The association between food groups and childhood anemia in Zambia, based on the analysis of Zambia Demographic and Health Survey 2018

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Abstract

High prevalence of anemia among children has been an important public health concern globally. In Zambia, the prevalence of anemia among children aged 6-59 months was 58%. Previous studies have suggested that feeding a variety of food prevents anemia. However, it is not yet determined if out of several food groups available locally, some foods have played crucial roles in anemia among young children. The objective of this study was to find out the food groups that were associated with childhood anemia among Zambian children aged 6-59 months. We have obtained the individual-level data related to health and nutrition of the Zambia Demographic Health Survey (ZDHS) 2018 with permission. Children's feeding, demographic, and household information were analyzed using logistic regression models. Children who consumed food made from grains (AOR:1.2; 95%CI: 1.01-1.46; p=0.044) and cheese or food made from milk (AOR:2.7; 95%CI: 1.19-6.00; p=0.018) showed relatively higher prevalence of anemia than those who did not. Additionally, malnutrition, mother's anemia and education, and area of living were also significantly associated with prevalence of anemia. Most common food in Zambia is food made from grain. Grain consists of phytic acids which can prevent iron absorption. This is a potential reason for the high-level anemia among children. Dephytinization strategies should be considered through further studies.

Introduction

Anemia among children has been an important public health concern, especially in developing countries. In 2019, anemia prevalence was 39.8% in children aged 6-59 months. This equates to 269 million children with anemia globally with the highest percentages in the African Region, followed by South East Asian Region.[1] Over the last two decades the WHO has recognized anemia prevalence among children to have gradually decreased from 48% in 2000 to 41.8% in 2010. The trend remained almost stagnant in the next decade.[2]

Anemia, low level of the hemoglobin in the blood, is caused by various factors that may be interlinked or complex. Iron deficiency is a common cause of anemia and is estimated to be responsible for half of all anemia cases in women and children globally.[3] Deficiencies of other nutrients such as cobalamin and folic acid also cause anemia. Haemoglobinopathies and infectious diseases, and some genetic features such as thalassemia, sickle cell and G6PD deficiency also cause anemia. Anemia may result in serious concern for children that can impair their cognitive development.[4]

According to the Zambia Demographic Health Survey (ZDHS) 2018, the prevalence of anemia among children age 6-59 months was 58% with no urban-rural difference.[5] A study reported that anemia was strongly linked to malaria and inflammation.[6]

Infant and young child feeding (IYCF) practices are not only very important for the appropriate growth and development but also beneficial for the minimizing health risks such as anaemia.[5] IYCF has three factors; minimum dietary diversity, minimum meal frequency, and minimum acceptable diet. The WHO Minimum Acceptable Diet recommendation is a combination of Minimum Dietary Diversity and Minimum Meal Frequency. These recommendations and appropriate milk feeds together constitute a child's Minimum Acceptable Diet.[7] According to the findings of ZDHS, the proportion of children age 6-23 months who receive acceptable diet was 12.5% and it was higher among breastfed children (15.6%) than among non-breastfed children (3.8%). Moreover, urban areas had more children who were fed minimum acceptable diet than rural areas, and there were remarkable differences (18.4-9.3%) by province as well.[5]

Previous studies revealed that infants need to consume a variety of foods to prevent anemia. A study in China concluded that consumption of the diverse and multi-nutrient-powder diets reduced the risk of anemia.[8] For the low-income households, regular consumptions of a variety of foods may not be possible. However, some food groups may be regularly available and affordable to the local low-income households. Therefore, the objective of this study was to find out the food groups that were associated with childhood anemia among Zambian children aged 6-59 months.

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Materials and Methods

Data source and sampling

We obtained the data from the Zambia Demographic Health Survey 2018 (ZDHS-2018) with permission from the Demographic and Health Surveys (DHS) Program. The ZDHS-2018 followed a stratified two-stage sample design. In the first stage, 545 clusters were selected. From each of the cluster, a fixed number of 25

households was selected in the second stage. In total, 13,625 households were finally selected ensuring national representativeness at provincial, urban, and rural level. All women of age 15-49 and men of age 15-59 who stayed in the selected household were eligible to be interviewed.[5]

In this study, we created children's dataset from ZDHS-2018 merged from 3 separate datasets, children's dataset, women's dataset and household dataset. The data of children that had missing information on either food groups or anemia was excluded. Final sample size after eliminating missing values was 4,158 that was analyzed for this study.

