RESEARCH ARTICLE

Prevalence of Iron Deficiency Anaemia Among Preschool-Aged Children in Uasin-Gishu County, Kenya

Sheila Chebichii Kosgei[*1] iD, Gertrude Were[1] iD, Charlotte Serrem[1] iD, Odipo Osano[2] iD and Emmanuel Ayua[1] iD

[1] Department of Family and Consumer Sciences, University of Eldoret, Kenya
[2] Department of Environmental Health and Biology, University of Eldoret, Kenya

*Corresponding Author: chebichiisheila@gmail.com

To read this paper online, please scan the QR code below:

ABSTRACT

Globally, approximately 40% of all preschool-aged children are affected by anaemia. Iron deficiency anaemia (IDA) is the most prevalent form of micronutrient deficiency and the leading cause of anaemia among children. In Kenya, the prevalence of IDA among these children is 25%. This study assessed the prevalence of IDA and its associated factors among preschool-aged children in urban, peri-urban and rural areas of Uasin Gishu County, Kenya. Ethical approval and a research permit were granted by AMREF ESRC and NACOSTI respectively. A cross-sectional survey design was used to identify 289 children using a stratified sampling technique. Biochemical tests were assessed using the HemoCue Hb 201. Data was analyzed using STATA version 18. The prevalence of IDA was 48.4%. Most of the children suffering from IDA were from the age groups of 6-12 months (22.1%) and 48-59 months (21.4%). Children from married parents were less likely to have IDA, [Odds ratio (OR):4.53; 95%CI, p-value <0.01]. An increase in wealth was associated with a decreased risk of IDA, [OR: 5.45; (95% CI, 1.18 to 5.125), p-value<0.01]. There was a significant relationship between dietary diversity and IDA, Tau (2, N = 289) = 0.0667, p-value = 0.0445. The predictors of IDA are multi-factorial, and thus multi-sectoral interventions may be necessary to combat IDA. Due to the high prevalence of IDA, the government should consider prophylactic iron supplementation for susceptible children, especially children aged between 6-23 months.

Keywords: *Iron Deficiency Anaemia, Preschool-Aged Children, Haemoglobin*

INTRODUCTION

Globally, approximately 40% of all children aged 6-59 months are affected by anaemia (WHO, 2023). Iron deficiency is considered the most common and the leading cause of anemia among preschool-aged children in both developed and developing countries (WHO, 2023; Kumar et al., 2022). Iron deficiency and Iron Deficiency Anemia (IDA) affect 2 billion people globally of which two-thirds are preschool-aged children (children between the ages of 6-59 months) (Mantadakis et al., 2020). The prevalence of IDA in developing countries is five times higher than that of developed countries (Obeagu et al., 2023). The Global Nutrition Report indicates that a total of 125 developing countries is facing the burden of anaemia with 38 of these countries facing the double burden of stunting and anaemia (Lemoine & Tounian, 2020).

IDA among preschool-aged children is recognized as a major public health problem (Afreen et al., 2023). It contributes substantially to morbidity and mortality among preschool-aged children (Global Nutrition Report, 2022). It has been linked to poor cognitive and impaired brain development even in mild to moderate forms (Gedfie et al., 2022). Furthermore, IDA is ranked among the top three causes of disability globally and the leading risk factors for the global disability-adjusted life years. Africa and Asia are most affected with three-quarters of the global mortality burden, and more than half of the disability-adjusted life years lost (Rugema et al., 2022). Despite the global strategies and policies put in place to combat IDA over the past decades, not much has changed in Sub-Saharan Africa (SSA) and Asia. This is perhaps not surprising, since eliminating IDA in these countries has proven difficult due to the double burden of IDA and other diseases such as malaria, HIV/AIDS, and parasitic infestations/infections among others which all contribute to the anaemia burden (Afreen et al., 2023).

In Kenya, the prevalence of IDA among preschool-aged children stands at 25% which is relatively high and considered a severe public health concern, yet very minimal intervention is conducted for this age group (Kenya Malaria Indicator Survey, 2015). Uasin Gishu County, one of the 47 counties in Kenya is considered a major food basket in the country. Despite this, reports indicate high levels of malnutrition among preschool-aged children in the county with 14% being stunted, 11% being underweight and 3% being wasted (Uasin Gishu County Integrated Development Plan [UGCIDP] 2018-2022). Macro- and micro-nutrient deficiencies are interdependent and thus the presence of stunting, wasting and underweight are key indicators for the presence of other underlying deficiencies such as IDA.

There are very few empirical studies on micronutrient deficiencies such as IDA in this county despite its tremendous consequences, especially among preschool-aged children. Like the neighboring East African countries, the Kenyan diet for preschool-aged children is dominated by cereals, legumes and root tubers which are poor sources of iron putting this age group at greater risk of IDA (Liu et al., 2022; Waswa et al., 2021). Other region-specific studies carried out in Keiyo South and Thika found a relatively high prevalence of IDA among this age group at 21.7% and 73.2% respectively (Onyangore et al., 2016; Wangusi et al., 2016). This study therefore sought to assess the prevalence and predictors of IDA among preschool-aged children in urban, peri-urban and rural areas of Uasin Gishu County, Kenya.

METHODS

Study Design and Study Area

This study adopted the cross-sectional survey design and was carried out in urban, peri-urban and rural areas of Uasin Gishu County, Kenya. Little is known about micronutrient deficiencies such as IDA in this county despite its tremendous consequences. Uasin Gishu County hosts 304,943 households with an estimated area of 2,955.3 Km$_2$ and a population of 1,163,186 people (KNBS, 2019). The county has approximately 236,039 children aged between 6-59 months. The main source of livelihood in the county is livestock keeping with most farmers rearing dairy and beef cattle (Ayrshire, Friesian and Sahilwal breeds), sheep, goats, pigs and chicken of both exotic and indigenous breeds. This county, which was once dominantly rural, has experienced rapid urbanization and an increase in informal settlements. The study was carried out in 11 wards, selected from Eldoret East region, Uasin Gishu County. The study wards included Huruma, Kapsaos, Kiplombe, Racecourse, Kimumu, Sergoit, Tembelio, Kipkenyo, Langas, Kapsoya and Kiunet/Kapsuswo wards.

