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

Emi Kobayashi,1 Bharat Negi,2 Minato Nakazawa2
1Department of International Health, Graduate School of Health Science, Kobe University; 2Division of Global Health, Department of Public Health, Graduate School of Health Sciences, Kobe University, Japan

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: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 concerns 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 anemia.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.

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.3

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

| 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                                                                   | 2761  | 66.4 |
| 20-34                                                                 | 902   | 21.7 |
| >=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  | 43.8 |
| 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 child-
birth, 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. This study showed that around 71% of children consumed food made from grain. Studies have reported that phytic acid present in the cere-

---

**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.\textsuperscript{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 $\alpha_s$-CPP, $\beta$-CPP, and $\alpha_2$-CPP reduces the iron absorption.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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              | 3596| 85.8|
| Yes             | 592 | 14.2|
| 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              | 3496| 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 Lower | 95% CI Upper | p-value |
|----------------------------------|------------|--------------|--------------|---------|
| 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         | 0.035   |
| 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.

References
1. WHO. Anaemia in women and children.
   WHO; 2021 Available from: https://www.who.int/data/gho/data/themes/topics/anaemia_in_women_and_children.
2. WHO. Global Health Observatory data repository. 2000-2020. Internet: WHO; 2021.
3. Kassem J, Jasrasaria R, Naghavi M, et al. A systematic analysis of global anemia burden from 1990 to 2010. Blood 2014;123:615-24.
4. Balarajan Y, Ramakrishnan U, Ozaltun E, et al. Anaemia in low-income and middle-income countries. Lancet 2011;378:2123-35.
5. Zambia Demographic and Health Survey 2018. Ministry of Health GoZ; 2019.
6. Barfou A, Schulze K, Kalungwana N, et al. Relative Contributions of Malaria, Inflammation, and Deficiencies of Iron and Vitamin A to the Burden of Anemia during Low and High Malaria Seasons in Rural Zambian
1. World Health Organization and the United Nations Children’s Fund. Indicators for assessing infant and young child feeding practices: definitions and measurement methods. Geneva: World Health Organization and the United Nations Children’s Fund; 2021.

2. Zou SH, Liu Y, Zheng AB, et al. Associations between dietary patterns and anaemia in 6- to 23-month-old infants in central South China. BMC Public Health 2021;21:699.

3. Jamovi. [Computer Software] Version 2.2.: The jamovi project 2021.

4. R: A Language and environment for statistical computing. (Version 4.0). R Core Team; 2021.

5. FAO. Food Balance (2010). In: FAO, editor. FAOSTAT. Internet 2022.

6. Iqbal TH, Lewis KO, Cooper BT. Phytase activity in the human and rat small intestine. Gut 1994;35:1233-6.

7. Hurrell RF, Reddy MB, Juillerat MA, et al. Degradation of phytic acid in cereal porridges improves iron absorption by human subjects. Am J Clin Nutr 2003;77:1213-9.

8. Faber M, van Jaarsveld PJ, Kunneke E, et al. Vitamin A and anthropometric status of South African preschool children from four areas with known distinct eating patterns. Nutrition 2015;31:64-71.

9. Galani YJH, Orfila C, Gong YY. A review of micronutrient deficiencies and analysis of maize contribution to nutrient requirements of women and children in Eastern and Southern Africa. Crit Rev Food Sci Nutr 2020;1-24.

10. Cowieson AJ, Ruckebusch JP, Sorbara JOB, et al. A systematic view on the effect of microbial phytase on ileal amino acid digestibility in pigs. Anim Feed Sci Tech 2017;231:138-49.

11. Gibson RS, Bailey KB, Gibbs M, et al. A review of phytate, iron, zinc, and calcium concentrations in plant-based complementary foods used in low-income countries and implications for bioavailability. Food Nutr Bull 2010;31:S134-46.

12. Levy-Costa RB, Monteiro CA. Cow’s milk consumption and childhood anaemia in the city of Sao Paulo, southern Brazil. Rev Saude Publica 2004;38:797-803.

13. Bramhagen AC, Axelsson I. Iron status of children in southern Sweden: effects of cow’s milk and follow-on formula. Acta Paediatr 1999;88:1333-7.

14. Kibangou IB, Bouhallab S, Henry G, et al. Milk proteins and iron absorption: contrasting effects of different caseinophosphopeptides. Pediatr Res 2005;58:731-4.

15. Hallberg L, Rossander-Hulthen L, Brune M, et al. Inhibition of haem-iron absorption in man by calcium. Br J Nutr 1993;69:533-40.

16. Prieto-Patron A, Van der Horst K, Hutton ZV, et al. Association between Anaemia in Children 6 to 23 Months Old and Child, Mother, Household and Feeding Indicators. Nutrients. 2018;10.

17. Seleistine H, Nzelai SS, Olusegun Babaniyi, Peter Songolo, Adamson S, Muula and Emmanuel Rudatsikira. Demographic, cultural and environmental factors associated with frequency and severity of malnutrition among Zambian children less than five years of age. J Public Health Epidemiol 2011;3:362-70.