Original Research Article

Risk factors of anemia among selected countries experiencing higher rate of under-5 mortality in sub-Saharan Africa: a three-way interaction model

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ABSTRACT

Background: Over 1.8 million under-five mortality could be avoided each year if anemia is dealt with. No adequate information on the determinants of anemia among the sub-Saharan countries experiencing higher prevalence of under-5 mortality. This study identified the risk factors of anemia among three sub-Saharan countries (Benin, Guinea and Nigeria).
Methods: A total of 24137 records from the 2018 demographic and health survey was used in this this study. The outcome variable was anemia status (Anemic=1, not anemic=0). Measures of effects (AOR) were assessed using binary logistic regression and random-effect generalized linear model. Stata MP 16 was used for the data analysis.
Results: Anemia was found to be common among children in Nigeria (59.4%), Benin (58.2%), and Guinea (46.0%). Children (<6 months) had higher risk of anemia (AOR: 1.20, 95% CI: 1.05-1.37). Intake of drugs for the treatment of intestinal parasites during pregnancy was found to be protective against anemia in Nigeria (AOR: 0.85, 95% CI: 0.89-0.97) and Guinea (AOR: 0.76, 95% CI: 0.63-0.91). Main cooking fuel: Kerosene (AOR: 1.32, 95% CI: 1.05-1.65) and firewood (AOR: 1.46, 95% CI: 1.17-1.81) were associated with a higher risk of anemia.
Conclusions: Children (<6 months) deserve priority attention in the battle against anemia. Intake of drugs for intestinal parasites during pregnancy presents a potentially impactful strategy for anemia prevention among under-5 children in addition to routine deworming and treatments. Also, rural residents, users of kerosene and firewood as main cooking fuel, and users of unprotected well as main source of drinking water needs attention in the awareness and campaigns against under-5 anemia.

Keywords: Anemia, Under-5 children, Mortality, Interaction-model

INTRODUCTION

In view of the ongoing efforts to further reduce child mortality globally, a call to end preventable death of newborns and under-5 children by 2030 has been placed by United Nation through Sustainable Development Goal (SDG) 3.2.1, desiring a result of as low as 12 per 1000 and 25 per 1000 of newborns and under-5 mortality respectively in all nations.[1] Highlighted remedies to achieve these goals were to improve access, coverage, and quality of child health services.[1] Efforts put in place to address these issues have been yielding significant

result. For instance, between year 2000 and 2019 under-five mortality has witnessed a yearly reduction rate of 3.7% worldwide.[2] This is quite encouraging but a holistic look at the prevalence across the regions revealed that over 50% of the estimated 5.2 million under-five children death occurred in sub-Saharan Africa.[2] Towering mortality rate has been reported among under-five who have anemia.[3] Findings from a systematic review suggests that over 1.8 million under-five mortality could be avoided each year if anemia is dealt with 4.

World Health Organization (WHO) defined Anemia as "*a condition in which the number of red blood cells or the hemoglobin concentration within them is lower than normal*" and its common symptoms includes fatigue, weakness, dizziness and shortness of breath.[5]

Globally, 41.7% under five children were anemic while about 59.3% of the anemic under-five children were from Africa. The burden among sub-Saharan African countries is alarming, for instance, the prevalence was 83.4% in Mali, 74.4% in Guinea, 68.3% in Nigeria and 62.1 in Benin.[6]

Some identified causes of anemia include nutritional deficiencies, particularly iron deficiency, though deficiencies in folate, vitamins B12 and A are also important causes; haemoglobinopathies; and infectious diseases, such as malaria, tuberculosis, HIV and parasitic infections.[5]

Reported risk factors were child's age below 24 months, stunting, mother's anemia, malaria, chronic child malnutrition.[7-9] Also, incomplete immunization, recent infection, absence of bed net, farming and fishing parent's occupation, low household living standard, rural residency, low maternal education, and low community development were identified as risk factors of anemia.[10]

Prevalence of anemia and its risk factors have been explored in many developed countries and in some developed countries, but there is paucity of paper on determinants of anemia among countries who have prevalence of anemia that is higher than average (78 per thousand) in sub-Saharan countries.

The level of anemia in these countries (Nigeria, Benn and Guinea) reporting higher mortality rate have not been carefully examined. Since Anemia has been reported to be a major contributor of under-five mortality, it will be expedient to have a holistic look at the countries who reported higher mortality rate so as to find out if these countries have similar pattern of anemia as well as unveiling if these countries have peculiar characteristics that exposed them to mortality through anemia.

This study aimed at bridging this gap by identifying the peculiar causes of anemia among three sub-Saharan countries (Benin, Guinea, and Nigeria).

METHODS

Study design and setting

In this study, we analyzed the cross-sectional data from Demographic and Health Survey (DHS) phase VII survey which was a community-based survey conducted in the year 2018 across several countries. The DHS survey collected data that are comparable across countries, further details of this survey is available in the DHS report 11. Sub-Saharan countries who have under-five mortality rate above 78 per 1000 (average mortality rate in Africa) in the DHS phase-VII survey were selected for this analysis namely Benin, Guinea and Nigeria.

Study population and sampling methods

The study population includes Benin, Guinea, and Nigeria. Children recode (Data for Children of age 0 to 59 months) was extracted from DHS dataset for the four sub-Saharan countries. The extracted dataset contains records for every child between the age of 0 to 59 months given birth to by the interviewed women, information such as child's pregnancy and postnatal care, immunization, health, mother's information and other indicators. A stratified sample was selected in two stages by separating each state into urban and rural areas, further details was provided in the DHS report 2018 11,12. After deleting records with missing data for anemia in the child's recode dataset 6,977 records was extracted for Benin, 4,024 records for Guinea and 13,136 records for Nigeria.