Study Population

This study targeted preschool-aged children aged between 6-59 months. The age between 6 and 59 months is a critical period of rapid growth and development, which significantly increases their iron requirements. Inadequate dietary intake, frequent infections, and high nutrient demands place this age group at a heightened risk of iron deficiency anemia (Kazi et al., 2022). Assessing iron status in this population is essential because anemia during early childhood can impair cognitive development, reduce immunity, and negatively affect long-term health and productivity (Lemoine & Tounian, 2020).

Sample Size Determination

Fisher's statistical formula was used to determine the sample size for this study (Fisher, 1999). Based on this approach, a minimum sample size of 289 preschool-aged children was calculated. The computation assumed a 95% confidence level (Z = 1.96), a prevalence of IDA among preschool-aged children in Kenya of 25% (p = 0.25), and a margin of error of 5% (d = 0.05). The complementary proportion (q) was obtained as (1 – p). To account for possible non-response or attrition, an additional 10% was added to the calculated sample size. This resulted in a final sample size of 318 preschool-aged children.

Sampling Procedure

A total of 318 preschool-aged children alongside their caregivers were selected through a three-tier sampling technique consisting of purposive sampling, stratified sampling and simple random sampling as shown in Figure 1 (Sedgwick, 2015). Whereby, Uasin Gishu County was purposively selected due to its high prevalence rate of stunting among preschool-aged children which stands at 14% relative to the national prevalence of 18% (UGCIDP, 2018). The study area was then stratified into 3 strata representing urban, peri-urban and rural areas. Lastly, a simple random sampling technique was used to identify 318 households with preschool-aged children. Proportionate sampling was used to calculate the number of households. The sample size for each stratum was obtained using the formula below:

$$\frac{number\ of\ households \in the\ stratum}{total\ number\ of\ households} \times \text{Study sample size}$$

Therefore, the sample size for the strata was: peri-urban (170 households), urban (55 households) and rural areas (64 households).

Figure 1:
Illustration of the Study Sampling Schema
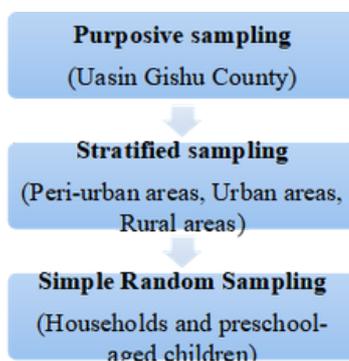
Eligibility Criteria
Inclusion criteria:

- All children aged 6- 59 months, who have been residing in Uasin Gishu County for the past year.
- All mothers or caregivers willing to participate in the study and subject their children to the necessary biochemical test were selected to participate in the study.

Exclusion criteria:

- Children whose caregivers reported having a genetic or autoimmune hematological disease (sickle cell disease, aplastic anaemia and hemolytic anaemia).
- Children who had been previously diagnosed with non-iron deficiency-related anaemia (megaloblastic and pernicious anaemia).
- Children who were unwell at the time of the study.

Data Collection

Research assistants were recruited from the Department of Family and Consumer Sciences at the University of Eldoret. These consisted of two postgraduate students undertaking a Master of Science in Community Nutrition and six undergraduate students registered in the nutrition program. They underwent a two-week training course on the standardized methods for data collection and the use of HemoCue Hb 201.

Socio-demographic and economic data

A researcher-administered structured questionnaire was used to capture data on the socio-demographic and economic characteristics of the study respondents. The socio-demographic variables assessed included the caregiver's age, level of education, marital status, parity and residence. Socio-economic variables assessed were occupation status and wealth index variables such as source of household drinking water, source of fuel, source of energy and type of toilet facility.

Hemoglobin analysis

IDA was determined using a haemoglobin meter known as the HemoCue® Hb 201+ system (HemoCueAB, Angelholm, Sweden). Recommended standard procedures were used to carry out the Hb test, the first step involved cleaning the sampling site which was either the pulp of the finger or the heel of the foot (Jain & Chowdhury, 2020). The sampling site was cleaned using 70% alcohol and allowed air dry for a few seconds after which a prick was applied on the side of the fingertip using a sterile lancet (Ughasoro et al., 2019). The first two blood samples were wiped away using a piece of sterile cotton wool and slight pressure was applied on the

fingertip to retrieve the blood drop that was used to fill the micro cuvettes (Moura et al., 2020). The micro cuvettes were then wiped to remove any excess blood samples and immediately placed into the HemoCue® 201+ device for analysis (Abraham et al., 2020). Lastly, the results were displayed numerically in g/dl, which was then recorded manually on the tablets for data collection. The Hb level (in g/dl) was summarized into IDA status by classifying; an Hb level of >11 as normal, an Hb level of more than 10 but less than 11 as mild anaemia, and an Hb level of <10 as severe anaemia (WHO, 2015). The HemoCue® 201+ device was cleaned daily before and after use according to the cleaning procedure provided by the company manual (Ughasoro et al., 2019).

Statistical Analysis

Data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 23. Descriptive statistics were used to analyze socio-demographic data. An asset-based wealth index was calculated using Principal Component Analysis (PCA) to convert wealth indicator variables into wealth index scores. Chi-square statistical tests were used to test for associations between the independent variables and the occurrence of IDA among preschool-aged children at a p-value of 0.05. A multiple ordinal logistic regression model was fitted and used to assess the relationship between the predictor variables and IDA among preschool-aged children at a p-value of 0.05.

Ethical Clearance

Ethical approval to conduct this study was granted by the AMREF Ethics and Scientific Review Committee (ESRC), approval number AMREF-ESRC P1009/2021. The National Commission for Science, Technology and Innovation (NACOSTI) also granted a research permit, license number: NACOSTI/P/22/18518. Respondents were included in the study by voluntarily giving consent through signing an informed consent. Before the data collection, the study participants were well-informed about the purpose, objectives, benefits, and risks. Confidentiality was maintained throughout the study using code numbers in the identification of households and preschool-aged children.

