PREVALENCE AND PREDICTORS OF IRON DEFICIENCY ANEMIA AMONG PRESCHOOL CHILDREN: A CASE OF UASIN GISHU COUNTY, KENYA

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DECLARATION

Declaration by the Candidate

This thesis is my original work and has never been presented for the award of an academic degree in any other university and should not be copied or reproduced in any format without written authority from the author and/or University of Eldoret.

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SAGR/FCS/M/008/20

Approval by the Supervisors

This thesis is submitted with our approval as the university supervisors.

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DEDICATION

This thesis is dedicated to my family, who have held my hand through this journey with love, support, and encouragement. I also dedicate this thesis to the children of Uasin Gishu County and beyond, whose health and well-being inspire my passion for understanding and addressing iron deficiency anemia. May this work contribute in some way to improving their future.

ABSTRACT

Iron Deficiency Anemia (IDA) is the most widespread micronutrient deficiency in Africa and South Asia. About 2 billion people in these continents have IDA with approximately 50% of them being children of preschool-age. In Kenya, IDA among preschool-aged children stands at 25% which is relatively high yet very minimal intervention is conducted for that age group. Furthermore, despite the fact that Uasin Gishu County is Kenya's food basket, reports indicate high levels of malnutrition among preschool-aged children in the county with 33% being stunted, 11% being underweight and 3% being wasted. Little is known about micronutrient deficiencies such as IDA in this county despite its tremendous consequences, especially among preschool-aged children. This study therefore sought to contribute towards improved community nutrition by assessing the predictors of IDA among preschool-aged children in Uasin Gishu County. The objectives of this study were; to evaluate the relationship between socio-economic characteristics and IDA among preschool-aged children in Uasin Gishu County, to assess the nutrition status of preschool-aged children through anthropometric measures in Uasin Gishu County, to determine the prevalence of IDA among preschool-aged children in Uasin Gishu County and to determine the influence of dietary diversity on IDA among preschool-aged children in Uasin Gishu County. A cross-sectional study design was used with a target sample size of 289 children aged 6-59 months. A three-tier sampling technique was used consisting of purposive sampling,stratified sampling and simple random sampling. Data was collected by use of researcher-administered questionnaires and the Hemoglobin levels were measured by the use of a portable HemoCue® Hb 201+ system. WHO Anthro Software and STATA version 18 were used to analyze data. From the results it's evident that the prevalence of IDA was 48.4%. The highest number of children suffering from IDA were between the ages of 6-12 months (44.4%) and 24-35 months with (44.8%) There was no statistically significant relationship between IDA and children's age group, (χ^2 = 5.5201, p-value=0.701). Children from married parents were 4.53 times more likely to be normal (not suffering from IDA) [Odds ratio (OR):4.53; 95%CI], p-value <0.01. An increase in wealth was found to be associated with a decreased risk of IDA, [OR: 5.45; (95% CI, 1.18 to 5.125), p-value<0.01]. A statistically significant relationship between dietary diversity and IDA, Tau (2, N = 289) = 0.0667, p-value = 0.0445. The predictors of IDA are poor nutrition status, low maternal education, low dietary diversity and low household wealth index. Due to the high prevalence of IDA, the government should consider prophylactic iron supplementation for susceptible children.

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LIST OF ABBREVIATIONS

CDDS	Child Dietary Diversity Score
DDS	Dietary Diversity Score
FAO	Food and Agriculture Organization
FFQ	Food Frequency Questionnaire
GDP	Gross Domestic Product
Hb	Hemoglobin
IDA	Iron Deficiency Anemia
IYCF	Infant and Young Child Feeding
KDHS	Kenya Demographic Health Survey
KNBS	Kenya National Bureau of Statistics
SDG	Sustainable Development Goals
SPSS	Statistical Package for the Social Sciences
UG-CIDP	Uasin Gishu County Integrated Development Plan
UNICEF	United Nations Children's Fund
WHO	World Health Organization

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CHAPTER ONE

INTRODUCTION

1.1 Background

Malnutrition specifically undernutrition accounts for almost half of the mortality cases among preschool-aged children worldwide translating to more than 3 million deaths yearly (Global Nutrition Report, 2021). Globally, 149.2 million children below 5 years are stunted whereas 45.5 million children are wasted (Global Nutrition Report, 2021). Approximately 75% of these undernourished children are from Sub-Saharan Africa and Asia (Munawar et al., 2024). An estimated 239 million children in Africa are affected by chronic malnutrition (Chacha & Laswai, 2020). Therefore, tackling malnutrition in all its forms remains among the key objectives of the global nutrition agenda and is indicated as the sustainable development goal 2 (SDG 2); Zero Hunger.

An estimated 239,446 children in Kenya have moderate acute malnutrition (MAM) with 10% of these children suffering from severe acute malnutrition (SAM) (Gudu et al., 2020). According to the Global Nutrition Report (2021), 3500 children under the age of five years die annually due to malnutrition. The Kenya Demographic Health Survey (KDHS) report shows that 26% of preschool-aged children suffer from stunting and this has been linked to decreased productivity in adulthood (KNBS & ICF, 2023). The Kenya National Bureau of Statistics (KNBS) estimates that 12 million Kenyans are food insecure, and this is the leading contributing factor for malnutrition due to insufficient household dietary intake (KNBS, 2018). The COVID-19 pandemic, natural calamities especially in Northen Kenya(droughts and locust outbreaks) and other livestock diseases have made the household food insecurity problem worse (Ouko et al., 2023). The COVID-19 pandemic revealed the flaws in the global food systems and Kenya was not

exempted, the pandemic restrictions affected food accessibility, availability and affordability.

Hidden hunger also referred to as micronutrient deficiency is becoming more prevalent and is a major public health issue that primarily affects preschool-aged children (DeLoughery, 2017). Iron Deficiency Anemia (IDA) is the most widespread micronutrient deficiency in developing countries in Africa and South Asia (Wangusi et al., 2016). IDA affects about 20% (2 billion people) of the world's population in developing nations with roughly half of these individuals being preschool-aged children (Mantadakis et al., 2020). IDA is five times more common in developing nations than in developed nations (Obeagu & Obeagu, 2023). According to the Global Nutrition Report (2022), 38 of the 125 developing nations that suffer from anemia also suffer from stunting. Globally, IDA is one of the top risk factors for disability-adjusted life years and among the leading causes of disability. Approximately 75% of the world's mortality burden and over half of the disability-adjusted life years occur in Africa and Asia (Blankenship et al., 2020). Early childhood anemia has been linked to congestive heart failure, poor cognitive development and increased morbidity and mortality (Parkin et al., 2016). Furthermore, poor mental development, psychomotor skills and emotional intelligence are also associated with IDA (Gashu et al., 2016). The Kenya Micronutrient Survey report states that 21% of preschool-aged children have IDA, despite this, very little intervention is carried out for this age group.

Kenya's economy is heavily dependent on agriculture, which accounts for 33% of the GDP and another 27% indirectly through its link to other industries such as transport (Food and Agriculture Organization [FAO], 2021). Despite agriculture being the nation's main source of income, 35% of preschool-aged children suffer from chronic malnutrition while 36.5% of the population still experiences food security (FAO, 2021).

This is also the case at the county level, with the agricultural based counties which are significant food producers still facing nutrition problems. For example, Uasin Gishu County is primarily an agricultural county with a high reliance on both crop and livestock products under a total acreage of 138,609 hectares. According to the data from the Uasin Gishu County Integrated Development Plan (UG-CIDP) (2019-2022), there is a high production of livestock products, particularly meat and milk, with an annual production of 2.5 million kilograms and 200 million kilograms respectively (Uasin Gishu County Government, 2023). Despite this region being a rich agricultural zone and among the leading food producers in Kenya, reports indicate high levels of malnutrition among preschoolaged children with 33% being stunted, 11% underweight and 3% wasted (Uasin Gishu County Government, 2023). Furthermore, the prevalence of stunting (33%) in this county is slightly higher than that of the national prevalence which stands at 26%. Small-scale backyard livestock rearing at the household level is the most widespread form of livestock keeping in the county producing up to 50% of the milk sold in the local markets. However, poverty levels and incidences of food insecurity remain to be a major concern in the county.

Malnutrition and dietary intake are directly intertwined in the UNICEF malnutrition conceptual framework. Diets of children in developing countries, Kenya included predominantly consist of starchy staples such as; maize (*ugali*) as well as plant-based proteins with very minimal intakes of animal-source foods and fruits (Onyangore et al., 2016). Therefore, understanding the dietary patterns of preschool children and the many complex socio-economic and demographic factors such as maternal education level, occupation, income, farming practices etc is vital to explain IDA and overall nutrition status comprehensively. Therefore, this study aimed to assess the prevalence and predictors of IDA among preschool-aged children in Uasin Gishu County, Kenya.

1.2. Problem Statement

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. Uasin Gishu County is a rich agricultural county well known for crop and livestock farming, however, despite the county being a major food producer it still suffers the Triple Burden of Malnutrition. In addition, there are very few empirical studies on micronutrient deficiencies such as IDA in this county despite its tremendous consequences, especially among preschool-aged children. Similar to 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. 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. 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.

1.3. Justification of the Study

Preschool-aged children are the most vulnerable to malnutrition and the resulting morbidity and mortality. In developing nations, more than 25% of preschool-aged children suffer from malnutrition (Gedfie et al., 2022). Malnutrition ranks third among the global disease burden in this age group, accounting for 3.5 million deaths annually (Gedfie et al., 2020). Additionally, 25-30% of deaths in developing countries is among

preschool-aged children (Gedfie et al., 2020). According to WHO (2020), approximately 5.4 million preschool-aged children die annually, with half of these deaths taking place in Sub-Saharan nations. As a result, this age group is crucial to study to develop effective interventions to address nutrition and subsequently lower the preschool-aged child morbidity and mortality rate. This makes it necessary to research preschool-aged children and evaluate their dietary practices and nutritional status in Uasin Gishu County.

Several authors have established that the diets of children especially in developing countries; Kenya included predominantly consist of staples (such as maize; *ugali*) and plant-based proteins with very low intakes of animal-source foods, which are below the dietary recommended intake levels (Gashu et al., 2016; Onyangore et al., 2016). Gashu et al. (2016), also noted that foods of rural populations in developing countries are dominated by non-refined cereals which are high in phytates that form insoluble complexes with minerals such as iron leading to limited bioavailability of the micronutrient. Many researchers have also found the presence of mild to moderate IDA among preschool-aged children in Kenya (Onyangore et al., 2016; Wangusi et al., 2016). Therefore, it is necessary to determine the haemoglobin levels of preschool-aged childrenin relation to their dietary patterns and consequently assess the prevalence of IDA among the target group.

1.4 Research objectives

1.4.1 Broad Objective

To investigate the prevalence and predictors of IDA among preschool-aged children in urban, peri-urban and rural areas of Uasin Gishu County, Kenya.

1.4.2 Specific Objectives

The specific objectives of this study were;

1. To determine the socio-demographic and economic characteristics of the preschool-aged children in urban, peri-urban and rural areas of Uasin Gishu County.
2. To determine the prevalence of IDA among preschool-aged children in Uasin Gishu County using hemoglobin levels.
3. To analyze the nutrition status of preschool-aged children in Uasin Gishu County using anthropometric measurements.
4. To assess the dietary diversity of preschool-aged children in Uasin Gishu County.

1.4.3. Research Questions

1. What are the socio-economic and demographic characteristics of preschool-aged children in Uasin Gishu County?
2. Do household characteristics such as socio-economic variables influence IDA among preschool-aged children?
3. What is the association between nutrition status and IDA among preschool-aged children?
4. Is there an association between dietary diversity and IDA among preschool-aged children?

1.5. Significance of the Study

This research will be fundamental in making efforts to address Infant and Young Child Nutrition (IYCN) outcomes in Kenya. It will be significant to stakeholders such as the Ministry of Health at the national and county levels, the Micronutrient Initiative, UNICEF and other concerned non-governmental organizations to ensure effective implementation of child nutrition policies. The study findings will also provide information on household and child dietary diversity as well as household food and nutrition security to the relevant policymakers at the County Government of Uasin Gishu and the wider national government to make an informed decision on food

security and nutrition through local food systems. Furthermore, data from the IDA assessment will assist the health caregivers in all health facilities to put in place appropriate strategies for preventive intervention among preschool-aged children. Additionally, the study findings will also help health authorities understand the prevailing situation and address any observed gaps to ensure that all children in the country are guaranteed the right to quality health and nutrition. Lastly, the study adds to the global body of knowledge on micronutrient deficiencies, offering a region-specific perspective that can inform tailored strategies, programs aimed at mitigating IDA and information to future researchers in this area of study.

