of the Municipality and regional capital of the region. It has a land area of approximately 579.86 square kilometers, which is about 6.4% of the Region [12]. The Municipality has six (6) Health Centers (HC), 26 functional/operational Community-based Health Planning and Service (CHPS) Zones, two (2) Clinics, 24 completed CHPS compounds, one (1) Adolescent Health Center and three (3) Private Health Facilities.

Study design, population and sampling

A cross-sectional study design was used. The study population was mothers with children aged 6–23 months from selected communities in Wa Municipality. A multi-stage sampling technique was used to select mothers with children aged 6–23 months. The Municipality was stratified into six (6) strata. A list of mothers with children aged 6–23 months in all communities in each stratum was obtained from the Wa Municipal Health Administration. This list contained the names of all mothers with children less than five years and it was updated in January 2018. Samples were proportionally allocated to each stratum based on the number of children 6–23 months of age attending CWCs. For each stratum, one community was randomly selected, and households chosen using systematic sampling method. Household lists were obtained from community health volunteers and divided by the required sampling size to get a sampling interval. The first household was selected at random from the interval using random number table and subsequent households were determined by adding the sampling interval to the preceding household number. This process continued until the required sample was obtained [13].

The sample size was determined using an estimated anemia prevalence of 88.1% based on hemoglobin level among children under-five years in Upper West Region [14]. We used a 95% confidence interval, 5% margin of error (e) and a sample size of 161.1 was estimated. The estimated sample size was multiplied by a Design Effect of 1.73. A total sample size of 278 was used to determine the prevalence of hemoglobin level and its associated factors among children 6–23 months of age in the study area.

Data collection procedure

The mothers were approached, consented and enrolled to participate in the study. Socio-demographic data were collected through face-to-face interviews using a semi-structured questionnaire. The mothers were interviewed on child breastfeeding practices, antenatal care (ANC) attendance, and dietary intake of children. Four (4) research assistants and two (2) trained laboratory technicians with previous experience in data collection and phlebotomy were recruited and trained on the data collection. The four data enumerators were trained nutritionist with either diploma or first degree in nutrition. Before the commencement of main data collection, the questionnaire was pre-tested among other children of the same age group in Sombo community in the Municipality to check its clarity and responsiveness. The Sombo community was not one of the communities selected for the main data collection. The necessary corrections were effected to the questionnaire before the main study was conducted. In the process of data collection and estimation of hemoglobin concentrations in the laboratory, instruments were calibrated and standardized methods used. Whole blood samples were stored in Ethylene Diamine Tetra acetic acid (EDTA) tubes and transported to the laboratory for analysis. The Huma Count 5L Haematology analyzer was calibrated daily for estimating the hemoglobin concentrations. Hemoglobin concentrations were determined immediately after return from the field each day. Data were double entered to check for accuracy and consistency. In validating data, codes were double-checked for out-of-range values and completeness.

Measurement of hemoglobin level and anemia classification

We obtained venous blood from the children by trained laboratory technicians. The Standard Operating Procedures (SOPs) for blood sample collection and analysis as described in District Laboratory Practice for Tropical Countries by Monica Cheesbrough was used [15]. Whole blood samples were drawn via venepuncture from the children and put in EDTA tubes. The blood was gently mixed in the tubes to prevent clotting. The blood samples were then transported to the Wa Regional Hospital Laboratory for estimation of hemoglobin concentration (Hb level). Hemoglobin estimation was done using a fully automated Huma Count 5L Haematology Analyzer as follows: 20 microlitres of EDTA whole blood (well mixed) was aspirated into the automated Haematolgy analyzer. Anemia was classified using the WHO standard for children under five years as follows: any anemia (<11.0 g/dl), mild anemia (10.0–10.9 g/dl), moderate anemia (7.0–9.9 g/dl) and severe anemia (< 7.0 g/dl) [16].

