Prevalence and correlates of anaemia among children aged 6 to 59 months in Nigeria

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Abstract

Background: Anaemia remains a global public health challenge affecting children aged 6 to 59 months. This study aimed to estimate the prevalence and identify the correlates of anaemia among children aged 6 to 59 months in Nigeria.

Methods: Data were drawn from the 2018 Nigeria Demographic and Health Survey. Study participants were children aged 6 to 59 months (n=10,451). Univariate analysis, bivariate analysis and multivariate logistic regression were conducted.

Results: The overall prevalence of anaemia among children aged 6 to 59 months was 67%. Of those, 26%, 38% and 3% had mild, moderate and severe anaemia respectively. Male gender, higher birth order, malaria in children, diarrhoea or fever in children, wasting, low maternal age, low maternal education, maternal anaemia, low mother's body mass index, geopolitical zone and low socio-economic status were significantly associated with anaemia among children aged 6 to 59 months.

Conclusions: The prevalence of anaemia among children aged 6 to 59 months is high making this a severe public health problem. The individual, maternal and household factors associated with anaemia among these children should be taken into account in the design of appropriate interventions for this age group.

Keywords: Anaemia; Child Nutrition; Malaria; Secondary data analysis; Nigeria

Introduction

Anaemia remains a global public health challenge affecting mainly pregnant women, and children aged 6-59 months (WHO, 2019). Anaemia is a condition in which the haemoglobin (Hb) concentration levels are below a certain cut-off point (11 g/dL, for young children), leading to a decreased capacity of the blood to carry oxygen to the body's tissues (Gayawan et al., 2014; Gebreegziabiher et al., 2014; NPC and ICF, 2019; WHO, 2011; WHO, 2015; WHO, 2019). Anaemia is a leading cause of morbidity and mortality among children under five years of age in Africa (Gayawan et al., 2014). This leads to impaired psychomotor and cognitive development, low productivity and have long-term health and economic consequences (Balarajan et al., 2011; Gayawan et al., 2014; Gebreweld et al., 2019; Grantham-McGregor and Baker-Henningham, 2010; Low et al., 2013; Menon and Yoon, 2015; Nambiena et al., 2019; WHO, 2015; National Population Commission and ICF, 2019; Stevens et al., 2013).

The factors contributing to anaemia in children between the ages of 6-59 months are multifactorial. Iron deficiency is the most common cause of anaemia in both women and children. According to the Nutrition Impact Model Study Group (Anaemia), iron deficiency has a prevalence of 43% in children, 29% in non-pregnant women and 38% in pregnant women globally (Stevens et al., 2013; Lopez et al., 2016). Other causes include malaria, cancer, tuberculosis, HIV, parasitic infections, nutritional deficiencies and genetic conditions such as thalassemia (Balarajan et al., 2011; da Silva et al., 2018; Egbi et al., 2014; Gebreweld et al., 2019; NPC and ICF, 2019; Pasricha et al., 2013; WHO, 2015; WHO, 2019). Findings from previous studies on anaemia in low- and middle-income countries revealed that among the total causes reported, malaria was 25%, genetic condition such as sickle cell, G6PD deficiency, and α-thalassemia was 60% (Chaparro and Suchdev, 2019).

World Health Organization (WHO) estimated that 1.62 billion people were affected by anaemia in 2011, with an estimated 293 million being children aged from 6-59 months thus resulting in a prevalence of 42.6% (WHO, 2011). Though affecting populations in both developed and developing countries, there is a higher prevalence of anaemia in the Africa region (WHO, 2015; Nambiena et al., 2019). Evidence suggests that the prevalence of anaemia among children aged 6-59 months in Africa was 60.2% in 2011, affecting approximately 95 million (WHO, 2015; Nambiena et al., 2019). Nigeria has one of the highest prevalences of anaemia among children aged 6-59 months in Africa (WHO, 2015). Consequently, the level of public health significance for anaemia in Nigeria is "severe".

There is a range of known determinants of anaemia among children under 5 years of age in developing countries (Asresie et al., 2020; Ewusie et al., 2014; Gebreweld et al., 2019; Goswmai and Das, 2015; Habib et al., 2016; Habyarimana et al., 2017; Harding et al., 2017; Menon and Yoon, 2015; Moschovis et al., 2018; Nambiena et al., 2019; Ntenda et al., 2018; Yusuf et al., 2019). Age and sex of the child, stunting, diarrhoea, fever, parasitic infection, mother's age and education, and maternal anaemia and Body Mass Index (BMI) are major ones (Moschovis et al., 2018). However, using a nationally representative household survey, there is limited evidence on the prevalence and factors associated with anaemia among children aged 6 to 59 months in Nigeria (Moschovis et al., 2018). The present study aimed to estimate the prevalence and identify the correlates of anaemia among children aged 6 to 59 months in Nigeria using the 2018 Nigeria Demographic and Health Survey (NDHS).

Methods

Data source

This study utilized secondary data from the 2018 NDHS. The 2018 NDHS is a nationally representative cross-sectional study conducted by the National Population Commission (NPC) in collaboration with the National Malaria Elimination Programme (NMEP) of the Federal Ministry of Health (FMoH), Nigeria with funding by the United States Agency for International Development (USAID), Global Fund, Bill and Melinda Gates Foundation (BMGF), the United Nations Population Fund (UNFPA), and WHO and technical support from ICF International through the Demographic and Health Survey (DHS) program (National Population Commission and ICF, 2019).