Sample size

The demographic and health survey child recode was used and the records of all children aged 0 to 59 months was extracted for Nigeria, Benin, and Guinea. This resulted into a total record of 13136 for Nigeria, 6977 in Benin and 4024 for Guinea.

Inclusion criteria

Record of under-five children were included in this study.

Exclusion criteria

Also, none de jure mothers (non-usual residence i.e those who didn't stay over the night) were considered ineligible for the survey.

Study variables

Anemia was the outcome variable of interest, Hemoglobin test was carried out to know the anemia status of the children, hemoglobin level below 8.0 G/DL were grouped as "severe" for malaria-related anemia. The explanatory variables were information about the child such as breastfeeding status, sex of child, birth order, age, child twin, diarrhea, intake of drugs for intestinal

parasite, child's fever status in two weeks before the survey, stunting, wasting and BMI for age. Also, characteristics of the dwelling place were also explored including the type of residence, toilet facility, cooking fuel, drinking water and geographical region. We as well included some information about the mothers such as mother's level of education, work status, marital status, wealth index, husband's occupation, exposure to media.

Data analysis

The prevalence of anemia was calculated using frequencies and percentages. Test of independence was carried out between the outcome variable (Anemia) and the explanatory variable with the use of Chi-square. Significant covariates at 5% level of significance were considered in the multivariate analysis using binary logistic regression. In the multivariate analysis, we fitted a binary logistic regression for Nigeria as model I, Benin model II, and Guinea as model III. Also, we fitted a random effect logistic regression for the interaction model to identify the distinctive risk factors of anemia among the three countries that are experiencing high mortality rate in sub-Sahara Africa. We as well computed the intra-cluster correlation to account for the correlation at geopolitical regions within the countries. Stata MP 16 was used for the data analysis.

Ethical approval

Secondary data was used for this paper and ethical approval was obtained by the demographic and health survey. However, the dataset has been de-identified by DHS and permission to use the dataset from Demographic and Health Survey (DHS) was granted by DHS with the authorization.

RESULTS

Characteristics of children

A total of 13136, 6977 and 4024 records from Nigeria, Benin and Guinea were respectively analyzed in this study. Figure 1 showed the prevalence of anemia while table 1 and 2 presents the characteristics of children and characteristics of mothers respectively. Anemia was common among children in Nigeria (59.4%), Benin (58.2%) and Guinea (46.0%). About 2%, 30% and 27% had severe, moderate and mild anemia respectively in Nigeria. Similarly, level of anemia: severe (1.6%), Moderate (30.3%) and mild (26.3%) accounted for the high prevalence (58.2%) of anemia among under-5 children in Benin. Also in Guinea, severe anemia (1.7%), moderate anemia (22.0%) and mild anemia (22.3%) summed up to 46.0% prevalence of all forms of anemia.

About 51% of the children in Nigeria, Benin and Guinea were male. Also, 47.2%, 43.0% and 43.7% of the children were of high (≥4) birth order in Nigeria, Benin and Guinea respectively.
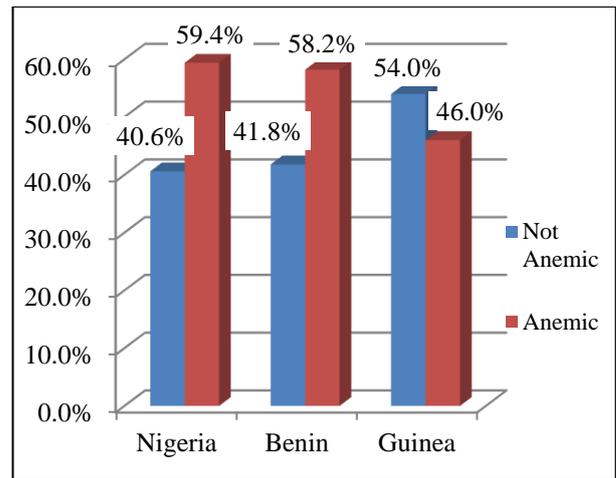
Figure 1: Anemia prevalence in Nigeria, Benin and Guinea.

The proportion of children aged 24-59 months was high in Nigeria (60.0%), Benin (58.4%) and Guinea (59.7%). Also, the percentage of children who were never breastfed was high (13.7%) in Guinea, low (5.5%) in Benin and lower (3.5%) in Nigeria. The menace of diarrhea among the under-5 children was exigent as about one out of every eight children in each of the three countries had diarrhea. A number of the children in Nigeria (26.4%), Benin (35.7%) and Guinea (32.2%) took drugs for intestinal parasite six-months before the survey. Additionally, Mothers who said they took drugs for intestinal parasite during the pregnancy of the child presented in this survey were very few in Nigeria (18.7%), average in Benin (66.0%) and as well few in Guinea (33.9%).

Mothers in Nigeria (25.5%), Benin (20.5%), and Guinea (16.0%) reported that their children had fever two-weeks before the survey. The anthropometric profile of the children showed that 12.8%, 7.6% and 9.8% had severe stunting in Nigeria, Benin and Guinea respectively. Sequentially, 7.1%, 4.0% and 5.4% were severely wasting in Nigeria, Benin and Guinea. The BMI for age indicated that only 71.7% of the children had normal weight in Nigeria and 73.4% in Benin as well as Guinea.