Measurement of dietary diversity and maternal nutritional knowledge

Dietary diversity scores of a child was determined by using WHO recommendations on measuring Minimum Dietary Diversity (MDD) for children aged 6–23 months [17]. Mothers/caregivers were asked to recall all food items and beverages given to the child during the previous day. Then, all food items and beverages consumed by the child were categorized into seven food groups as (i) grains, roots, and tubers, (ii) legumes and nuts, (iii) dairy products, (iv) flesh foods, (v) eggs, (vi) vitamin-A rich fruits and vegetables, and (vii) other fruits and vegetables [17]. Using dietary diversity score of four (4) (MDD score) as cut-off point, a child was defined as not meeting the dietary diversity if he/she consumed <4 food groups while having met dietary diversity” if he/she consumed ≥ 4 or more food groups [17].

Maternal nutritional knowledge was assessed on the WHO recommended Infant and Young Child Feeding (IYCF) indicators with a questionnaire. For our study, the questions were adopted from a similar questionnaire used earlier to assess maternal nutritional knowledge on child feeding in Ghana [18]. Maternal nutritional knowledge was taken and scored quantitatively. Based on the responses, a score of one (1) was assigned for each valid answer, or zero (0) scored for non-recommended practices with a maximum possible score of 5 for five (5) questions. A mother’s overall knowledge of recommended child feeding practices was rated by calculating the total of all the valid responses. The overall composite child feeding knowledge index, therefore, ranged from a minimum of zero (0) to a maximum of five (5). Maternal nutritional knowledge on child feeding scores were added to form a total score for each mother. Those who had scores equal to or more than the mean score of the total sample were classified as high/average knowledge while mothers scoring less than the mean were low knowledge [18].

Statistical analysis

Data were entered and cleaned in SPSS (version 21). Statistical analyses were performed in Stata (version 15). Categorical variables have been presented as frequencies and percentages. Continuous variables are presented as means and standard deviations. Household wealth status was determined by principal component analysis using possession of 14 household durable equipment including radio, television, satellite dish, sewing machine, mattress, refrigerator, DVD, computer, electric fan, mobile phone, bicycle, motorcycle/tricycle, animal drawn cart, and car/truck. The factor that explained the largest variability was extracted and categorized into four quartiles (poorest/poor, medium, wealthy and wealthiest) [19, 20]. The first two quartiles (Q1 & Q2) were combined to represent low wealth households, while the last two quartiles (Q3 & Q4) were also combined to represent high wealth households.

The association between maternal and child factors on one hand and hemoglobin level of children on the other was assessed with t-test as first line statistic to identify factors that show some evidence of association ($p \leq 0.3$) with hemoglobin level for consideration in regression modelling. Age and sex of child were chosen *a priori* (‘forced variables’) for adjustment in the final model. Linear regression was used to identify the final factors associated with child hemoglobin level. P-values reported in the linear regression

model are partial F-test p-values. This test the association between an explanatory variable and the outcome (hemoglobin level) accounting for the effects of all other explanatory variables in the model.

Results

Socio-demographic characteristics, feeding indicators and anemia status of study sample

Table 1 presents the socio-demographic characteristics, feeding indicators and anemia status of study sample. The majority of mothers were from the Waala ethnic group (69.4%) and 47.1% were aged below 26 years with a mean age of 26.4 ± 5.4 . Less than half (39.2%) of the mothers had no formal education and 42.1% were farmers. The majority (71.6%) of the respondents practiced Islamic religion and nearly all (96.0%) of them were married. Over half (54.7%) of mothers had more than two children. Generally, mothers had high nutritional knowledge (77.3%). That is, they scored above the mean value on maternal nutritional assessment.

More than half (52.9%) of the sampled children were females and 60.4% were between the ages of 13 and 23 months. The majority of the children had adequate birth weight of at least 2.5 kg (89.8%). Only 23.0% of the children consumed at least four (4) food groups (MDD) in a 24-hour recall. The majority (92.1%) of the children did not receive the minimum meal frequency. The mean Hb was 8.5 ± 1.5 g/dl. Anemia prevalence using hemoglobin ($Hb < 11.0$ g/dl) level among young children was high in the study area. More than nine in ten (95.0%) children had some form of anemia: 11.5% mildly anemic, 68.7% moderately anemic, and 14.8 severely anemic.

