

# Prevalence and Risk Factors of Anaemia Among Children Under Five Years in Ghana: Analysis From the Ghana Demographic and Health Survey

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## Research Article

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# Abstract

**Background:** Childhood anaemia remains a public health challenge in developing countries, mostly in children under five years in Sub-Saharan Africa. Anaemia in children is a preventable condition; however, it has serious consequences including growth retardation, low cognitive functioning, poor immune system causing an increased susceptibility to diseases, and death. This study determined the prevalence and associated risk factors of anaemia among children under five years in Ghana.

**Methods:** Data from the most recent Ghana Demographic and Health Survey (DHS-VIII) was analysed in this study. Anaemia was examined as a binary variable- anaemic (coded as 1) and non-anaemic (coded as 0). The explanatory variables included age, child's malaria vaccination status, mother's number of antenatal visits and household source of drinking water. Bivariate and multivariate logistic regression model were conducted to identify the risk factors of anaemia in the defined population.

**Results:** 2,434 children aged 6-59 months were included in this analysis. The majority were males (50.5%), aged from 24-42 months (36.1%), and had received malaria vaccine (94.3%). The prevalence of anaemia in the population was 58.35% (95%CI=52.72-63.96). The logistic regression indicated that female children under five years in Ghana are less likely to have anaemia than male children under five years [aOR= 0.74, 95% CI=0.62-0.88, p<0.001]. Also, children with malaria had about two times the odds of anaemia than those without malaria [95% CI = 1.28-1.87, p<0.001]. Further, children whose mothers had received tertiary education were less likely to have anaemia [aOR= 0.60, 95% CI=0.38-0.96, p=0.03] than those whose mothers had no formal education.

**Conclusion:** The prevalence of anaemia is high among children under five years in Ghana, and this prevalence is determined by child's age and malaria status, maternal education, household wealth index, and place of residence. Consequently, anaemia prevention and management strategies must prioritise these factors to reduce the anaemia prevalence in this population.

## Background

According to the World Health Organisation (WHO), anaemia encompasses a broad range of public health problems, including deficiencies of micronutrients, especially iron [1, 2]. Globally, anaemia is one of the largest contributors to child mortality, causing an estimated 45% of the total deaths of children younger than five years [3]. It is estimated that 273 million (approximately 42.6%) children under five years are anaemic worldwide with a higher prevalence in Sub-Saharan African (SSA) countries [1]. However, studies have shown that anaemia prevalence among children in settings where malaria is endemic range from 49–76% [3–5]. Anaemia prevalence in the WHO African region is 47.5–67.6% among the general population and 68% among children who are under five years [1]. The WHO considers anaemia as a severe public health threat if the prevalence is higher than 40.0% in children, thus signifying that this percentage represents a very serious public health problem that requires immediate collective effort and response [6, 7].

Studies have reported a high prevalence of childhood anaemia. For instance, a study based on data from Demographic and Health Survey (DHS) in Togo among children under five years revealed 70.9% anaemia prevalence [8]. In other developing countries, the prevalence of childhood anaemia ranges from 27.2% in Mexico to 60.6% in Haiti [9, 10]. In Ghana, studies have established that anaemia prevalence is 78% and 84% among children aged 2–5-years and under 2 years, respectively [2, 11]. Anaemia aetiology is multifactorial and context-dependent and can include malaria, intestinal parasites, and malnutrition [7]. Commonly, it is the most vulnerable, the poorest and the least educated who are disproportionately affected by iron deficiency, and they stand to gain the most by its reduction and experience the severe forms of anaemia [12]. In addition to anaemia's adverse health consequences, the economic effect of anaemia on human capital results in the loss of billions of dollars annually which subsequently affect productivity [13, 14].

This double burden of anaemia has caused both national and international up look to implement anaemia preventive programmes such as food fortification and intermittent iron supplementation [15]. Also, in Ghana, new efforts are getting underway to improve child's health and wellbeing. It is important to characterize the baseline situation and associated factors of anaemia in the most vulnerable population groups to serve as a benchmark for monitoring progress. A recent study in Ghana using data from the DHS revealed a high prevalence of 78.4% anaemia among under five children [16]. However, the associated determinants contributing to the higher prevalence was not established. This current study sort to bridge the gap and adds evidence to the literature on prevalence and determinants of childhood anaemia. In general, the success of community programs in Sub-Saharan Africa and particularly in Ghana require a good knowledge and understanding of the risk factors of anaemia. As a result, this study aimed to determine the prevalence and risk factors of anaemia among children under five years (aged 6 to 59 months) using the most recent DHS dataset in Ghana.