A two-stage sampling technique was used. The first stage involved the selection of 1,400 Enumeration Areas (EAs) with probability proportional to EA size (the number of households in the EA) (National Population Commission and ICF, 2019). A household listing operation was carried out in all selected EAs, and the resulting lists of households served as a sampling frame for the selection of households in the second stage (National Population Commission and ICF, 2019). The second stage involved the selection of a fixed number of 30 households in every cluster through equal probability systematic sampling, resulting in a total sample size of approximately 42,000 households (National Population Commission and ICF, 2019). The 2018 NDHS data were collected from 14 August 2018 to 29 December 2018 (NPC and ICF, 2019). The study population were children under five years of age and their mothers.

The 2018 NDHS measured haemoglobin levels (anaemia) among children in a subsample of households selected for a male survey (National Population Commission and ICF, 2019). Blood specimens were collected from all children aged 6-59 months for whom consent was obtained from their parents or guardians (National Population Commission and ICF, 2019). A drop of blood was taken from a finger prick (or a heel prick for children age 6-11 months) (National Population Commission and ICF, 2019). A haemoglobin analysis was carried out on-site with the battery-operated portable HemoCue analyser (National Population Commission and ICF, 2019). Results were provided verbally and in writing to the parents. Parents of children with a haemoglobin level below 8 g/dl were instructed to take the child to a health facility for follow-up care (National Population Commission and ICF, 2019). Malaria testing was also carried out among children age 6-59 months (National Population Commission and ICF, 2019). With the same finger (or heel) prick used for anaemia testing, another drop of blood was tested immediately using the SD Bioline Ag P.f. (HRP-II)^{TM} rapid diagnostic test, which is a qualitative test for the detection of histidine-rich protein II (HRP-II) antigen of *Plasmodium falciparum* (Pf). Children who tested positive were offered a full course of treatment according to the standard procedures for treating malaria in Nigeria if they did not have a severe case of malaria (diagnosed by symptoms or the presence of severe anaemia), were not currently on treatment, and had not completed a full course of artemisinin-based combination therapy during the preceding 2 weeks.

Outcome variable

The outcome variable in this study was anaemia status among children aged 6-59 months (coded as 1 if a child had Hb level <11 g/dl and zero otherwise). According to WHO, mild anaemia is defined as Hb level between 10.0 and 10.9 g/dl, moderate anaemia as Hb level between 7.0 and 9.9 g/dl and severe anaemia as Hb level < 7.0 g/dl (National Population Commission and ICF, 2019; WHO, 2011).

Explanatory variables

The explanatory variables were guided by reviews on the determinants of anaemia in children under-5 years of age (Asresie et al., 2020; Ewusie et al., 2014; Gaston et al., 2018; Gayawan et al., 2014; Gebreegziabiher et al., 2014; Gebreweld et al., 2019; Goswmai and Das, 2015; Habib et al., 2016; Habyarimana et al., 2017; Harding et al., 2017; Khan et al., 2016; Kuziga et al., 2017; Menon and Yoon, 2015; Moschovis et al., 2018; Nambiena et al., 2019; Ngnie-Teta et al., 2007; Ntenda et al., 2018; Woldie et al., 2015; Yusuf et al., 2019). Explanatory variables were examined at the individual, maternal and household levels.

The individual characteristics of the child include gender, birth order, malaria diagnosis, bed net use, history of fever, history of diarrhoea, iron supplement intake and nutritional status. Gender was coded as female or male. Birth order referred to the ranking of the child according to birth order and was coded as 1, 2-3, 4-5 and 6+. Malaria diagnosis and bed net use were coded as yes or no. History of fever and diarrhoea were defined as the occurrence in the last two weeks preceding the survey. Current iron supplement intake was coded as yes or no. Nutritional status was classified as stunted (HAZ < -2 SD), wasted (WHZ < -2 SD), and underweight (WAZ < -2 SD), each separately coded as yes or no. Maternal characteristics include age, education, occupation, anaemia status and BMI. Maternal age was categorized as 15-24, 25-34 and 35+. Maternal education referred to the highest level of education attained and was categorized into no education, primary education, secondary or higher education. Mothers were coded as not working or employed. Maternal anaemia was defined as Hb level below 11.0 g/dl in pregnant women and below 12.0 g/dl in non-pregnant women and was categorized as anaemic and not anaemic. Maternal BMI referred to the body mass index, categorized as underweight (BMI < 18.5 kg/m^2), normal (BMI between 18.5 – 24.9 kg/m^2), overweight (BMI 25 – 29.9 kg/m^2) and obese (BMI > 30 kg/m^2). The household characteristics include household size, place of residence, geopolitical zones, and socioeconomic status. Household size was defined as the number of individuals in a household and was categorized as less than five members and five or more members. The place of residence refers to the location of children's residence, grouped into urban and rural areas. Nigeria is divided into six geo-political zones: North Central, North East, North West, South East, South West and South-South. A SES index was constructed using Principal Component Analysis (PCA) based on data from variables on household ownership of assets and housing conditions (Vyas and Kumaranayake, 2006). These variables include ownership of a car/truck, ownership of radio, ownership of refrigerator, ownership of bicycle, ownership of motorcycle, main wall material, main floor material, main roof material, type of fuel for cooking, source of electricity, source of drinking water, time to get to water source and type of toilet facility used. PCA generated a factor score on each household asset. The resulting asset scores were standardized while the standardized scores were used to generate SES quintile as poorest, poorer, middle, richer and richest.