Characteristics of mothers

As presented in table 2, most of the mothers in Nigeria (62.4%), Benin (60.9%) and Guinea (73.0%) lived in the rural. Similarly, 19.4% mothers in Nigeria, 10.2% in Benin and 37.8% in Guinea defecates in an uncovered pit latrine. Also, use of firewood as main cooking fuel was common in Nigeria (72.5%) Benin (67.3%) and Guinea (68.5%). A number of mothers in Nigeria (17.0%), Benin (21.4%) and Guinea (5.7%) used unprotected well as their main source of drinking water. In the same vein, many of the mothers in Nigeria (39.6%), Benin (66.5%) and Guinea (77.3%) had no education.

Table 1: Level of anemia and characteristics of children.

Variables	Nigeria		Benin		Guinea	
	n= 13136	%	n= 6977	%	n=4024	%
Anemia						
Severe	231	1.8	113	1.6	70	1.7
Moderate	3974	30.3	2112	30.3	885	22.0
Mild	3594	27.4	1834	26.3	896	22.3
Not anemic	5337	40.6	2918	41.8	2173	54.0
Health characteristics of the children						
Sex of child						
Male	6678	50.8	3528	50.6	2055	51.1
Female	6458	49.2	3449	49.4	1969	48.9
Birth order						
1	2528	19.2	1458	20.9	799	19.9
2	2360	18.0	1337	19.2	800	19.9
3	2047	15.6	1182	16.9	665	16.5
>=4	6201	47.2	3000	43.0	1760	43.7
Age of child (in months)						
<6	1308	10.0	726	10.4	491	12.2
6-23	3947	30.0	2179	31.2	1131	28.1
24-59	7881	60.0	4072	58.4	2402	59.7
Child is twin						
Single birth	12625	96.1	6594	94.6	3853	95.8
1st of multiple	254	1.9	190	2.7	85	2.1
2nd of multiple	254	1.9	190	2.7	85	2.1
Duration of breastfeeding						
Ever breastfed, not currently breastfeeding	8876	67.6	4254	61.0	2084	51.8
Never breastfed	456	3.5	383	5.5	551	13.7
Still breastfeeding	3804	29.0	2340	33.5	1389	34.5
Had diarrhoea recently						
No	10395	87.4	5741	89.3	3203	88.3
Yes, last two weeks	1495	12.6	685	10.7	425	11.7
Drugs for intestinal parasites in last 6						
No	8711	73.6	4125	64.3	2450	67.8
Yes	3129	26.4	2288	35.7	1165	32.2
Drugs for intestinal parasites during						
No	6728	81.3	1504	34.0	1807	66.1
Yes	1547	18.7	2915	66.0	928	33.9
Had fever in last two weeks						
No	8851	74.5	5122	79.5	3052	84.0
Yes	3034	25.5	1324	20.5	581	16.0
Stunting						
Severe stunting	1452	12.8	483	7.6	340	9.8
Moderate stunting	1983	17.4	1122	17.8	495	14.2
No stunting	7945	69.8	4715	74.6	2652	76.1
Wasting						
Severely wasting	803	7.1	251	4.0	189	5.4
Moderately wasting	1656	14.6	833	13.2	389	11.2
Not wasting	8735	76.8	4996	79.1	2780	79.7
Overweight	186	1.6	240	3.8	129	3.7
Under-weight /over -weight for age						
Severely underweight	721	6.3	215	3.4	142	4.1

Variables	Nigeria		Benin		Guinea	
Moderately underweight	2159	19.0	1125	17.8	516	14.8
Normal	8162	71.7	4642	73.4	2561	73.4
Overweight for age	338	3.0	338	5.3	268	7.7

Table 2: Mother's characteristics.

Variables	Nigeria		Benin		Guinea	
	n= 13136	%	n= 6977	%	n=4024	%
Type of place of residence						
Urban	4940	37.6	2729	39.1	1088	27.0
Rural	8196	62.4	4248	60.9	2936	73.0
Toilet facility						
Flush Water system	1836	14.0	186	2.7	280	7.0
Covered pit latrine	4819	36.7	1758	25.2	1465	36.4
Uncovered pit latrine	2542	19.4	711	10.2	1520	37.8
Others	3939	30.0	4322	61.9	759	18.9
Type of cooking fuel						
Electricity	94	0.7	18	0.3	38	0.9
Liquefied gas	1075	8.2	-	-	3	0.1
kerosene	1256	9.6	157	2.3		
Coal/ charcoal	794	6.0	1744	25.0	1044	25.9
Firewood	9530	72.5	4694	67.3	2755	68.5
Other	387	2.9	364	5.2	184	4.6
Sources of drinking water						
Piped water	433	3.3	1286	18.4	579	14.4
Public tap	900	6.9	927	13.3	184	4.6
Tube well/borehole	4590	34.9	2134	30.6	1666	41.4
Protected well	1366	10.4	312	4.5	454	11.3
Unprotected well	2230	17.0	1491	21.4	228	5.7
Spring	384	2.9	117	1.7	524	13.0
Others	3233	24.6	710	10.2	389	9.7
Highest educational level						
No education	5206	39.6	4642	66.5	3110	77.3
Primary	2195	16.7	1219	17.5	442	11.0
Secondary	4596	35.0	1040	14.9	404	10.0
Higher	1139	8.7	76	1.1	68	1.7
Respondent currently working						
No	4037	30.7	1315	18.8	1434	35.6
Yes	9099	69.3	5662	81.2	2590	64.4
Wealth index						
Poor	2762	21.0	2839	40.7	1952	48.5
Average	2715	20.7	1444	20.7	772	19.2
Rich	2898	22.1	2694	38.6	1300	32.3
Marital status						
Currently not in union	1186	9.0	1772	25.4	309	7.7
Currently Married	11950	91.0	5205	74.6	3715	92.3
Husband/partner's occupation						
Not working	370	3.0	543	7.8	261	7.0
Professional/technical/ managerial/services	4919	39.7	2253	32.4	1022	27.4
Agricultural	4624	37.4	2884	41.4	1622	43.5
Others	2467	19.9	1281	18.4	822	22.1
Media use (exposure to television, radio, newspaper or internet)						
Yes	1399	10.7	255	3.7	162	4.0
No	11737	89.3	6977	96.4	3862	96.0