Measures

Primary outcome of this study was the anemia among children aged 6-59 months. The test for anemia was conducted to all children aged 6-59 and women aged 15-49 who consented. Hemoglobin level was measured on-site using a battery-operated portable HemoCue 201+ analyser. Children whose hemoglobin concentration was less than 110 g/L were classified as anemia. The physiological neonatal anemia was not included in this study because the anemia test was conducted only to children aged 6-59 months.

The anemia risk factors consisted of food groups, vitamin supplementation, and deworming and thus we used those variables. Socio-demographic characteristics such as age, sex, occupation, economic status, area of residence, malnutrition, educational level of mother, and other social factors were also included. In addition, health problems of children and mothers were included. However, due to the reasons that all respondents gave the same answer (tobacco use of mother and owning livestock) or all answers were missing (malaria), we could not use some potentially important variables for the analysis.

Inappropriate and incomplete data were eliminated from the study. General characteristics of the final screened characteristics of both child and mother are presented in the table below using percentage, proportion, and mean and standard deviation. To assess the association between child anemia and other variables, multivariate logistic regression was applied. As there was a large list of variables, we included only the variables in the multivariate logistic regression model that meet the *p*-value less than 0.1 in bivariate logistic regressions with child anemia using forward stepwise selection method. Variables with the *p*-value less than 0.05 were considered statistically significant in the multivariate logistic regression analysis. Statistical analysis was performed using Jamovi version 2.0.0.0. statistical software.[9,10]

Ethical considerations

Permission to use the de-identified data for secondary analysis was obtained from the DHS Program.

Results

General characteristics

Table 1 shows the general demographic and mother's characteristics. Mother's and household characteristics revealing that

Table 1. General demographic and mother's characteristics.

Characteristics	No.	%
Province		
Central	392	9.4
Copperbelt	332	8.0
Eastern	535	12.9
Luapula	539	13.0
Lusaka	391	9.4
Muchinga	365	8.8
North Western	336	8.1
Northern	485	11.7
Southern	427	10.3
Western	356	8.6
Residence		
Rural	3057	73.5
Urban	1101	26.5
Age of mother at birth (year)		
<20	902	21.7
20-34	2761	66.4
>=35	495	11.9
Anemia		
No	3035	73.4
Yes	1101	26.6
Education		
No education	469	11.3
Primary education	2274	54.7
Secondary education and Higher	1415	34.0
Marital status		
Married	3410	82.0
Living with partner	14	0.3
Divorced/Separated/Widowed	364	8.8
Never in union	370	8.9
Occupation		
Currently working	1916	46.1
On leave	78	1.9
In the past	350	8.4
Not working	1814	43.6
Household Wealth		
Poor	2416	58.1
Middle	784	18.9
Rich	958	23.0
Owning livestock		
No	0	0.0
Yes	4158	100.0
Owning agricultural land		
No	1499	36.1
Yes	2659	63.9
Accessing Health Service		
No	1766	42.5
Yes	2392	57.5
Source of drinking water		
No	1092	26.3
Yes	3064	73.7
Breastfeeding		
Never breastfed	61	1.5
Still breastfed	1852	44.5
Ever breastfed, not currently breastfeeding	2245	54.0

around 66% of mothers at the time of childbirth, belonged to 20-34 age group. Among all mothers, around 11% were uneducated and 43.6% were unemployed. Prevalence of anemia among mothers was 26.6% and 1.5% of the mothers had never breastfed the child. Moreover, 57.5% of mothers had no access to health services.

Table 2 shows the general characteristics of the children. Among the study of children, around 50% were female. Similarly, 40.5% children were below 18 months. Out of 4158 children assessed in this study, the prevalence of anemia, stunting, wasting and low birthweight were 65.9%, 36.6%, 13.1% and 8.7%, respectively. Vitamin A supplementation coverage was 70%, while only 10.5% of the children had taken iron pills and slightly over half (55.6%) of the children took deworming tablets. 73% of household had improved drinking water source.

Table 3 shows the food groups fed to the child on the previous day of the survey. The variety of food consumption was low among Zambian children: The mean value of food variety was 4.53. Besides plain water, the most consumed food group was food made from grains (70.9%) followed by any dark green leafy vegetable (51.1%), other solid, semi-solid or soft food (34.1%), and clear broth (28.6%).