1.6. Scope and Limitations

This study considered only preschool-aged children (between 6- 59 months of age) paired with their mothers. The study was carried out in Uasin Gishu County but only focused on 5 sub-counties which are; Ainabkoi, Soy, Kapseret, Moiben and Turbo. This study only investigated malnutrition forms related to wasting, stunting, underweight and IDA. There were several limitations in this study, these include; first, the cross-sectional design captured data at a single point in time, which limited the ability to infer causality or observe changes over time. Self-reported data from mothers may introduce recall bias, affecting the accuracy of dietary and socioeconomic information. To reduce recall bias, we used memory aids, simplified questionnaires and triangulated self-reported dietary data with other sources. Encouraging mothers to focus on recent dietary and socioeconomic experiences also helped in improving data accuracy. This study focused on specific predictors such as marital status, wealth, and dietary diversity, potentially overlooking other relevant predictors like genetics, environmental influences, and healthcare access. Lastly, the regional focus on Uasin

Gishu County may restrict the findings generalizability to other areas with different and distinct demographic and socioeconomic characteristics.

1.7 Conceptual Framework

This research adopted and modified the UNICEF conceptual framework on the Determinants of Maternal and Child Nutrition (2020). The framework identifies three types of determinants; the enabling, underlying and immediate determinants that influence children's nutritional outcomes. This model links various social-organizational levels to the causes of undernutrition. The framework states that, the environment, political stability, governance and economic structure make up the enabling determinants at the societal level. The ability of households, and particularly children, to obtain adequate nutrition is impacted by social factors like gender, income and poverty. According to this study, environmental determinants included proper waste disposal, water treatment, toilet ownership and hand washing habits.

Socio-demographic characteristics like the mother's /caregiver's age, income, marital status, occupation and educational attainment were enabling determinants of interest for this study. These factors may have an impact on the food and nutrition security of the household. Inadequate maternal knowledge of food choices and child dietary diversity were the underlying determinants in this study. Dietary intake and dietary diversity were the immediate determinants in this study. As illustrated in Fig 1.1, all these factors will subsequently result in both poor nutritional status and IDA among preschool-aged children.

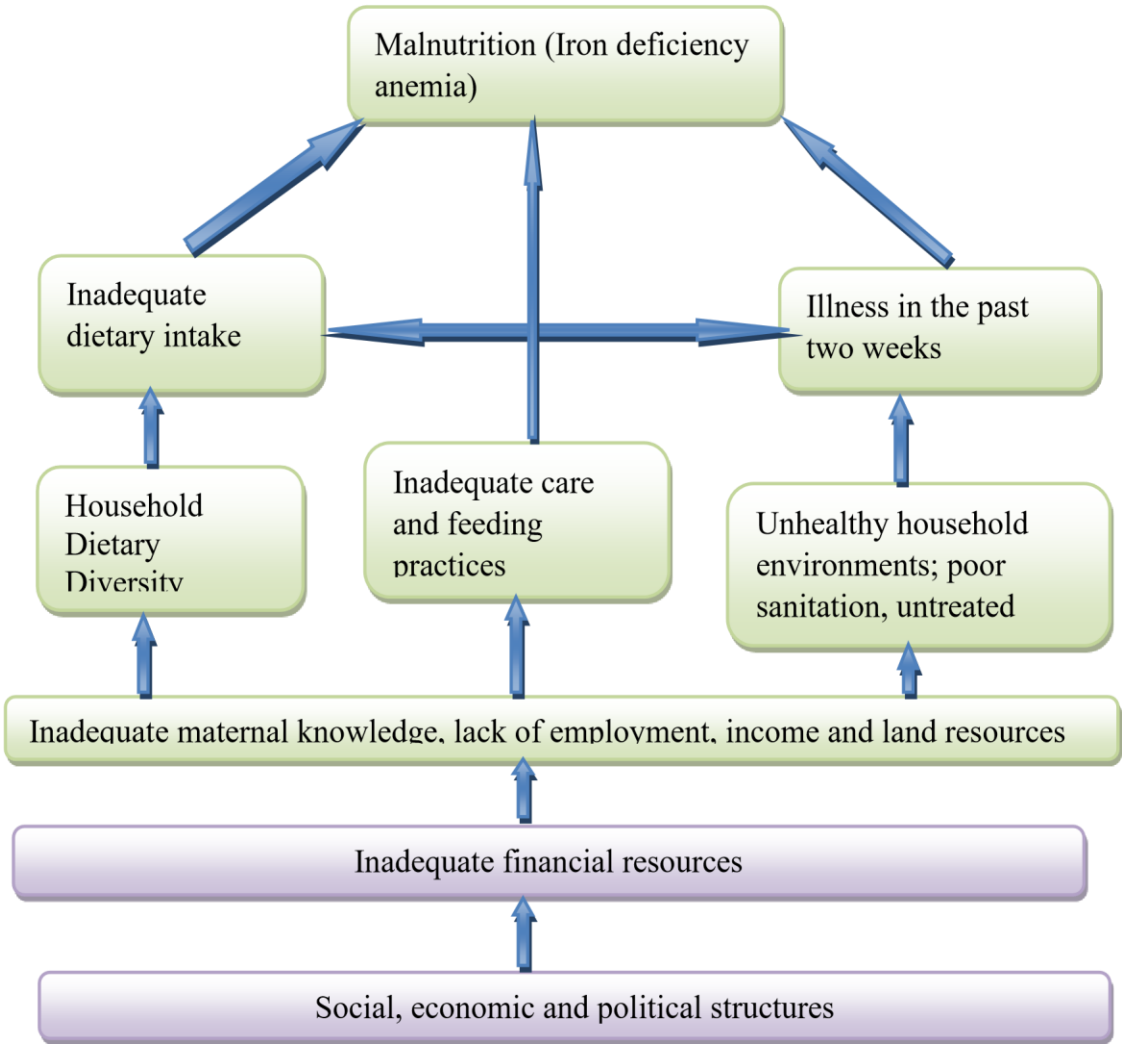

Fig 1.1: Conceptual Framework

Source: Adopted from UNICEF (2020). (The green colored boxes show the section of the flow chart that directly relate to the study).

CHAPTER TWO

LITERATURE REVIEW

2.1. Overview of Iron Deficiency Anemia

2.1.1. Global and regional prevalence of IDA

IDA remains the most prevalent micronutrient deficiency worldwide accounting for 50% of all anemia (Mantadakis et al., 2020). According to WHO, an estimated 1.6 billion people and 800 million children have anemia globally (WHO, 2020). Worldwide, IDA affects close to 273.2 million or 41.7% of preschoolers (Habib et al., 2023). The bulk of IDA cases are found in low and middle-income countries, with African countries leading with an estimated 60% of preschoolers being affected by IDA (Ishimwe et al., 2020). It is a major public health concern in Africa especially since the continent is a malaria-endemic zone (Zewude & Debusho, 2022). In Kenya, according to the Kenya Micronutrient Survey (KMS) report, 21% of children from 6-59 months have IDA. Most recently, a survey conducted by the Ministry of Health in partnership with Kenya Medical Research Institute under the Kenyan Malaria Indicator Survey (KMIS) in 2015, found that 25% of children had IDA with the prevalence being highest in infancy (6-24 months).

2.1.2. Health Consequences of IDA

IDA manifests various symptoms in a person which include; pallor of the skin, the eyes and the nail beds as well as; fatigue, dyspnea which progresses to difficulty in breathing when resting, headache, vertigo and tachycardia (Bathla & Arora, 2021). Several observational studies have shown an association between IDA and poor cognitive development outcomes among children aged 6-59 months (Accinelli & Leon-Abarca,

2020; Donahue Angel et al., 2017; Habib et al., 2016). IDA causes alterations in the structure and functioning of the brain, an effect which is irreversible even upon treatment (WHO, 2020). This occurs when the deficiency takes place in infancy during which neurogenesis and differentiation are occurring in different sections of the brain. However, a clear causal relationship between IDA and delayed cognitive development has not been fully established (WHO, 2017). Impaired cognitive development leads to decreased productivity among children, which later affects their adult life. According to WHO (2020), economic losses due to physical and cognitive impairment associated with IDA have been estimated at US$ 3.64 per person or 0.81% of the GDP in developing nations. This is even greater in countries where IDA is most prevalent, for instance in India, lifetime costs associated with IDA among children aged 6-59 months stand at 8.3 million USD.

2.1.3. Biochemical tests for IDA

IDA is frequently assessed at a population level by measuring blood hemoglobin concentration (Hb). However, though less frequently used, IDA can be diagnosed by measuring; hematocrit, mean cell volume, blood film analysis, Hb electrophoresis and blood reticulocyte count (WHO, 2020). Hb varies with age, sex, altitude and physiological state thus WHO has established cut-off values of Hb level that are sex-, age- and pregnancy-specific (Table 2.1.). Hb is relatively easy to measure in a field set up by the use of portable electronic devices such as the

HemoCue that do not require highly skilled individuals to carry out the measurements. However, due to the nature in which Hb varies in normal and iron-deficient individuals, it is not considered the most suitable indicator for IDA. This is because Hb is

influenced by physiological conditions such as the presence of a chronic disease or inflammation, which are mostly high in developing countries.

Therefore, the most precise and effective biochemical indicator is the use of serum ferritin (DeLoughery, 2017). This measurement can be carried out in addition to a Hb measurement to ascertain whether anemia is a result of iron deficiency. Serum ferritin is a measurement of the total body iron stores in a healthy individual, ferritin levels increase when the iron stores are present and consequently decrease when the iron stores are depleted. According to WHO (2020), a serum ferritin level of below 12µg/L among preschool-aged children is an indicator of depleted iron stores. Other biochemical tests for iron deficiency include; the measure of serum transferrin receptor, total iron-binding capacity, transferrin saturation, erythrocyte protoporphyrin, zinc protoporphyrin or bone marrow biopsy.

Table 2.1. Cut off points for haemoglobin levels(g/dl)

Population (age group)	**Mild anemia**	**Moderate anemia**	**Severe anemia**
Children 6-59 months	10.0-10.9	7.0-9.9	<7.0
Children, 5-11 years	≥11.5	8.0-10.9	<8.0
Children, 12-14 years	≥12.0	8.0-10.9	<8.0
Non-pregnant women, > 15 years	≥12.0	8.0-10.9	<8.0
Pregnant women	≥11.0	7.0-9.9	<7.0
Men, 15 years and above	≥13.0	8.0-10.9	<8.0

Source: (WHO, 2020)

2.2. Predictors of IDA among preschool-aged children

Several studies carried out in different settings have found various factors associated with IDA commonly divided into three; household-level factors, community-level factors and intrinsic or individual factors (Bathla & Arora, 2021; Donahue Angel et al., 2017; Gedfie et al., 2022; Keokenchanh et al., 2021; Wirth et al., 2022). The household-level factors commonly referred to as socio-demographic characteristics discovered to be connected to IDA are; maternal age, maternal education level, marital status, household wealth index, family size or parity, household food security status and ethnicity (Gedfie et al., 2022; Keokenchanh et al., 2021). On the other hand, the community-level factors are residence (whether; rural, urban or peri-urban), cultural beliefs and practices (Keokenchanh et al., 2021). Lastly, the intrinsic factors include; child's age, gender of the child and health condition of the child (Accinelli & Leon-Abarca, 2020).

2.2.1. Household-level predictors

2.2.1.1. Maternal Marital status and Education Level

The contribution of maternal marital status to the nutrition status of a child has conflicting findings, with some authors establishing a significant difference between marital status and IDA while others find no significant associations. For instance, a study carried out in Tanzania found that children residing with single parents specifically a mother only were more prone to be stunted with an odds ratio of 2.11, 95% CI (Ishimwe et al., 2020). Whereas, a study conducted in Rwanda found no significant relationship between maternal marital status both stunting and IDA (Donahue Angel et al., 2017).

On the other hand, maternal education level has been proven to have a significant effect on the nutrition outcomes of a child by various studies (Gedfie et al., 2022; Habib et al., 2016; Keokenchanh et al., 2021; Wirth et al., 2022; Zewude & Debusho, 2022). These findings are supported by that of KDHS report which shows that children from mothers who had low education levels i.e. no formal education and primary level were most affected by malnutrition in all its forms (KNBS & ICF, 2023). Whereas children from mothers with a tertiary level of education had the lowest prevalence of acute and chronic malnutrition.

