

## ANEMIA IN PRESCHOOL CHILDREN AND ITS ASSOCIATION WITH NUTRITIONAL STATUS AND OTHER FACTORS IN DUHOK PROVINCE, IRAQ

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### ABSTRACT

Anemia is a very important nutritional issue all over the world. It is most commonly present in preschool children with a prevalence of 47.4%. Factors like low socio-economic status, large family size, ignorance and illiteracy are associated with anemia among children less than five years. Aim: To estimate the prevalence of anemia and identify the factors associated with it in children aged 2–5 years.

**Patients and Methods:** A cross sectional study included 798 pre-school children (2–5 years of age) selected from those children who visited health care centres and Heevi Pediatric Teaching Hospital. Dietary, biochemical and anthropometrical, and information were collected through a questionnaire. Children with hemoglobin (Hb) values of <11.0 g/dl were considered anemic. Heights, weights and Body Mass Index [BMI] were measured. Children with [BMI] above 85<sup>th</sup> centile was considered as overweight and above 95<sup>th</sup> centile as obese. Data such as past breastfeeding practices, birth weights, time of starting weaning food, duration of breastfeeding, type of weaning food, time of starting infant formula, child's chronic illness, child's eating habits, mother's age, occupation and education were collected.

**Results:** The overall incidence of anemia is 29.8% (238/798). The male: female ratio 1.03:1 in the anemic children. The body weight of the anemic patients was most commonly between 5<sup>th</sup> and 85<sup>th</sup> centiles, 155 (65.12%). The most frequent birth weight of the anemic patients was between 2.5 and 4 Kg, 191 (80.25%). Most of anemic patients had history of breast feeding for equal to or more than six months, 113 (47.47%). The weaning foods of most of the anemic patients were cereals, vegetables and fruit 146 (61.34%). About 139 (58.4%) of patients were eating regularly and 156 (65.54%) with the family. Chronic illnesses were present in 63 (26.47%) among anemic patients. About 135 (56.72%) of anemic patients had less than three siblings. The age of the mothers was less than 30 years in 112 (47.05%). Illiterate mothers were 63 (26.47%) among anemic patients and only 18 (7.56%) were employed mothers. The significant association was with the age ( $p < 0.038$ ), the frequency of eating with family ( $p < 0.01$ ) and chronic illnesses ( $p < 0.001$ ). There was a strongly significant correlation between hemoglobin concentration and age group, weight and height. Female was 1.009 times more likely to be anemic.

**Conclusion:** The overall incidence of anemia is 29.8%. The gender, the age of starting weaning foods, the type of weaning foods and the presence of chronic illnesses are significant factors associated with the risk of anemia in the children in Duhok.

**KEY WORDS:** Anemia, Hemoglobin, Chronic, Breast Feeding, Preschool

### INTRODUCTION

Anemia is a very important nutritional issue all over the world that involves around 1.62 billion persons all over the world. It is most commonly present in preschool children with a prevalence of 47.4%<sup>1</sup>.

In the developing countries with low-and middle-income, its prevalence among 6–59-month age children were >20% based on latest

demographic and health survey (DHS) report rounds that classified it as a severe public health problem<sup>2,3</sup>. Factors like low socio-economic status, large family size, illiteracy and ignorance are associated with the presence of anemia in children aged under five years. Intestinal helminths and hook worm infestations can lead to gastro-intestinal blood loss and depleting iron stores with resultant impaired erythropoietin<sup>2</sup>. Consequently, the malabsorption and appetite

inhibition worsen micronutrient deficiency and anemia<sup>4</sup>.

The bad health effects of anemia in under five age children are mainly poor mental performance, impaired tolerance to infection and even death due to anemic heart failure<sup>2,4</sup>.

Multifactorial etiology of anemia has been found since numerous studies concluded that more than 50% of the burden of anemia is due to iron deficiency anemia globally<sup>5</sup>. The key causative factor of anemia in children is the nutritional factors but the contribution of these factors to the risk of anemia is not well known and may vary with the infection level and the diet quality. It has been found that around 37% of cases of anemia among West African preschool children could be cured by only correcting the nutrition factors related<sup>6</sup>.