Table 3: Association between anemia and profile of the under-5 children and their mothers in Nigeria, Benin and Guinea.

	Nigeria			Benin			Guinea		
		Test statistics	P value		Test statistics	P value		Test statistics	P value
Variables	Anemic			Anemic			Anemic		
Sex		0.66	0.418		0.10	0.753		0.01	0.913
Male	3942 (59.0)			2046 (58.0)			947 (46.1)		
Female	3857 (59.7)			2013 (58.4)			904 (45.9)		
Age of child (in months)		8.62	0.013**		2.61	0.271		10.33	0.006**
<6	821 (62.8)			434 (59.8)			259 (52.7)		
6-23	2296 (58.2)			1239 (56.9)			506 (44.7)		
24-59	4682 (59.4)			2386 (58.6)			1086 (45.2)		
Birth Order		13.04	0.005*		4.78	0.189		2.19	0.553
1	1482 (58.6)			846 (58.0)			379 (47.4)		
2	1350 (57.2)			746 (55.8)			360 (45.0)		
3	1188 (58.0)			687 (58.1)			29 (44.1)		
>=4	3779 (60.9)			1780 (59.3)			819 (46.5)		
Child is twin		11.25	0.004*		0.02	0.992		0.94	0.624
Single birth	7459 (59.1)			3839 (58.2)			1778 (46.1)		
1st of multiple	169 (66.5)			110 (57.9)			36 (42.4)		
2nd of multiple	169 (66.5)			110 (57.9)			36 (42.4)		
Duration of breastfeeding		0.30	0.862		3.52	0.172		1.34	0.511
Ever breastfed, not currently breastfeeding	5284 (59.5)			2511 (59.0)			942 (45.2)		
Never breastfed	270 (59.2)			213 (55.6)			263 (47.7)		
Still breastfeeding	2245 (59.0)			1335 (57.1)			646 (46.5)		
Had diarrhea recently		0.00	0.960		0.00	0.986		1.26	0.262
No	6140 (59.1)			3346 (58.3)			1445 (45.1)		
Yes, last two weeks	882 (59.0)			399 (58.2)			204 (48.0)		
Drugs for intestinal parasites in last 6 months		1.50	0.221		4.61	0.032**		13.12	0.000**
No	5176 (59.4)			2367 (57.4)			1171 (47.8)		
Yes	1820 (58.2)			1376 (60.1)			482 (41.4)		
Drugs for intestinal parasites during pregnancy		13.69	0.000**		2.58	0.108		13.00	0.000**
No	4029 (59.9)			901 (59.9)			873 (48.3)		
Yes	847 (54.8)			1673 (57.4)			381 (41.1)		
Had fever in last two weeks		9.41	0.002**		1.28	0.257		12.55	0.000**
No	5154 (58.2)			2968 (57.9)			1348 (44.2)		
Yes	1863 (61.4)			790 (59.7)			303 (52.2)		
stunting		30.27	0.000**		7.71	0.021**		0.22	0.896
Severe stunting	949 (65.4)			304 (62.9)			155 (45.6)		

Continued.