Table 4 shows the result of multivariate logistic regression analysis that presents the factors associated with anemia of children. This study could not find any statistical association between food groups and anemia in children. However, the children who took the foods made from grains (AOR:1.2; 95%CI: 1.01-1.46; p=0.044) and cheese or the foods made from milk (AOR:2.7; 95%CI: 1.19-6.00; p=0.018) had higher prevalence of anemia than those who didn't take those. Similarly, the children who were stunting and wasting showed higher prevalence of anemia than those who were not stunting and wasting (AOR:1.3; 95%CI: 1.09-1.51; p=0.002 and AOR:1.3; 95%CI: 1.05-1.73; p=0.019, respectively)

Discussions

In this study, we found the significant associations of anemia with the consumption of two food groups (grains and milk products), stunting, wasting, and born from an anemic mother.

Consumption of foods made from grains as a staple food in Zambia is common and maize is mostly used.[11] This study showed that around 71% of children consumed food made from grain. Studies have reported that phytic acid present in the cereal or grain inhibits bioavailability of certain minerals including iron. Phytic acid bounds with metal ions such as iron, calcium, and zinc resulting in insoluble complexes in gastrointestinal tract unavailable for absorption into circulation.[12,13] Studies reported that complimentary food that include mainly maize is introduced in very young children *i.e.,* between 4-6 months.[14] The nutritional component of maize is mainly made by starch which is generally up to 80% of the dry weight and protein 10-15% of dry weight.[15] Maize is reach in phosphorus (60-80%) in the form of phytic acid.[16] The nature of phytic acid that inhibits iron absorption in the gut may be resulting in anemia among children in Zambia. People in Zambia take almost half of energy (48.2%) from maize.[11] So, the methods to reduce the phytate in the food made from grain will be necessary in Zambia to prevent from anemia. Some measures such as soaking, germination, fermentation, and pounding are the process for dephytinization at the household level and it can remove only about 50% of the phytate in plant-based foods. As the manufactured products, dephytinization of grains can be achieved completely by using either exogenous or intrinsic phytases. Dephytinization for the commercial products could significantly enhance the absorption of iron and zinc.[17] A better approach to use the maize or food made from grain is dephytinization strategies such as soaking, fermentation, or pounding to prevent iron absorption inhibition activities in the gut minimizing risk of anemia. Although cheese or milk products were eaten at the lowest frequency (1%) among the foods fed to children in Zambia,

Table 2. General characteristics of children.

Characteristics	No.	%
Age (months)		
<18	1685	40.5
18-35	1148	27.6
36-59	1325	31.9
Sex		
Male	2090	50.3
Female	2068	49.7
Anemia		
No	1418	34.1
Yes	2740	65.9
Stunting		
No	2611	63.4
Yes	1507	36.6
Current weight status		
Underweight	154	3.7
Overweight	189	4.6
Normal	3778	91.7
Wasting		
No	3610	86.9
Yes	545	13.1
Diarrhea (in last 2 weeks)		
No	3200	79.2
Yes	840	20.8
Fever (in last 2 weeks)		
No	3293	81.5
Yes	746	18.5
Weight of baby at birth		
<2500	278	8.7
>=2500	2915	91.3
Vitamin A		
No	1211	30.0
Yes	2820	70.0
Iron pills		
No	3607	89.5
Yes	425	10.5
Deworming		
No	1790	44.4
Yes	2246	55.6
Salt iodine		
No	1179	32.3
Yes	2469	67.7

our study showed that the consumption of cheese or food made from milk were associated with anemia among children. So far, several studies have found that cow's milk cause iron deficiency anemia as the cow's milk inhibits the iron absorption.[18,19] However, to the best of our knowledge, the association between anemia and the consumption of milk products has not yet been reported. We suggest two considerable reasons behind the 2.7 times higher risk of anemia among the children who consumed cheese or food made from milk than those who didn't take those. Firstly, caseinophosphopeptides (CPP) that are found in the milk reduces the absorption of iron. Previous research has reported that α_s-CPP, β-CPP, and α_s-CPP reduces the iron absorption.[20] Secondly, calcium which is one of the main minerals in milk products had the inhibitory effect on iron absorption when consumed along with milk products. That is why the foods which have the source of the dietary iron is not recommended to be consumed with milk products for children.[21]

Besides the food groups, other factors such as malnutrition, mother's anemia and education, and area of living were significantly associated with anemia. Similar results were already reported in many studies that malnutrition, mother's anemia and mother's education were associated with anemia among children.[22] The provinces of Zambia, which had significantly more anemia prevalence among children than that of Lusaka were children living in Copperbelt, Luapula, North Western, Northern and Western provinces. This finding matched with the previous study that, due to the geographical differences such as Luapula, Northern and North Western being mountainous, the children living there showed more underweight than Western province, where more children were underweight than Lusaka.[23]

This study was based on secondary data analysis of ZDHS-2018. Child feeding information was asked for the previous 24 hours only and therefore, that might not reflect the participants' daily diet. Moreover, the frequencies of consumptions of some food groups such as cheese or milk products were very low. We cannot speculate any specific reason but only 1% of children who took cheese or milk products might be in a very special subgroup among Zambia children. In such condition this food group may not show true association with anemia of children.