Statistical analysis

All analyses were performed using STATA version 12 software. Descriptive statistics was used to analyse the demographic and socio-economic characteristics of the study sample as well as the outcome variable in the form of graphs, frequency tables and simple percentages. Chi-square analysis was used to test for associations between independent variables and anaemia among children aged 6 to 59 months. After that, multivariate logistic regression was used to examine associations between the dependent variable and the independent variables. A manual step-wise backward selection was performed and factors significantly associated with anaemia among children aged 6 to 59 months were retained. Weighting factors constructed by Measure DHS were used to adjust for common causes, clustering and sampling weights.

Ethical considerations

In obtaining the micro data, a request was made on the DHS program website on February 11, 2020 and approval was granted to download the data on the same day. Hence, there were no ethical issues of concern. The 2018 NDHS was approved by the National Health Research Ethics Committee of Nigeria (NHREC) and the ICF Institutional Review Board.

Results

Overall, 67% of children aged 6 to 59 months were anaemic. The prevalence of mild, moderate and severe anaemia was 26%, 38% and 3% respectively.

Table 1 presents the study population characteristics. More than half (50.60%) of the study sample were male. More than two-thirds (96.09%) of the children had no malaria diagnosis. More than half (55.25%) used bed net. Only 27.06% of the children had fever in the previous 2 weeks while 13.13% had diarrhoea in the previous 2 weeks. 20% had received iron supplementation. 49.39% of the sample were stunted, 64.34% were wasted, and 57.37% were underweight. 51.74% of the mothers were aged 25-34 years. More than two-thirds (73.97%) of the mothers were employed. More than half (56.99%) of children had mothers who are anaemic. More than two-thirds (74.82%) of households had five or more members. Details are given in Table 1.

Table 1. Study population characteristics

Individual, maternal and household characteristics	**(*N* = 10,451)**	
	n	**(%)**
Individual characteristics		
Gender		
Male	5,288	50.60
Female	5,163	49.40
Birth order		
1	2,015	19.28
2-3	3,587	34.32
4-5	2,522	24.13
6 +	2,327	22.27
Malaria diagnosis		
No	10,042	96.09
Yes	409	3.91
Bed net use		
No	4,677	44.75
Yes	5,774	55.25
Fever in the previous 2 weeks		
No	7,623	72.94
Yes	2,828	27.06

Diarrhoea in the previous 2 weeks		
No	9,079	86.87
Yes	1,372	13.13
Received iron supplementation		
No	8,361	80.00
Yes	2,090	20.00
Stunting		
No (HAZ ≥ -2 SD)	5,289	50.61
Yes (HAZ < -2 SD)	5,162	49.39
Wasting		
No (WHZ ≥ -2 SD)	3,727	35.66
Yes (WHZ < -2 SD)	6,724	64.34
Underweight		
No (WAZ ≥ -2 SD)	4,455	42.63
Yes (WAZ < -2 SD)	5,996	57.37
Maternal characteristics		
Maternal age (in years)		
15-24	2,170	20.76
25-34	5,407	51.74
35 +	2,874	27.50
Maternal education		
No education	4,018	38.45
Primary education	1,763	16.87
Secondary or higher	4,670	44.68
Maternal employment		
Not working	2,720	26.03
Employed	7,731	73.97
Maternal anaemia status		
Not anaemic	4,495	43.01
Anaemic	5,956	56.99
Maternal BMI		
Underweight (<18.5 kg/m^2)	993	9.50
Normal (18.5 - 24.9 kg/m^2)	6,428	61.51
Overweight (25.0 - 29.9 kg/m^2)	1,894	18.12
Obese (30 kg/m^2 or higher)	1,136	10.87
Household characteristics		
Household size		
< 5 members	2,632	25.18
5 or more members	7,819	74.82
Place of residence		
Urban	4,082	39.06
Rural	6,369	60.94
Geopolitical zones		
North Central	1,808	17.30
North East	1,883	18.02
North West	2,541	24.31
South East	1,527	14.61
South South	1,179	11.28
South West	1,513	14.48

Socio-economic status		
Poorest	2,111	20.20
Poorer	2,075	19.85
Middle	2,300	22.01
Richer	2,185	20.91
Richest	1,780	17.03

Hb = haemoglobin; BMI = body mass index

Correlates of anaemia

The bivariate analysis of the factors associated with anaemia are presented in Table 2.