RESULTS

Socio-Demographic Characteristics of the Study Participants

Out of the Three hundred and eighteen (318) respondents selected for this study, a total of (289) participated in the study. The response rate was therefore 90.9%, which was adequate. Most of the respondents were female (93%) compared to their male (7%) counterparts as shown in Table 1. The average age of the caregivers was 28 years with the youngest being 18 years and the eldest being 69 years. The majority (67%) of the respondents had attained a secondary level of education with few (14%) caregivers having attained a tertiary level of education. Most of the respondents were married (67.8%) however 14.2% were divorced or separated while 18% were single parents. Generally, households (51.9%) were large with between 4-6 children.

Table 1:

Socio-Demographic Characteristics of the Caregivers of Preschool-Aged Children in Uasin Gishu County, Kenya

Variables	N	%	Median	IQR
Gender of the Caregiver (N=289)				
Female	270	93.43		
Male	19	6.58		
The average age of the Caregiver (N=289)			28	11
Level of education (N=289)				
Primary Level	52	17.99		
Secondary Level	196	67.82		
Tertiary Level	41	14.19		
Marital Status (N=289)				
Single	52	17.99		
Married	196	67.82		
Divorced or separated	41	14.19		

Residence (N=289)				
Rural	64	22.15		
Urban	55	19.03		
Peri-urban	170	58.82		
Number of Children in the Household				
1-3 Children	80	27.68		
4-6 Children	150	51.9		
Above 6 Children	59	20.42		

IQR = Interquartile Range

Socio-Economic Characteristics of the Study Participants

The socio-economic characteristics of the study participants were established using two indicators: the occupation status of the caregiver and the Household Wealth Index. Almost all the participants were involved in different income-generating activities as shown in Figure 2.

Figure 2:

Occupation Status of the Caregivers of Preschool-Aged Children in Uasin Gishu County, Kenya

The household wealth index was classified as per the KDHS report (KNBS & ICF, 2023). The results showed that most of the households (42.5%) were classified under the second category while 28.7% were under the middle-class category. However, 2% were classified under the highest wealth index quintile as shown in Figure 3.

Figure 3:

Wealth Index of Households with Preschool-Aged Children in Uasin Gishu County, Kenya

Characteristics of Preschool-Aged Children

Out of the 289 children studied, 53% were male and 47% were female. Nineteen per cent (19%) of the children were between the ages of 6-12 months, 16.3% were between the ages 12-23 months with the majority (65%) of the children being above 24 months of age. The mean age was 30 months. More than half (57%) of the children resided in peri-urban areas while 25% were in urban areas and 18% in rural areas respectively.

Prevalence of IDA Among Preschool-Aged Children

Results from this study showed that slightly over half of the children (51.6%) had normal Hb levels, twenty-one per cent (21%) had mild IDA and twenty-seven per cent (27%) had severe IDA. Therefore, the prevalence of IDA among preschool-aged children in this study was 48.4%.

Predictors associated with IDA among preschool-aged children

i. Gender

The study results indicated that female children had a higher Hb with a mean of 11.02 g/dl compared to their male counterparts who had a mean of 10.64 g/dl. Despite the differences in means of Hb levels between the male and female children, statistical tests did not show any significant differences between the two groups, χ_2 (1, n=289) = 3.0256, P-value=0.220 as shown in Table 2.

Table 2:

Relationship Between IDA and Gender of the Preschool-Aged Children in Uasin Gishu County, Kenya

Variables	Gender		Chi-square / Fisher's Exact Value	p-value
	Female	Male		
	(%)	n (%)		
Iron Deficiency Anemia (N=289)				
Normal	56.93	46.71		
Mild Anemia	18.98	23.03	3.0256	0.220
Severe Anemia	24.09	30.26		

ii. Age

Most of the children suffering from IDA were from age groups, 6-12 months (22.1%) and 48-59 months (21.4%) respectively. However, results from Table 3, indicated that there was no statistically significant relationship between IDA and children's age group, χ_2 (1, n=289) = 5.5201, p-value=0.701.

Table 3:

Relationship Between IDA and Age Groups of Preschool-Aged Children in Uasin Gishu County Kenya

Variables	Iron Deficiency Anemia (N=289)			Chi-square value	p-value
	Normal	Mild Anemia	Severe		
	(%)	(%)	(%)		
Children Age-group (N=289)					
6-12	15.44	22.95	21.52		
12-23	18.79	11.48	15.19		
24-35	20.13	24.59	20.25	5.5201	0.701
36-47	18.79	22.95	18.19		
48-59	26.85	18.03	24.05		

iii. Socio-demographic and economic characteristics

Table 4 revealed that children from married parents were 4.53 times more likely to be normal (not suffering from IDA) compared to those from single parents [Odds ratio (OR):4.53; 95% confidence interval (CI)], p-value <0.01. The findings also indicated that an increase in wealth was found to be associated with an increase in the odds of being normal (not suffering from IDA), with an odds ratio of 5.45 (95% CI, 1.18 to 5.125), p-value<0.01 compared to children from households in the poorest wealth quintile. With regards to the occupation status of the mothers/caregivers, there was no significant relationship noted with the occurrence of IDA among the preschool-aged children, p value> 0.05.

Table 4:

Relationship Between IDA and Socio-Economic Characteristics of Caregivers of Preschool-Aged Children in Uasin Gishu County, Kenya

Variables	Odds Ratio	95% CI	
		Lower	Upper
Marital Status			
Single	REF		
Married	4.53	1.85	4.02*
Divorced or separated	4.36	1.41	3.53*
Residence			
Rural	REF		
Urban	0.301	0.134	0.676
Peri-urban	0.41	0.156	1.087
Occupation			
Employed	REF		
Self-employed	0.78	0.488	1.232
Manual worker	1.19	0.744	1.921
Unemployed	0.31	0.117	0.876
Farmer	1.28	0.149	11.06
Wealth Index			
Poorest	REF		
Poorer	1.62	0.89	2.943
Middle	1.48	0.79	2.76
Richer	1.97	0.939	4.167
Richest	5.45	1.18	5.125*

Means significant at 95% CI: REF = Reference point

Results showed that 69% of preschool-aged children with severe IDA reside in peri-urban areas, however, there was no significant statistical difference observed among the three study areas which included rural, urban and peri-urban areas. Lastly, about maternal education, the results as shown in Table 5 indicated that there was a statistically significant relationship between IDA and maternal level of education p value= 0.015.