2.2.1.2. Household Food Security

Household food security characterized by the availability and accessibility of food by the household plays a critical role in the nutrition status of the household and most especially for the preschoolers. A study carried out in Pakistan found a widespread food insecurity situation attributed to the economic instability at that time, the authors established a significant association between household food insecurity and IDA among children (Habib et al., 2016). These findings concur with that of a study carried out in Indonesia that indicated a significant relationship between food insecurity and the nutrition status of preschoolers (Ginting, 2022). The author established that 36.5% of children who were undernourished were from food insecure households.

2.2.1.3. Household Wealth Index

The household wealth index is a direct indicator for household economic accessibility to food and quality health care and consequently to a child's nutrition status. According to the recently released KDHS report household wealth index has been categorized into five wealth quintiles; lowest, second, middle, fourth and highest wealth quintile

(KNBS & ICF, 2023). The report shows that malnutrition in all its forms; stunting, wasting and underweight is highest among the poor households (lowest and second lower wealth quintiles) and lowest among the richest households. These findings are similar to the findings of Wirth et al. (2022) who carried out a study in Somalia and found that household wealth was associated with IDA in children. The author noted that children residing in households within the highest wealth quintile were less prone to have IDA compared to those in the lowest wealth quintile.

The wealth index determines the household's capacity to purchase nutritious foods and this might explain the trend in good nutrition among children from households within the highest wealth quintile (Ginting, 2022). Alternatively, other authors have noted that children from households within the lowest wealth quintiles have more exposure to poor water and sanitation practices and thus are more exposed to infections associated with IDA eg; helminth infestation unlike their counterparts living in households from the highest wealth quintile who have limited exposure (Wirth et al., 2022).

2.2.1.4. Parity

The number of births is a key factor, especially in maternal iron stores. This has a ripple effect on the child since children from 0-6 months depend solely on the maternal iron stores. A Taiwan study comparing the occurrence of IDA in nulliparous and multiparous women, established that IDA is more common in multiparas than in nulliparous women (Imai, 2020). This is mostly due to the blood loss that occurs during delivery and the low adherence by pregnant women to the recommended micronutrient supplementation (Iron and Folic Acid). Therefore, more number of births exposes a woman to a chain of iron depletion before the body has fully replenished its iron stores

(Wirth et al., 2022). This results in depleted iron stores in the fetus leading to adverse birth outcomes.

2.2.2. Community level predictors

2.2.2.1. Residence

There is conflicting evidence regarding the relationship between IDA and the residence of a child. Some studies show significant differences between children living in rural and urban centres while others have contrary findings. For instance, a study carried out in Pakistan established that children residing in rural areas were less prone to IDA unlike their counterparts in urban areas (Habib et al., 2016). The authors noted that most of the children in rural areas in Pakistan had access to dark green leafy vegetables, which explained their reduced risk of IDA. These findings concur with the findings of Donahue Angel et al. (2017) who also found disparities in the occurrence of IDA among children in the North and South provinces of Rwanda. Several studies have also shown that residence in regards to whether the child lives in a highland or lowland is also a key contributor as many populations in higher altitudes have a higher Hb concentration (Accinelli & Leon-Abarca, 2020). This is mainly due to the low environmental oxygen pressure to which they are exposed in their day-to-day lives. These findings are consistent with that of a study in Lao People's Democratic Republic which showed that children who resided in mountainous areas of altitudes 1500m above sea level had a higher Hb and lesser risk of IDA compared to those residing in lowland areas of altitudes < 1000m (Keokenchanh et al., 2021).

2.2.3. Individual-level Predictors

2.2.3.1. Child's Age

A Kenyan study by Wangusi et al. (2016), established that children aged 12-23 months were less prone to IDA compared to their counterparts of age 6-12 months. The author found that children aged 12-23 months had the lowest mean cell volume of 51FL and hence were less prone to IDA. These findings suggest that as a child's age increases the risk of being affected by IDA also increases. These findings concur with the findings by Zewude & Debusho (2022) who also reported a significant relationship between age and the occurrence of IDA among children below 5 years. However, these findings are contradictory to the findings by Keokenchanh et al. (2021) who found that older children aged; 12-23 months, 24-35 months, 36-47 months and 48-59 months were less likely to have IDA compared to those aged 6-11 months. These disparities in haemoglobin levels among children of different ages have led to an increased need for the adoption of age specific criteria in IDA diagnosis since studies have shown a gradual increase in haematological levels as the child grows (Accinelli & Leon-Abarca, 2020).

2.2.3.2. Gender of the Child

Several studies have established a difference in haemoglobin levels between male and female children however upon analysis, no significant relationship was found (Gedfie et al., 2022; Keokenchanh et al., 2021; Zewude & Debusho, 2022). A study carried out in Lao People's Democratic Republic among children aged 6-59 months found an increased odds of developing IDA among male children than female children (Keokenchanh et al., 2021). These findings have been backed up by other studies carried out in India, Brazil and Sub-Saharan Africa (Awasthi et al., 2021; Gedfie et al.,

2022). This variation in the occurrence of IDA in male and female children has been noted due to their different physiological processes with boys having a relatively higher growth rate than girls thus requiring more iron during their early years of life.

2.2.3.3. Nutrition Status of the Child

The majority of micronutrient deficiencies are a manifestation of a long duration of deprivation of a particular nutrient, thus most of the time chronic malnutrition goes hand in hand with micronutrient deficiency. One of the key forms of chronic malnutrition of concern is stunting. Multiple studies have shown an association between IDA and stunting in children under 5 years of age (Donahue Angel et al., 2017; Habib et al., 2016; Wirth et al., 2022; Zewude & Debusho, 2022). Wirth et al. (2022) observed that stunted children were more prone to have IDA than non-stunted children. The author hypothesized that this association might be because both conditions were caused by poor diets and long periods of nutritional deprivation, which are potentially their main causes. These findings are similar to the findings of Keokenchanh et al. (2021) who also found a significant relationship between underweight and IDA in children.

2.2.3.4. Child's health/disease State

Infection and inflammation significantly alter the Hb and serum ferritin levels of an individual and are thus a key predictor of IDA. Infections such as; HIV/AIDS, malaria and parasitic infestations contribute to IDA and lead to a vicious cycle of anaemia throughout life (Bathla & Arora, 2021). Prsechoolers in malaria endemic zones are more prone to IDA, this is because malaria causes the suppression of erythropoietin activity hence leading to the breakdown of red blood cells and consequently IDA. On

the other hand, parasitic infestation such as hookworm infestation prevents the body from restoring iron levels and thus leads to IDA.

Serum ferritin is a protein and thus its concentration increases in response to either infection or inflammation (DeLoughery, 2017). Therefore, WHO recommends that during iron status assessment, markers of infection and inflammation should also be measured (WHO, 2020). Since these markers are vital in differentiating and determining, whether anemia is due to an acute or chronic disease state rather than a micronutrient deficiency. However, this is very difficult to practice. The markers of infection and inflammation include C-reactive protein (CRP) and alpha-1 acid glycoprotein (AGP).

2.3. Nutrition status of Preschool-aged Children

Current statistics by the World Health Organization (2021) indicate that globally, 149 million children below 5 were stunted (too short for age), 45 million were wasted (too thin for height), and 38.9 million were overweight or obese. Despite reductions in stunting, 150.8 million children (22.2%) below 5 years are stunted, 50.5 million children under five are wasted and 20 million newborn babies are estimated to be of low birth weight, while 38.3 million children under five years of age are overweight. Around 45% of deaths among children under 5 years of age are linked to undernutrition. These mostly occur developing countries.

UNICEF estimates that in Kenya, 239,446 children suffer from MAM and 2600 children suffer from SAM (Gudu et al., 2020). The KDHS reports that 26% of children < 5 years are stunted, 4% are wasted, and 11% are underweight (KNBS & ICF, 2023). As of April 2021, 26.2% of children under five years were affected by chronic malnutrition in Kenya. The lack of adequate nutrients over a long period leads the

infants to growth failure. In the same period, 4.2 per cent of the children were affected by acute malnutrition, which concerns a rapid deterioration in the nutritional status over a short period. deterioration in the nutritional status over a short period. The country though has made substantive strides in reducing the prevalence of stunting nationally, falling from 35% in 2008 to 26% in 2014 (KNBS & ICF, 2023). Stunting is highest in the Coast, Eastern, and Rift Valley regions. It is most prevalent among children 18-23 months, indicating that poor complementary feeding, hygiene, and sanitation practices likely contribute to stunting in that age group. This present study focused on the Rift Valley region, which is most affected by stunting. Uasin Gishu is one of the Counties in the region where a marked prevalence of malnutrition has been observed. In Uasin Gishu County, 31% of preschoolers suffer from stunting, 3% from wasting and 11% from underweight, the stunting prevalence is marginally greater than the national prevalence. This represents 77,651 malnourished children (UGCIP, 2017).

2.4. Dietary Diversity of Preschool-aged Children

Dietary diversity directly affects children's nutritional status and is a vital element of healthy diets. Dietary diversity affects children's health outcomes and considered a method to assess dietary quality, micronutrient adequacy, and food access (Gashu et al., 2016). Research indicates that insufficient nutritional diversity and quality causes undernutrition, which manifests as wasting, underweight, and stunting (Awasthi et al., 2021; Gashu et al., 2016; Khamis et al., 2019). For proper growth and development, WHO recommends that children, especially preschoolers, should eat at minimum four of the following seven food groups: grains, roots, and tubers; legumes and nuts; dairy products; flesh foods (meat, fish, poultry, and organ meats); eggs; and other fruits and vegetables that are high in vitamin A (FAO & FHI 360, 2016).

Dietary diversity is a gauge of micronutrient adequacy and may increase the nutritional density of complementary food therefore supporting children's growth and development (Khamis et al., 2019). Inadequate dietary intake places children at risk for major illnesses, opportunistic infections and undernutrition (Aboagye et al., 2021). It has been discovered that the diets of many developing nations are less varied, particularly for preschool-aged children. Phytates, which bind to iron and form insoluble complexes that lower iron's bioavailability, are typically found in unrefined cereals and legumes consumed by low-income rural populations. (Gashu et al., 2016). These groups eat comparatively fewer foods derived from animals, which are high in readily available iron and function as stand-alone enhancers of iron absorption. Therefore, in addition to insufficient dietary intake, decreased iron bioavailability may be the main cause of IDA. The diets of most African rural communities are low in animal-based foods and high in plant-based foods.

2.6 Summary of literature and gap in knowledge

Existing literature extensively covers the prevalence, risk factors, and consequences of iron deficiency anemia (IDA) among preschool-aged children, highlighting dietary intake, infections, and socioeconomic factors as key contributors. Studies have also explored the effectiveness of various interventions, including micronutrient supplementation and dietary diversification, in addressing IDA. However, there is a paucity of literature specific to Uasin Gishu County regarding the causative factors of IDA among preschool-aged children, particularly in relation to local dietary habits, health-seeking behaviors, environmental influences and socio-economic factors. This study aims to fill this gap by investigating the specific predictors of IDA in this context, providing evidence-based insights to guide targeted interventions.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the research methodology employed in the study, detailing the procedures used to collect and analyze data.

3.2 Study Design

The cross-sectional survey design was adopted. This study design was the most ideal as it allowed for the simultaneous examination of multiple variables, providing insights into potential predictors, which can guide further research and intervention planning (Sodde et al., 2023).

3.3 Study area

Uasin Gishu County located in Kenya's Rift Valley region lies between longitudes 340 50'East and 350 37' East and latitude 00 03' South and 00 55' North, covering approximately 3345.2km^2 It borders Trans Nzoia County to the North, Elgeyo Marakwet County to the East, Baringo County to the South East, Kericho County to the South, Nandi County to the South West and Kakamega County to the North West (Appendix I). The altitude ranges from about 1500m to 2700m above sea level and features plateau and highland areas transversed by major rivers such as Kipkaren and Sosiani. Ecologically, the county falls within highland zones, characterized by fertile volcanic soils and reliable rainfall averaging 625- 1,560mm annually. The temperatures range between 7°C and 29°C, which is favorable for both crop and livestock production. Livestock rearing, particularly dairy farming, is the main source of livelihood for the county's households. These geographic, ecological and livelihood

conditions influence household food security and dietary diversity, making Uasin Gishu County a relevant study area. Ten wards representing characteristic features of urban, peri-urban and rural areas were selected from Eldoret East region of Uasin Gishu County as shown in Table 3.1 (Appendix I).