Table 2. Bivariate analysis of factors associated with anaemia among Nigerian children aged 6 to 59 months

Individual, maternal and household characteristics	**Anaemia (Hb < 11 g/dL)**		
	Yes (*N* = 7,003) n (%)	**No (*N* = 3,448) n (%)**	***p* value**
Individual characteristics			
Gender			<0.001
Male	3,638 (68.80)	1,650 (31.20)	
Female	3,365 (65.18)	1,798 (34.82)	
Birth order			<0.001
1	1,247 (61.89)	768 (38.11)	
2-3	2,350 (65.51)	1,237 (34.49)	
4-5	1,729 (68.56)	793 (31.44)	
6 +	1,677 (72.07)	650 (27.93)	
Malaria diagnosis			0.005
No	6,703 (66.75)	3,339 (33.25)	
Yes	300 (73.35)	109 (26.65)	
Bed net use			<0.001
No	3,039 (64.98)	1,638 (35.02)	
Yes	3,964 (68.65)	1,810 (31.35)	
Fever in the previous 2 weeks			<0.001
No	4,872 (63.91)	2,751 (30.09)	
Yes	2,131 (75.35)	697 (24.65)	
Diarrhoea in the previous 2 weeks			<0.001
No	5,981 (65.88)	3,098 (34.12)	
Yes	1,022 (74.49)	350 (25.51)	
Received iron supplementation			<0.001
No	5,652 (67.60)	2,709 (32.40)	
Yes	1,351 (64.64)	739 (35.36)	
Stunting			0.170
No (HAZ ≥ -2 SD)	3,577 (67.63)	1,712 (32.37)	
Yes (HAZ < -2 SD)	3,426 (66.37)	1,736 (33.63)	
Wasting			<0.001
No (WHZ ≥ -2 SD)	2,385 (63.99)	1,342 (36.01)	
Yes (WHZ < -2 SD)	4,618 (68.68)	2,106 (31.32)	

Underweight			0.026
No (WAZ ≥ -2 SD)	3,038 (68.19)	1,417 (31.81)	
Yes (WAZ < -2 SD)	3,965 (66.13)	2,031 (33.87)	
Maternal characteristics			
Maternal age (in years)			<0.001
15-24	1,551 (71.47)	619 (28.53)	
25-34	3,579 (66.19)	1,828 (33.81)	
35 +	1,873 (65.17)	1,001 (34.83)	
Maternal education			<0.001
No education	2,955 (73.54)	1,063 (26.46)	
Primary education	1,231 (69.82)	532 (30.18)	
Secondary or higher	2,817 (60.32)	1,853 (39.68)	
Maternal employment			0.003
Not working	1,885 (69.30)	835 (30.70)	
Employed	5,118 (66.20)	2,613 (33.80)	
Maternal anaemia status			<0.001
Not anaemic	2,588 (57.58)	1,907 (42.42)	
Anaemic	4,415 (74.13)	1,541 (25.87)	
Maternal BMI			<0.001
Underweight (<18.5 kg/m^2)	760 (76.54)	233 (23.46)	
Normal (18.5 - 24.9 kg/m^2)	4,492 (69.88)	1,936 (30.12)	
Overweight (25.0 - 29.9 kg/m^2)	1,176 (62.09)	718 (37.91)	
Obese (30 kg/m^2 or higher)	575 (50.62)	561 (49.38)	
Household characteristics			
Household size			0.003
< 5 members	1,702 (64.67)	930 (35.33)	
5 or more members	5,301 (67.80)	2,518 (32.20)	
Place of residence			<0.001
Urban	2,469 (60.49)	1,613 (39.51)	
Rural	4,534 (71.19)	1,835 (28.81)	
Geopolitical zones			<0.001
North Central	1,176 (65.04)	632 (34.96)	
North East	1,273 (67.60)	610 (32.40)	
North West	1,781 (70.09)	760 (29.91)	
South East	1,050 (68.76)	477 (31.23)	
South South	828 (70.23)	351 (29.77)	
South West	895 (59.15)	618 (40.85)	
Socio-economic status			<0.001
Poorest	1,624 (76.93)	487 (23.07)	
Poorer	1,538 (74.12)	537 (25.88)	
Middle	1,520 (66.09)	780 (33.91)	
Richer	1,404 (64.26)	781 (35.74)	
Richest	917 (51.52)	863 (48.48)	

Hb = haemoglobin; BMI = body mass index

While there were statistically significant associations between anaemia and all other variables listed, stunting was not significantly associated with anaemia. While most associations were in an expected direction, children who used bed nets had a significantly higher prevalence of anaemia than children who did not. Children who live in South-South (70.23%) and North West region (70.09%), had a significantly higher prevalence of anaemia.

Only variables that were statistically significant with the outcome variable were included in the logistic regression model. The results of this multivariate analysis are presented in Table 3.