Conclusions

Our study revealed that food made from

Table 3. Foods that were fed to the children in the last 24 hours.

Characteristics	No.	%
Plain water		
No	592	14.2
Yes	3566	85.8
Juice or juice drinks		
No	3599	86.6
Yes	559	13.4
Milk such as tinned, powdered, or fresh animal milk		
No	3979	95.7
Yes	179	4.3
Infant formula		
No	4108	98.8
Yes	50	1.2
Any provita, delight, cerelac, soya porridge		
No	3627	87.2
Yes	531	12.8
Clear broth		
No	2967	71.4
Yes	1191	28.6
Any other liquid		
No	3506	84.3
Yes	652	15.7
Foods made from grains		
No	1210	29.1
Yes	2948	70.9
Foods made from roots		
No	3748	90.1
Yes	410	9.9
Eggs		
No	3486	83.8
Yes	672	16.2
Any meats		
No	3577	86.0
Yes	581	14.0
Pumpkin, carrots, squash or sweet potatoes (Vitamin A)		
No	3841	92.4
Yes	317	7.6
Any dark green, leafy vegetables		
No	2034	48.9
Yes	2124	51.1
Ripe mangoes, paw, apricot, watermelon		
No	3661	88.0
Yes	497	12.0
Other Fruits or Vegetables		
No	3206	77.1
Yes	952	22.9
Organ meats		
No	4009	96.4
Yes	149	3.6
Fresh or dried fish or shellfish		
No	3211	77.2
Yes	947	22.8
Foods made from beans, peas, lentils or nuts		
No	3359	80.8
Yes	799	19.2
Cheese or food made from milk		
No	4115	99.0
Yes	43	1.0
Other solid, semi-solid or soft food		
No	2739	65.9
Yes	1419	34.1
Caterpillars, other insects or other small protein foods		
No	4042	97.2
Yes	116	2.8
Yogurt		
No	4021	96.7
Yes	137	3.3
Number of food variety	4.53	2.7

Table 4. Associated factors of anemia of children.

Predictor	Odds ratio	95%CI		p-value
		Lower	Upper	
Age (month)				
<18	1.0			
18-35	0.7	0.55	0.87	0.002
36-59	0.3	0.26	0.45	<0.001
Residence (Province)				
Lusaka	1.0			
Central	1.0	0.72	1.30	0.900
Copperbelt	1.5	1.10	2.13	0.012
Eastern	1.2	0.89	1.60	0.247
Luapula	2.2	1.58	3.03	<0.001
Muchinga	1.0	0.75	1.44	0.808
North Western	1.7	1.23	2.43	0.002
Northern	1.4	1.03	1.94	0.033
Southern	1.2	0.89	1.63	0.241
Western	1.5	1.06	2.10	0.023
Stunting				
No	1.0			
Yes	1.3	1.09	1.51	0.002
Wasting				
No	1.0			
Yes	1.3	1.05	1.73	0.019
Underweight/Overweight				
Normal	1.0			
Underweight	1.1	0.75	1.68	0.579
Overweight	1.0	0.70	1.39	0.950
Mother's anemia				
No	1.0			
Yes	1.7	1.41	1.95	<0.001
Mother's education				
No education	1.0			
Primary education	0.7	0.52	0.84	<0.001
Secondary education and higher	0.7	0.54	0.90	0.006
Plain water				
No	1.0			
Yes	1.1	0.87	1.42	0.389
Clear broth				
No	1.0			
Yes	1.1	0.90	1.30	0.389
Foods made from grains				
No	1.0			
Yes	1.2	1.01	1.46	0.044
Fresh or dried fish or shellfish				
No	1.0			
Yes	1.0	0.79	1.15	0.608
Cheese or food made from milk				
No	1.0			
Yes	2.7	1.19	6.00	0.018

Note: This model is adjusted for breastfeeding, childhood diarrhea, Fever, Mother's marital status, no of food varieties given to children and deworming pills provided to children.

grains and cheese or food made from milk were significantly associated with the anemia among children in Zambia. It may not be wise to recommend avoiding maize, which is one of the grains that is widely fed to children as a staple food and is major source of energy in Zambia.

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