ORIGINAL ARTICLE

Factors associated with anaemia in under-five children in Zambia: Secondary analysis of the 2021 Malaria Indicator Survey Data

Gertrude Konkola, Cephas Sialubanje,MukumbutaNawa

Levy Mwanawasa Medical University, Department of Biostatistics and Epidemiology, P. O. Box 33991, Lusaka, Zambia.

ABSTRACT

Introduction: Anaemia is one of the major public health concerns in many developing countries including Zambia. Unless it is acute, the consequences of anaemia are not immediate but have long-term debilitating effects such as growth and intellectual retardation and as such it does not receive the necessary attention it deserves. This study set out to assess the prevalence and associated factors of anaemia in under-five children in Zambia.

Methods: This study was a secondary analysis of the 2021 Malaria Indicator Survey. We extracted data from the datasets at the National Malaria Elimination Centre after obtaining permission from the Ministry of Health. The extracted data was analysed in STATA 14, summarised in frequencies, cross-tabulations between independent variables and the outcome and multivariable logistic regression was used to assess the associations between variables and anaemia.

Findings: The prevalence of anaemia was found to be 53.8%. Anaemia was found to be associated more with children below one year compared to older children, children whose household heads had no or only have primary education compared to those with secondary or tertiary education and in the northern parts of the country such as Luapula and Northern provinces compared to the southern province. Further anaemia was more common in those with malaria than those without malaria and those with febrile illnesses than those without febrile illnesses. In addition, anaemia was less common in those who slept under insecticide-treated nets.

Conclusion: Anaemia in Zambia has been found to be higher than the average in Southern Africa, it is associated with younger age groups, poverty conditions and where diseases like malaria and other febrile illnesses are more common than where they are not. The use of interventions like insecticide-treated nets is associated with reduced prevalence of anaemia.

INTRODUCTION

Zambia like many other developing countries continues to face significant challenges in child health, with anaemia emerging as a major public

Corresponding Author:
Gertrude Konkola,
Levy Mwanawasa Medical University, Department of Biostatistics and Epidemiology, P. O. Box 33991, Lusaka, Zambia.
Email: gertrudekonkola@gmail.com Tel: +260977717623

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health concern among children under the age of five . Anaemia is a condition characterized by a lower haemoglobin concentration in the blood, leading to insufficient oxygen supply to body tissues; it is defined as haemoglobin below 11 g/dl and further classified as mild if the haemoglobin is between 7 – 11 g/dl and severe if it is below 7 g/dl . The prevalence of anaemia among children globally was estimated at 43% (95%CI 38 – 47%), however, this differs between developing and developed countries and by regions. In high-income countries such as the United States of America and Western Europe, the prevalence was estimated at 11% (95%CI 6 – 20%), in Africa it is higher and observed to be highest in West Africa at 71% (95%CI 67 – 74% whilst in Southern Africa it was estimated at 46% (31 – 62%) . In Zambia, a recent nationally representative survey found that the prevalence of anaemia was 64.8%, however, there were regional differences with anaemia being highest in the northern (80.1%)and western (78.9%) provinces and lowest in the capital Lusaka (48.4%) and western province (51.2%). There were no statistical differences between boys (64.7%) and girls (64.9%) (P-value = 0.920), however, the difference between rural (68.7%) and urban (52.6%) was statistically significant (P-value< 0.001).

Factors contributing to this high prevalence are complex and multifaceted, encompassing a range of biological, environmental, and socio-economic determinants. Anaemia in early childhood will affect growth and development negatively resulting in growth retardation, further, the consequences of anaemia extend beyond immediate health issues, affecting cognitive abilities and school performance in later life. Inadequate dietary intake of essential nutrients, particularly iron, folate, and vitamin B12, plays a pivotal role in the development of anaemia among under-five children. Sub-Saharan Africa faces challenges related to food security and nutritional diversity, contributing to widespread deficiencies that exacerbate the prevalence of anaemia. In Zambia, a recent study found that children whose dietary intakes predominantly consisted of grains such as maize were associated with increased odds of anaemia (aOR = 1.2, 95%CI 1.01 – 1.46) .

Other factors include parasitic infections and infestations, such as malaria and intestinal helminths which are common in Zambia and other sub-Saharan countries . These infections contribute significantly to anaemia by affecting the production and lifespan of red blood cells. Rapid breakdown of red blood cells that exceeds the rate of production due to chronic or repeated malaria infections leads to haemolytic anaemia, this may explain why the northern parts of Zambia where there is more malaria are associated with more anaemia compared to Lusaka and Southern where there is less malaria .