Several factors predispose to anemia and 43% of anemia cases in childhood are due to iron deficiency<sup>7</sup>. The deficiency may result from poor dietary intake, malabsorption, chronic blood loss, and increased demand for iron during rapid growth. Other causes of anemia include vitamin B12, folate and Vitamin A deficiencies, intestinal helminths, Malaria, chronic disease, viral infections, hemolysis, hemoglobinopathies, and bone marrow disorders<sup>7-9</sup>. Various studies also revealed that factors such as sex, age, early initiation of complementary food, residence, maternal health status, under-nutrition, poor socioeconomic status and maternal education are associated significantly with anemia<sup>10,11</sup>. In children, major health issues, such as behavioural problems, poor motor and cognitive development can result from iron deficiency<sup>1,7</sup>.

Prevalence of anemia is affected by socioeconomic factors such as household wealth status, education, wealth index of communities, occupation<sup>12-14</sup>, sex, age, maternal age<sup>15,16</sup>, maternal anemia<sup>15,17</sup>, malnutrition (especially stunting)<sup>16</sup>, recent diarrhea, insufficient meals per day, worm infestations and fever<sup>15,17,19</sup>.

The anemia prevalence in children of preschool-age in middle east remains relatively high<sup>1</sup>. Identifying children at risk for iron deficiency anemia is vital. It is necessary to specify the factors related between mothers and children for the sake of developing successful programs of education and intervention. This study aims to estimate the prevalence of anemia and identify the associated factors among children aged 2–5 years in Duhok.

## Patients and Methods

A cross sectional study was conducted in Duhok north of Iraq in the period from June 2021 to February 2023. A sample of 798 preschool children (2–5 years of age) were selected from those children who visited health care centres and Heevi Pediatric Teaching Hospital. The enrolled subjects were either healthy children and visited the hospitals with their parents or they had simple diseases that could be treated as outpatient like upper respiratory tract infections, gastroenteritis, hepatitis, urinary tract infections. We excluded from the study any child who had hemoglobinopathies, Fanconi anemia, chronic kidney diseases, malabsorption diseases and children receiving vitamins and minerals regularly. Also, subjects were excluded from the study were: very low birth weight (<1500 g), children's age <2 and >5 and incomplete questionnaire.

Anthropometrical, biochemical and dietary information were collected for the study through a questionnaire that was developed and validated during that period. Children aged below 5 years who had hemoglobin (Hb) values of <11.0 g/dl were regarded as anemic. We measured their heights without shoes through the use of a stadiometer and their weights also in light clothing and without shoes using electronic balances. Body Mass Index [BMI] for age was used to recognize overweight and obese children. Those who had Body Mass Index [BMI] >85<sup>th</sup> centile was regarded as overweight and those above 95<sup>th</sup> centile as obese.

Using the questionnaire, we collected data such as past breastfeeding practices, birth weights, child's eating habits, time of starting weaning food, duration of breastfeeding, time of starting infant formula, child's chronic illness, type of weaning food and whether the child ate regularly and the frequency of eating with the family were collected through the use of the questionnaire. Also, the mother's education, age and occupation information were collected in the questionnaire

Statistical analyses were carried out using SPSS 23. The level of statistical significance was set at 0.05. The chi-square test or Fisher's exact test were used to assess the association between two qualitative variables wherever appropriate. Pearson's correlation was used to test the significant association between two quantitative variables. Multiple logistic regressions were used to estimate the risk of

different factors on the prevalence of anemia (0 for absent and 1 for present) after controlling/confounding between them. The adjusted odds ratios and their 95% CI for significantly associated factors were reported

## RESULTS

The study population was 798 children of whom 238 were anemic. The overall incidence of anemia in this study is 29.8%. The male: female ratio was 1.04:1 in the study sample and 1.03:1 in the anemic children. The body weight of the anemic patients was most commonly between 5<sup>th</sup> and 85<sup>th</sup> centiles, 155(65.12%). The most frequent birth weight of the anemic patients was between 2.5 and 4 Kg,191(80.25%). Most of anemic patients had history of breast feeding for

equal to or more than six months ,113(47.47%). The weaning foods of most of the anemic patients were cereals, vegetables and fruit in 146(61.34%). Among anemic patients, 139(58.4%) patients were eating regularly and 156(65.54%) were always eating with the family. Chronic illnesses were present in 63(26.47%) anemic patients. Most of the anemic patients, 135(56.72%) had less than three siblings. The age of the mothers of anemic patient was less than 30 years in 112(47.05%). Illiterate mothers were 63(26.47%) among anemic patients and only 18(7.56%) were employed mothers. The significant association was with the age, the frequency of eating with family and chronic illnesses. These characteristics are shown in table-1-.