Factors associated with hemoglobin level of children

A number of variables such as sex of child, age of child, household wealth, ANC visit, maternal nutritional knowledge, dietary diversity and religion of mother were tested in a t-test to determine their associations with hemoglobin levels of children. Household wealth status ($p = 0.05$), number of ANC visits ($p = 0.04$) and maternal nutritional knowledge ($p = 0.06$) were found to be associated with hemoglobin levels of children (Table 2).

In linear regression modeling, we found strong evidence for increased hemoglobin (Hb) levels among children whose mothers had high nutritional knowledge ($\beta = 0.61$, $p < 0.005$). Children whose mothers attended ANC for at least 4 times during pregnancy had increased Hb level ($\beta = 0.42$, $p = 0.04$). We found some evidence for increased Hb level among female children ($\beta = 0.34$, $p = 0.06$) and those who lived in high wealth households had lower Hb levels ($\beta = -0.75$, $p = 0.06$). There was borderline association between Hb level of children and their mother's religion ($\beta = -0.39$, $p = 0.05$) (Table 3).

Discussion

This study sought to determine the factors associated with hemoglobin level of children 6 –23 months of age in Wa Municipality of Ghana. We found that the prevalence of anemia (Hb <11.0 g/dl) was 95.0% and moderate/severe anemia (Hb <10.0g/dl) was 83.5% in the study population. There was an association between Hb levels of children and mothers who had high nutritional knowledge ($\beta = 0.61$, $p < 0.005$) and those who attended ANC for at least four (4) times during pregnancy ($\beta = 0.42$, $p = 0.04$). Similarly, we found some association between sex of child ($\beta = 0.34$, $p = 0.06$), household wealth ($\beta = -0.75$, $p = 0.06$) and Hb level.

In this study, we found that anemia prevalence was unacceptably high among children aged 6–23 months. This is more than twice the global estimates [21] of anemia in children and also higher than the national prevalence of 66.0% and regional prevalence (Upper West Region) of 73.8% in Ghana. There was also a disparity in severe-moderate anemia in the current study (83.4%), which is more than double compared to 40% in the country [4]. Similarly, the prevalence of severe anemia alone in the Wa Municipality was nearly twice the Upper West Region estimate of 8.2% or 7.8% observed earlier [21]. Although, the current prevalence of anemia in children is exceedingly higher than the regional estimates reported in 2014 [4], it is similar to the findings of Ewusie *et al* [14], where 98.7% of children between one and two years of age were anemic. This implies that nearly all children less than two years of age are anemic in the study area, which is a major health concern. The high levels of anemia among children in the study area could be due to the timing (seasonality) of the survey and general poverty. The Upper West Region is one of the poorest regions in the country. In Ghana, there is disparity between rural and urban areas in terms of anemia [4]. Thus, the observed prevalence of anemia could be explained by geographical variations and rural-urban disparities within the country since the study involved more rural communities. For example, anemia prevalence vary between urban (58.0%) and rural (72.0%) in Ghana [4]. Another possible explanation for the high anemia prevalence in the study area could be attributed to micronutrient insufficiency among mothers. Malnourished mothers have poor nutrient stores and they are likely to give birth to low birth weight and premature children. These children often have poor iron stores at birth which is compounded by exclusive breastfeeding if delayed cord clamping was not performed at birth [22]. Introduction of complementary foods often occur within this period, which is also a period for rapid physical development with increased blood volume and a corresponding increase demand for iron which is often limiting in most rural complementary foods.

The high prevalence of anemia in the study area could also be explained by low diet quality reflected in the small proportion meeting the recommended minimum dietary diversity. Similarly, only a few children were fed according the recommended frequency for their age compared to national practice [4]. The low dietary diversity could be influenced by the seasonal variation in food availability. This study was conducted in January which is the dry season in northern Ghana. During the dry season, fresh vegetable and fruits are mostly out of season and hence the less diverse diets observed. Thus, children possibly missed essential micronutrients often available in diverse diets including iron. The increased susceptibility of children to infections and diseases, which affect their nutrition and feeding could also explain the high anemia in this age group [9].