## Methods

### Data source

The data used in the study was extracted from the 2019 Ghana Malaria Indicator Survey (GMIS) which is the eighth phase of the Ghana Demographic and Health Survey (GDHS) programme. GDHS has been effective since 1988 and is part of the international Demographic and Health Survey (DHS) programme which seeks to collect household surveys in developing countries with the goal to provide governments with recent and reliable information on population health indicators to allow for adaptation of health policies. The DHS led by the United States Agency for International Development (USAID) deals with many health issues, including anaemia, family planning and reproduction, child health (breastfeeding and nutrition, vaccinations, acute respiratory infections, and diarrhoea), malaria and the Human Immunodeficiency Virus (HIV) [17]. The 2019 GMIS is the most recent DHS programme in Ghana, and it was implemented by the Ghana Statistical Service (GSS), in close collaboration with the Ghana National Malaria Control Programme (NMCP) and the National Public Health Reference Laboratory (NPHRL) of the Ghana Health Service (GHS).

Financial support for the survey was provided by the United States Agency for International Development (USAID) and the Government of Ghana. The survey was designed to provide estimates at the national level, urban and rural areas, and for each of the 10 administrative regions. In 2019, Ghana created six new regions; however, the new administrative boundaries were not available during survey design of the 2019 GMIS. The survey used a stratified, two-stage cluster design, where a total of 200 clusters, which consisted of 97 clusters in urban areas and 103 in rural areas were chosen. Details about the survey can be found in the 2019 MIS report [18]. Since the main objective of the study was to determine the prevalence and risk factors of childhood anaemia among under five years, the children's data recode file part of 2019 GMIS datasets was used for the analysis [18].

### **Outcome variable**

During the 2019 GMIS, anaemia was tested with a single-use retractable, spring-loaded, sterile lancet for the finger or heel prick. Haemoglobin (Hb) analysis was performed on site with a battery-operated portable HemoCue 201+ analyser, which could give result in less than a minute (haemoglobin level) in grams per decilitre (g/dl) of blood. The World Health Organisation (WHO) estimates that children aged 6-59 months with Hb concentration level below 11.0 g/dl corresponds to anaemia, a level below 7.0 g/dl is considered as severe anaemia, a level between 7.0 g/dl and 9.9 g/dl is considered as moderate anaemia and a level between 10.0 g/dl and 10.9 g/dl is considered as mild anaemia [2]. In regard to the WHO haemoglobin levels of classification, the dependent variable was coded into two levels (anaemia and not anaemia). A child was classified as anaemic if the Hb level was below the WHO threshold of 11.0 g/dl.

### **Weighting the sample**

In order to adjust for the unequal probability of selection between the geographically defined strata, and to compensate for sample variability as well as for nonresponse during the survey, a sample weight was applied during the analysis to get statistics that are representative of Ghana. A detailed explanation of the weighting procedure can be found in the methodology section of the survey report [18].

### **Independent variables**

The independent variables were grouped into child related characteristics, Maternal characteristics, and Household characteristics. The child's related variables were sex, child's age, malaria status, and whether a child took the mosquirix (malaria vaccine). Variables related to the child's mother were educational status, mother's age, ethnicity, number of antenatal clinic (ANC) visit, and religion. Household related characteristics were wealth index, place of residence, household source of drinking water, and region located.

### **Statistical Analysis**

Data analysis was conducted with STATA/SE version 17. The characteristics of the sample was summarised with frequencies and proportions in a descriptive analysis. Then, statistical significant differences between the independent variables and anaemia were determined using the Pearson Chi-

Square test ( $\chi^2$ ). Further, logistic regression analysis was fitted to estimate the odds of anaemia odds ratios (ORs). The findings were reported with a 95% Confidence Interval (95% CI) and a p-value less than 0.05 was considered statistically significant.

## **Ethical approval**

Ethical approval was received from the Brunel Research Ethics Committee [Reference: 31563-NER-Jul/2021- 33647-1]. Also, written consent was obtained from the Demographic and Health Survey (DHS) programme data archivist before the dataset was accessed and used for the analysis.