Table 3.1. Study wards and in the respective sub-counties

Sub-County	**Study Wards**
Turbo	*Kiplombe* *Huruma* *Kapsaos*
Moiben	*Kimumu* *Tembelio* *Sergoit*
Ainabkoi	*Kapsoya*
Kapseret	*Langas* *Racecourse*
Soy	*Kiunet Kapsuswa*

3.4 Study Population

Uasin Gishu County has a population of 1,163,186 and hosts 304,943 households as per 2019 census (KNBS, 2019). Furthermore, the population of children below 5 years of age (preschool-aged children) stands at approximately 236,039 children (UGCIPD, 2023). The target population in this study was preschool-aged children of 6-59 months.

3.5 Sample Size

Fisher's statistical formula was used to determine the sample size of 318 preschoolaged children (Fisher's et al, 1999) as shown below;

$$\mathbf{N} = \frac{\boldsymbol{Z^2 \times p \times q}}{\boldsymbol{d^2}}$$

Where;

n- The desired sample size when the population is more than 10,000

Z- The standard normal deviation at the required confidence level

p- The proportion in the target population estimated to have characteristics being measured (Prevalence of IDA in Kenya among preschool-aged children that is 25%)

q= 1-p d=level of statistical significance set Therefore; z= 1.96

p= prevalence of IDA among pre-school aged children in Kenya 25% (0.25) (Kenya Malaria Indicator Survey Report, 2015) d=0.05 q= 1- 0.33=0.67

n= 289 preschool-aged children + 10% attrition rate (29 children)

n= 318 preschool-aged children

The sample size for the three strata (urban, peri-urban and rural areas) was calculated using the proportionate stratified sampling method (Naissuma, 2000). The sample for the three strata was obtained using the formula below:

$$\frac{number\ of\ households\ in\ the\ stratum}{total\ number\ of\ households\ in\ Uasin\ Gishu\ County} \times study\ sample$$

The sample size for the strata was disproportionate whereby; rural (70 households), urban (61 households) and peri-urban (187 households)

3.6 Sampling Procedure

A three-tier sampling technique was incorporated in this study consisting of purposive, stratified random and simple random sampling as shown in Figure 3.1 (Sedgwick,

2015). Uasin Gishu County was purposively selected due to its high prevalence of stunting (33%) compared to the national prevalence of 26%. The study area was then stratified into 3 strata with each stratum having similar characteristics either representing urban, peri-urban and rural areas (Rahman et al, 2022). These strata were selected from 10 wards; Langas, Huruma and Kiplombe wards representing periurban areas, Kiunet/Kapsuswa, Kapsaos, Sergoit and Tembelio wards representing rural areas, and Kapsoya, Racecourse and Kimumu wards representing urban areas. This was done so as to give a good representation of the county as well as a basis of comparison for the urban, peri-urban and rural areas (Rahman et al, 2022). Simple random sampling was done to select households with preschool-aged children and their caretakers. This was done through prior mapping of the households by use of GPS software known as Maps.me. The use of this application in the research was crucial for accurately mapping and identifying households with preschool-aged children, ensuring a random and unbiased sampling process It enhanced the efficiency of locating sampled households using GPS coordinates.

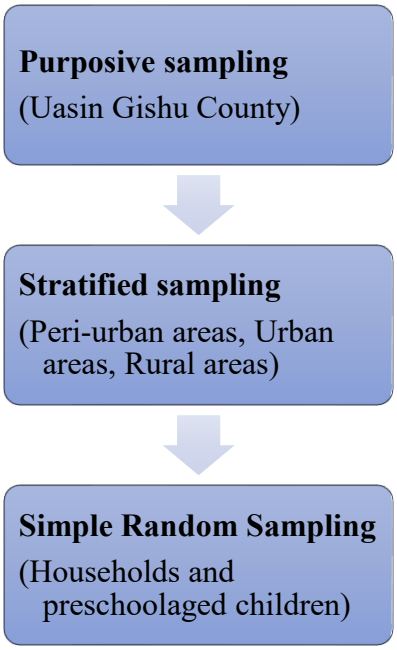

Figure 3.1: Illustration of the Study Sampling Schema

3.6.1 Inclusion Criteria

- All children aged 6- 59 months, who were permanent residents of Uasin Gishu County.
- All mothers or caregivers who voluntarily participated in the study and allowed their children to the necessary biochemical test.

3.6.2 Exclusion Criteria

- Every child who wasn't a permanent resident of Uasin Gishu County.
- Children reported to be sick over the past 2 weeks and those who were unwell at the time of study.
- Children whose caregiver reported of having a genetic or autoimmune haemotological disease e.g.: - sickle cell disease, aplastic anaemia and haemolytic anaemia.

- All mothers or caregivers who did not consent. 3.6. Data Collection Methods and Tools

3.7. Data collection Methods

This study mainly utilized the interview method for data collection. Trained research assistants conducted face-to-face interviews with the mothers or caregivers of preschool-aged children. This approach allowed for real-time clarification of questions, reducing the risk of misinterpretation, particularly as the questionnaires were translated into Kiswahili and vernacular languages for better understanding.

3.7.1. Recruitment and Training of Research Assistants

The researchers identified and hired eight research assistants from the University of Eldoret: two postgraduate students and six undergraduate students from the Department of Family and Consumer Sciences and the Department of Environmental health. Thereafter, they underwent a one-week training on the data collection methods and tools as indicated blow::

a) They were first trained on the structured questionnaire to ensure accurate interpretation of each question during the interview and how to fill the entries upon receiving the answers for the questions.

b) The use of structured protocols for measuring anthropometric data; weight and height/recumbent length

c) Lastly, they received training on the standard protocol for the use of the HemoCue®Hb 201 device to measure Hb concentration of the preschool children. This training aimed at ensuring was done to ensure accuracy and high-quality data was recorded of the results.

3.7.2. Pre-testing of the Data Collection Tools

The data collection tools were pre-tested in Kapseret ward using 10% of the sample size. The purpose of the pre-test was to identify vague questions and thereafter allow for proper layout of the questions and enhance respondents' understanding. Furthermore, during the pre-test, the duration of time each questionnaire took to be administered was established thus making the actual data collection more effective. Finally, the pre-test made the research assistants familiarize with the data collection tools before the actual study.

3.7.3. Data Collection Tools

A researcher-administered structured questionnaire was the main tool for data collection. This household survey questionnaire was divided into three parts; sociodemographic (SECTION 2), household characteristics (SECTION 3) and child health (nutrition and IDA (SECTION 4). The other tools used were the 24-hour dietary recall and the Child Dietary Diversity Score (CDDS) tool. The 24-hour dietary recall involved mothers or caregivers recalling all foods and beverages consumed by the preschool-aged child in the previous 24 hours, providing detailed information on meal types, quantities, and preparation methods (Sirasa et al., 2020).

The CDDS tool was then used to evaluate the variety of food groups consumed during this period, serving as an indicator of dietary quality (Gassara & Chen, 2021; Kuche et al, 2020; Mahmood et al, 2021; Sekartaji et al, 2021; Woldegebriel et al, 2020).The following data was collected in this study:

3.7.3.1. Socio-demographic and economic data

Socio-demographic data was collected from the mothers/caregivers of the preschool aged children by use of structured questionnaires administered by the research assistants (Appendix III). The questions were translated to Kiswahili and vernacular language to ensure accuracy. The socio-economic data captured in the questionnaire included; age, parity, level of education, occupation, land ownership, income, marital status, source of fuel, sanitation practices, child morbidity and agricultural practices.

3.7.3.2. Anthropometric Data Measurements

In this study, the anthropometric measurements taken were weight and height measurements of the preschool-aged children. These measurements were used to calculate key indices: weight-for-height (to assess wasting status), weight-for-age (to determine underweight status), and height-for-age (to evaluate stunting). All measurements followed standard protocols to ensure accuracy and consistency.

3.7.3.2.1. Taking length/height measurements

Length was measured for children below 2 years in a recumbent position on a flat surface by the use of a wooden length board. Prior to taking these measurements the mothers/ caregivers were requested to remove the children's shoes, socks and hair ornaments. The mothers/caregivers were also requested to assist in holding the child's head while the research assistants held the child's knees and took the measurements (WHO,2006). On the other hand, for toddlers above 2 years of age, their height measurement was taken using a calibrated wooden height board which was mounted at a right angle on a level floor and against a straight vertical surface preferably a wall.

3.7.3.2.2. Taking weight measurements

Weight measurement was undertaken using a battery-powered digital scale (Ramptons Bathroom Scale- RM/304) with a precision of 0.1 kg. This measurement was carried out with the children having very light clothes, emptied pockets, no shoes and no hair ornaments. The weighing scale was calibrated daily before data collection by using a standard 1 kg packet of sugar to ensure accuracy. The scale reading was adjusted to align precisely with the known weight. This routine calibration maintained the reliability of the weight measurements. The readings were taken twice and the average was recorded by rounding off to the nearest 0.1kg. The average of these was adequate for the study.

3.7.3.2.3. Biochemical Data

A hemoglobinometer called the HemoCue® Hb 201+ system (HemoCueAB, Angelholm, Sweden) was used to gather this data. The steps taken are described below:

- Cleaning the sampling site with 70% alcohol and then letting it air dry for a short while was the first step.
- Secondly, a sterile lancet was used to prick the side of the fingertip (Rappaport et al., 2021).
- The capillary blood sample was extracted from the heel of the foot or the pulp of the finger on the left side of the body (Ughasoro et al., 2019). The left middle finger was used whenever possible, this is to avoid the within-subject variation in Hb concentration from left to the right hand noted in previous studies (Hinnouho et al., 2018).

- The drop of blood used to fill the microcuvettes was extracted by gently pressing the fingertip after the first two blood samples were removed with a piece of cotton wool (Mendes et al., 2021).
- After wiping away any extra blood sample, the microcuvettes were promptly put into the HemoCue® 201+ apparatus for examination (Hinnouho et al., 2018).
- Following the numerical display of the results in g/dl, the data was manually entered into a notebook and the data collection tablets.
- Lastly, in accordance with the company handbook's cleaning instructions, the HemoCue® 201+ device was cleaned every day before and after use (Rappaport et al., 2021).

3.7.3.2.4. The 24hr Dietary Recall Tool

The children's dietary intake was collected by the use of a 24-hour dietary recall tool (Appendix IV). The mothers or other caregivers of the children were asked by the research assistants to make a list of the foods the child had eaten in the 24 hours before the interview. The research assistants used the electronic devices to record the food items and the amount of time. The 24-hour dietary recall data was used to calculate the children's dietary diversity score (CDDS) (Coates et al., 2006). The FAO guidelines for measuring dietary diversity in households and individuals served as the model for the DDS tool used in this study (FAO & FHI 360, 2016). The tool evaluates how many food groups the child ate the day before. According to Appendix V, each food group received a 1 for consumption and a 0 for non-consumption. Each child received an overall score after the scores were totaled. A child was considered to have a low DDS if their score was between 0 and 3, a medium DDS if their score was between 4 and 6, and a high DDS if their score was greater than 6 (Waswa et al, 2021).

3.8. Data management and analysis

Data from the survey was coded, cleaned and imported to Microsoft Excel. STATA Version 17 (published in April 2021) was used to analyze the data. Sociodemographic data were analyzed using descriptive statistics. An asset-based Wealth Index was calculated using the Principal Component Analysis (PCA) to convert household wealth indicator variables into wealth index scores. The household wealth index was categorized into 5 categories as per the KDHS report (KNBS & ICF, 2023). The WHO Anthro Software analyzed the length/ height-for-age indices of the preschoolers (Gashu et al., 2016). According to the WHO (2006) reference manual, height for-age standard deviation of less than negative two (Z-score < -2SD) below the growth standards was defined as stunting. The weight measurement was converted to the weight-for-height and height-for-age indices by use of the WHO Anthro Software and consequently categorize the child as either wasted or underweight respectively. Wasting was defined by a weight-for-height Z score of <-2SD whereas underweight was defined by a weight-for-age Z score of <-2SD (WHO,2006). 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 (Table 3.1).