Geographic and climatic factors also play a role in the prevalence of anaemia. Climatic conditions such as regions with higher rainfall and temperatures influence the distribution of vector-borne diseases, such as malaria, further contributing to anaemia. Further, the socio-economic status of families is a critical determinant of a child's susceptibility to anaemia. Poor families may have limited access to nutritious food, healthcare services, and preventive measures, creating a cycle of vulnerability to anaemia. Maternal education and empowerment are also key factors influencing child health outcomes. Educated mothers are more likely to adopt healthier feeding practices, provide adequate nutrition for their children, and seek timely healthcare interventions.

While factors associated with anaemia in under-five children have been studied elsewhere, there is limited data in Zambia, studies such as the Demographic and Health Surveys (DHS) and the Malaria Indicator Surveys (MIS) though nationally representative are descriptive in nature and therefore are limited in guiding interventions other than presenting where the health problem exists. This present study will therefore add to the body of knowledge in Zambia on factors associated with anaemia which in some parts of the country is as high as 80% among children below the age of five years.

Understanding the factors associated with anaemia among under-five children is essential for designing

effective interventions to mitigate its impact and improve the overall health and well-being of children in Sub-Saharan Africa.

METHODOLOGY

Study Design

This study was a secondary analysis of the 2021 Malaria Indicator Survey (MIS). The MIS is a nationally representative survey that is designed to not only be nationally representative but powered to be representative at the provincial level and for the urban and rural strata in Zambia.

Study settings

The study was carried out in Zambia which is a sub-Saharan African country in southern Africa. It is divided into ten provinces which are further subdivided into 116 districts. The country has a tropical climate with dry hot weather for six to eight months and wet hot weather for four to six months. The country experiences transmission of infectious diseases such as Human Immunodeficiency Virus (HIV), Tuberculosis, Malaria, pneumonia and diarrhoeal diseases. The country is also experiencing a wave of Non-Communicable Diseases (NCDs) such as hypertension, diabetes and cancers among others due to rising sedentary lifestyles, unhealthy diets, alcohol and smoking. In children, the most common diseases are infectious diseases such as diarrhoea, respiratory infections, malaria, malnutrition and skin diseases. Due to the endemicity of many childhood illnesses, anaemia is a common condition in children. Because it tends to be chronic with few or no symptoms, anaemia does not get the attention it deserves and over half of the children in Zambia have anaemia which is also not treated. The government carries out routine vaccinations against common childhood diseases such as measles, rubella, tuberculosis and pneumonia. Recently, the government has also introduced the malaria vaccine. Other prevention interventions include the distribution of insecticide-treated nets and indoor residual spraying against malaria. Access to prevention and treatment services is more in urban areas compared to rural areas where health facilities are far spaced in between. The primary study was carried out in households throughout the country in all ten provinces.

Participants

The primary study included the general population in the households, our secondary analysis only included children aged six to fifty-nine months.

Sample size calculation

To be able to detect the estimated prevalence of anaemia of 64.8%reported in the malaria indicator survey of 2021, our study needed to have at least 351 participants based on 95% confidence level, power of 80% and an alpha level of five percent using the formula:

$n = Z^2 p(1-p)/d^2$ where $Z = 1.96$ at 95% confidence level, $p = 0.648$ and $d = 0.05$

Because we used secondary data, we extracted data for all under-five children who were included in the primary study.

Data Collection

We extracted the data with permission from the dataset that is kept at the Ministry of Health's National Malaria Elimination Program (NMEP) which is kept in CSV format. The data was imported into STATA version 14 software where it was analysed. The data that was extracted included the anonymised identity number, province, sex, age, education level of household head, type of residence, wealth quintile, the status of use of insecticide-treated nets and indoor residual spraying, results of malaria rapid diagnostic tests, fever in the last two weeks and haemoglobin level results.

Data Analysis

The data was analysed in STATA 14, continuous data such as age which was collected in months was categorised into years completed and haemoglobin was categorised into anaemia and non-anaemia. Frequencies for all variables were calculated and comparisons among the categories were done using

a test of proportions and a test of multiple comparisons to ascertain differences. Further, the independent variables were cross-tabulated with the outcome variable haemoglobin and a chi-square test of association was performed. Univariate and multivariable logistic regression was conducted to ascertain associations between the independent variables and the outcome variable. Further, we stratified certain variables such as age, education, wealth and provinces to address differential effects among the categories in the multivariable logistic regression.