Table 5*:*

Relationship Between IDA and the Level of Education of Caregivers of Preschool-Aged Children in Uasin Gishu County, Kenya

Variable	Iron Deficiency Anemia			Chi-square value	p-value
	Normal	Mild Anemia	Severe Anemia		
	(%)	(%)	(%)		
Level of education (N=289)					
Primary Level	23.49	16.39	8.9		
Secondary Level	65.77	60.66	77.22	12.388	0.015*
Tertiary Level	10.74	22.95	13.92		

*Association significant at p<0.05

iv. Dietary Diversity

This study's findings revealed that the majority (66.4%) of children had a low dietary diversity score as shown in Figure 4, characterized by high consumption of foods from cereals, grains and root tubers with very low consumption of meat/meat products, fruits and vegetables. It was also noted that 77% of the children with IDA had a low dietary diversity whereas only 11% of the children with IDA had a high dietary diversity. The relationship between dietary diversity and IDA was assessed using Kendall's Tau test of association. The results indicated that there was a statistically significant relationship between dietary diversity and IDA, Tau (2, N = 289) = 0.0667, p-value = 0.0445 as shown in Table 6.

Figure 4:

Dietary Diversity Scores of Preschool-Aged Children in Uasin Gishu County, Kenya
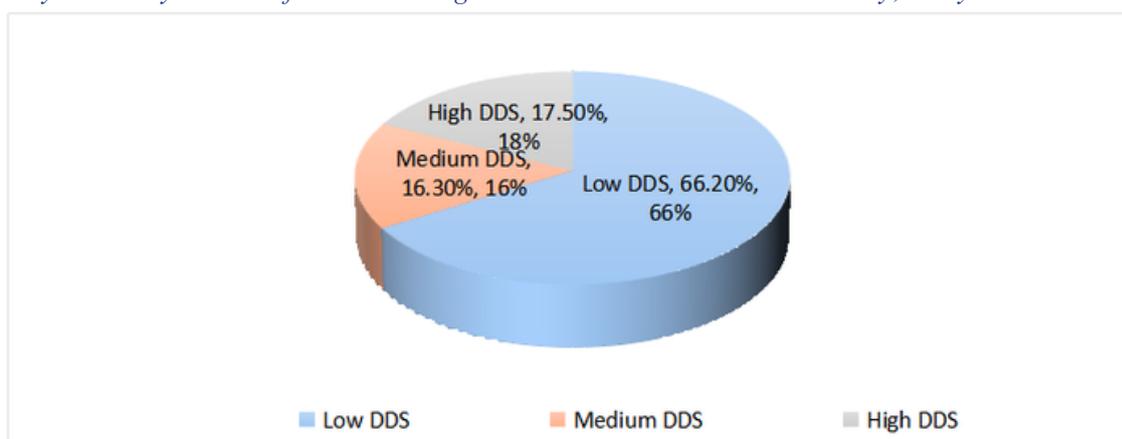
Table 6*:*

Association Between Dietary Diversity and IDA Among Preschool-Aged Children in Uasin Gishu County, Kenya

Variables	Iron Deficiency Anemia			Tau value	p-value
	Normal	Mild Anemia	Severe		
	(%)	(%)	(%)		
Dietary Diversity (N=289)					
Low diversity	59.73	68.85	77.22		
Medium diversity	18.79	16.39	11.39	-0.0667	0.0445*
High diversity	21.48	14.75	11.39		

*Association significant at p<0.05

DISCUSSION

Results from this study indicate that most participants attained secondary school education. This is in line with the government's efforts to provide free and compulsory primary education and 100% transition to secondary school. The level of education of the respondents in this study is consistent with the findings of Komo (2021) who found that the majority (98%) of caregivers in informal settlements in Kenya have either a secondary or primary level of education with very few having attained tertiary education (2%). With regards to household parity, results from the present study concur with the results of the HDHS report that also showed most of the Kenyan households had between 4 and 6 children (KNBS & ICF, 2023). Almost all respondents were engaged in an income-generating activity with most of them being either self-employed or casual workers. These findings are consistent with those of Nyamasege et al. (2021) who found that 34.5% of caregivers in urban and peri-urban areas of Nairobi, Kenya were casual labourers while 39% were unemployed. The unemployment rate in Kenya stands at 16.8% and is highest among youth aged 20-24 years, this explains the percentage (6%) of unemployed respondents (UGCIPD, 2018).

Many of the study respondents were from peri-urban areas also known as informal settlements where most of the residents engage in casual or manual work. This is probably because many residents of these areas mostly have an incomplete level of education with the majority having either a primary level or secondary level of education. This places them at a disadvantage for permanent employment. Thirty-one per cent (31%) of the study respondents were self-employed. This depicts a true picture of peri-urban areas in Kenya at large, which are characterized by Small and Medium Scale enterprises (SMEs) led by residents in these areas as their sole source of income (Murage, 2021). Despite Uasin Gishu County being an agricultural hub, it is interesting to note that only 1% of the study respondents were engaged in farming activities as their sole source of income. Various factors might be associated with this. However, the rapid urbanization being experienced in the county and other rural parts of Kenya and Sub-Saharan Africa at large stands as the main contributor to the decrease in farming activities (Davies et al., 2021).

This study used a disproportionate stratified sampling method to calculate the sample size of children in urban, peri-urban and rural areas. The high population of children in urban and peri-urban areas is probably due to the increase in rural-to-urban migration being experienced in Kenya and Sub-Saharan Africa as a whole. It is reported that 62% of the population in Sub-Saharan Africa reside in peri-urban areas better known as informal settlements (Machiyama et al., 2019). In addition, according to the UN State of the Cities report, it has been projected that Sub-Saharan Africa will account for 50% of the world's population increase by 2050 (UN, 2013). The bulk of this population growth will occur almost entirely in urban areas. The high percentage (57%) of children in peri-urban areas, can also be attributed to the high unmet need for modern contraceptives and the high number of unintended pregnancies in these areas (Machiyama et al., 2019).