**Table (1):** Prevalence of anemia among children according to child characteristics (n = 798).

Variables	Anemia	Non anemic	Number	p-Value
<i>Child's age (years)</i>				
2	71	121	192	0.038
3	56	151	207	
4	61	134	195	
5	50	154	204	
<i>Gender</i>				
Female	117	274	391	0.952
Male	121	286	407	
<i>Weight centile</i>				
<5	67	128	195	0.106
>95	5	22	27	
5_85	155	371	526	
85-95	11	39	50	
<i>Birth weight</i>				
< 2.5	40	71	111	0.253
>4	7	13	20	
2.5-4	191	476	667	
<i>Duration of breastfeeding</i>				
<1	73	150	223	0.709
=>6	113	276	389	
1_2	22	54	76	
3_5	30	80	110	
<i>type of weaning food</i>				
cereals	48	144	192	0.135
cereals, fruits & vegetables	146	311	457	
family foods	29	85	114	
fruit& vegetables	8	11	19	

<i>Child eat meals regularly</i>				
No	99	197	296	0.086
Yes	139	363	502	
<i>Frequency of child eating with family</i>				
Always	156	415	571	0.01
Sometimes	63	121	184	
Once a day	13	10	23	
Twice a day	6	14	20	
<i>Chronic illness</i>				
Yes	63	83	146	0.001
No	175	477	652	
<i>No. of siblings</i>				
<3	135	320	455	0.993
3_5	86	200	286	
=>6	17	40	57	
<i>Age of mother (years)</i>				
<30	112	251	363	0.737
30-39	100	252	352	
=>40	26	57	83	
<i>Mother's level of education</i>				
Graduate	48	118	166	0.828
Preparatory	37	70	107	
Intermediate	36	86	122	
Primary	54	126	180	
Illiterate	63	160	223	
<i>Mother's working status</i>				
Homemaker	220	501	721	0.193
Working	18	59	77	

According to Table 2, there was a strongly significant correlation between hemoglobin concentration and each of age, weight and height

while the correlation with BMI was not significant

**Table (2):** Correlation of quantitative variables with Hemoglobin concentrations

Variables	Hemoglobin			
	mean	St. Deviation	r	P value
Hb	11.32	1.588	1	
Weight	14.25	3.377	0.175	0.0001
Height	95.89	11.061	0.2	0.0001
Age	3.52	1.115	0.139	0.0001
BMI	15.48	2.712	0.042	0.237

As per Table 3, by multivariate logistic regression analysis, the risk factors associated with the presence of anemia among the children were the gender, age of starting weaning foods, the type of weaning foods and the presence of

chronic illnesses. Female was 1.009 times more likely to be anemic. Age of starting weaning foods of equal to or more than six months was 1.31 times more likely to be anemic. Having cereals, fruits and vegetables as weaning foods

was associated with 1.753 times the likelihood of being anemic. The presence of chronic illnesses was associated with 1.786 times risk of having anemia. Each of the age, weight, duration of

breastfeeding, age of starting formula feeding, regularity of having meals, mothers' employment and mother's education were not risk factors.

**Table (3):** Significant factors associated with anemia by multiple logistic Regression analysis

Variable		odds ratio	95% CI		p-Value
<i>Weight</i>	Normal	0.756	0.850	1.021	0.111
	Underweight	1.091	0.956	1.587	
<i>Gender</i>	female	1.009	0.745	1.367	0.004
	male	0.997			
<i>age</i>	0-36 months	1.099	.949	1.272	0.216
	> 36 months	.907	.774	1.062	
<i>Breastfeeding duration</i>	6 months and above	0.963	0.823	1.128	0.64
	less than 6 months	1.036	0.895	1.198	
<i>Age of starting formula (months)</i>					
	<1	1.059	0.697	1.61	0.787
	1_3	0.51	0.103	2.536	0.404
	> 3	0.859	0.469	1.571	0.621
<i>Age of starting weaning foods (months)</i>					
	=>6	1.31	1.003	1.709	0.041
	4_5	0.901	0.82	0.99	
<i>type of weaning food</i>					
	cereals	0.927	0.434	1.979	0.845
	cereals, fruits & vegetables	1.753	1.098	2.798	0.018
	family foods	1.781	0.607	5.221	0.289
	fruit& vegetables	0.3	0.022	4.06	0.348
<i>Child eat meals regularly</i>					
	Yes	0.92	0.835	1.014	0.086
	No	1.208	0.975	1.496	
<i>Chronic illness</i>					
	Yes	1.786	1.336	2.387	0.00
	No	0.863	0.794	0.939	
<i>Mother's working status</i>					
	Homemaker	1.305	0.858	1.985	
	Working	0.907	0.794	1.035	
<i>Mother education level</i>					
	Illiterate	1.59	0.174	14.506	0.679
	primary	0.695	0.63	0.766	0.253
	intermediate	0.833	0.073	9.491	0.883
	preparatory	1.612	0.162	16.064	0.681
	graduated	0.695	0.63	0.766	0.3