Table 3. Multivariate logistic regression model of the correlates of anaemia among Nigerian children aged 6 to 59 months

Individual, maternal and household characteristics	**Anaemia (Hb < 11 g/dL)**					
	Unadjusted OR	**95% C.I.**	***p* value**	**Adjusted OR**	**95% C.I.**	***p* value**
Individual characteristics						
Gender						
Male	1	1	1	1	1	1
Female	0.83	0.76 – 0.91	<0.001	0.83	0.77 – 0.91	<0.001
Birth order						
1	1	1	1	1	1	1
2-3	1.34	1.18 – 1.56	<0.001	1.32	1.17 – 1.50	<0.001
4-5	1.66	1.42 – 1.95	<0.001	1.62	1.40 – 1.89	<0.001
6 +	1.95	1.61 – 2.35	<0.001	1.90	1.59 – 2.27	<0.001
Malaria diagnosis						
No	1	1	1	-	-	-
Yes	0.99	0.77 – 1.27	0.949	-	-	-
Bed net use						
No	1	1	1	1	1	1
Yes	1.11	1.01 – 1.21	0.029	1.11	1.01 – 1.21	0.027
Fever in the previous 2 weeks						
No	1	1	1	1	1	1
Yes	1.48	1.32 – 1.65	<0.001	1.47	1.32 – 1.64	<0.001
Diarrhoea in the previous 2 weeks						
No	1	1	1	1	1	1
Yes	1.22	1.06 – 1.40	0.006	1.22	1.06 – 1.40	0.006
Received iron supplementation						
No	1	1	1	-	-	-
Yes	1.02	0.91 – 1.13	0.769	-	-	-
Wasting						
No (WHZ ≥ -2 SD)	1	1	1	1	1	1
Yes (WHZ < -2 SD)	1.20	1.10 – 1.32	<0.001	1.19	1.09 – 1.30	<0.001
Underweight						
No (WAZ ≥ -2 SD)	1	1	1	-	-	-
Yes (WAZ < -2 SD)	0.95	0.87 – 1.04	0.268	-	-	-
Maternal characteristics						
Maternal age (in years)						
15-24	1	1	1	1	1	1
25-34	0.72	0.64 – 0.83	<0.001	0.71	0.63 – 0.82	<0.001
35 +	0.58	0.49 – 0.68	<0.001	0.57	0.48 – 0.67	<0.001

Maternal education						
No education	1	1	1	1	1	1
Primary education	0.86	0.75 – 0.99	0.040	0.85	0.74 – 0.98	0.025
Secondary or higher	0.74	0.64 – 0.85	<0.001	0.73	0.63 – 0.83	<0.001
Maternal employment						
Not working	1	1	1	-	-	-
Employed	0.93	0.84 – 1.03	0.187	-	-	-
Maternal anaemia status						
Not anaemic	1	1	1	1	1	1
Anaemic	1.85	1.69 – 2.01	<0.001	1.86	1.70 – 2.02	<0.001
Maternal BMI						
Underweight (<18.5 kg/m^2)	1	1	1	1	1	1
Normal (18.5 - 24.9 kg/m^2)	0.80	0.68 – 0.94	0.007	0.79	0.68 – 0.94	0.006
Overweight (25.0 - 29.9 kg/m^2)	0.69	0.57 – 0.83	<0.001	0.69	0.57 – 0.83	<0.001
Obese (30 kg/m^2 or higher)	0.49	0.40 – 0.61	<0.001	0.49	0.40 – 0.60	<0.001
Household characteristics						
Household size						
< 5 members	1	1	1	-	-	-
5 or more members	0.96	0.86 – 1.08	0.523	-	-	-
Place of residence						
Urban	1	1	1	-	-	-
Rural	1.09	0.98 – 1.21	0.114	-	-	-
Geopolitical zones						
North Central	1	1	1	1	1	1
North East	0.71	0.61 – 0.82	<0.001	0.71	0.61 – 0.82	<0.001
North West	0.80	0.69 – 0.93	0.004*	0.81	0.69 – 0.93	0.005
South East	1.62	1.38 – 1.90	<0.001	1.60	1.38 – 1.90	<0.001
South South	1.68	1.42 – 1.99	<0.001	1.70	1.42 – 1.99	<0.001
South West	1.24	1.06 – 1.45	0.008*	1.21	1.06 – 1.45	0.015
Socio-economic status						
Poorest	1	1	1	1	1	1
Poorer	0.91	0.78 – 1.05	0.207	0.91	0.78 – 1.04	0.163
Middle	0.65	0.56 – 0.75	<0.001	0.63	0.54 – 0.73	<0.001
Richer	0.65	0.55 – 0.77	<0.001	0.62	0.53 – 0.73	<0.001
Richest	0.49	0.41 – 0.59	<0.001	0.47	0.39 – 0.56	<0.001

OR = odds ratio, CI = confidence interval, 1 = reference

In the adjusted regression model, female children were 0.83 times less likely to be anaemic compared to male children. The odds of anaemia was significantly higher among children of 2-3 birth order (adjusted odds ratio [AOR]: 1.32; 95% CI: 1.17-1.50), 4-5 birth order (1.62; CI: 1.40-1.89) and six or more birth order (1.90; CI: 1.59-2.27) compared to the first child. Children who used bed nets were 1.11 times more likely to be anaemic. The odds of anaemia was significantly higher for children who, in the past 2 weeks had a fever (1.47; CI: 1.32-1.64) or diarrhoea (1.22; CI: 1.06-1.40). The odds of anaemia was significantly higher for children who were wasted (1.19; 95% CI: 1.09-1.30). Children whose mothers were anaemic were 1.86 times more likely to be anaemic compared with children whose mothers were not anaemic. The odds of anaemia was lower for children whose mothers were normal (0.79; CI: 0.68-0.94), overweight (0.69; CI: 0.57-0.83) or obese (0.49; CI: 0.40-0.60) compared with children whose mother was underweight. Children from North East region and North West region were 0.71

and 0.81 times respectively less likely to be anaemic while children from South East region, South South region and South West region were 1.60, 1.70 and 1.21 times respectively more likely to be anaemic compared with children from the North Central zone. The odds of anaemia was lower for children from middle income (0.63; CI: 0.54-0.73), richer (0.62; CI: 0.53-0.73) and richest (0.47; CI: 0.39-0.56) households, compared with those from the poorest quintile.