In this study, the prevalence of IDA among preschool-aged children was 48.4% which is higher than the national prevalence of 25%. It is also slightly higher than that of a study carried out in Keiyo South, Kenya among children aged 6-23 months which found a prevalence of 21.7% (Onyangore et al., 2016). These results are like those of a Tanzanian study by Msaki et al. (2021), which found a prevalence of 59% among children aged 6-59 months. This high prevalence is attributed to inadequate intake of iron-rich foods especially animal-sourced foods among children as seen in these results and other studies (Mantadakis et al., 2020; Waswa et al., 2021; Onyangore et al., 2016). It has been noted that children from developing countries tend to have monotonous diets which are mostly less diverse and dominated by cereals, grains and root tubers (Mantadakis et al., 2020, Gedfie et al., 2022; Lui et al., 2022). Other probable causes include high poverty rates, limited access to proper healthcare facilities and poor living conditions (Global Nutrition Report, 2022). Preschool-aged children are also more prone to helminthic infestation and infections which have been associated with IDA (Muriuki et al., 2020).

Results from this study showed no significant differences in the occurrence of IDA among boys and girls. This finding is like that of a study carried out in India which also found no significant association between IDA and the gender of the child (Patel et al., 2021). However, other studies have revealed conflicting results which indicate that there is a higher prevalence of IDA in boys than girls in children between 6-59 months (Msaki et al., 2022). This is probably due to the presence of testosterone hormone in boys, which is known to stimulate erythropoiesis and enhance metabolism causing younger boys to have a higher nutrient requirement for iron than girls during this age period (Melku et al., 2018).

The prevalence of IDA was highest among children aged 6-12 months and lowest among

children aged 12-23 months. These findings are consistent with that of a study from Tanzania that also found a high prevalence of IDA among children in the lower age groups of between 6-23 months and a gradual decline in risk of IDA as the child grew in age (Msaki et al., 2022). Cedrick et al. (2022) in their study in Rwanda also found a strong association between age and IDA. The authors found that children under 12 months of age were more likely to be anaemic compared to older children. This observation could be backed by the fact that maternal stores passed to the baby from birth are adequate to sustain the baby until 6 months of age (Kazi et al., 2022). Thereafter, the iron stores are depleted particularly due to poor complementary practices, yet the child depends fully on dietary sources of iron to replenish their iron stores. Therefore, inadequate dietary intake of iron-rich foods may give rise to IDA, especially in this younger age group. This age group is also the most crucial as rapid growth, and development is taking place thus the increased demand for iron and other micronutrients. Children below the age of 2 years have not yet fully developed their immune systems and thus are more prone to infections and consequently anaemia (Gedfie et al., 2022).

Children from households with married parents were less likely to be affected with IDA, unlike their counterparts from single-parent households. This is consistent with Laksono et al. (2022) results, which revealed that children from married parents were less likely to have poor nutrition compared to children from single parents and divorced/widowed parents. However, it is important to note that maternal marital status is not the leading cause of IDA but may be a predictor due to its contribution to the household's well-being. Being married has been associated with better health outcomes not only for the couple but also for the children. Most married couples tend to have better household income, greater access to health insurance and greater levels of social support which has been associated with better child health and nutrition outcomes (Lawrence et al., 2019).

Children from poor households were more likely to suffer from IDA compared to their counterparts residing in wealthier households. This is consistent with the findings of Patel et al. (2021) who revealed that children from poor families had a higher prevalence of IDA compared to those from middle-class and rich families. In addition, various studies have demonstrated this association between IDA and low socio-economic status especially among children aged 6-59 months (Andriastuti et al., 2020). Children from resource-poor families are most vulnerable to IDA because poor families tend to have poor sanitation facilities which are associated with helminthic infections and consequently IDA. Studies have shown that households from lower socio-economic status have poor health-seeking behaviour which might be associated with the occurrence of IDA (Moura et al., 2020, Mrema et al., 2021; Rutayisire & Marete, 2020; Zheng et al., 2020). Another direct causative factor of IDA among these resource-poor households is the fact that most of the children from these families rarely get adequate dietary intake of iron-rich foods due to limited economic access to these foods (Ali et al., 2019). These households have also been found to be at a higher risk of food insecurity which has been associated with micronutrient deficiencies (Ogunniyi et al., 2021).

This study found that the occupation status of the parent/caregiver did not have any statistically significant relationship with the occurrence of IDA. This is contrary to Msaki et al. (2022) findings which revealed that children of caregivers who had formal jobs were less likely to have IDA compared to their counterparts who were either unemployed or doing manual/casual jobs. The authors deduced that household heads doing manual/casual jobs tend to get low wages and are less likely to afford iron-rich foods such as animal-sourced foods for their children. This inadequate dietary intake of iron-rich foods will eventually put the child at higher risk of IDA than a child whose caregiver/mother holds a higher-paying professional job. Other authors have debated that maternal employment may lead to reduced time spent on childcare leading to the cessation of breastfeeding, early introduction of complementary feeding, poor adherence to vaccination/immunization schedule and supplementation schedule e.g., Vitamin A which eventually puts the child at risk of poor nutrition (Nankinga et al., 2019). However, this chain of thought is countered by the tremendous benefits that come with maternal employment which positively influence both child and maternal health. Income generated by the mother plays a vital role in contributing to a child's food intake and most importantly health care budget allocation which are key predictors of IDA and poor nutrition (Chipili & Sz, 2018).

In this study, the study area was stratified into three; rural, urban and peri-urban areas, with a keen interest in the prevalence of IDA and the different causative factors in those areas. The prevalence of IDA was highest in the peri-urban areas and lowest in rural areas. However, despite the differences in the prevalence of IDA in these areas, no statistically significant differences were noted in those areas. Contrary to this finding, a

study in India found that children from rural areas are more prone to IDA than children from urban areas (Patel et al., 2021). In Kenya, this may not be the case since children from rural areas tend to have access to plenty of dark green indigenous leafy vegetables and animal-sourced foods due to the presence of kitchen gardens and backyard livestock keeping in many of the households. However, their counterparts in peri-urban areas tend to be the most susceptible to IDA and other micronutrient deficiencies due to the poor living conditions. These households otherwise referred to as the 'urban poor' living below a dollar a day (Wanyama et al., 2019). They also tend to have limited economic access to food and proper healthcare services (Issa, 2021). This might explain the increased prevalence of IDA in these peri-urban areas.