	Nigeria			Benin			Guinea		
Moderate stunting	1186 (59.8)			676 (60.2)			219 (44.2)		
No stunting	4585 (57.7)			2705 (57.4)			1202 (45.3)		
Wasting		34.82	0.000*		0.17	0.982		2.05	0.562
Severely wasting	533 (66.4)			148 (59.0)			85 (45.0)		
Moderately wasting	1039 (62.7)			488 (58.6)			189 (48.6)		
Not wasting	5034 (57.6)			2907 (58.2)			1245 (44.8)		
Overweight	114 (61.3)			142 (59.2)			57 (44.2)		
BMI for age		39.09	0.000*		4.50	0.213		0.99	0.803
Severely underweight	479 (66.4)			117 (54.4)			63 (44.4)		
Moderately underweight	1323 (61.3)			679 (60.4)			239(46.3)		
Normal	4690 (57.5)			2684 (57.8)			1147 (44.8)		
Overweight for age	228 (67.5)			205 (60.7)			127 (47.4)		
Characteristics of parents									
place of residence		86.05	0.000*		0.28	0.596		1.73	0.188
Urban	2680 (54.3)			1577 (57.8)			482 (44.3)		
Rural	5119 (62.5)			2482 (58.4)			1369 (46.6)		
Type of toilet facility		87.77	0.000**		39.95	0.005**		7.79	0.051
Flush Water system	930 (50.7)			104 (55.9)			122 (43.6)		
Covered pit latrine	2814 (58.4)			923 (52.5)			637 (43.5)		
Uncovered pit latrine	1605 (63.1)			395 (55.6)			727 (47.8)		
others	2450 (62.2)			2637 (61.0)			365 (48.1)		
Type of cooking fuel		175.02	0.000*		9.28	0.054		2.28	0.684
Electricity	45 (47.9)			15 (83.3)			18 (47.4)		
Liquefied gas	486 (45.2)			90 (57.3)			2 (66.7)		
kerosene	689 (54.9)			-			-		
Coal/ charcoal	393 (49.5)			976 (56.0)			473 (45.3)		
Firewood	5952 (62.5)			2765 (58.9)			1265 (45.9)		
other	234 (60.5)			213 (58.5)			93 (50.5)		
Source of drinking water		40.16	0.000*		10.02	0.124		9.38	0.153
Piped water	233 (53.8)			752 (58.5)			259 (44.7)		
public tap	515 (57.2)			505 (54.5)			100 (54.3)		
tube well/borehole	2762 (60.2)			1240 (58.1)			744 (44.7)		
protected well	749 (54.8)			181 (58.0)			203 (44.7)		
unprotected well	1424 (63.9)			873 (58.6)			103 (45.2)		
spring	220 (57.3)			77 (65.8)			251 (47.9)		
Others	1896 (58.6)			431 (60.7)			191 (49.1)		
Mother's highest level of education		116.17	0.000**		35.35	0.000**		4.49	0.214
No education	3332 (64.0)			2755 (59.3)			1442 (46.4)		

Continued.

	Nigeria		Benin		Guinea	
Primary	1295 (59.0)		742 (60.9)		205 (46.4)	
Secondary	2624 (57.1)		528 (50.8)		181 (44.8)	
Higher	548 (48.1)		34 (44.7)		23 (33.8)	
Currently working	29.97	0.000*	0.00	0.952	1.07	0.302
No	2539 (62.9)		766 (58.3)		644 (44.9)	
Yes	5260 (57.8)		3293 (58.2)		1207 (46.6)	
Wealth index	127.50	0.000***	20.17	0.000**	9.62	0.008**
Poor	3506 (64.0)		1720 (60.6)		943 (48.3)	
Average	1762 (60.8)		861 (59.6)		325 (42.1)	
Rich	2531 (53.2)		1478 (54.9)		583 (44.8)	
Current marital status	0.00	0.958	12.78	0.000*	0.01	0.918
currently not in union	705 (59.4)		1095 (61.8)		143 (46.3)	
Currently Married	7094 (59.4)		2964 (56.9)		1708 (46.0)	
Husband/partner's occupation	58.94	0.000*	6.59	0.086	7.05	0.070
Not working	236 (63.8)		319 (58.7)		103 (39.5)	
professional/technical/ managerial/services	2739 (55.7)		1261 (56.0)		475 (46.5)	
Agricultural	2921 (63.2)		1707 (59.2)		777 (47.9)	
Others	1446 (58.6)		761 (59.4)		371 (45.1)	
Media use (exposure to television/radio/ internet)	9.89	0.002**	3.94	0.047***	4.73	0.030***
Yes	776 (55.5)		133 (52.2)		61 (37.7)	
No	7023 (59.8)		3926 (58.4)		1790 (46.3)	

*P value significant for only one country ** P value significant for two countries *** p value significant for all the three countries

Table 4: Risk factors of anemia among children 0 to 59 months old in Nigeria, Benin and Guinea.

Variables	Model I (Nigeria) AOR (95%CI)	Model II AOR (95%CI)	Model III AOR (95%CI)	Model IV AOR (95%CI)
Age of child (in months)				
<6	1.20 (1.05-1.37)*	1.17 (0.97-1.40)	1.36 (1.09-1.70)*	1.10 (0.78-1.27)
6 -23	0.95 (0.88-1.04)	0.93 (0.83-1.04)*	0.94 (0.80-1.10)	0.90 (0.69-1.16)
24 – 59	Reference			
Birth order				
1	Reference			
2	0.92 (0.78-1.09)	0.83 (0.68-1.03)	0.98 (0.73-1.31)	1.10 (084-1.43)
3	0.92 (0.77-1.09)	0.92 (0.74-1.14)	0.78 (0.58-1.05)	1.00 (0.76-1.33)
≥4	0.9 (0.78-1.05)	0.9 (0.75-1.09)	0.94 (0.73-1.22)	1.00 (0.79-1.28)
Drugs for intestinal parasite during the pregnancy of the child				
No	Reference			
Yes	0.85 (0.89 - 0.97)*	0.94 (0.81 - 1.09)	0.76 (0.63 -	0.96 (0.79-1.17)
Child is twin				
Single birth	Reference			
1st of multiple	1.29 (0.89 - 1.86)	-	-	-

Continued.