Ethical Considerations

Respondent's privacy and confidentiality were assured through anonymization of the dataset. Access to the dataset was granted by permission through the Ministry of Health. Assent for the children was obtained from the guardians during the primary study. Ethical clearance for the study was obtained at the University of Zambia Biomedical Ethics Committee (UNZABREC).

Results

A total of 3,731 children aged six to fifty-nine months were included in the study, more children 1936 (52%) were female compared to 1795 (48%) who were male. In terms of age, 433 (11.6%) were infants whilst 88.4% were older children. The majority of the children resided in rural areas 3339 (89.5%) compared to only 10.5% who resided in urban areas and over half 58.1% of the heads of the households interviewed had no or only primary education. In terms of provinces, the highest number of respondents came from Eastern province (19.8%) whilst the lowest came from Muchinga province (6%). In terms of the use of malaria interventions, 47.9% of the children resided in houses that had indoor residual spraying whilst 82.5% had slept in an insecticide-treated net the night before the survey. Malaria was positive in 33.8% of the children surveyed using rapid diagnostic tests. The prevalence of anaemia among the children was 53.8%. Table 1 summarises the basic characteristics and findings among the respondents.

Table 1: Summary of the Characteristics of the Respondents

Variable	Categories	No.	Percentage	P value
Sex	Female	1936	52	**0.021***
	Male	1795	48	
Age (Years)	Below 1 Year	433	11.6	**< 0.001****
	One year	750	20.1	
	Two year	773	20.7	
	Three Years	801	21.5	
	Four Years	974	26.1	
Education Household Head	No or Primary	1803	58.1	**< 0.001****
	Secondary	1161	37.4	
	Tertiary	141	4.5	
Residence Type	Rural	3339	89.5	**< 0.001***
	Urban	392	10.5	

Table 1: Summary of the Characteristics of the Respondents continued

Variable	Categories	No.	Percentage	P value
Province	Central	383	10.3	**< 0.001****
	Copperbelt	387	10.4	
	Eastern	739	19.8	
	Luapula	432	11.6	
	Lusaka	216	5.8	
	Muchinga	223	6	
	Northern	326	8.7	
	North-Western	265	7.1	
	Southern	304	8.2	
	Western	456	12.2	
Wealth Quintiles	1 (Lowest)	719	19.3	**< 0.001****
	2 (Upper Low)	732	19.6	
	3 (Middle)	777	20.8	
	4 (Lower High)	944	25.3	
	5 (Highest)	559	15	
House Indoor Residual Spray	Sprayed	1766	47.9	**0.009***
	Not Sprayed	1945	52.1	
ITN Use	Use ITN	1696	82.5	**< 0.001***
	Not Use ITN	361	17.6	
Malaria (RDT)	Positive	1260	33.8	**< 0.001***
	Negative	2468	66.2	
Fever in Last two weeks	Fever	728	19.5	**< 0.001***
	No Fever	3003	80.5	
Haemoglobin	Anaemic	1932	53.8	**< 0.001***
	Not Anaemic	1657	46.2	

* Test of Proportions

** Multiple Proportions Test (Marascuilo Procedure)

When the frequency of anaemia was stratified by different variables, it was not different in the female and male sexes of the children (P-Value = 0.92). However, by age groups, anaemia was most common among children below the age of one year, as children grow older, the anaemia is seen to be reducing steadily from 58.1% among those below one year to 49.3% among those who are four years old and the difference is statistically significant (P value = 0.001). In terms of the highest educational attainment of the household head, anaemia was more common among the children whose household head had no or only primary education and less among those more educated, however, there were fewer respondents among those with tertiary education, therefore the percentage may not be a true reflection. Further, anaemia was also higher in children from rural areas compared to urban areas,

however, this difference was not statistically significant (P-value = 0.605).