# **Results**

## **Characteristics of the study population**

The dataset consisted of three thousand and four (n=3004) children under five years of age. However, this analysis only included two thousand four hundred and thirty-four (n=2434) children aged 6-59 months whose anaemia status was determined and were available. The proportion of male and female populations in the sample was 1228 (50.5%) and 1206 (49.6%), respectively, and the most represented age group were children aged 24–42 months (n=879, 36.1%). The majority (n=2296, 94.3%) had received malaria vaccine (Mosquirix); however, more than one-third (n=857, 35.2%) reported fever or malaria. Furthermore, more than 50% of the children (n=1335) lived in poor households, and nearly 62% (n=1508) were from rural areas. Also, the source of the most common household drinking water was dug well (41.2%).

Most of the children were from the Northern region (15.9%), were from poor households (54.85%) and had mothers who had no formal education (46.1%). Also, while nearly 27% of the mothers did not visit the Antenatal Clinic (ANC), about 47% of them visited the ANC 6-10 times.

## **Prevalence of anaemia**

Overall, the prevalence of anaemia among children under five years (6-59months) in Ghana was 58.35% (95%CI=52.72-63.96). Also, a higher proportion of anaemia was observed among children with fever or malaria (66.27%, p<0.001). Similarly, the proportion of anaemia was higher among children whose mothers had no formal education (65.54%, p<0.001) and were younger than 25years (65.61%, p<0.001). Moreover, anaemia prevalence was significantly higher among children from poor households (66.67%, p<0.001) and those living in rural areas (62.74%, p<0.001). The distribution of anaemia prevalence among children in the regions of Ghana is Upper East (72.84%), Northern (67.87%), Central (66.20%), Upper West (62.57%), Brong Ahafo (59.36%), Volta (53.55%), Western (50.51%), Greater Accra (47.43%), Eastern (47.08%), and Ashanti (42.91%). The descriptive characteristics of the children, their mothers, households, and the distribution of anaemia prevalence across the child-related factors, maternal and household factors with respective p-values and 95% CI are shown in Table 1

**Table 1** Prevalence of anaemia among Ghanaian under-5 children by demographics, maternal and household characteristics

Factors	Sample size (%)	Anaemia (n)	Prevalence of anaemia		p-value
			Unweighted prevalence (95%CI)	Weighted prevalence (95%CI)	
Total	2434(100.0)	1420	58.34(56.38-60.30)	58.35(52.72-63.96)	
Child related factors					
Sex of children					0.003
Male	1228(50.45)	753	61.32(58.59-64.05)	61.31(56.47-66.16)	
Female	1206(49.55)	667	55.31(52.50-58.12)	55.30(58.56-62.06)	
Age of children (Months)					<0.001
6-23	869(35.70)	600	69.04(65.97-72.12)	69.05(62.54-75.54)	
24-42	879(36.11)	523	59.50(56.25-62.75)	59.49(53.01-65.98)	
43-59	686(28.18)	297	43.29(39.58-47.01)	43.29(36.61-49.97)	
Child had fever/malaria					<0.001
No	1577(64.79)	852	54.03(51.56-56.49)	54.03(48.23-59.82)	
Yes	857(35.21)	568	66.28(63.11-69.45)	66.27(60.60-71.95)	
Took malaria vaccine					0.041
No	138(5.87)	69	50.00(41.62-58.38)	50.00(43.85-54.14)	
Yes	2296(94.33)	1351	58.84(56.83-60.86)	58.84(53.08-64.60)	
Maternal factors					
Mother's education status					<0.001
No education	1123(46.14)	736	65.54(62.76-68.32)	65.54(61.79-69.28)	

Primary	983(40.39)	536	54.53(51.41-57.64)	54.52(48.98-60.07)	
Secondary	213(8.75)	102	47.89(41.16-54.61)	47.88(41.63-54.14)	
Tertiary	115(4.72)	46	40.00(31.00-48.99)	40.00(30.95-49.05)	
Mother's age (years)					<0.001
15-24	535(21.98)	351	65.61(61.58-69.64)	65.61(61.94-69.28)	
25-34	1179(48.44)	672	57.00(54.17-59.83)	56.99(49.00-64.99)	
35-44	649(26.66)	349	53.78(49.93-57.62)	53.78(48.40-59.15)	
>44	71(2.92)	48	67.61(56.64-78.57)	67.61(58.42-76.80)	
Ethnicity					<0.001
Akan	791(32.50)	407	51.45(47.97-55.94)	51.45(43.07-59.83)	
Ewe	361(14.83)	193	53.46(48.31-58.62)	53.46(47.16-59.77)	
Ga	98(4.03)	49	50.00(40.04-59.96)	50.00(36.65-63.35)	
Grusi	237(9.74)	146	61.60(55.40-67.81)	61.60(57.12-66.08)	
Mole-dagbani	848(34.84)	562	66.27(63.09-69.46)	66.27(59.74-72.80)	
Others	99(4.07)	63	63.64(54.11-73.17)	63.64(55.69-71.59)	
Number of ANC visit					<0.001
No visit	654(26.87)	332	50.76(46.93-54.60)	50.77(42.56-58.97)	
1-5	456(18.73)	294	64.47(60.07-68.87)	64.48(56.85-72.10)	
6-10	1146(47.08)	691	60.30(57.46-63.13)	60.29(55.35-65.25)	
>10	178(7.31)	103	57.87(50.59-65.14)	57.86(49.96-65.77)	