	Model I (Nigeria)	Model II	Model III	Model IV
2nd of multiple	1.20 (0.79 -1.99)	0.93 (0.63 - 1.37)	0.57 (0.30 - 1.09)	1.36 (0.80-2.34)
Drugs for intestinal parasites in last 6 months				
No	Reference			
Yes	1.13 (0.99-1.28)	1.23 (1.06 -	0.86 (0.70 - 1.05)	0.95 (0.78-1.16)
Had fever in last two				
No	Reference			
Yes	1.04 (0.93 - 1.17)	1.1 (0.95 - 1.28)	1.37 (1.10 -	1.00 (0.83-1.21)
Stunting				
No stunting	Reference			
Severe stunting	1.14 (0.93 - 1.40)	1.29 (0.95 - 1.77)	0.99 (0.71 - 1.38)	0.96 (0.66-1.40)
Moderate stunting	1 (0.87 - 1.15)	1.17 (0.97 - 1.41)	0.93 (0.72 - 1.20)	0.88 (0.69-1.12)
Wasting				
Severely wasting	Reference			
Moderately wasting	1.01 (0.81- 1.27)	1.03 (0.70 - 1.51)	1.5 (0.97 - 2.31)	0.97 (0.62-1.52)
Not wasting	0.922 (0.74 - 1.14)	1.27 (0.87 - 1.84)	1.17 (0.79 - 1.71)	0.70 (0.45-1.09)
Overweight	1.10 (0.71 - 1.71)	1.22 (0.72 - 2.09)	1.07 (0.60 - 1.89)	0.83 (0.41-1.67)
Place of residence				
Urban	Reference			
Rural	1.13 (1.00 - 1.28)*	0.94 (0.81 - 1.09)	0.98 (0.71 -1.36)	1.20 (0.98-1.46)
Type of toilet facility				
Flush Water system	0.95 (0.77 - 1.18)	1.00 (0.62 - 1.60)	0.99 (0.65 - 1.49)	0.87 (0.51-1.47)
Covered pit latrine	0.99 (0.85 -1.16)	0.85 (0.67 - 1.08)	0.83 (0.66 - 1.05)	1.06 (0.79-1.42)
Uncovered pit latrine	Reference			
Others	1.02 (0.87 - 1.18)	1.22 (0.98 - 1.51)	1 (0.77 - 1.28)	0.72 (0.54-0.94)
Type of cooking fuel				
Electricity	0.95 (0.52 - 1.74)	1.76 (0.44 - 7.07)	0.76 (0.28 - 2.04)	0.49 (0.11-2.29)
Liquefied gas	Reference			
Kerosene	1.32 (1.05 - 1.65)*			-
Coal/ charcoal	1.04 (0.80 - 1.36)	0.85 (0.55 - 1.32)	1.07 (0.66 - 1.76)	1.22 (0.72-2.05)
Firewood	1.46 (1.17 - 1.81)*	0.69 (0.44 - 1.10)	1.02 (0.64 - 1.61)	1.74 (1.02-2.94)*
Other	1.34 (0.93 - 1.92)	0.64 (0.37 - 1.08)		1.90 (0.98-3.71)
Source of drinking				
Piped water	0.93 (0.68 - 1.27)	1.18 (0.94 - 1.48)	0.9 (0.57 -1.43)	0.98 (0.66-1.46)
public tap	0.95 (0.75 - 1.19)	0.88 (0.71 - 1.10)	1.26 (0.74 - 2.16)	1.07 (0.77-1.48)
tube well/borehole	1.01 (0.86 - 1.19)	1.05 (0.88- 1.25)	0.92 (0.64 -1.34)	0.91 (0.70-1.16)
protected well	0.80 (0.65 - 0.97)*	1.16 (0.83 - 1.63)	0.92 (0.60 - 1.42)	0.69 (0.47-1.03)
unprotected well	Reference			
Spring	0.95 (0.69 - 1.31)	1.31 (0.75 - 2.29)	0.95 (0.63 - 1.44)	0.69 (0.36-1.33)
Others	0.95 (0.80 - 1.12)	1.08 (0.84 -1.39)	1.01 (0.64 - 1.58)	0.85 (0.62-1.17)
Mother's highest level of				
No education	Reference			
Primary	0.94 (0.80 - 1.09)	0.98 (0.82 - 1.17)	1.04 (0.78 - 1.37)	0.84 (0.66-1.07)
Secondary	0.93 (0.79 - 1.07)	0.73 (0.59-0.90)*	1.12 (0.79 - 1.56)	1.04 (0.80-1.36)
Higher	0.79 (0.63 - 0.99)*	0.54 (0.29-0.98)*	0.87 (0.41 - 1.83)	1.33 (0.69-2.55)
Mother Currently				
No	Reference			
Yes	0.91 (0.81 - 1.01)	1.01 (0.85 - 1.19)	1.83 (0.98 - 1.43)	0.92 (0.75-1.13)
Wealth index				
Poor	Reference			
Average	0.92 (0.80 - 1.07)	1.01 (0.84 - 1.21)	0.84 (0.66 - 1.08)	0.84 (0.66-1.07)
Rich	0.88 (0.74 - 1.06)	0.84 (0.68 - 1.03)	1.11 (0.79 - 1.57)	0.96 (0.72 - 1.26)

	Model I (Nigeria)	Model II	Model III	Model IV
Father's occupation				
Not working	Reference			
Professional/technical/	0.89 (0.66 - 1.20)	0.96 (0.75 - 1.22)	1.32 (0.77 - 2.31)	0.91 (0.62-1.35)
Agricultural	0.99 (0.74 - 1.34)	1.00 (0.80 - 1.35)	1.24 (0.87 - 1.76)	0.91 (0.61-1.35)
Others	1.02 (0.75 - 1.39)	1.04 (0.80 - 1.35)	1.14 (0.79 - 1.66)	0.95 (0.63-1.43)
Media use (exposure to television, radio or internet)				
Yes	Reference			
No	0.86 (0.73 - 1.02)	0.93 (0.66 - 1.31)	1.33 (0.77 - 2.31)	1.03 (0.70-1.52)

High proportion of mothers in Nigeria (30.7%), Benin (18.8%) and Guinea (35.6%) were not working. Almost all the mothers in Nigeria (91%), Benin (74.6%) and Guinea (92.3%) were currently married. Exposure to media was poor among the respondents as almost all the mothers were not exposed to media use in Nigeria (89.3%), Benin (96.4%) and Guinea (96%).

