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 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.\textsuperscript{1} Highlighted remedies to achieve these goals were to improve access, coverage, and quality of child health services.\textsuperscript{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. 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. Towering mortality rate has been reported among under-five who have anemia. Findings from a systematic review suggests that over 1.8 million under-five mortality could be avoided each year if anemia is dealt with.

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.

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.

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.

Reported risk factors were child’s age below 24 months, stunting, mother’s anemia, malaria, chronic child malnutrition. 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.

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-Saharan 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.

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 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.

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%).

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Table 1: Level of anemia and characteristics of children.

| Variables                                      | Nigeria | Benin | Guinea |
|-----------------------------------------------|---------|-------|--------|
|                                               | n= 13136 | n= 6977 | n=4024 |
| ANEMIA                                        |         |       |        |
| Severe                                        | 231     | 113   | 70     |
| Moderate                                      | 3974    | 2112  | 885    |
| Mild                                          | 3594    | 1834  | 896    |
| Not anemic                                    | 5337    | 2918  | 2173   |
| HEALTH CHARACTERISTICS OF THE CHILDREN        |         |       |        |
| SEX OF CHILD                                  |         |       |        |
| Male                                          | 6678    | 3528  | 2055   |
| Female                                        | 6458    | 3449  | 1969   |
| BIRTH ORDER                                   |         |       |        |
| 1                                             | 2528    | 1458  | 799    |
| 2                                             | 2360    | 1337  | 800    |
| 3                                             | 2047    | 1182  | 665    |
| &gt;=4                                        | 6201    | 3000  | 1760   |
| AGE OF CHILD (IN MONTHS)                      |         |       |        |
| &lt;6                                          | 1308    | 726   | 491    |
| 6-23                                         | 3947    | 2179  | 1131   |
| 24-59                                         | 7881    | 4072  | 2402   |
| CHILD IS TWIN                                 |         |       |        |
| Single birth                                  | 12625   | 6594  | 3853   |
| 1st of multiple                               | 254     | 190   | 85     |
| 2nd of multiple                               | 254     | 190   | 85     |
| DURATION OF BREASTFEEDING                     |         |       |        |
| Ever breastfed, not currently breastfeeding   | 8876    | 4254  | 2084   |
| Never breastfed                               | 456     | 383   | 551    |
| Still breastfeeding                           | 3804    | 2340  | 1389   |
| HAD DIARRHEA RECENTLY                         |         |       |        |
| No                                            | 10395   | 5741  | 3203   |
| Yes, last two weeks                           | 1495    | 685   | 425    |
| DRUGS FOR INTESTINAL PARASITES IN LAST 6      |         |       |        |
| No                                            | 8711    | 4125  | 2450   |
| Yes                                           | 3129    | 2288  | 1165   |
| DRUGS FOR INTESTINAL PARASITES DURING         |         |       |        |
| No                                            | 6728    | 1504  | 1807   |
| Yes                                           | 1547    | 2915  | 928    |
| HAD FEVER IN LAST TWO WEEKS                   |         |       |        |
| No                                            | 8851    | 5122  | 3052   |
| Yes                                           | 3034    | 1324  | 581    |
| STUNTING                                      |         |       |        |
| Severe stunting                               | 1452    | 483   | 340    |
| Moderate stunting                             | 1983    | 1122  | 495    |
| No stunting                                   | 7945    | 4715  | 2652   |
| WASTING                                       |         |       |        |
| Severely wasting                              | 803     | 251   | 189    |
| Moderately wasting                            | 1656    | 833   | 389    |
| Not wasting                                   | 8735    | 4996  | 2780   |
| OVERWEIGHT/UNDERWEIGHT FOR AGE                |         |       |        |
| Severely underweight                          | 721     | 215   | 142    |

Continued.
### 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.

| Variables                                    | Nigeria | Benin | Guinea |
|----------------------------------------------|---------|-------|--------|
|                                              | Test statistics | P value | Test statistics | P value | Test statistics | P value |
| Sex                                          | Anemic  | 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.
| Characteristics of parents | 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 |
| Severe 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 |
| Severe underweight          | 479 (66.4) | 117 (54.4) | 63 (44.4) |
| Moderately underweight      | 1323 (61.3) | 679 (58.4) | 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) |
| 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.
| Variables                                      | Model I (Nigeria) | Model II | Model III | Model IV |
|------------------------------------------------|------------------|----------|-----------|----------|
|                                                 | AOR (95%CI)      | AOR (95%CI) | AOR (95%CI) | 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 (0.84-1.43) |
| 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 - 0.86) | 0.96 (0.79-1.17) |
| **Child is twin**                               |                  |          |           |          |
| Single birth                                   | Reference        |          |           |          |
| 1st of multiple                                | 1.29 (0.89 - 1.86) | -        | -         | -        |

*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.
| Parameter                                      | 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 education            |                   |          |           |          |
| 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)|

Continued.
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 furthermore, 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.

| 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) |
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-Saharan 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. 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. 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.

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. 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.

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. 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. 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. 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. 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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