Religion					<0.001
Christianity	1727(70.95)	942	54.55(52.20-56.90)	54.54(48.53-60.56)	
Islam	583(23.95)	390	66.90(63.07-70.72)	66.89(59.31-74.48)	
Traditional	51(2.10)	32	62.75(49.33-76.15)	62.74(52.82-72.67)	
Others	73(3.00)	56	76.71(66.94-86.48)	76.71(69.90-83.52)	
p-value<0.05 was considered statistically significant.					

**Table 1** Prevalence of anaemia among Ghanaian under-5 children by demographics, maternal and household characteristics (continued)

Factors	Sample size (%)	Anaemia (n)	Prevalence of anaemia		p-value
			Unweighted prevalence (95%CI)	Weighted prevalence (95%CI)	
Household factors					
Wealth Index					<0.001
Poor	1335(54.85)	890	66.67 (64.14-69.20)	66.67(62.37-70.96)	
Middle	476(19.56)	261	54.83(50.35-59.31)	54.83(49.16-60.50)	
Rich	623(25.60)	269	43.18(39.28-47.07)	43.18(39.58-46.77)	
Place of residence					
Rural	1508(61.96)	946	62.73(60.29-65.17)	62.74(55.76-69.70)	
Urban	926(38.04)	474	51.19(47.96-54.41)	51.18(44.56-57.81)	
Source of drinking water					<0.001
Dug well	1002(41.17)	625	62.38(59.37-65.38)	62.38(56.59-68.16)	
Pipe	717(29.46)	413	57.60(53.98-61.22)	57.60(51.19-64.01)	
Rainwater	62(2.55)	47	75.81(65.05-86.56)	75.80(67.40-84.21)	
River/lake	193(7.93)	124	64.25(57.47-71.03)	64.24(52.44-76.05)	
Sachet water	460(18.90)	211	45.87(41.31-50.43)	45.87(41.09-50.65)	
Region					<0.001
Ashanti	261(10.72)	112	42.91(36.89-48.93)	42.91(39.60-46.22)	
Brong Ahafo	251(10.31)	149	59.36(53.27-65.45)	59.36(38.08-80.65)	
Central	216(8.87)	143	66.20(59.88-72.53)	66.20(51.26-81.15)	
Eastern	189(7.76)	89	47.09(39.95-54.23)	47.08(44.68-49.50)	
Greater Accra	156(6.41)	74	47.44(39.57-55.30)	47.43(42.19-52.67)	
Northern	386(15.86)	262	67.88(63.21-72.54)	67.87(57.50-78.25)	
Upper East	232(9.53)	169	72.84(67.11-78.58)	72.84(67.75-77.94)	
Upper West	334(13.72)	209	62.57(57.37-67.78)	62.57(47.83-77.32)	
Volta	211(8.67)	113	53.55(46.81-60.30)	53.56(41.05-66.06)	
Western	198(8.13)	100	50.51(43.52-57.49)	50.51(36.86-64.15)	

## Factors associated with anaemia

In the crude regression analysis (model 1), female children under 5 years were 22% less likely to have anaemia compared to male children under 5 years [cOR=0.78, 95%CI=0.66-0.92, p<0.001]. Also, children aged 24-42months [cOR=0.66, 95% CI=0.54-0.80, p<0.001] and 43-59months [cOR= 0.34 (95% CI=0.27-0.42), p<0.001] were 34% and 66% respectively less likely to have anaemia compared to children aged 6-23months. Additionally, children with fever or malaria were 67% more likely to have anaemia than children who had no fever or malaria [cOR=1.67, 95%CI=1.41-2.00, p<0.001]. However, child whose mother has some form of education, living in an urban area and has a middle or rich wealth index were less likely to have anaemia. Moreover, children who were in a household that uses pipe [cOR=0.82, 95% CI=0.67-0.99, p=0.046] and sachet water [cOR= 0.51, 95% CI=0.41-0.64, p<0.001] as their source of drinking water were 18% and 49% respectively less likely to have anaemia.