Association between anemia and profile of the under-5 children and their mothers in Nigeria, Benin and Guinea

In this study we discovered that some of the characteristics of children and their mothers were associated with anemia, table 3 presents the results. For instance, anemia was more pronounced (62.8%) among children <6 months old compared to those aged 6 -23 months (58.2%) and those who were 24-59 month old (59.4%) (p=0.013). Children of higher birth order (≥4) were more (60.9%) anemic in relative to others (p=0.005). We also found out that twins (1st of multiple and 2nd of multiple were more (66.5%) anemic compared to single birth children (p=0.004). Similarly, lower proportion (54.8%) of children whom their mother took drugs for intestinal parasite during pregnancy had anemia compared to the higher (59.4%) proportion who did not (p=0.000). Also, more (61.4%) of children who had fever 2-weeks before the survey had anemia compared to those (58.2%) who did not have fever (p=0.002). In addition, the rate of anemia occurrence was higher (65.4%) among children who had severe stunting and moderate stunting (59.8%) compared to children who were not stunted (p=0.000). The pattern was alike for the wasting, more of children who were severely wasting (66.4%), moderately wasting (62.7%) and overweight (61.3%) were anemic compared to those (57.6%) who were not wasting (p=0.000). Also, body mass index for age showed that more of children who were severely underweight (66.4%), moderately underweight (61.3%) and overweight for age (67.5%) had anemia compared to children whose BMI for age (57.5%) were normal (p=0.000). Further, place of residence, type of toilet facility, type of cooking fuel, source of drinking water, mother's education, work status, wealth index, partner's occupation and media use were associated with anemia (p<0.05).

In Benin, we found out that the rate of anemia occurrence was higher (62.9%) among children who had severe stunting and moderate stunting (60.2%) compared to children who were not stunted (p=0.021). Also, type of toilet facility, mother's education, wealth index, marital status and media exposure were associated with anemia (p<0.05).

In like manner among under-5 children in Guinea, anemia was more pronounced (52.7%) among children <6 months old compared to those aged 6-23 months (44.7%) and those who were 24-59 month old (45.2%) (p=0.006). Also, lower proportion (41.4%) of children who took drugs for intestinal six months before survey had anemia compared to the higher (47.8%) proportion who did not (p=0.000). Similarly, lower proportion (41.1%) of children whom their mother took drugs for intestinal parasite during pregnancy had anemia compared to the higher (48.2%) proportion who did not (p=0.000). Also, more (52.2%) of children who had fever 2-weeks before the survey had anemia compared to those (44.2%) who did not have fever (p=0.000). Finally, wealth index and media use were associated with anemia (p<0.05).

Risk factors of anemia among children 0 to 59 months old in Nigeria, Benin and Guinea

The results of the identified risk factors of anemia at individual country level and interaction between the three countries were presented in Table 8. In the three countries, younger children (<6 months old) were at higher risk of anemia. For instance, Children under 6 months of age had higher risk of anemia (AOR: 1.20, 95% CI: 1.05 – 1.37) compared to children aged 24 – 59 years in Nigeria. In the same vein, Children under 6 months of age (AOR: 1.17, 95% CI: 0.97 – 1.40) were more likely to have anemia compared to children aged 24-59 years old in Benin. Also, in Guinea Children under 6 months of age had higher risk of anemia (AOR: 1.36, 95% CI: 1.09 – 1.70) compared to children aged 24 – 59 years old. In furtherance, we found out that children whose mother took drugs for intestinal parasite during pregnancy in Nigeria (AOR: 0.85, 95% CI: 0.89-0.97) and in Guinea (AOR: 0.76, 95% CI: 0.63-0.91) were less like to be Anemic in relative to children whose mother did not take drug for intestinal parasite during pregnancy.

The interaction effect revealed that mothers who took drugs for intestinal parasite during pregnancy reduced the chances of the child been anemic (AOR: 0.96, 95% CI: 0.79-1.17) in the three sub-Saharan countries.

Also, it was revealed among children in Benin that children who took drugs for intestinal parasite in the last six months (AOR: 1.23, 95% CI: 1.06-1.42) had 1.23 odds of Anemia compared to children who did not take drugs for anemia in the last six months. Guinea children who had fever two weeks prior the survey (as well as anemia test) (AOR: 1.37, 95% CI: 1.10-1.72) were 1.37 times more likely to be anemic compared to those who did not have fever two weeks prior the survey. Also, rural residence was identified as risk factor of anemia in Nigeria, Children from the rural area (AOR: 1.13, 95% CI: 1.06-1.42) had higher probability of 13% compared to their counterparts in urban area. Children from household whose main cooking fuel were kerosene (AOR: 1.32, 95% CI: 1.05-1.65) and firewood (AOR: 1.46, 95% CI: 1.17-1.81) were more likely to be anemic compared to household using liquefied gas as main cooking fuel. The interaction model identified the use of firewood as a peculiar risk factor of anemia across the three countries (AOR: 1.74, 95% CI: 1.02-2.94). Also, the use of protected well as source of drinking water (AOR: 0.80, 95% CI: 0.65-0.97) were less likely to develop anemia compared to household using unprotected well. Further, higher education was protective for anemia. For clarification, children birthed by mothers who have attained secondary education in Benin (AOR: 0.73, 95% CI: 0.59-0.90), higher education in Nigeria (AOR: 0.79, 95% CI: 0.63-0.99) and higher education in Benin were less likely to be anemic.