The study findings showed that most of the mothers were categorized under secondary level of education which included both complete and incomplete secondary education. The mothers with secondary education levels had the highest number of children with severe IDA compared to the other groups. These findings are consistent with that of a study in Indonesia which also revealed that lower maternal education was associated with a higher risk of poor nutrition (Laksono et al., 2022). Similarly, a study carried out in Tanzania also found that a low level of maternal education was associated with IDA in children aged 6-59 months (Msaki et al., 2022). Mothers are the main caregivers in most households, they make all the decisions about child-feeding practices including breastfeeding, complementary feeding, health-seeking behaviour and sanitation practices (Chipili et al., 2018). Therefore, a lower education level directly affects the decisions made about child feeding practices which consequently affect their nutrition status. Like many other developing countries, Kenya also considers education level as an essential issue, especially in the rural and peri-urban areas where the education completion rate remains unacceptably low. Many studies have reported that a higher education level is a strong determinant of better health outcomes on the other hand, a poor education level acts as a barrier to better health and nutrition output due to a lack of nutrition knowledge, poor health-seeking behaviour, deep-rooted cultural beliefs and practices (Laksono et al., 2022; Nankinga et al., 2019; Chipili & Sz, 2018; Rashad & Sharaf, 2019). It has also been noted that a low education level is usually accompanied by unemployment or manual jobs which leads to poor socio-economic status and thus reduced access to good nutrition and health care and consequently higher risk of IDA (Msaki et al., 2022). Further, educated mothers have been found to carry out improved child feeding and childcare practices as they tend to be well-informed and exposed (Chipili & Sz, 2018).

Most of the children had a low dietary diversity characterized by consuming less than three food groups the previous day. This is consistent with the findings of Liu et al. (2022) who carried out a study in Western Kenya and found that most of the children in those areas had low DDS and inadequate micronutrient intake. In Kenya, this is expected especially due to the fluctuating food prices and the seasonal scarcity of enhancing citrus fruits and vegetables (Waswa et al., 2021). Dietary diversity is a proxy indicator for micronutrient intake and low dietary diversity has been previously associated with IDA (Mantadakis et al., 20220). Various authors have argued that in developing countries, Kenya included, children's diets are monotonous and are dominated by cereal flours which are rich in phytates and other iron-binding phenols (Othoo et al., 2021; Yirga et al., 2019). This coupled with low consumption of vitamin C rich fruits that promote the absorption of non-heme iron put the children at risk of IDA. The low consumption of animal-sourced foods which are rich in highly bioavailable iron (heme iron) has also been noted in resource-limited countries [Onyangore et al., 2016; Wanyama et al., 2019). This is often due to their high costs and other cultural and/or religious beliefs that prevent children from consuming these foods which poses a risk factor for IDA.

Conclusion

Based on the results of this study, the following conclusions can be made: Almost half of the preschool-aged children suffered from IDA. Children between the ages of 6-12 months were the most susceptible to IDA. Children residing in peri-urban areas were the most affected by IDA. The major predictors of IDA among preschool-aged children in Uasin Gishu County, Kenya were low maternal level of education, low dietary diversity and poor socio-economic status.

Recommendations

From the results found in this study the following recommendations can be made: The government should consider prophylactic iron supplementation for susceptible children, especially between the age group of 6-23 months. Nutrition education interventions should address dietary diversity among preschool-aged children. Public health and nutrition programs should be put in place in peri-urban areas which were the most affected to address macro- and micronutrient deficiencies. Efforts to improve women's education and economic empowerment

should be considered as these are likely to significantly reduce IDA among preschool-aged children. Future studies should consider ascertaining the deworming status of preschool-aged children and assessing the contribution of sanitation practices among the households in Uasin Gishu County.

Acknowledgements

Funding

Conflict of Interest

The authors declare no conflict of interest.

REFERENCES

Abraham, R. A., Agrawal, P. K., Johnston, R., Ramesh, S., Porwal, A., Sarna, A., ... & Ramakrishnan, L. (2020). Comparison of hemoglobin concentrations measured by HemoCue and a hematology analyzer in Indian children and adolescents 1-19 years of age. International Journal of Laboratory Hematology, 42(4). https://doi.org/10.1111/ijlh.13209

Afreen, S., Musthafa, M. M., Sanjeev, R., Himaya, S., & Mohamed, S. (2023). A Comparative Review on Iron Deficiency Anemia among Children and Long-Term Strategy. International Journal of Human and Health Sciences, 7(April 2023), 106–116. https://doi.org/10.31344/ijhhs.v7i2.537

Ali, N. B., Tahsina, T., Hoque, D. M. E., Hasan, M. M., Iqbal, A., Huda, T. M., & El Arifeen, S. (2019). Association of food security and other socio-economic factors with dietary diversity and nutritional statuses of children aged 6-59 months in rural Bangladesh. PloS ONE, 14(8), https://doi.org/10.1371/journal.pone.0221929

Andriastuti, M., Ilmana, G., Nawangwulan, S. A., & Kosasih, K. A. (2020). Prevalence of anemia and iron profile among children and adolescent with low socio-economic status. International Journal of pediatrics and adolescent medicine, 7(2), 88-92. https://doi.org/10.1016/j.ijpam.2019.11.001

Cedrick, I., Agarwal, L., Habyarimana, T., & Ndishimye, P. (2022). Assessment of anemia and its associated risk factors among children under 5 years old attending Rwanda military hospital. World Journal of Pharmaceutical Research, 11(16), 1011-1020. https://doi.org/10.20959/wjpr202216-25944

Chipili, G., J, M., & Sz, M. (2018). Women Empowerment and the Nutrition Status of Children Aged Between 6-59 months. Journal Nutriton and Health Sciences, 5(3), 1–6.