Table 3.1. Summary of the data analysis techniques used in this study

Research Objective	**Indicators**	**Statistical Test/ Software (STATA Version 17)**
To evaluate the socio-demographic and economic characteristics of the preschoolaged children in urban, peri-urban and rural areas of Uasin Gishu County.	Sociodemographic	Descriptive means, ±SD, and, percentages
	Socioeconomic status	Principle Component Analysis
To determine the prevalence of IDA among preschool-aged children in Uasin Gishu County using HemoCue.	Hemoglobin level	Descriptive (means, ±SD, and percentages) Chi-square test
To analyze the nutrition status of preschoolaged children in Uasin Gishu County using anthropometric measurements.	Weight measurement Height measurement	WHO Anthro software (Z scores; WAZ, WHZ, HAZ) Chi-square test
To assess the dietary diversity of preschoolaged children in Uasin Gishu County	Dietary Diversity Score	Descriptive (means, ±SD, and percentages) Chi-square test
To assess the relationship between the predictor variables and IDA among preschool-aged children	Odds Ratio	Multiple Ordinal Logistic Regression

3.9. Ethical Consideration

Ethical approval was granted by the AMREF Ethics and Scientific Review Committee (ESRC), approval number AMREF-ESRC P1009/2021 (Appendix VI). This study was conducted as part of a larger research project titled *'The Role of Wet Markets and Backyard Livestock in Supporting Nutrition of Preschool-Aged Children in Eldoret, Kenya: Challenges from COVID-19 Influenced Closure*.' The overarching project aimed to investigate the impact of COVID-19-related disruptions on food systems and child nutrition, providing a contextual framework for understanding the predictors of IDA among preschool-aged children in Uasin Gishu County. A research permit was also granted by the National Commission for Science, Technology and Innovation (NACOSTI), license number: NACOSTI/P/22/18518. Ethical issues were upheld throughout the study and informed consent was acquired from the participants before commencing data collection (Appendix II).

CHAPTER FOUR

RESULTS

4.1. Overview

This chapter highlights the results from this study. The purpose of this study was to assess the prevalence and predictors of IDA among preschool-aged children in urban, peri-urban and rural areas of Uasin Gishu County, Kenya. The study sample size was 318 children with 289 complete responses. The response rate was 90.9%, this was found to be adequate of this study.

4.2. Socio-demographic Characteristics of the Study Participants

Caregivers' demographic characteristics were summarized into frequencies, percentages, median and interquartile ranges. More females (93%) than males (7%) participated in the study and their average age was 28 years. Over two-thirds (67.8%) of the participants completed secondary school while only 14% had attained tertiarylevel education (Table 4.1). The majority of the study participants were married (67.8%). Nonetheless, 14.2% were divorced or separated while 18% were single. Over half of them (58.8%) lived in urban areas while 22.2% lived in rural areas. Generally, more than half of the households (51.9%) had between 4-6 children.

Table 4.1: Caregiver's Socio-demographic Characteristics

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				

4.2.1. Socio-demographic characteristics of the preschool-aged children

The children's demographic characteristics were summarized into frequency, percentages and median as shown in Table 4.2. More male children (53%) than female children (47%) participated in the study and their average age was 30 months. More than half of the children (57%) resided in peri-urban areas followed by 25% in urban areas and 18% in rural areas (Table 4.2).

Table 4.2: Preschool-aged Children Socio-demographic Characteristics

Variables	n	%	Median
Pre-school aged children Gender (N=289)			
Female	137	47.4	
Male	152	52.6	
Average age of Children in Months (N=289)			30
Pre-school aged children Age-group (In Months)			
6-12	54	18.69	
12-23	47	16.26	
24-35	61	21.11	
36-47	57	19.72	
48-59	70	24.22	
Incidence of Illness (N=289)			
No Illness	217	75	
Cough and fever	58	20	
Diarrhea	14	5	
Residence (N=289)			
Rural	52	18	
Urban	73	25.3	
Peri-urban	164	56.7	

4.2.2. Socio-economic characteristics of the caregivers

The socio-economic characteristics were established using two indicators which are; the occupation status of the caregiver and the Household Wealth Index.

4.2.3. Occupation

In terms of the caregiver occupation, almost all the participants were involved in different income-generating activities; 35% were employed, 31% were self-employed, 27% were manual workers and 1% were farmers. However, 6% of the caregivers were unemployed as shown in Figure 4.1.

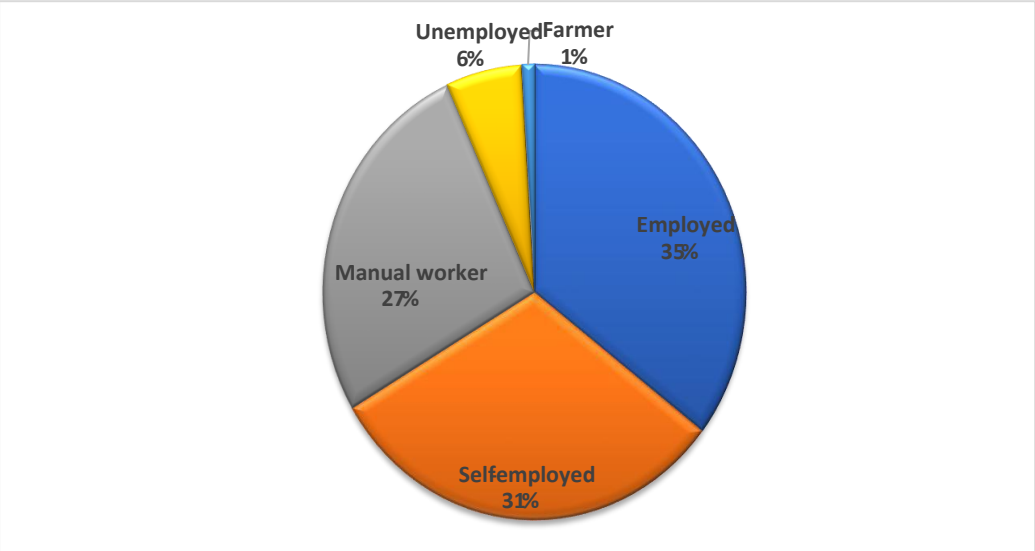

Figure 4.1: Caregivers' Occupation

4.2.4. Household Wealth Index

PCA was performed to convert wealth indicators such as the source of fuel, source of energy, ownership of electrical appliances, type of house and sanitation facilities into wealth index scores. The wealth index scores were summarised into various wealth index quintiles by dividing the range of the scores (wealth index scores) equally into five groups (quintiles) and presented in a bar graph as shown in Figure 4.2. The wealth quintiles were categorized as per the KDHS report; lowest, second, middle, fourth and the highest wealth quintile (KNBS & ICF, 2023). From the bar graph, most of the respondents, 57.2%, were under the lowest wealth quintile while 28.7% were under the middle wealth quintile. Nonetheless, about 2% were classified under the highest

wealth quintile and thus considered the wealthiest compared to the other wealth quintile groups as displayed in Figure 4.2.

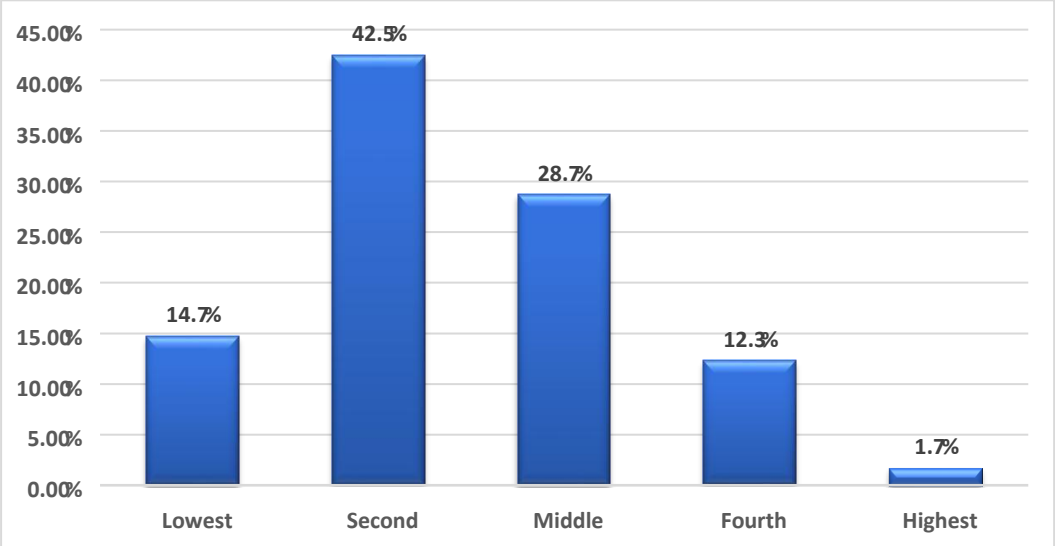

Figure 4.2: Household Wealth Index Summary

4.3. Nutrition Status of the preschool-aged children

4.3.1. Stunting

Majority of the preschoolers (70.6%) were normal. However, 29.4% of the preschoolers were classified as stunted, which can further be divided into severely stunted (14.9%) and moderately stunted (14.5%) (Figure 4.3).

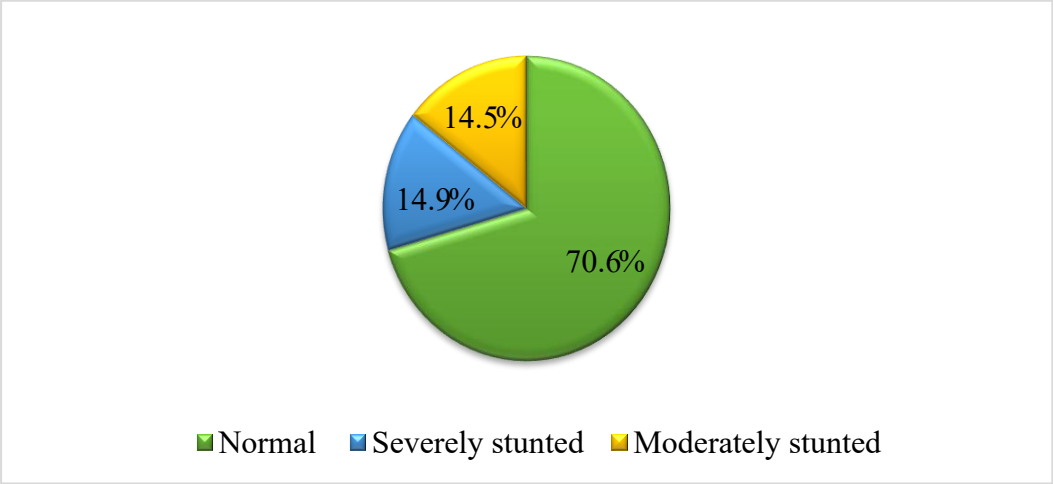

Figure 4.3. Prevalence of stunting

4.3.2. Underweight

Underweight status results indicated that 90.3% of the children were normal. Nevertheless, 4.5% were severely underweight while 5.2% were moderately underweight. Thus, the prevalence of underweight among preschool-aged children was 9.7%.

4.3.3. Wasting

Similar trends were established under wasting status where most of the children (78.6%), were normal. While 2.4% and 2.1% were severely and moderately wasted respectively (Figure 4.4).

4.3.4. Overweight and obesity

The study findings revealed that 10.03% were obese and 6.9% were overweight. This high prevalence of obesity and overweight as well as wasting depicts a coexistence of both over-nutrition and under-nutrition among preschool-aged children (Figure 4.4).

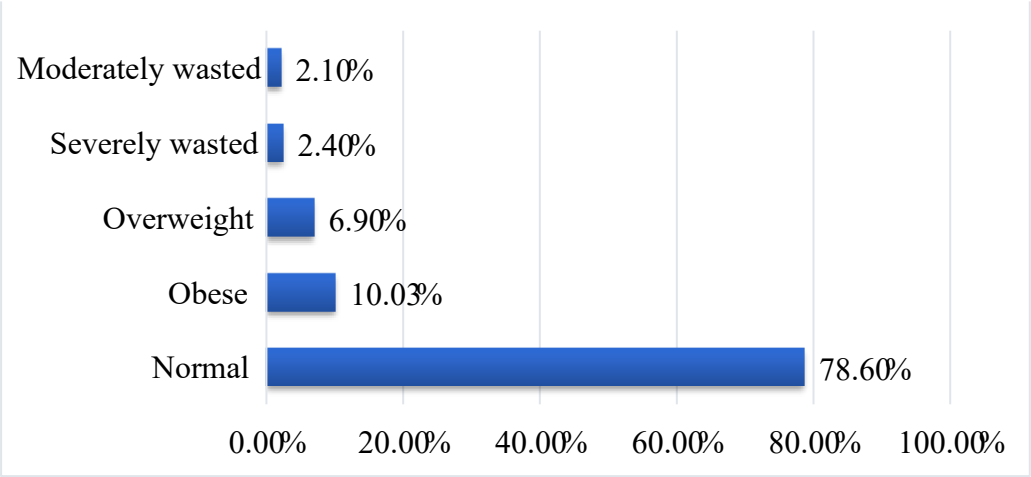

Figure 4.4. Weight for Height (WHZ) indices

4.3.5. Relationship between nutrition status and residence

The prevalence of stunting was highest in urban areas where 32.7% of the preschool aged children were stunted. This was further divided into, 12.7%% being moderately stunted and 20% being severely stunted as shown in Figure 4.5. Furthermore, peri-urban areas and rural areas had slightly similar stunting prevalence levels of 28.8% and 28.1% respectively. However, the preschool-aged children in rural areas had a slightly higher prevalence of severe stunting (15.6%) compared to their counterparts in peri-urban areas (12.9%). Despite these disparities in the prevalence of stunting levels in urban, peri-urban and rural areas, the chi-square test of independence revealed that there was no statistically significant relationship between stunting and residence (rural, urban and peri-urban), p-values>0.05.