## DISCUSSION

The present study found that the prevalence of anemia among children 2-5 years old was 29.8%. This is a bit higher than what was found in, Indonesia 29.4%<sup>18</sup> and Kuwait 23%<sup>1</sup>. It is significantly lower than the prevalence in Tanzania 84.6%<sup>22</sup>, Togo 70.9%<sup>23</sup>, India 58.7%<sup>23</sup> and Ethiopia 41.1%<sup>7</sup>. It is significantly higher, almost three times, than developed countries like Belgium 8.7% and Austria 10.5%<sup>1</sup>. These variations are most likely related to the differences in nutrition and economic status between developed and developing countries.

According to the socio-demographic characteristics recorded, the prevalence of anemia among preschool children differs statistically significantly for some variables but not for others. Age distribution shows that two years age is associated with the higher rate of anemia with significant difference from the older age. This is different from another study that showed a higher rate among 5 years old<sup>1</sup>. Our result is consistent with other studies that showed a significant association with the age.<sup>7,21,25-27</sup> While another study showed no significant association with the age<sup>28</sup>. The lower Hb in younger children may be caused by the combination of the high requirement of iron due to the rapid growth and the typical low intake of iron in quantity and bioavailability.<sup>29</sup>

A significant association with the gender was found in our study with females being more prone to anemia. This is similar to other studies like Dutta et al in India<sup>24,30</sup> and Aliyo et al in Ethiopia<sup>30</sup> that found anemia more common in female but is inconsistent with other studies that showed male gender is associated with anemias<sup>25,31-34</sup> while others showed no significant association.<sup>1,6,23,25</sup>

The frequency of having diet with the family is significantly associated with anemia that was more prevalent in those always eating with the family. Al-Qauod et al in Egypt found that showed most of the anemic children were always having diet with the family but the association was not found significant<sup>1</sup>. This reflects clearly that frequent eating with the family does not necessarily mean that the child is having the proper amount and quality of food that can prevent having anemia.

Another factor significantly associated with anemia was having a chronic disease in contrary to another study that showed no significant association<sup>1</sup> but other studies proved a

significant association with the presence of diarrheal diseases<sup>24,31</sup> while others revealed a significant association with intestinal worms<sup>2,30</sup> and malaria.<sup>32,34</sup> The association found in our study can be best explained by the loss of appetite and impaired absorption in addition to the suppressed hematopoiesis in the presence of chronic diseases.

A significant risk factor for anemia in this study is the growth status as reflected by weight and height. Since there are common causes for anemia and malnutrition, they are expected to co-occur in the same individual. So stunted children are predisposed to anemia. This has been proved by other studies that found similar association.<sup>1,6,26,29,31</sup>

The type of weaning food in this study is found as a predisposing factor for anemia where those who had cereals, fruits and vegetables as weaning foods were at highest risk. This is possibly explained by that these foods are not well enriched with iron. This result is consistent with the results of other studies that showed consuming fruits and vegetables<sup>1</sup> and not consuming meat, beans and vegetables<sup>33,35</sup> as weaning foods predispose to anemia.

Unexpectedly the duration of breast feeding was not significantly associated with anemia in agreement with other studies<sup>29,37</sup> in contradiction with another study<sup>1</sup> that showed that a longer duration of breast feeding was a significant predisposing factor while the age of starting formula feeding was shown to be significantly associated with anemia in agreement with another study<sup>7</sup> which is due to high content of iron in cereals.

Also, this study did not show significant association between anemia and maternal employment and education level similar to another study<sup>1</sup>. This may be because other factors were more significant than them. At the same time most of the mothers in our study had more than 12 years of education. This is contrast with other study that proved a significant association of maternal employment and education level with anemia.<sup>23,25,31,32</sup>

The main limitations with our study were the use of hemoglobin level rather than serum ferritin as a proxy indicator of deficiency of iron. Also, data on the dietary intake were not collected and hence causation and effect cannot be linked.

## CONCLUSION

The overall incidence of anemia in this study is 29.8%. The gender, the age of starting weaning foods, the type of weaning foods and the presence of chronic illnesses are significant risk factors associated with the presence of anemia among the children in Duhok. Anemia is still regarded as a public health issue among preschool aged children in Duhok. We recommend further studies to be accomplished to evaluate the underlying factors especially the nutritional habits.