Regionally within the country, anaemia was more common in areas around the northern parts of the country such as Luapula, Northern and Muchinga provinces compared to the southern and western parts of the country and the differences were statistically significant (P-Value = < 0.001). There was a statistically significant difference (P Value = 0.045) in anaemia among the children when stratified by wealth status based on the standard Measure Evaluation classification of wealth such as households owning land and household properties such as televisions and bicycles. Children from lower wealth quintiles were more likely to be anaemic compared to those from wealthier households. Among those who used malaria preventive interventions such as Insecticide Treated Nets (ITNs) and Indoor Residual Spraying (IRS), there were statistically significant differences between the users of malaria preventive interventions. However, for Indoor Residual Spraying, anaemia was seen to be higher among the users instead of the non-users, this will be explored further in the regression analysis and discussion as this data is still confounded at this stage but it is important to note this. Anaemia was also noted to be more common among those who had malaria as detected by serological Rapid Diagnostic Tests (RDTs) and those who had fever in the two weeks preceding the survey. In both instances, anaemia was higher in the children with malaria and fever compared to those who did not have malaria and fever. Whilst this study was not about malaria as an outcome, we cross-tabulated malaria by RDTs against fever as malaria is known to manifest in fever, only about 20% of both the group that had malaria and those that did not have malaria had fever, there was no difference in fever among children with malaria and those without malaria (P-Value = 0.161).

Table 2: Stratification of Anaemia Frequency by other Variables

Variable	Categories	Haemoglobin		P-Value*
		Not Anaemic n(%)	Anaemic n(%)	
Sex	Female	857 (46.2)	996 (53.8)	0.92
	Male	800 (46.1)	936 (53.9)	
Age (Years)	Below 1 Year	172 (41.9)	239 (58.1)	**0.001**
	One year	314 (43.8)	403 (56.2)	
	Two year	325 (42.5)	440 (57.5)	
	Three Years	376 (49.0)	392 (51.0)	
	Four Years	470 (50.7)	458 (49.3)	
Education Household Head	No or Primary	762 (44.5)	952 (55.5)	**0.017**
	Secondary	563 (49.7)	569 (50.3)	
	Tertiary	59 (43.4)	77 (56.6)	
Residence Type	Rural	1474 (46.0)	1729 (54.0)	0.605
	Urban	183 (47.4)	203 (52.6)	

Table 2: Stratification of Anaemia Frequency by other Variables continued

Variable	Categories	Haemoglobin		P-Value*
		Not Anaemic n(%)	Anaemic n(%)	
Province	Central	160 (43.5)	208 (56.5)	**< 0.001**
	Copperbelt	180 (47.1)	202 (52.9)	
	Eastern	311 (42.8)	414(57.2)	
	Luapula	170 (40.3)	252 (59.7)	
	Lusaka	105 (49.8)	106 (50.2)	
	Muchinga	91 (42.2)	122 (57.3)	
	Northern	133 (42.2)	182 (57.8)	
	North-Western	126 (54.1)	107 (45.9)	
	Southern	166 (56.9)	126 (43.1)	
	Western	215 (50.5)	211 (49.5)	
Wealth Quintiles	1 (Lowest)	302 (43.5)	392 (56.5)	**0.045**
	2 (Upper Low)	312 (44.1)	395 (55.9)	
	3 (Middle)	338 (45.5)	405 (54.5)	
	4 (Lower High)	456 (50.4)	449 (49.6)	
	5 (Highest)	249 (46.1)	291 (53.9)	
House Indoor Residual Spray	Sprayed	757 (44.0)	962 (56.0)	**0.014**
	Not Sprayed	900 (48.1)	970 (51.9)	
ITN Use	Use ITN	786 (48.1)	847 (51.9)	**0.04**
	Not Use ITN	146 (42.1)	201 (57.9)	
Malaria (RDT)	Positive	314 (25.8)	902 (74.2)	**< 0.001**
	Negative	1341 (56.6)	1030 (43.4)	
Fever in last two weeks	Fever	294 (42.1)	405 (57.9)	**0.015**
	No Fever	1363 (47.2)	1527 (52.8)	

Variable	Categories	No Fever n(%)	Fever n(%)	P-Value*
Malaria (RDT)	Positive	1030 (82.8)	230 (18.2)	0.161
	Negative	498 (20.2)	1970 (79.8)	

* Chi Square Test of Association

This study's findings suggest that the sex of a child is not associated with anaemia before and after adjusting for other confounders aOR 1.2 (95%CI 0.98 – 1.48) such as age, socio-economic variables, use of preventive interventions for malaria and malaria testing and whether a child had a fever or not. On the other hand, children below the age of one year were at increased odds of anaemia aOR 1.44 (95%CI 1.02 – 2.04) compared to children who were aged four years. Other age groups of one, two and three years were not statistically associated with anaemia compared to those aged four years. The educational status of the head of the household was associated with anaemia, those whose household heads had no or only primary education had 36% more odds of anaemia aOR 1.36 (95%CI 1.08 –

1.70) compared to those whose household heads had secondary education, however, there were no statistically significant differences between those with secondary and tertiary education probably because those with secondary education were able to meet the basic requirements for nutrition, health services and disease prevention interventions.