In the adjusted regression analysis (model 2), the findings showed that females were less likely to get anaemia than males [aOR= 0.74, 95% CI=0.62-0.88, p<0.001]. Again, children who were 24-42 and 43-59 months old were 36% and 67% times respectively less likely to get anaemia compared to children who were 6-23months old [aOR= 0.64, 95% CI=0.51-0.79, p<0.001] and [aOR= 0.33, 95% CI=0.25-0.42, p<0.001] respectively. Also, children whose mother had some forms of education, thus primary [aOR= 0.78, 95% CI=0.62-0.97, p<0.027], secondary [aOR= 0.65, 95% CI=.46-0.92, p<0.015], and tertiary [aOR= 0.60, 95% CI=.0.38-0.96, p<0.034], were less likely to have anaemia. However, children with fever or malaria were more likely to have anaemia [aOR= 1.55, 95% CI=1.28-1.87, p<0.001]. Moreover, children who lived in middle [95% CI=0.51-0.88, p=0.005] and rich [95% CI=0.36-0.70, p<0.001] wealth index households were 0.67 and 0.50 times less likely to be anaemic. Regarding residence, living in urban areas showed a negative association with childhood anaemia compared to living in rural areas [aOR= 0.86, 95% CI=0.68-1.09, p<0.003]. Finally, the mother's age, ethnicity and number of antenatal clinic visits showed no significant association with childhood anaemia in the multivariate model. See table 2 for the logistic findings on the crude and adjusted indicators of childhood anaemia.

## Table 2 Factors associated with anaemia in children under-5 years in Ghana

Factors	Model 1		Model 2	
	cOR(95%CI)	p-value	aOR(95%CI)	p-value
Child related factors				
Sex of children				
Male	Ref		Ref	
Female	0.78(0.66-0.92)	0.003	0.74(0.62-0.88)	0.001
Age of children (Months)				
6-23	Ref		Ref	
24-42	0.66(0.54-0.80)	<0.001	0.64(0.51-0.79)	<0.001
43-59	0.34(0.27-0.42)	<0.001	0.33(0.25-0.42)	<0.001
Child had fever/malaria				
No	Ref		Ref	
Yes	1.67(1.41-2.00)	<0.001	1.55(1.28-1.87)	<0.001
Took malaria vaccine				
No	Ref		Ref	
Yes	1.42(1.01-2.02)	0.042	1.21(0.83-1.78)	0.315
Maternal factors				
Mother's education status				
No education	Ref		Ref	
Primary	0.63(0.53-0.75)	<0.001	0.78(0.62-0.97)	0.027
Secondary	0.48(0.36-0.65)	<0.001	0.65(0.46-0.92)	0.015
Tertiary	0.35(0.24-0.52)	<0.001	0.60(0.38-0.96)	0.034
Mother's age (years)				
15-24	Ref		Ref	
25-34	0.69(0.56-0.86)	0.001	0.88(0.70-1.12)	0.303
35-44	0.61(0.48-0.77)	<0.001	0.76(0.58-0.99)	0.041
>44	1.09(0.65-1.86)	0.739	1.27(0.71-2.26)	0.419
Ethnicity				
Akan	Ref		Ref	

Ewe	1.08(0.84-1.39)	0.527	1.05(0.75-1.47)	0.757
Ga	0.94(0.62-1.44)	0.786	0.99(0.62-1.60)	0.985
Grusi	1.51(1.13-2.04)	0.006	0.86(0.58-1.27)	0.446
Mole-dagbani	1.85(1.52-2.26)	<0.001	1.30(0.90-1.87)	0.165
Others	1.65(1.07-2.54)	0.023	1.11(0.65-1.89)	0.700
Number of ANC visit				
No visit	Ref		Ref	
1-5	1.76(1.38-2.25)	<0.001	1.17(0.89-1.57)	0.253
6-10	1.47(1.21-1.79)	<0.001	1.09(0.87-1.34)	0.430
>10	1.33(0.95-1.86)	0.093	1.20(0.12-1.76)	0.365
Religion				
Christianity	Ref		Ref	
Islam	1.68(1.38-2.05)	<0.001	1.37(1.04-1.80)	0.023
Traditional	1.40(0.79-2.50)	0.248	1.10(0.59-2.07)	0.008
Others	2.75(1.58-4.72)	<0.001	1.11(0.65-1.13)	0.759
cOR: crude odds ratio, aOR: adjusted odds ratio, 95% CI: 95% confidence interval				