## REFERENCES

- Al-Qaoud NM, Al-Shami E, Prakash P. Anemia and associated factors among Kuwaiti preschool children and their mothers. *Alexandria Journal of Medicine* 2015; 51(2):161-166
- Kebede, D., Getaneh, F., Endalamaw, K. *et al.* Prevalence of anemia and its associated factors among under-five age children in Shanan gibe hospital, Southwest Ethiopia. *BMC Pediatr* **21**, 542 (2021). <https://doi.org/10.1186/s12887-021-03011-5>
- Hasan MM, Magalhaes RJ, Ahmed S, Pervin S, Tariqujjaman M, Fatima Y, et al. Geographical variation and temporal trend in anemia among children 6-59 months of age in low-and middle-income countries during 2000-2018: forecasting the 2030 SDG target. *Public Health Nutr.* 2021;9:1–20.
- Ginzburg YZ, Glassberg J. Inflammation, hemolysis, and erythropoiesis lead to competitive regulation of hepcidin and possibly systemic iron status in sickle cell disease. *EBio Medicine.* 2018;34:8–9.
- Georgieff MK. Long-term brain and behavioural consequences of early iron deficiency. *Nutr Rev* 2011;69:S43–S48.
- El-Asheer, O.M., Naeem, M.S., Abdel-Hafez, F.A. *et al.* Iron deficiency in preschool non-anemic Egyptian children. *Egypt Pediatric Association Gaz* **69**, 32 (2021).
- Gebreweld A, Ali N, Ali R, Fisha T. Prevalence of anemia and its associated factors among children under five years of age attending at Guguftu health center, South Wollo, Northeast Ethiopia. *PLoS One.* 2019 Jul 5;14(7):e0218961.
- Lopez A, Cacoub P, Macdougall IC, Peyrin-Biroulet L. Iron deficiency anaemia. *The Lancet.* 2016;387(10021):907–16.
- Janus J, Moerschel SK. Evaluation of Anemia in Children. *American Family Physician.* 2010;81(12):1462–1471.
- Woldie H, Kebede Y, Tariku A. Factors associated with anemia among children aged 6–23 months attending growth monitoring at Tsitsika Health Center, Wag-Himra Zone, Northeast Ethiopia. *Journal of nutrition and metabolism.* 2015;2015.
- Cardoso MA, Scopel KK, Muniz PT, Villamor E, Ferreira MU. Underlying factors associated with anemia in Amazonian children: a population-based, cross-sectional study. *PLoS one.* 2012;7(5):e36341
- Sunuwar, D.R., Singh, D.R., Pradhan, P.M.S. *et al.* Factors associated with anemia among children in South and Southeast Asia: a multilevel analysis. *BMC Public Health* 2023;**23**:343 .
- Balarajan Y, Ramakrishnan U, Özaltin E, Shankar AH, Subramanian SV. Anaemia in low-income and middle-income countries. *Lancet.* 2011;378:2123–35.
- Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F, et al. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. *Lancet Glob Heal.* 2013;1:16–25.
- Ntenda PAM, Nkoka O, Bass P, Senghore T. Maternal anemia is a potential risk factor for anemia in children aged 6–59 months in Southern Africa: a multilevel analysis. *BMC Public Health.* 2018;18:1–13.
- Ngesa O, Mwambi H. Prevalence and risk factors of anaemia among children aged between 6 months and 14 years in Kenya. *PLoS ONE.* 2014;9.
- Moschovis PP, Wiens MO, Arlington L, Antsygina O, Hayden D, Dzik W, et al. Individual, maternal and household risk factors for anaemia among young children in sub-saharan Africa: a cross-sectional study. *BMJ Open.* 2018;8:1–14.
- Wieringa FT, Dahl M, Chamnan C, Poirot E, Kuong K, Sophonneary P et al. The high prevalence of anemia in cambodian children and women cannot be satisfactorily explained by nutritional deficiencies or hemoglobin disorders. *Nutrients.* 2016;8.
- Hurrell RF, Reddy M, Cook JD. Inhibition of non-haem iron absorption in man by polyphenolic-containing beverages. *Br J Nutr.* 1999;81:289–95.
- Desai MR, Terlouw DJ, Kwena AM, Phillips-Howard PA, Kariuki SK, Wannemuehler KA, et al. Factors associated with hemoglobin concentrations in pre-school children in