Staying in rural areas was not associated with anaemia compared to staying in rural areas. Using Southern province which has the least malaria cases as a reference, even after adjusting for malaria, most of the provinces in the northern and western parts of the country had increased odds of anaemia, the only provinces that were not statistically significant were Eastern, Muchinga and North-western provinces. Owning land and properties(wealth) and staying in a house that was sprayed with residual chemicals for malaria prevention were not associated with anaemia whilst sleeping in an insecticide-treated net aOR 0.71 (95%CI 0.53 – 0.94) is associated with a reduction in the odds of anaemia, having malaria test positive aOR 3.65 (95%CI 2.88 – 4.64) and having had fever in the recent past aOR 1.39 (955CI 1.07 – 1.81) were associated with increased odds of anaemia. Table 3 summarises the factors associated with anaemia among under-five children.

Table 3: Factors Associated with Anaemia among Under-five Children

Variable	Category	Unadjusted OR	95%CI	Adjusted OR	95%CI
Sex	Female	Ref		Ref	
	Male	1.01	0.88 - 1.15	1.2	0.98 - 1.48
Age-group	Below 1 year	1.42	1.13 - 1.80	**1.44**	**1.02 - 2.04***
	1 Year	1.32	1.08 - 1.60	1.1	0.81 - 1.50
	2 Years	1.39	1.15 - 1.68	1.16	0.85 - 1.59
	3 Years	1.06	0.88 - 1.30	1.14	0.82 - 1.60
	4 Years	Ref		Ref	
Education	No & Primary	1.24	1.06 - 1.44	**1.36**	**1.08 - 1.70***
	Secondary	Ref		Ref	
	Tertiary	1.29	0.90 - 1.85	1.4	0.60 - 2.15
Residence	Rural	0.86	0.86 - 1.31	0.93	0.61 - 1.43
	Urban	Ref		Ref	
Province	Central	1.71	1.26 - 2.33	**2.28**	**1.32 - 3.96***
	Copperbelt	1.48	1.09 - 2.01	**2.29**	**1.25 - 4.20***
	Eastern	1.76	1.34 - 2.32	1.6	0.94 - 2.75
	Luapula	1.95	1.44 - 2.64	**2.11**	**1.21 - 3.68***
	Lusaka	1.33	0.93 - 1.89	**2.4**	**1.20 - 4.79***
	Muchinga	1.77	1.24 - 2.52	1.12	0.61 - 2.08
	Northern	1.8	1.31 - 2.48	**2.46**	**1.38 - 4.39***
	North-Western	1.12	0.79 - 1.58	1.84	0.99 - 3.41
	Southern	Ref		Ref	
	Western	1.29	0.95 - 1.74	**1.74**	**1.02 - 2.96***

Table 3: Factors Associated with Anaemia among Under-five Children continued

Variable	Category	Unadjusted OR	95%CI	Adjusted OR	95%CI
Wealth Quintile	Low	Ref		Ref	
	Upper Low	0.98	0.79 - 1.20	1.36	0.98 - 1.88
	Middle	0.92	0.75 - 1.14	0.99	0.71 - 1.39
	Low High	0.76	0.62 - 0.93	0.78	0.56 - 1.08
	Highest	0.9	0.72 - 1.13	1.33	0.83 - 2.11
IRS	Not Sprayed	Ref		Ref	
	Sprayed	0.94	0.74 - 0.97	0.94	0.75 - 1.17
ITN Use	Not Slept ITN	Ref		Ref	
	Slept ITN	0.78	0.62 - 0.98	**0.71**	**0.53 - 0.94***
Malaria (RDT)	Negative	Ref		Ref	
	Positive	3.74	3.21 - 4.35	**3.65**	**2.88 - 4.64***
Fever	No Fever	Ref		Ref	
	Fever	1.23	1.04 - 1.45	**1.39**	**1.07 - 1.81***

*Statistically Significant Odds Ratios and Confidence Intervals

DISCUSSION

This study set out to find the prevalence of anaemia and its associated factors in Zambia; it found that anaemia was present in 53.8% of the children in Zambia. This estimate was found to be higher than the reported average of 46% in Southern Africa and also higher than the global average of 43% . Many factors can lead to this higher-than-average prevalence of anaemia in Zambia, however, this study did not set out to find causes of the anaemia but associated factors due to the nature of cross-social studies.