**Table 2** Factors associated with anaemia in children under-5 years in Ghana (continued)

Factors	Model 1		Model 2	
	cOR(95%CI)	p-value	aOR(95%CI)	p-value
Household factors				
Wealth Index				
Poor	Ref		Ref	
Middle	0.61(0.49-0.75)	<0.001	0.67(0.51-0.88)	0.005
Rich	0.38(0.31-0.46)	<0.001	0.50(0.36-0.70)	<0.001
Place of residence				
Rural	Ref		Ref	
Urban	0.62(0.53-0.74)	<0.001	0.86(0.68-1.09)	0.003
Source of drinking water				
Dug well	Ref		Ref	
Pipe	0.82(0.67-0.99)	0.046	1.19(0.93-1.52)	0.150
Rainwater	1.90(1.04-3.43)	0.036	2.45(1.29-4.67)	0.006
River/lake	1.08(0.97-1.50)	0.622	0.92(0.64-1.32)	0.659
Sachet water	0.51(0.41-0.64)	<0.001	1.14(0.81-1.60)	0.448
Region				
Ashanti	Ref		Ref	
Brong Ahafo	1.94(1.37-2.76)	<0.001	1.64(1.11-2.41)	0.012
Central	2.60(1.79-3.79)	<0.001	2.62(1.74-3.96)	<0.001
Eastern	1.18(0.81-1.73)	0.379	1.24(0.81-1.88)	0.319
Greater Accra	1.20(0.81-1.79)	0.369	1.78(1.11-2.83)	0.016
Northern	2.81(2.03-3.89)	<0.001	1.57(1.03-2.39)	0.037
Upper East	3.57(2.44-5.21)	<0.001	2.10(1.31-3.37)	0.002
Upper West	2.22(1.60-3.10)	<0.001	1.18(0.75-1.85)	0.481
Volta	1.53(1.06-2.21)	0.022	1.23(0.78-1.94)	0.375
Western	1.36(0.94-2.00)	0.106	1.24(0.83-1.86)	0.293
cOR: crude odds ratio, aOR: adjusted odds ratio, 95%CI: 95% confidence interval				

## Discussion

This study determined the factors associated with anaemia among two thousand four hundred and thirty-four (2,434) Ghanaian children under 5-years old. The findings showed a significantly higher prevalence of anaemia in Ghana (58.35%, 95%CI=52.72-63.96) compared to the World Health Organisation (WHO) global prevalence of anaemia (42.0%) in children under five years old [1]. This finding is of public health importance, and a continued effort is imperative to create anaemia awareness in Ghana to save lives. The prevalence of anaemia identified in this study is consistent with similar studies conducted in other lower-and-middle-income countries (LMICs), such as Uganda (58.8%) and India (59%) [4,19]. However, it is considerably higher than the prevalence reported by studies in Ethiopia, another LMIC [20, 21]. The differences in anaemia prevalence between Ghana and Ethiopia could be due to variations in geographic characteristics, like climate changes, in the two countries [22]. However, it could also emanate from differences in this study's research approach and that of the studies from Ethiopia.

This study also identified varied anaemia prevalence among the different geographic areas in Ghana. For example, the Upper East (72.84%), Northern (67.88%), Central (66.20%) and Upper West (62.57%) regions in Ghana have a relatively higher anaemia prevalence compared to the other regions. Also, the prevalence of anaemia was higher in rural (62%) than urban (51.2%). Again, these findings are consistent with similar studies on anaemia prevalence in under five years old in Ghana [16, 23]. The rural and urban anaemia prevalence variation could be attributed to poverty and low propitious living conditions, poor sanitation, and difficult access to good drinking water in the rural areas, resulting in diseases that subsequently increase anaemia risk [22]. For emphasis, this study identified that children under five years from households with dug wells, rivers, and rainwater as the source of drinking water recorded are more likely to be anaemic, and these drinking water sources are more characterised in rural areas. These inherent rural characteristics further explain the significant relationship between rural dwellings and the risk of anaemia in children under five years in Ghana.