DISCUSSION

In view of the need to flatten the curve of child's mortality through putting an end to preventable death of newborn and under-5 children, we identified the risk factors of anemia among under-5 children as well the peculiar risk factors of anemia among children in the three selected countries experiencing higher mortality rate in sub-Sahara Africa. Information of children aged 0 to 59 months were extracted from the round 7 survey of the Demographic and health survey (2018), that is, Nigeria (n=13136), Benin (n=6977) and Guinea (n=4024). Information about these children were provided by their caregivers. The net effects of child's characteristics, mother and father's profile on anemia were examined in this study. Prevalence of anemia was on the high side in Nigeria, Benin and Guinea. This study revealed that more than a half of the children in Nigeria and Benin were anemic while about a half of children in guinea were anemic. These proportions are quite higher than the prevalence reported in Ethiopia, but similar to that of Brazil.[13,14] The differences could be as a result of the level of interventions towards improving the health of under-5 children at country level. For example, the national strategy for new born and child's survival in

Ethiopia has been reported to effectively reduce child mortality and its surrounding factors such as anemia.[15] The menace of two weeks diarrhea was common among under-5 children in Nigeria, Benin and Guinea. Scholars in Rwanda and Ethiopia reported higher prevalence of two-week diarrhea among the under-5 children.[16]

In this study we also revealed factor that were independently associated with anemia in each of the countries, but the novel findings in this study is that we also presents the associated factors that were peculiar across at least two of the three sub-Saharan countries. For further clarification, Anemia implicated the age of children, child's use of drugs for intestinal parasite in the last six months before the survey, mother's use of drugs for intestinal parasite during pregnancy, children who had fever in the last two weeks, child's anthropometric status, such as stunting and BMI for age. Also, type of toilet, mother's level of education, wealth index and media use were associated with anemia in at least two countries. These identified factors were not surprising because studies carried out in different setting reported similar findings in Bangladesh and Tanzania.[17,18] The similarities in the findings are likely to be as a result of the economic status of the concerned countries as studies have reported that anemia in common among countries of low or low-middle income countries.[19]

Further, after adjusting for confounder, we found out that children of older age (6-23 months and 24-59 months) have a lower risk of anemia in relative to age <6 months in each of the countries, this findings was corroborated by Engidaye et al in a study carried out among children in Ethiopia, level of immunity would have accounted for this, as children older age have been reported to have stronger immunological response.[19,20]

Use of drugs for intestinal parasite during pregnancy reduced the chances of anemia among children in Nigeria and Guinea. Studies in other countries have established that children with intestinal parasite and children birthed by mothers with parasitic infection during pregnancy have higher risk of anemia, implying that treatment of parasitic infection will be helpful in combating the high surge of anemia among children.[21] In the same vein, fever was found to increase the risk of anemia among children. This is quite unique but not a standalone findings, fever has been linked with anemia among children as one of the common symptoms of anemia is fever, but was discovered in this study that fever increases the risk of anemia among under-5 children.[22] The use of firewood and kerosene as main fuel for cooking was found to increase the risk of anemia among under-5 children, this is a novel findings, although could be linked to excessive carbon mono oxide released when using kerosene or firewood as main cooking fuel. The theory of Carboxyhemoglobin explained this, when carbon mono oxide is inhaled it combines with hemoglobin to form carboxyhemoglobin at any or all of the oxygen-binding sites of hemoglobin, and also increases the stability of the

bond between hemoglobin and oxygen, this reduces the ability of the hemoglobin molecule to release oxygen bound to other oxygen-binding sites and hereby increases the risk of anemia.[23] Notably, as revealed in the interaction model, the risk posed by the use of firewood for main cooking fuel was distinctive for the countries experiencing higher mortality rate in sub-Saharan Africa.

Limitations

As a result of the secondary data used for this study, we could not explore beyond the information (variables) that were made available in the dataset. However, this limitation does not undermine the strength and power of this study.

CONCLUSION

Children of younger age (<6 month) deserve much attention in the battle against anemia as they are at higher risk of anemia. Taking drug for intestinal parasite during pregnancy was protective against anemia condition among children. Also, routine use of drugs to treat intestinal parasite among under-5 children should be considered. Higher risk of anemia was found among children who had fever two weeks prior the survey. Rural residency, using kerosene and firewood as cooking fuel and drinking water from unprotected well has implicated the risk of anemia among children 0 to 59 months. In the same vein, secondary and higher education were protective against the risk of anemia.

Recommendations

Intervention that aimed at improving livelihood, access to modern cooking fuel, clean drinking water and economy should be considered in the efforts to reduce under-5 mortality through lowering the cone of anemia. Children <6 month of age, presented for fever and reported to have parasitic infection should gain extra attention in the battle against anemia. Also, treatment of parasitic infection for pregnant women should be prioritized.

Strength

Internationally representative data and powerful statistical techniques were employed in this paper, this ensured the reliability and precision of the estimates provided in this study. Also, we have identified some novel findings in this study which will be helpful in policy making, health campaign and reduction of child's mortality.

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