Some provinces had a higher prevalence of anaemia compared to others, those with the highest prevalence included regions in the northern parts of the country such as Luapula, Muchinga, Northern, Eastern, Central and North-western provinces and it was lowest in Southern and Lusaka provinces. This finding is in line with a previous study in Zambia which also found that northern parts of the country such as Luapula and Northern Provinces were associated with higher odds of anaemia among children below the age of five years . It is known that the northern parts of Zambia have a higher prevalence of malaria compared to the southern parts of the country, in this study we adjusted for malaria, so other factors were also at play in predisposing to anaemia apart from the higher prevalence of malaria. Whilst we call for more causality studies to fully understand the aetiology of anaemia in Zambia, some factors can be elucidated from existing literature. Regular consumption of milk and milk products which are rich in iron, folate and vitamin B12 is associated with less nutritional deficiency anaemia, people in the southern parts of Zambia are known to keep more cattle and consume milk compared to the northern parts of Zambia . On the other hand, Luapula and Northern provinces have large water bodies such as Lake Bangweulu, Mweru and Tanganyika, however, due to reduced fish stocks due to over-fishing and fish-bans for

three months, the available fish protein for children is limited .

In terms of age, our study found that children aged below one year were more at risk of anaemia compared to older children. Another study in Zambia also found that older children were less likely to have anaemia compared to younger children below 18 months . The Malaria Indicator Surveys usually test haemoglobin in children who are older than six months and most children are weaned at six months accompanied by cessation of breast milk . Weaning not only deprives children of the protein and minerals in milk but also predisposes children to infections such as diarrhoeal diseases leading to malabsorption and further compromising haemoglobin levels . Older children on the other hand are more assertive in foraging for food such as wild fruits, eating from neighbours and taking in larger quantities of food compared to infants who have to be fed by adults . There were no differences in anaemia between boys and girls and between urban and rural residents, however, the educational levels of the heads of the households were associated with the presence of anaemia among the children, those whose household heads had no or only primary education had significantly higher odds of anaemia than those whose household heads had secondary or tertiary education. This may be related to the ability to provide more nutritious foods and different varieties of food by those who were more educated compared to those who are less educated. Further, the more educated may have better access to health services including treating illnesses and access to prevention interventions for childhood illnesses such as vaccinations .

Those who use malaria prevention interventions such as sleeping under an insecticide-treated net (ITN) were significantly associated with reduced odds of anaemia. There were also reduced odds of anaemia among children whose households were sprayed with residual chemicals against mosquito vectors although the effect was not statistically significant probably because the study may not have been adequately powered to detect the effect measure. Similarly, children who tested positive for malaria were also found to have increased odds of anaemia. Malaria is known to cause the breakdown of red blood cells leading to anaemia . Other studies have also found an association between malaria and increased risk of anaemia and also the use of preventive measures such as IRS and ITNs, and the reduced odds of anaemia . Other than malaria, this study also found increased odds of anaemia among children with febrile illnesses. Febrile illnesses can directly cause haemolysis, other pathways include loss of appetite leading to malnutrition and other febrile illnesses are associated with malabsorption such as diarrheal diseases .

CONCLUSION

Anaemia in Zambia has been found to be higher than the average in Southern Africa and sub-Saharan Africa. It is associated with younger age group, poor education and where diseases like malaria and other febrile illnesses are more common than where they are not. The use of interventions like insecticide-treated nets is associated with reduced prevalence of anaemia.

Recommendations

We recommend further studies to characterise the anaemia among under-five children in terms of the common aetiologies such as the proportions of iron, folate and vitamin B12 deficiency anaemia. We further recommend consideration for routine supplementation of under-five children with haematinics, especially between six to twelve months.

Limitations

The study used a cross-sectional design, therefore it is limited to associations and does not elicit causal inferences. Further, whilst this study adjusted for confounding factors that may independently be associated with anaemia, adjusting for confounders in regression cannot remove all confounding as not

all confounders were included in the primary study such as nutritional status of the children, dietary diversity and diarrheal diseases among others. Therefore, more studies on the aetiology and characterisation of anaemia can further address these gaps in our research.

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Competing interests

The authors declare no competing interests

Author's Contributions

GK came up with the concept and discussed it with CS and NM. GK developed the protocol and manuscript, and CS and NM contributed significantly to the protocol and manuscript. All authors reviewed and approved the manuscript for publication.

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