The results show strong evidence of association between high maternal nutritional knowledge and high ANC attendance and increased Hb. Similar findings have been reported earlier in the literature [23, 24]. These studies show that mothers' ability to practice recommended feeding practices was associated with their nutritional knowledge probably acquired during ANC attendance. Mothers with high nutritional knowledge were also more likely to give a diversified diet compared to those who had lower knowledge [20]. Regardless of household food availability, inadequate knowledge of the appropriate combinations of the different food groups may result in low quality diets. Also, some traditions and cultures have eating taboos binding on their families especially children and women. For example, children may not be permitted to eat eggs or fish in some cultures which are highly nutritious and stimulates blood production [18, 25]. High maternal knowledge on child feeding practices may imply that mothers were more likely to make appropriate feeding choices. In addition, they were likely overcome some food taboos and hence the observed increased Hb in their children. Similarly, a mother who made adequate ANC visits were likely to know more nutritious foods, locally available and good for their children compared to mothers who made fewer ANC visits since education on appropriate child feeding practices is part of antenatal care in Ghana. These findings highlight the importance of appropriate child feeding education during ANC attendance. The recent increase of the minimum ANC visits from four (4) to eight (8) by WHO [26] could likely impact on maternal nutritional knowledge and feeding practices in settings where child feeding faces challenges of both food availability and cultural limitations.

Strengths and limitations

Our findings should be interpreted considering some limitations. We measured Hb level which does not differentiate between iron deficiency anemia and other forms of anemia. However, these findings suggest that iron status is likely poorer in the population because other early stage status indicators such ferritin or serum transferrin receptor saturation would have included sub-clinically deficient children. In addition, we included only children who attended health facilities. These children could be different from those who do not attend CWC. However, as CWC attendance in the area is high, our estimates are more likely representative. We used the most recent automated haematology analyzer to estimate hemoglobin levels within 12-hours of sample collection with high precision and accuracy.

Conclusion

Anemia in children 6–23 months of age remains very high in the Wa Municipality of Ghana and higher than the national average. High maternal knowledge on child feeding and antenatal care attendance during pregnancy were associated with increased hemoglobin level of children. We recommend that maternal education on child feeding practices during ANC should be intensified by health workers.

Declarations

List of abbreviations

ANC: Antenatal Care; CHPS: Community-based Health Planning and Service; CWC: Child Welfare Clinics; DVD: Digital Video Disc; EDTA: Ethylene Diamine Tetra acetic acid; Hb: Hemoglobin; IDA: Iron deficiency anemia; SOP: Standard Operating Procedures; SPSS: Statistical Package for Social Science; SSA: Sub-Saharan Africa; WHO: World Health Organization

Ethical approval and consent to participate

Ethical approval for the study was obtained from the University for Development Studies Institutional Review Board (*UDSIRB*), Tamale, Ghana. We also obtained permission from the Regional Health Directorate of the Upper West Region to conduct the study in the health facilities. All participants were informed about the nature and processes involved in the study, the research objectives, and the confidentiality of the data. The participation of the subjects was completely voluntary in nature, and signature/thumbprint consent was obtained from each mother before their children were recruited into the study.

Consent for publication

Not applicable

Availability of data and materials

Data will be available upon request from corresponding author.

Competing interests

The authors have no competing interests.

Funding

Authors funded this research

Author's contributions

ATKL and MNA conceived the idea, planned and conducted the research. ZA was responsible for the statistical analysis and interpretation of data. ATKL, MNA and ZA contributed to the analysis, manuscript preparation and revision. All authors approved the final version.

Acknowledgements

We thank the mothers for their participation in this study. We are also grateful to the Regional and Municipal Directors of Ghana Health Service in the Upper West Region and Wa Municipality respectively for granting permission to undertake this research.

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Tables

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