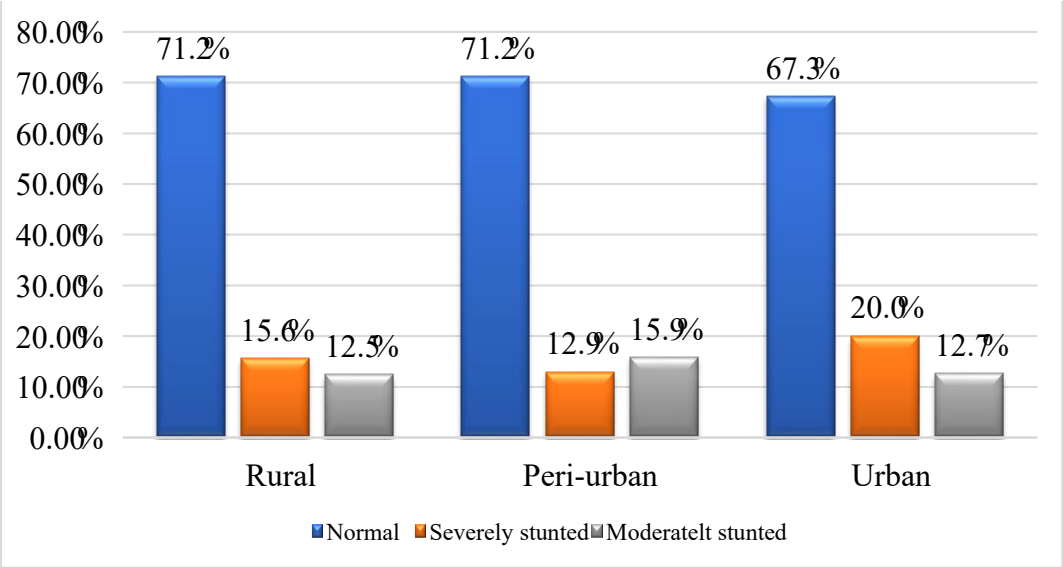

Figure 4.5. Prevalence of stunting against residence.

Preschool-aged children residing in peri-urban areas had the highest prevalence of underweight (11.8%) as well as the highest number of children classified as severely underweight (5.9%) (Figure 4.6). This was closely followed by those children residing in rural areas whose prevalence of underweight was 9.4%. The children residing in urban areas had the least prevalence of underweight at 3.6%. The chi-square test of

independence revealed that there were statistically significant differences in underweight status across the three areas as indicated by p-value<0.05.

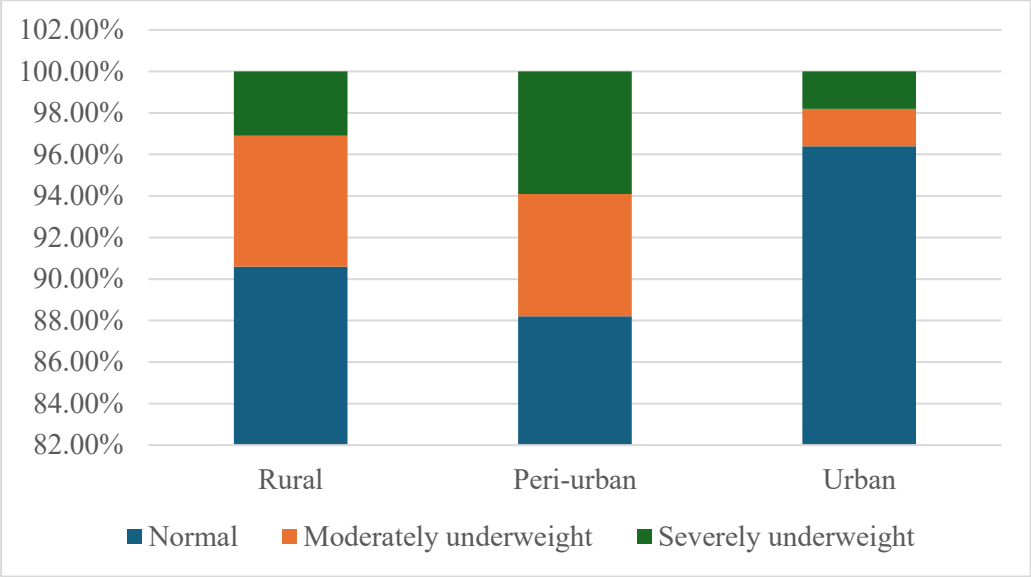

Figure 4.6. Prevalence of underweight against residence

Lastly, 15.6% of the preschool-aged children residing in rural areas were obese. On the other hand, 10.9% of the children residing in urban areas were overweight. It is interesting to note that no child residing in the urban areas was classified as wasted. Almost all the children classified as wasted were from peri-urban areas (7.1%) with very few residing in rural areas (1.6%). The chi-square test of independence showed a mild but significant relationship between wasting status and residence as indicated by a p-value of 0.059 (Table 4.3).

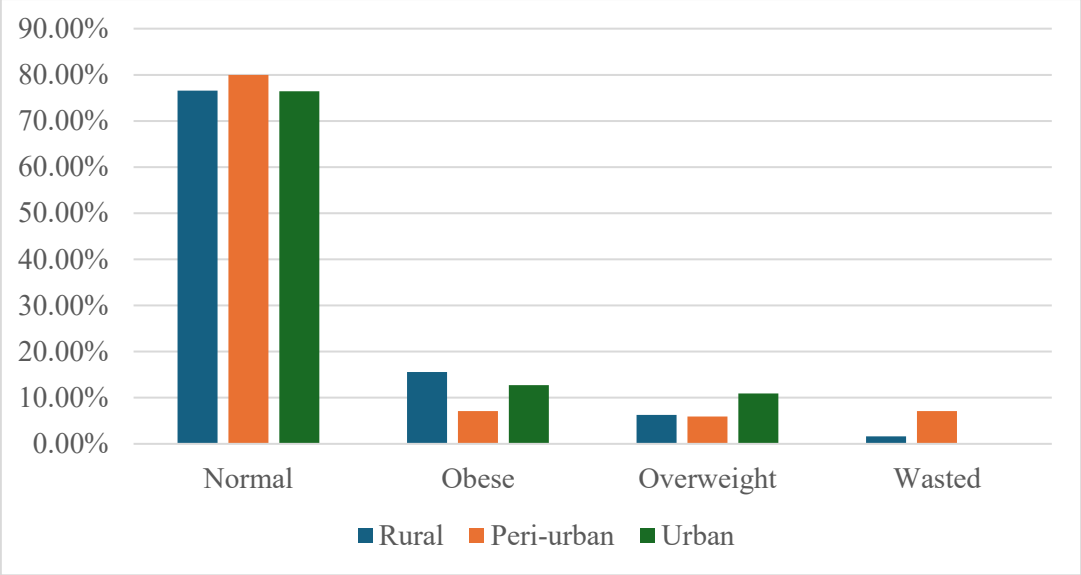

Figure 4.7. Comparison of Prevalence of Obesity, Overweight and Wasting

Table 4.3: Relationship between Nutrition Status and Residence

Chisquare / Variables	Residence			Fisher's Exact Value	p-value
	Rural	**Peri-urban**	**Urban**		
Stunting Status (N = 289)	(%)	(%)	(%)		
Normal	71.88	71.18	67.27		
Severely stunted	15.63	12.94	20	2.0498	0.727
Moderately stunted	12.5	15.88	12.73		
Underweight status (N = 289)					
Normal	90.63	88.24	96.36		
Moderately underweight	6.25	5.88	1.82	0.727	0.452
Severely underweight	3.13	5.88	1.82		
Wasting Status (N = 289)					
Normal	76.56	80	76.36		
Obese	15.63	7.06	12.73		
Overweight	6.25	5.88	10.91	12.1607	0.059
Severely wasted	1.56	3.53	0		
Moderately wasted	0	3.53	0		

4.3.6. Relationship between nutrition status and child's age

The results indicated that most of the children (46.8%) who were stunted were from the age group of 12-23 months. There were minimal disparities in the prevalence of stunting across the other age groups as shown in Figure 4.8. The chi-square test of independence showed that there was a mild but significant relationship between the occurrence of stunting across the age groups with a p-value=0.051.

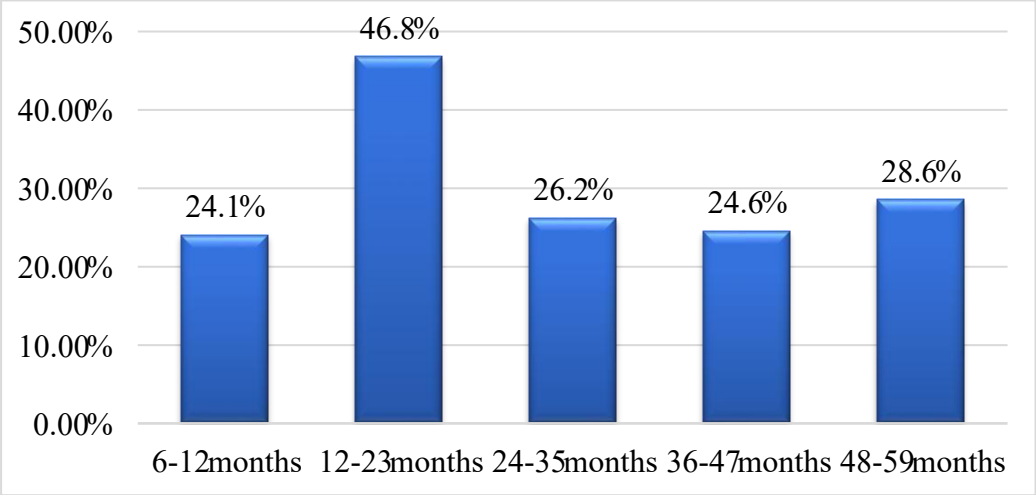

Figure 4.8. Prevalence of stunting across the age groups

With regards to underweight, the older children were more affected with 20% of the children aged between 48-59 months and 10.5% of the children aged between 36-47 months being classified as underweight (Figure 4.9). The chi-square test of independence showed that there was an association between underweight status and children's age groups, χ^2 (1, n=289) = -0.175, p -value=0.049 (Table 4.4).

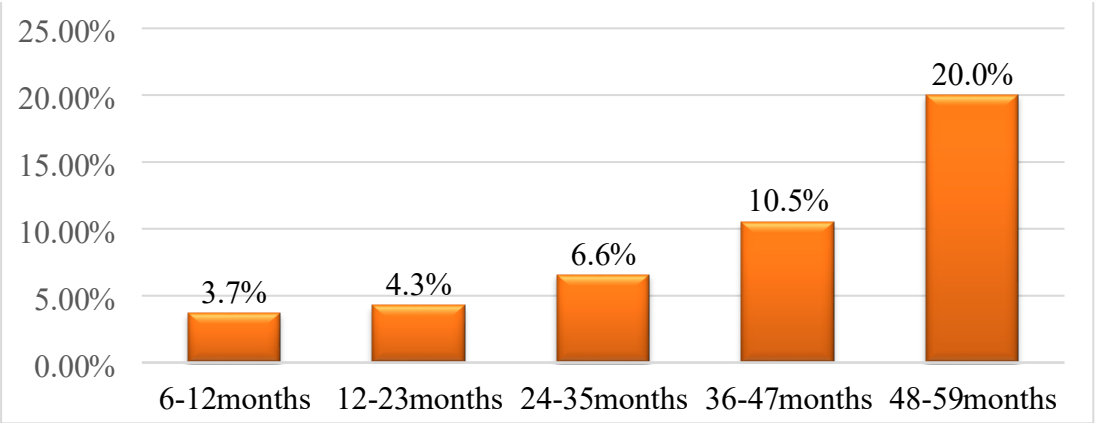

Figure 4.9. Prevalence of underweight across the age groups

The study findings indicated that the younger children had the highest prevalence of obesity and overweight, with 20.4% of the children aged 6-12 months being obese as well as 12.8% of the children aged 13-23 months. On the other hand, 12.3% of the children aged 36-47 months were also obese as shown in Figure 4.10. The study results also revealed that, despite the high prevalence of obesity among children aged 6-12 months, wasting prevalence was also highest in this age group (7.41%). The chi-square test of independence showed that there was a mild but significant relationship between the weight for height indices (wasting, obesity and overweight) and the age groups with a p-value=0.052 (Table 4.4).