- western Kenya: cross-sectional studies. *Am J Trop Med Hyg.* 2005;72:47–59.
- Sunardi, D., Bardosono, S., Basrowi, R. W., Wasito, E., & Vandenplas, Y. (). Dietary determinants of anemia in children aged 6–36 months: A cross-sectional study in Indonesia. *Nutrients* 2021;13(7).
- Kejo D, Petrucka PM, Martin H, Kimanya ME, Mosha TCE. Prevalence and predictors of anemia among children under 5 years of age in Arusha District, Tanzania. *Pediatric Health Med Ther.* 2018;9:9-15 <https://doi.org/10.2147/PHMT.S148515>
- Nambiema, A., Robert, A. & Yaya, I. Prevalence and risk factors of anemia in children aged from 6 to 59 months in Togo: analysis from Togo demographic and health survey data, 2013–2014. *BMC Public Health* 2019;19: 215.
- Dutta, M., Bhise, M., Prashad, L., Chaurasia, H., & Debnath, P. (). Prevalence and risk factors of anemia among children 6–59 months in India: A multilevel analysis. *Clinical Epidemiology and Global Health* 2020;8(3):868–878.
- Keokenchanh S, Kounnavong S, Midorikawa K, Ikeda W, Morita A, Kitajima T, et al. Prevalence of anemia and its associated factors among children aged 6–59 months in the Lao People’s Democratic Republic: A multilevel analysis. *PLoS ONE* 2021;16(3): e0248969.
- Gedfie S, Getawa S, Melku M. Prevalence and Associated Factors of Iron Deficiency and Iron Deficiency Anemia Among Under-5 Children: A Systematic Review and Meta-Analysis. *Glob Pediatr Health.* 2022 Jul 6;9:2333794X221110860.
- Teni D, Bedaso T. Risk factors for the prevalence of anemia in children aged 6–59 months at different levels in Ethiopia. *An International Interdisciplinary Journal for Research, Policy and Care* 2022;17(4):359-67
- Zewude BT, Debushe LK. Prevalence rate and associated risk factors of anaemia among under five years children in Ethiopia. *Nutrients.* 2022;14(13):1–13.
- Oliveira DN, Martorell, R. & Nguyen, P. Risk factors associated with hemoglobin levels and nutritional status among Brazilian children attending daycare centers in Sao Paulo City, Brazil. *Arch. Latinoam. Nutr.*
- Aliyo A, Jibril A . Assessment of anemia and associated risk factors among children under-five years old in the West Guji Zone, southern Ethiopia: Hospital-based cross-sectional study. *PLoS ONE* 2022;17(7):
- Obasohan PE, Walters SJ, Jacques R, Khatab K. A Scoping review of the risk factors associated with anaemia among children under five years in Sub-Saharan African Countries. *Int. J. Environ. Res. Public Health.* 2020;17:23.
- Ngesa O, Mwambi H. Prevalence and Risk Factors of Anaemia among Children Aged between 6 Months and 14 Years in Kenya. *PLoS ONE* 2014;9(11): e113756.
- Zuffo CRK, Osório MM, Taconeli CA, Schmidt ST, Silva BHC, Almeida CCB. Prevalence and risk factors of anemia in children. *J Pediatr (Rio J);* 2016; (92):353–60.
- Legason ID, Atiku A, Ssenyonga R, Olupot-Olupot P, Barugahare JB. Prevalence of Anaemia and associated risk factors among children in North-Western Uganda: a cross sectional study. *BMC Hematology.* 2017;17(1):1–9.
- Parbey PA, Tarkang E, Manu E, Amu H, Ayanore MA, Aku FY, Ziema SA *et al.* Risk Factors of Anaemia among Children under Five Years in the Hohoe Municipality, Ghana: A Case Control Study. *Anemia*, vol. 2019, Article ID 2139717, 9 pages, 2019.
- Endris, B.S., Dinant, GJ., Gebreyesus, S.H. *et al.* Risk factors of anemia among preschool children in Ethiopia: a Bayesian geo-statistical model. *BMC Nutr* 2022;8:2.
- Kejo D, Petrucka PM, Martin H, Kimanya ME, Mosha TCE. Prevalence and predictors of anemia among children under 5 years of age in Arusha District, Tanzania. *Pediatric Health Med Ther.* 2018;9:9-15
- Muleviciene A, Sestel N, Stankeviciene S, et al.. Assessment of risk factors for iron deficiency anemia in infants and young children: a case-control study. *Breastfeed Med.*2018;13(7):493-499.