Also, the findings suggested that as the children aged, their odds of anaemia become progressively lower. This observation may be due to the iron supplements given to the older children ( $\geq 6$  years old) in Ghana. Thus, to address this anaemia burden in children under five years, the Ghana government could include this population in their nationwide iron supplemental for children intervention, especially as younger children are more susceptible to diseases and infections resulting in anaemia [16, 25]. The finding on age and anaemia is similar to a study conducted in Togo on prevalence and risk factors of anaemia in children aged from 6 to 59 months [8]. Again, a lower prevalence of anaemia as a child age was reported in another study [24]. Hence, health systems must prioritise younger children in their anaemia prevention strategies.

The mother's educational status also showed a statistically significant association with childhood anaemia in this study. Children whose mothers had primary, secondary and tertiary education were 22%, 35% and 40% times less likely to have anaemia. Additionally, children whose mothers had frequent ANC

visits were less likely to be anaemic under five years old. Similar findings have been reported in several studies [26,27]. This finding could be since educated mothers are more likely to know better and observe safe and hygienic practices to prevent diseases that could trigger anaemia in children. Also, FOCUSED antenatal care intervention, a flagship ANC policy implemented in Ghana, could account for the low anaemic risk in children whose mothers frequently visit ANC centres. This intervention, spearheaded by the Ghana government, provides tailor-made and individualistic interventions to expectant mothers in government hospitals across the country. Based on this study's findings, this intervention is recommended to be sustained and extended to hard-to-reach areas in Ghana to ensure comprehensive coverage and reduction in nationwide anaemia prevalence. Finally, even though the prevalence of anaemia in this study is a tad lower than that reported by WHO in 2020 (59.5%) for children under five years old in Ghana [1], there is still the crucial need for critical stakeholders in Ghana to review and improve their anaemia prevention and management strategy to significantly reduce the burden of anaemia in Ghana.

To the best of the researchers' knowledge, this is the first study to estimate anaemia's prevalence and risk factors in Ghana using the most recent DHS. Therefore, the findings could inform contemporary interventions to address the anaemia prevalence in Ghana. Additionally, the relatively larger sample size in this study due to the use of the DHS dataset ensured the external validity of the study's findings. Nonetheless, because of the retrospective nature of the DHS dataset, there is a tendency of recall bias; thus, the findings of this study must be interpreted with caution. Finally, because of the observational nature of this study, no causal association could be inferred from the explanatory variables and anaemia.

## Conclusion

This study identified a high prevalence of anaemia among under five years children in Ghana. This prevalence was determined by factors such as child's age and malaria status, maternal education, household wealth index and place of residence. The findings suggest the need for Ghana to target these factors in their anaemia prevention and control strategies. Policies like continuous distribution of mosquito nets, especially in the northern region of Ghana, could help address the risk of malaria and by extension anaemia. Also, mass media campaigns on anaemia prevention should be sustained and trickled down to sub-district and regional levels in Ghana. FOCUS antenatal practice in Ghana should be continued with increased emphasis on anaemia education.

## Abbreviations

95% CI: 95% confidence intervals; aOR: Adjusted odds ratio; cOR: Crude odds ratio; DHS: Demographic and Health Surveys; Hb: Hemoglobin; GMIS: Ghana Malaria Indicator Survey; GSS: Ghana Statistical Service; HIV: Human Immunodeficiency Virus; NMCP: National Malaria Control Programme; USAID: United States Agency for International Development; WHO: World Health Organization.

## Declarations

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Not applicable

## Availability of data and materials

The dataset analysed during the study is available in the [DHS Programme] repository, [<https://dhsprogram.com/Data/>].

## Authors' contributions

Ebenezer Opoku (EO), Shirley Crankson (SC) and Nana Kwame Anokye (NKA) conceptualised the study and performed the statistical analysis. NKA supervised the conduct of the study. EO drafted the first manuscript and all the authors agreed on the first draft.

## Ethics approval and consent

Ethical approval was received from the Brunel Research Ethics Committee before the commencement of the study and a written consent was obtained from the DHS program data archivist before the dataset was accessed and used for the analysis. The study adhered to the ethical principles and all methods were performed in accordance with the ethics committee guidelines and regulations that were outlined.

## Consent for publication

Not applicable

## Competing interests

Authors declare no competing interests

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