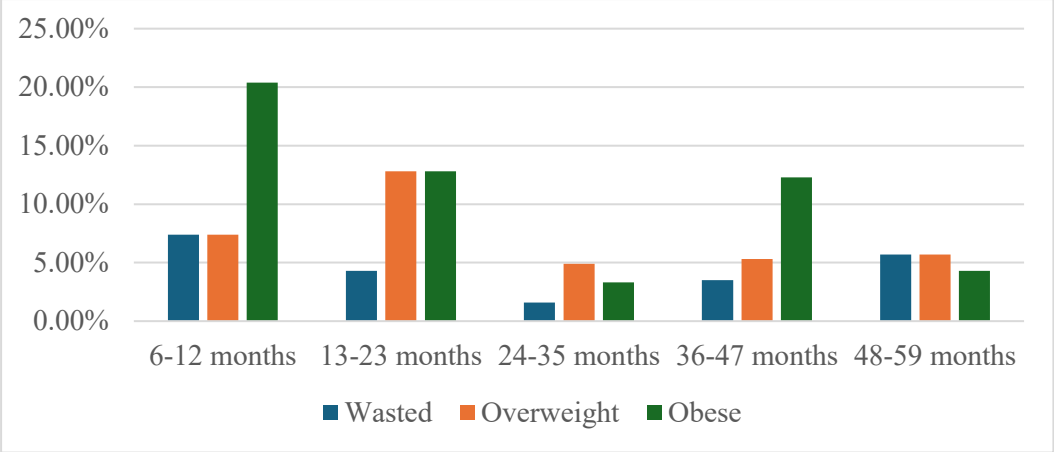

Figure 4.10. Prevalence of wasting, overweight and obesity across the age groups

Table 4.4: Relationship between nutrition status and children's age

Variables	Age-group in Months					Chi-square / Fisher's Exact Value	p-value
	6 -12 (%)	13-23 (%)	24-35 (%)	36-47 (%)	48-59 (%)		
Stunting Status (N = 289) Normal							
	75.93	53.19	73.77	75.44	71.43		
Severely stunted	11.11	25.53	9.84	15.79	14.29	0.0321	**0.051***
Moderately stunted	12.96	21.28	16.39	8.77	14.29		
Underweight status (N = 289)							
Normal	96.30	95.74	93.44	89.47	80		
Moderately underweight	1.85	4.26	4.92	1.75	11.43	-0.175	**0.049***
Severely underweight	1.85	0	1.64	8.77	8.57		
Wasting Status (N = 289) Normal							
	64.81	70.21	90.16	78.95	84.29		
Obese	20.37	12.77	3.28	12.28	4.29		
Overweight	7.41	12.77	4.92	5.26	5.71	-0.1383	0.052
Severely wasted	1.85	0	0	3.51	5.71		
Moderately wasted	5.56	4.26	1.64	0	0		

*Significant at p value of 0.05

4.3.7. Relationship between nutrition status and child's gender

The results showed that more male children were stunted (33.6%) compared to female children (24.8%) (Figure 4.11). Similarly, more male children (18.4%) were either overweight or obese compared to their female counterparts (15.3%). Despite these differences, statistical tests showed no statistically significant relationship between nutritional status and gender, with all p-values>0.05 (Table 4.5).

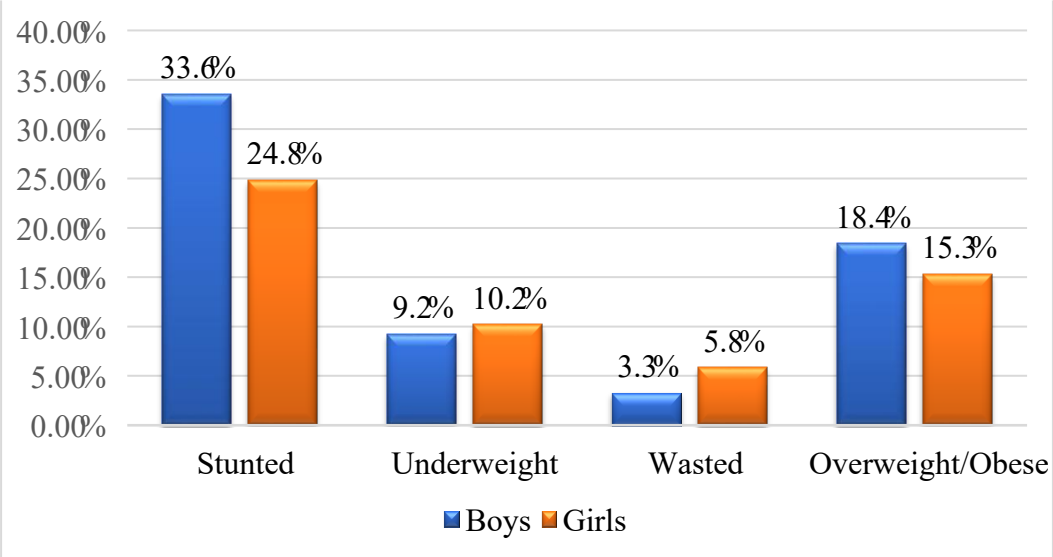

Figure 4.11. Nutrition status indices and child gender

Table 4.5: Relationship between nutrition status and gender

	Gender		Chi-	
Variables	Female (%)	Male (%)	**square/Fisher's Exact Value**	**P-value**
Stunting Status (N = 289)				
Normal	75.18	66.45		
Severely stunted	11.68	17.76	2.92	0.232
Moderately stunted	13.14	15.79		
Underweight status (N = 289)				
Normal	89.78	90.79		
Moderately underweight	5.84	4.61	0.2277	0.892
Severely underweight	4.38	4.61		
Wasting Status (N = 289)				
Normal	78.83	78.29		
Obese	8.76	11.18		
Overweight	6.57	7.24	2.108	0.716
Severely wasted	3.65	1.32		
Moderately wasted	2.19	1.97		

4.4. Prevalence of IDA among preschool-aged children in Uasin Gishu County

Hb level (in g/dl) was summarized into IDA by classifying Hb level>=11 as normal, Hb level >= 10 < 11 as mild IDA and Hb level<10 as severe IDA. Slightly over half, (51.6%), of the children, were normal. However, about 27.3% suffered from severe IDA while 21.1% had mild IDA (Figure 4.12). This brings the overall prevalence of

IDA in this study to 48.4%.

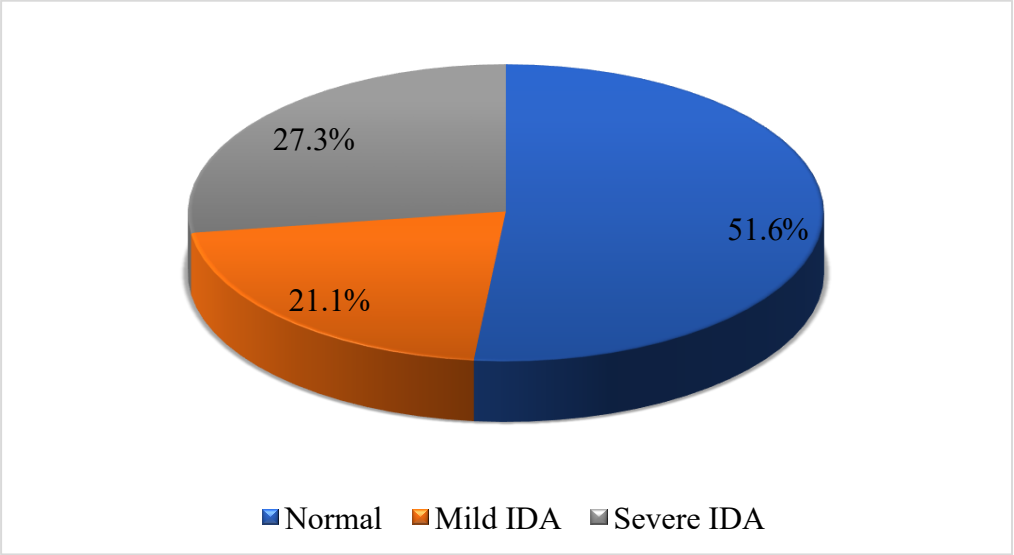

Figure 4.12. Prevalence of IDA among preschool-aged children

4.4.1. Distribution of IDA by gender

The study findings revealed that female children had a higher Hb level with a mean of 11.0 g/dl compared to their male counterparts who had a mean of 10.6 g/dl. However, the means of the Hb levels of the male and the female children did not differ significantly as shown in Figure 4.13.

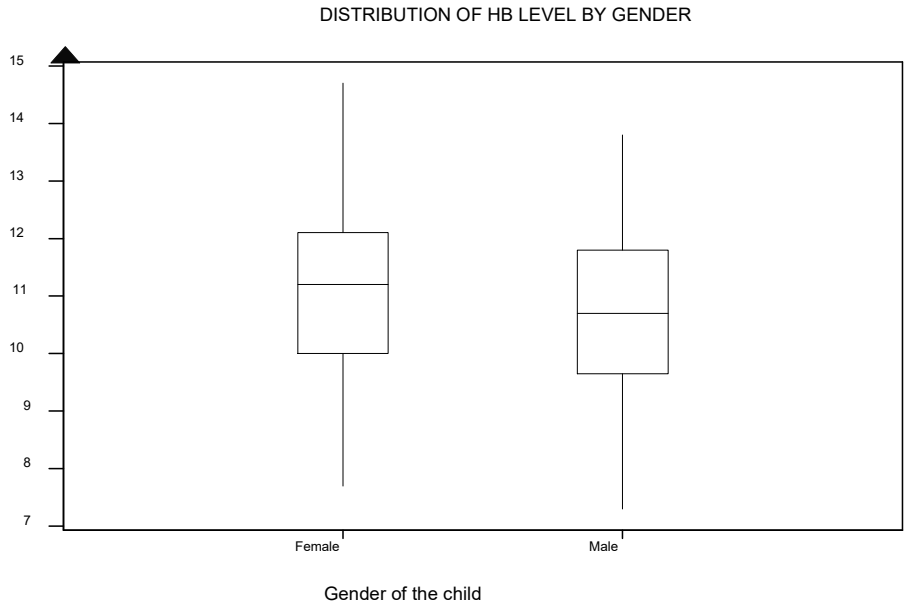

Figure 4.13. Distribution of Hb level by gender

4.4.2. Relationship between IDA and gender of the preschool-aged children

More than half (53.3%) of the male children had IDA whereas 43.1% of the female children had IDA. Despite these differences, chi-square tests revealed that there was no statistically significant relationship between IDA and gender, χ^2 (1, n=289) = 3.0256, p-value=0.220 (Table 4.6).

Table 4.6: Relationship between IDA and Gender

Variables	Female (%)	Male (%)	Chi-square / Fisher's Exact Value	p-value
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		

4.4.3. Relationship between IDA and the age of the children

The study results showed that children between the ages of 6-12 and 24-35 months were the most affected by IDA with a prevalence of 44.4% and 44.8% respectively (Figure 4.14). The findings also indicated that children between the ages of 13-23 months were the least affected. However, chi-square tests revealed that there was no statistically significant relationship between IDA and the children's age group, χ^2 (1, n=289) = 5.5201, p-value=0.701 (Table 4.7).