Davies, J., Hannah, C., Guido, Z., Zimmer, A., McCann, L., Battersby, J., & Evans, T. (2021). Barriers to urban agriculture in Sub-Saharan Africa. Food Policy, 103. https://doi.org/10.1016/j.foodpol.2020.101999

FAO. 2011. Guidelines for measuring household and individual dietary diversity. Food and Agriculture Organization of the United Nations, Rome, Italy.

Fisher, S. D. (1999). Complex variables. Courier Corporation.

Gedfie, S., Getawa, S., & Melku, M. (2022). Prevalence and Associated Factors of Iron Deficiency and Iron Deficiency Anemia Among Under-5 Children: A Systematic Review and Meta-Analysis. Global Pediatric Health (Vol. 9, pp. 1–13). SAGE Publications Inc. https://doi.org/10.1177/2333794X221110860

Global Nutrition Report (2022). Stronger commitments for greater action. Bristol, UK: Development Initiatives.

Habitat, U. N. (2013). State of the world's cities 2012/2013: Prosperity of cities. Routledge.

Issa, E. H. (2021). Life in a slum neighborhood of Addis Ababa, Ethiopia : morphological facts and their dysfunctions. Heliyon, 7(5), 1–13. https://doi.org/10.1016/j.heliyon.2021.e07139

Jain, A., & Chowdhury, N. (2020). Comparison of the accuracy of capillary hemoglobin estimation and venous hemoglobin estimation by two models of HemoCue against automated cell counter hemoglobin measurement. Asian Journal of Transfusion Science, 14(1), 49-53. https://doi.org/10.4103/ajts.AJTS_93_17

Kazi, N. H., Qureshi, R., Kousar, T., Saba, A., & Memon, S. A. (2022). Factors Responsible for Iron Deficiency Anemia in Children Under Five Years. Pakistan Journal of Medical & Health Sciences, 16(01), 1047–1049. https://doi.org/10.53350/pjmhs221611047

KNBS. (2019). 2019 Kenya Population and Housing Census. In 2019 Kenya Population and Housing Census: Vol. II.

KNBS and ICF. 2023. Kenya Demographic and Health Survey 2022. Key Indicators Report. Nairobi, Kenya, and Rockville, Maryland, USA: KNBS and ICF

Komo, T. W. (2021). Undernutrition and its associated factors in pre-school children in asembo , siaya county , kenya. Jomo Kenyatta University of Agriculture and Technology.

Kumar, S. B., Arnipalli, S. R., Mehta, P., Carrau, S., & Ziouzenkova, O. (2022). Iron deficiency anemia: efficacy and limitations of nutritional and comprehensive mitigation strategies. Nutrients, 14(14), 2976. https://doi.org/10.3390/nu14142976

Laksono, A. D., Wulandari, R. D., Amaliah, N., & Wisnuwardani, R. W. (2022). Stunting among children under two years in Indonesia: Does maternal education matter? PLoS ONE, 17(7 July), 1–11. https://doi.org/10.1371/journal.pone.0271509

Lawrence, E. M., Rogers, R. G., Zajacova, A., & Wadsworth, T. (2019). Marital Happiness, Marital Status, Health, and Longevity. Journal of Happiness Studies, 20(5), 1539–1561. https://doi.org/10.1007/s10902-018-0009-9

Lemoine, A., & Tounian, P. (2020). Childhood anemia and iron deficiency in sub-Saharan Africa – risk factors and prevention: A review. Archives de Pédiatrie. https://doi.org/10.1016/j.arcped.2020.08.004

Liu, T., Broverman, S., Puffer, E. S., Zaltz, D. A., Thorne-lyman, A. L., & Benjamin-neelon, S. E. (2022). Dietary Diversity and Dietary Patterns in School-Aged Children in Western Kenya : A Latent Class Analysis. International Journal of Environmental Research and Public Health, 19(9130), 1–12.

Machiyama, K., Mumah, J. N., Mutua, M., & Cleland, J. (2019). Childbearing desires and behaviour: a prospective assessment in Nairobi slums. BMC Pregnancy and Childbirth, 19, 1-12. https://doi.org/10.1186/s12884-019-2245-3

Mantadakis, E., Chatzimichael, E., & Zikidou, P. (2020). Iron deficiency anemia in children residing in high and low-income countries: Risk factors, prevention, diagnosis and therapy. Mediterranean Journal of Hematology and Infectious Diseases (Vol. 12, pp. 1–12). Universita Cattolica del Sacro Cuore.https://doi.org/10.4084/MJHID.2020.041

Melku, M., Takele, W. W., Anlay, D. Z., Ekubagewargies, D. T., Getaneh, Z., Abebe, M., & Abebe, Z. (2018). Male and undernourished children were at high risk of anemia in Ethiopia: A systematic review and meta-analysis. Italian Journal of Pediatrics (Vol. 44, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s13052-018-0513-x

Moura, M., Marçal, G. D. M., Di, M., Mafra, G., Maria, T., Toledo, D. M., Bueno, N. B., Paula, A., & Clemente, G. (2020). Association between iron deficiency anaemia and complementary feeding in children under 2 years assisted by a Conditional Cash Transfer programme. Public Health Nutrition, 9. https://doi.org/10.1017/S1368980020002542

Mrema, J. D., Elisaria, E., Mwanri, A. W., & Nyaruhucha, C. M. (2021). Prevalence and Determinants of Undernutrition among 6- To 59-Months-Old Children in Lowland and Highland Areas in Kilosa District, Tanzania: A Cross-Sectional Study. Journal of Nutrition and Metabolism, 2021. https://doi.org/10.1155/2021/6627557

Msaki, R. V, Lyimo, E., Masumo, R. M., Mwana, E., Katana, D., Id, N. J., Munuo, A., Leyna, G., Issaka, I., Dhami, M. V, & Agho, K. E. (2022). Predictors of iron deficiency anaemia among children aged 6 – 59 months in Tanzania : Evidence from the 2015 – 16 TDHS-MIS cross- sectional household survey. PLOS Global Public Health, 2(11), 1–28. https://doi.org/10.1371/journal.pgph.0001258

Murage, M. (2021). Mobile Loans as Financing Options in Kenya and the Financial Performance of SMEs in Low Income Areas in Nairobi County. African Journal of Empirical Research, 2(1&2), 114-122. https://10.0.202.155/ajer.v2i2.21

Muriuki, J. M., Mentzer, A. J., Webb, E. L., Morovat, A., Kimita, W., Ndungu, F. M., Macharia, A. W., Crane, R. J., Berkley, J. A., Lule, S. A., Cutland, C., Sirima, S. B., Diarra, A., Tiono, A. B., Bejon, P., Madhi, S. A., Hill, A. V. S., Prentice, A. M., Suchdev, P. S., … Williams, T. N. (2020). Estimating the burden of iron deficiency among African children. BMC Medicine, 18(31), 1–14.