Discussion

We examined the prevalence and correlates of anaemia in children aged 6 to 59 months in Nigeria. The prevalence was 67%, indicating a severe public health problem (based on WHO category of over 40% (WHO 2011)). This finding is consistent with similar studies in Africa that found that the prevalence of anaemia among children aged 6 to 59 months is very high (Asresie et al., 2020; Ewusie et al., 2014; Kuziga et al., 2017; Nambiena et al., 2019; Ngnie-Teta et al., 2007; Woldie et al., 2015).

It was found in this study that female children were less likely to be anaemic compared with male children. Son preference is an issue in Nigeria leading to a situation where parents invest more in the male child compared to the female child (Milazzo, 2014). A possible explanation is that female children are breastfed longer and receive more health care and nutrition thereby improving their health status. Sons are also likely to roam farther from the mother, which may lead to higher levels of parasitosis, blood loss from wounds, etcetera. This finding is consistent with results from a similar study in Nigeria (Gayawan et al., 2014), Pakistan (Habib et al., 2016) and Namibia (Ntenda et al., 2018) but contrary to findings from a study to determine the prevalence of malaria and anaemia among children less than 5 years old in Benin City, Edo State, Nigeria (Akinbo et al., 2009), and a study in Rwanda (Habyarimana et al., 2017). A study in Ethiopia found no association between a child's sex and anaemia (Gebreegziabiher et al., 2014).

In our study, children of higher birth order were more likely to be anaemic. A possible reason is that a mother's ability to meet the iron requirement of children reduces with an increasing number of children. This finding is supported by similar studies in India (Goswmai and Das, 2015) and sub-Saharan Africa (SSA) (Moschovis et al., 2018).

In this study, children who had a fever in the previous 2 weeks were more likely to be anaemic. This could be due to the destruction of the red blood cells and decreased red blood cell production as a result of malaria infection (Gayawan et al., 2014). This result is corroborated by similar studies (Asresie et al., 2020; Gaston et al., 2018; Gayawan et al., 2014; Habyarimana et al., 2017; Khan et al., 2016; Menon and Yoon, 2015; Moschovis et al., 2018; Nambiena et al., 2019; Ntenda et al., 2018). Children who had diarrhoea in the previous 2 weeks were also more likely to be anaemic. A possible explanation is that children with diarrhoea loss appetite and experience malabsorption (Woldie et al., 2015). This finding is similar to studies conducted in Ethiopia (Woldie et al., 2015) and SSA (Moschovis et al., 2018). We found that children suffering from wasting were more likely to be anaemic. This may be because malnutrition and anaemia share common causes (Gebreegziabiher et al., 2014). In addition, inadequate nutrition impairs the immunity of children leading to anaemia (Khan et al., 2016). Similar studies support this finding (Habyarimana et al., 2017; Khan et al., 2016).

Children of older mothers were less likely to be anaemic. A possible explanation is that mothers aged 15-24 years are unable to meet the iron requirement during pregnancy for their growth thereby limiting their ability to increase the Hb concentration of their children (Habyarimana et al., 2017). This finding is supported by similar studies (Asresie et al., 2020; Habyarimana et al., 2017; Moschovis et al., 2018).

Children whose mothers had primary education and secondary or higher education were less likely to be anaemic. A possible explanation is that mothers with no education lack knowledge about good dietary practices and provide a poor diet for their children. This finding is supported by other studies (Gebreweld et al., 2019; Nambiena et al., 2019; Woldie et al., 2015).

Children whose mothers were anaemic were more likely to be anaemic. This could be due to mothers and children sharing a common environment, socioeconomic and dietary conditions (Khan et al., 2016). This finding is consistent with results from similar studies (Asresie et al., 2020; Gaston et al., 2018; Habib et al., 2016; Habyarimana et al., 2017; Harding et al., 2017; Khan et al., 2016; Moschovis et al., 2018; Nambiena et al., 2019; Ntenda et al., 2018; Yusuf et al., 2019).

Children whose mothers were underweight were more likely to be anaemic. A plausible explanation is that underweight mothers are likely to have other associated co-morbidity illness (Gaston et al., 2018). This finding is supported by similar studies in Rwanda (Habyarimana et al., 2017), Lesotho (Gaston et al., 2018) and SSA (Moschovis et al., 2018).

We found that children from the North East region and North West region were less likely to be anaemic while children from South East region, South South region and South West region were more likely to be anaemic than those in the North Central zone. Although, the living standard in the southern region is higher, easier accessibility of animal foods such as beef in the northern region might influence this outcome. However, another study in Nigeria did not find these same regional differences (Gayawan et al., 2014).

Children from middle income, richer and the richest households were less likely to be anaemic compared with children from poorer households. This could be attributable to children from poor households receiving a diet that is low in iron. This finding is consistent with results from similar studies (Asresie et al., 2020; Gayawan et al., 2014; Gebreegziabiher et al., 2014; Habyarimana et al., 2017; Khan et al., 2016; Woldie et al., 2015; Yusuf et al., 2019).