National Malaria Control Programme (NMCP), Kenya National Bureau of Statistics (KNBS), and ICF International. 2016. Kenya Malaria Indicator Survey 2015. Nairobi, Kenya, and Rockville, Maryland, USA: NMCP,

Nankinga, O., Kwagala, B., & Walakira, E. J. (2019). Maternal employment and child nutritional status in Uganda. PLoS ONE, 14(12), 1–14. https://doi.org/10.1371/journal.pone.0226720

Nyamasege, C. K., Kimani-Murage, E. W., Wanjohi, M., Kaindi, D. W. M., & Wagatsuma, Y. (2021). Effect of maternal nutritional education and counselling on children's stunting prevalence in urban informal settlements in Nairobi, Kenya. Public Health Nutrition, 24(12), 3740-3752. https://doi.org/10.1017/S1368980020001962

Obeagu, E. I., Opoku, D., & Obeagu, G. U. (2023). Burden of nutritional anaemia in Africa: A Review. International Journal of Advanced Research and Biological Sciences, 10(2), 160-163. https://doi.org/10.22192/ijarbs

Ogunniyi, A. I., Omotoso, S. O., Salman, K. K., Omotayo, A. O., Olagunju, K. O., & Aremu, A. O. (2021). Socio-economic drivers of food security among rural households in Nigeria: Evidence from smallholder maize farmers. Social Indicators Research, 155, 583-599. https://doi.org/10.1007/s11205-020-02590-7

Onyangore, F., Were, G. M., & Mwamburi, L. (2016). Prevalence Of Iron Deficience Anaemia and Dietary Iron Intake Among Infants aged Six to Nine Months in Keiyo South Sub County, Kenya. African Journal of Food, Agriculture, Nutrition and Development, 16(2), 10884–10897. https://doi.org/10.18697/ajfand.74.15285

Othoo, D. A., Ochola, S., Kuria, E., & Kimiywe, J. (2021). Impact of Spirulina corn soy blend on Iron deficient children aged 6 – 23 months in Ndhiwa Sub-County Kenya: a randomized controlled trial. BMC Nutrition, 7(70), 1–12.

Patel, K. K., Vijay, J., Mangal, A., Mangal, D. K., & Gupta, S. D. (2021). Burden of anaemia among children aged 6–59 months and its associated risk factors in India – Are there gender differences? Children and Youth Services Review, 122. https://doi.org/10.1016/j.childyouth.2020.105918

Rashad, A. S., & Sharaf, M. F. (2019). Does maternal employment affect child nutrition status? New evidence from Egypt. Oxford Development Studies, 47(1), 48–62. https://doi.org/10.1080/13600818.2018.1497589

Rugema, J., Mukantwari, J., Twagirayezu, I., Tuyisenge, M. J., Rutayisire, R., & Katende, G. (2022). Predictors and factors associated with stunting among under-five-year children: a cross-sectional population-based study in Rwanda of the 2014-2015 demographic and Health Survey. African Health Sciences, 22(4), 671-678. https://doi.org/10.4314/ahs.v22i4.73

Rutayisire, E., & Marete, O. (2020). Prevalence of Iron Deficiency Anaemia and Associated Factors among Children Aged Six to Fifty-Nine Months Seen at Kabutare District Hospital Rwanda. EC Nutrition, 14, 1–12.

Sedgwick, P. (2015). Multistage sampling. BMJ (Online), 351(July), 1–2. https://doi.org/10.1136/bmj.h4155

Uasin Gishu County Integrated Development Plan (UGCIDP) 2018-2022, County Government of Uasin Gishu. http://10.0.0.19/handle/123456789/842

Ughasoro, M. D., Madu, A. J., & Kela-Eke, I. C. (2019). Evaluation of the performance of haemoglobin colour scale and comparison with HemoCue haemoglobin assay in diagnosing childhood anaemia: a field validation study. International Journal of Pediatrics, 2019(1), 3863070. https://doi.org/10.1155/2019/3863070

Wangusi, N. L., Waudo, J. N., & Mugendi, B. (2016). Prevalence and determinants of iron-deficiency anaemia among children 6-23 Months attending Thika level-5 hospital , Kiambu County , Kenya. International Journal of Food Science and Nutrition, 1(6), 28–38.

Wanyama, R., Gödecke, T., & Qaim, M. (2019). Food Security and Dietary Quality in African Slums. Sustainability, 11(21), 1–17. https://doi.org/https://doi.org/10.3390/su11215999

Waswa, L. M., Jordan, I., Krawinkel, M. B., & Keding, G. B. (2021). Seasonal Variations in Dietary Diversity and Nutrient Intakes of Women and Their Children (6 – 23 Months) in Western Kenya. Frontiers in Nutrition, 8(March), 1–20. https://doi.org/10.3389/fnut.2021.636872

World Health Organization (WHO). (2023). Accelerating anaemia reduction: a comprehensive framework for action.

World Health Organization (WHO). (2015). The Global Prevalence of Anemia in 2011. World Health Organization, Geneva.

Yirga, A. A., Mwambi, H. G., Ayele, D. G., & Melesse, S. F. (2019). Factors affecting child malnutrition in Ethiopia. African Health Sciences, 19(2), 1897–1909. https://doi.org/10.4314/ahs.v19i2.13

Zheng, H., Long, W., Tan, W., Yang, C., Cao, M., & Zhu, Y. (2020). Anaemia , iron deficiency , iron-deficiency anaemia and their associations with obesity among schoolchildren in Guangzhou , China. Public Health Nutrition, 23(10), 1693–1702. https://doi.org/10.1017/S1368980019003604