Another study in Nigeria reported that household wealth, gender and age of the child and fever or malaria status of the child in the two weeks preceding the survey were factors that increased the risk of anaemia (Gayawan et al., 2014). Conversely, another study reported no association between gender, socioeconomic and nutritional status and anaemia status (moderate/severe) in this population (Ughasoro et al., 2011).

Findings from this study have implications for policy makers in Nigeria. This study identified individual, maternal and household factors that were significantly associated with anaemia among children aged 6 to 59 months. Policy-makers should target these risk factors in the design of interventions to reduce the prevalence of anaemia among children aged 6 to 59 months. In particular, the national malaria control program needs to be more effective in reducing the incidence of malaria and therefore anaemia among children aged 6 to 59 months. Additional interventions that should get more attention include food fortification, supplementation with iron and other micronutrients, nutrition education, poverty alleviation and maternal anaemia reduction. Each has the potential to reduce the prevalence of anaemia and its negative impact on the development of young Nigerian children.

This study has some limitations. It used cross-sectional data; hence the actual causality for the factors associated with anaemia among children aged 6 to 59 months could not be established. Other potential limitations include the risk of recall bias due to self-reported information. The study was also limited to variables contained in the NDHS dataset. The strength of the study is that the samples were nationally representative and the response rate of the survey interview was high (99%).

Conclusions

This study examined the prevalence and correlates of anaemia in children aged 6 to 59 months in Nigeria. There is limited evidence on the prevalence and correlates of anaemia in children of this age group at the national level. We find that there is a high prevalence of anaemia among children aged 6 to 59 months in Nigeria, making this a severe public health problem based on WHO classification. Male gender, higher birth order, malaria in children, diarrhoea or fever in children, wasting, low maternal age, low maternal education, maternal anaemia, low mother's body mass index, geopolitical zone and low socio-economic status were significantly associated with anaemia among these children. The individual, maternal and household factors associated with anaemia among children in this age group should be taken into account in the design of appropriate interventions. Additional interventions that should get more attention include food fortification, supplementation with iron and other micronutrients, nutrition education, poverty alleviation and maternal anaemia reduction. Each has the potential to reduce the prevalence of anaemia and its negative impact on the development of young Nigerian children.

Conflict of interest declaration

The authors declare that they have no conflict of interest.

Authors' contribution

Conception and design of the study: BSA, Acquisition of data: BSA, Data analysis: BSA, Interpretation of data: BSA, OMO and KA, Drafting of manuscript: BSA. All authors revised the manuscript for important intellectual content. The authors approved this version to be published.

References

Akinbo FO, Omoregie R, Mordi R, Okaka CE. 2009. Prevalence of malaria and anaemia among young children in a tertiary hospital in Benin city, Edo state, Nigeria. *Fooyin Journal of Health Sciences* 1(2):81-84.

Asresie MB, Fekadu GA, Dagnew GW. 2020. Determinants of anaemia among children aged 6-59 months in Ethiopia: Further analysis of the 2016 Ethiopian Demographic and Health Survey. *Advances in Public Health* Mar 9, 2020.

Balarajan Y, Ramakrishnan U, Ozaltin E, Shankar AH, Subramanian SV. 2011. Anaemia in low-income and middle-income countries. *Lancet* 10:62304–5.

Chaparro CM, Suchdev PS. 2019. Anaemia epidemiology, pathophysiology and etiology in low- and middle-income countries. *Annals of the New York Academy of Sciences* 1450(1):15-31.

da Silva LLS, Fawzi WW, Cardoso MA, ENFAC Working Group. 2018. Factors associated with anaemia in young children in Brazil. *PLoS ONE* 13(9):e0204504.

Egbi G, Steiner-Asiedu M, Kwesi FS, Ayi I, Ofosu W, Setorglo J, et al. 2014. Anaemia among school children older than five years in the Volta Region of Ghana. *Pan Afr. Med. J.* 17(Suppl 1):1-10.

Ewusie JE, Ahiadeke C, Beyene J, Hamid JS. 2014. Prevalence of anaemia among under-5 children in the Ghanaian population: estimates from the Ghana demographic and health survey. *BMC Public Health* 14(626):1-10.

Gaston RT, Ramroop S, Habyarimana, F. 2018. Determinants of factors associated with anaemia among children under five years in Lesotho. *African Population Studies* 32(1):3893-3902.

Gayawan E, Arogundade ED, Adebayo SB. 2014. Possible determinants and spatial patterns of anaemia among young children in Nigeria: a Bayesian semi-parametric modelling. *Int. Health* 6(1):35–45.

Gebreegziabiher G, Etana B, Niggusie D. 2014. Determinants of anaemia among children aged 6–59 months living in Kilte Awulaelo Woreda, Northern Ethiopia. *Anaemia* 2014(245870):1-9.

Gebreweld A, Ali N, Ali R, Fisha T. 2019. Prevalence of anaemia and its associated factors among children under five years of age attending at Guguftu health center, South Wollo, Northeast Ethiopia. *PLoS ONE* 14(7):e0218961.

Goswmai S, Das KK. 2015. Socio-economic and demographic determinants of childhood anaemia. *J. Pediatr. (Rio J)* 91:471-77.

Grantham-McGregor S, Baker-Henningham H. 2010. Iron deficiency in childhood: causes and consequences for child development. *Annales Nestlé (English ed)* 68(3):105–19.

Habib MA, Black K, Soofi SB, Hussain I, Bhatti Z, Bhutta ZA, et al. 2016. Prevalence and predictors of iron deficiency anaemia in children under five years of age in Pakistan, a secondary analysis of National Nutrition Data 2011-2012. *PLoS ONE* 15(5):e0155051.

Habyarimana F, Zewotir T, Ramroop S. 2017. Structured addictive quantile regression for assessing the determinants of childhood anaemia in Rwanda. *Int. J. Environ. Res. Public Health* 14(16):652

Harding KL, Aguayo VM, Namirembe G, Webb P. 2017. Determinants of anaemia among women and children in Nepal and Pakistan: An analysis of recent national survey data. *Maternal & Child Nutrition* e12478:1-13.

Khan JR, Awan N, Misu F. 2016. Determinants of anaemia among 6-59 months aged children in Bangladesh. Evidence from nationally representative data. *BMC Pediatrics* 16(3):1-10.

Kuziga F, Adoke Y, Wanyenze RK. 2017. Prevalence and factors associated with anaemia among children aged 6 to 59 months in Namutumba district, Uganda: a cross-sectional study. *BMC Paediatrics* 17(1):25–33.

Lopez A, Cacoub P, Macdougall IC, Peyrin-Biroulet L. 2016. Iron deficiency anaemia. *The Lancet* 387(10021):P907-916.

Low M, Farrell A, Biggs B-A, Pasricha S-R. 2013. Effects of daily iron supplementation in primary-school–aged children: systematic review and meta-analysis of randomized controlled trials. *C.M.A.J.* 185:E791–E802.

Menon MP, Yoon SS. 2015. Prevalence and factors associated with anaemia among children under 5 years of age—Uganda, 2009. *Am. J. Trop. Med. Hyg.* 93(3):521–526.

Milazzo A. 2014. Son preference, fertility and family structure: Evidence from reproductive behavior among Nigerian women. Policy Research Working Paper 6869. Washington DC: World Bank.

Moschovis PP, Wiens MO, Arlington L, Antsygina O, Hayden D, Dzik W, et al. 2018. Individual, maternal and household risk factors for anaemia among young children in sub-Saharan Africa: a cross-sectional study. *BMJ Open* 8(5):e019654.

Nambiena A, Robert A, Yaya I. 2019. Prevalence and risk factors of anaemia in children aged from 6 to 59 months in Togo: analysis from Togo demographic and health survey data, 2013–2014. *BMC Public Health* 19(215):1-9.

National Population Commission (NPC) [Nigeria] and ICF. 2019. Nigeria Demographic and Health Survey 2018. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF.

Ngnie-Teta I, Receveur O, Kuate-Defo B. 2007. Risk factors for moderate to severe anaemia among children in Benin and Mali: Insights from a multilevel analysis. *Food and Nutrition Bulletin* 28(1):76-89.

Ntenda PAM, Nkoka O, Bass P, Senghore T. 2018. Maternal anaemia is a potential risk factor for anaemia in children aged 6-59 months in Southern Africa: a multilevel analysis. *BMC Public Health* 18(650):1-13.

Pasricha SR, Drakesmith H, Black J, Hipgrave D, Biggs BA. 2013. Control of iron deficiency anaemia in low- and middle-income countries. *Blood* 121:2607–2617.

Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca, F. 2013. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. *The Lancet Global Health* 1:e16–e25.

Ughasoro MD, Emodi IJ, Okafor HU, Ibe BC. 2011. Prevalence of moderate and severe anaemia in children under 5 in University of Nigeria Teaching Hospital Enugu, Southeast Nigeria. *Pediatr. Res.* 70:489–98.

Vyas S, Kumaranayake L. 2006. Constructing socio-economic status indices: How to use principal components analysis. *Health Policy Planning* 21(6):459-468.

Woldie H, Kebede Y, Tariku A.2015. Factors associated with anaemia among children aged 6–23 months attending growth monitoring at Tsitsika Health Center, Wag-Himra Zone, Northeast Ethiopia. *Journal of Nutrition and Metabolism* 928632. https://doi.org/10.1155/2015/928632

World Health Organization. 2011. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva, World Health Organization. (WHO/NMH/NHD/MNM/11.1) http://www.who.int/vmnis/indicators/haemoglobin.pdf

World Health Organization. 2015. The global prevalence of anaemia in 2011. Geneva: World Health Organization.

World Health Organization. 2019. Anaemia. https://www.who.int/health-topics/anaemia#tab=tab_1

Yusuf A, Mamun ASMA, Kamruzzaman M, Saw A, Elfetoh NMA, Lestrel PE, et al. 2019. Factors influencing childhood anaemia in Bangladesh: a two-level logistic regression analysis. *BMC Paediatrics* 19(213):1-10.

Zimmermann MB, Hurrell RF. 2007. Nutritional iron deficiency. *The Lancet* 370:511–520.