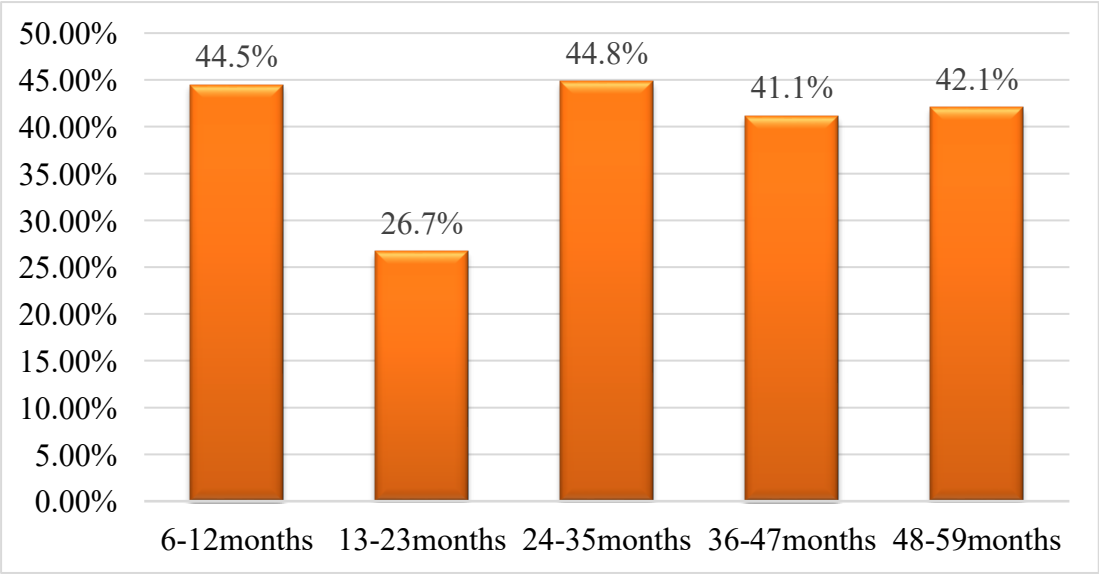

Figure 4.14. Prevalence of IDA across the age groups

Table 4.7: Relationship between IDA and age

Variables	Iron Deficiency Anemia (N=289)			Chi-square value	p-value
	Normal n (%)	Mild Anemia n (%)	Severe n (%)		
Children age group (N=289)					
6-12	23 (15.44)	14 (22.95)	17 (21.52)	5.5201	0.701
12-23	28 (18.79)	7 (11.48)	12 (15.19)		
24-35	30 (20.13)	15 (24.59)	16 (20.25)		
36-47	28 (18.79)	14 (22.95)	15 (18.19)		
48-59	40 (26.85)	11 (18.03)	19 (24.05)		

4.4.4. Relationship between IDA and Residence

More than half of the children (56.4%) residing in peri-urban areas suffered from IDA. Children residing in urban and rural areas were equally affected with an IDA prevalence of 47.1% and 45.3% respectively (Figure 4.15). Statistical analysis indicated that there was no statistically significant relationship between IDA and residence, χ^2 (1, n=289) = 4.3776, p-value=0.357 (Table 4.8).

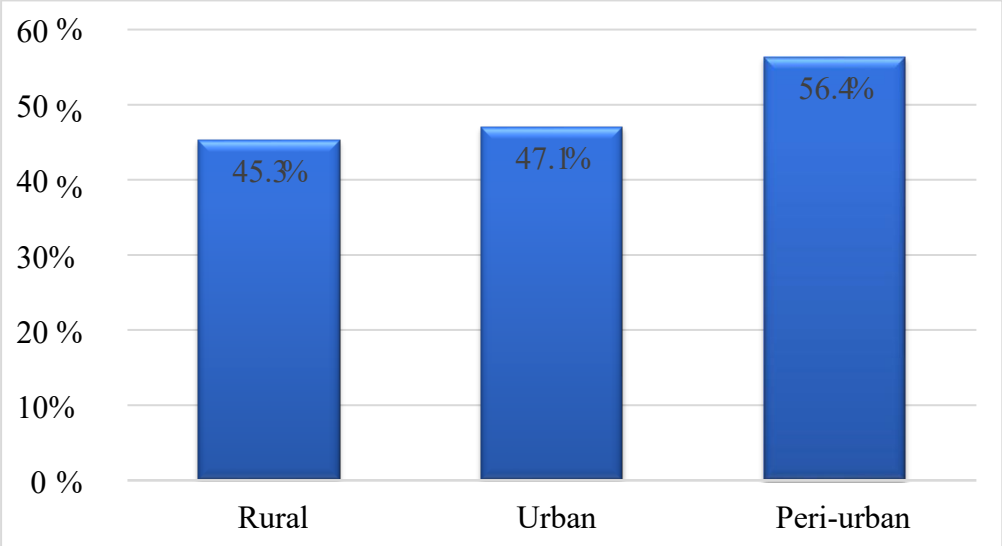

Figure 4.15. Prevalence of IDA in rural, urban and peri-urban areas

Table 4.8: Relationship between IDA and Residence

Variables	Residence			Chi-square value	p-value
	Rural n (%)	Urban n (%)	Peri-urban n (%)		
IDA (N=289)					
Normal	35 (54.69)	90 (52.94)	24 (43.64)		
Mild Anemia	13 (20.31)	31 (18.24)	17 (30.91)	4.3776	0.357
Severe Anemia	16 (25.00)	49 (28.82)	14 (25.45)		

4.4.5. Relationship between Nutrition Status and IDA

The study findings showed that 57.7% of the children who were stunted also suffered from IDA. Similarly, 50% of the underweight children also suffered from IDA. While 57.1% of the children who were either overweight or obese also suffered from IDA. With regards to wasting, 30.8% of the children who were classified as wasted also suffered from IDA. However, statistical analysis indicated that there was no statistically significant relationship between nutrition status and IDA, χ^2 (1, n=289) = 4.3776, pvalue=0.282, p value=0.979. A mild relationship was noted between wasting indices and IDA with a p-value = 0.052 as shown in Table 4.9.

Table 4.9: Relationship between nutrition status and IDA

	Iron Deficiency Anemia			Chi-square / Fisher's Exact	p-value
Variables	Normal (%)	Mild (%)	Severe (%)	**Value**	
Stunting Status (N = 289)					
Normal	75.84	67.21	63.29		
Severely stunted	12.75	18.03	16.46	5.0503	0.282
Moderately stunted	11.41	14.75	20.25		
Underweight status (N = 289)					
Normal	90.60	88.52	91.14		
Moderately underweight	4.70	6.56	5.06	0.444	0.979
Severely underweight	4.70	4.92	3.80		
Wasting Status (N = 289)					
Normal	79.87	68.85	83.54		
Obese	8.72	14.75	8.86		
Overweight	5.37	13.11	5.06	0.0001	**0.052***
Severely wasted	3.36	3.28	0		
Moderately wasted	2.68	0	2.53		

* Significant at p-value of 0.05

4.4.6. Relationship between socio-demographic characteristics and IDA

The relationship between IDA and socio-economic characteristics was assessed using ordinal logistic regression. All assumptions were tested during the preliminary test and

all of them were met. However, the level of education was omitted in the model because of high multi-collinearity. The overall model was statistically significant, p-value<0.01. The results indicated that only marital status and wealth index were significantly associated with IDA suggesting that; children from married parents were 4.53 times more likely to be normal (not suffering from IDA) while those of divorced or separated parents were 4.36 times more likely to be normal as compared to single parents. Further, an increase in wealth (households from the richest family) 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. (Table 4.10)

Table 4.10: Relationship between IDA and socio-economic characteristics

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 (Source of Income)			
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***

* Significant at 95% CI; REF = Reference point

4.5. Dietary patterns of preschool-aged children

4.5.1. Dietary diversity of the preschool-aged children

Data obtained from the 24-hour recall was then classified into food groups according to the FAO guidelines on the 9 food groups for children (FAO & FHI 360, 2016). The food groups were then summarized into Dietary Diversity Scores (DDS) (1-3 food groups as low DDS; 4-6 food groups as medium DDS and 7 and above as high DDS). The results showed that the majority of the preschool-aged children (67%), had low dietary diversity. Nonetheless, 17% of the children had a high dietary diversity, with only 16% having medium dietary diversity as shown in Figure 4.16.

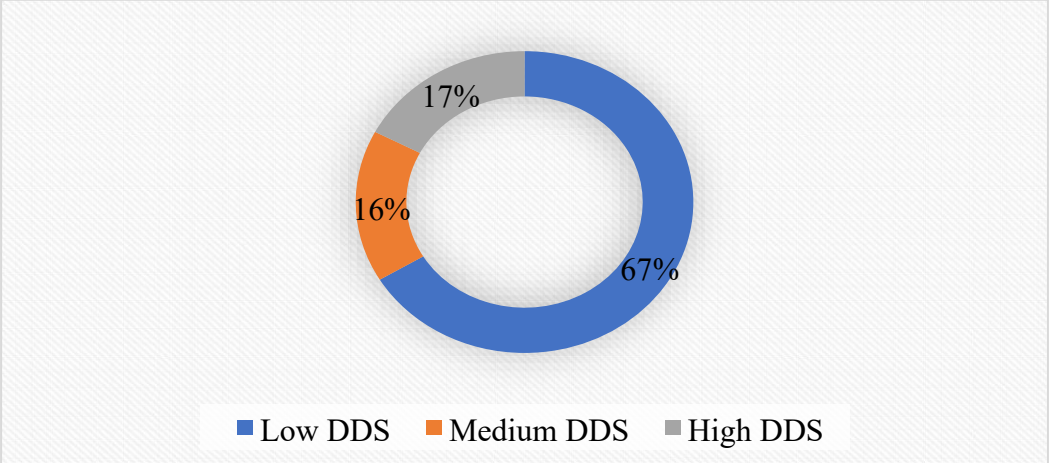

Figure 4.16. Dietary diversity of the preschool-aged children

4.5.2. Relationship between DDS and residence of preschool-aged children

The study findings revealed that the majority of the children (71.2%) living in periurban areas had a low DDS, followed by those living in rural areas (62.5%) and those residing in urban areas (56.4%) respectively (Figure 4.17). However, chi-square tests indicated that there was no statistically significant relationship between dietary diversity and residence, χ^2 (1, n=289) = 5.5907, p-value=0.232 as shown in Table 4.11.

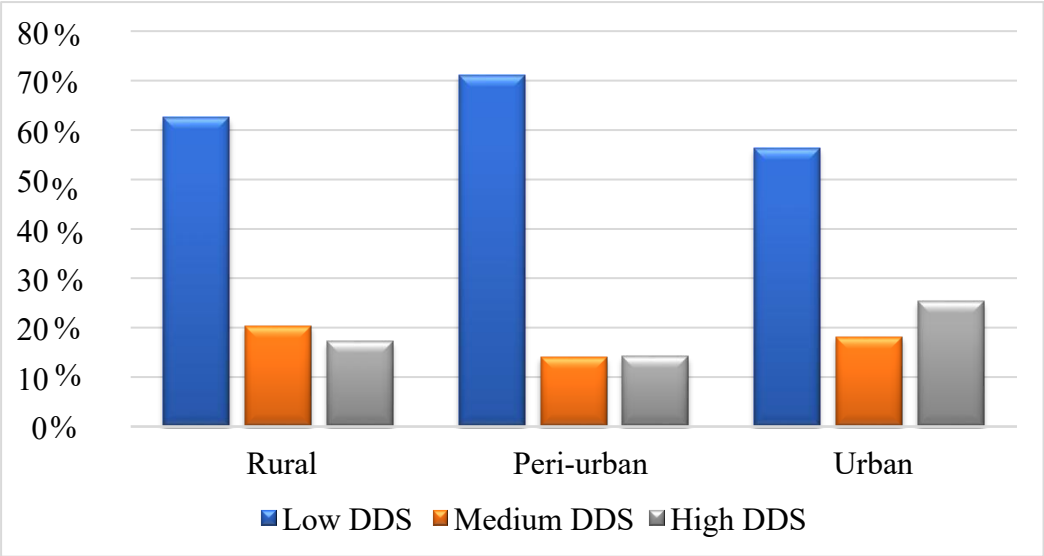

Figure 4.17. Dietary diversity scores across the three areas

Table 4.11: Relationship between dietary and residence of preschool-aged children

	Residence				
	Rural	Urban	Peri-urban	**Chi-square**	
Variables	n (%)	n (%)	n (%)	**value**	**p-value**
IDA (N=289)					
Normal	35 (54.69)	90 (52.94)	24 (43.64)		
Mild Anemia	13 (20.31)	31 (18.24)	17 (30.91)	4.3776	0.357
Severe Anemia	16 (25.00)	49 (28.82)	14 (25.45)		

4.5.3. Association between dietary diversity and IDA among preschool-aged children

The results indicated that 77.2% of the children who had severe IDA also had low dietary diversity. It is interesting to note that 11.4% of the children with a high dietary diversity also suffered from IDA. The relationship between dietary diversity and IDA

was assessed using Kendall's Tau test of association. The results revealed 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 4.12.

Table 4.12. Association between dietary diversity and IDA among pre-school aged children

	Iron Deficiency Anemia				
Variables	Normal (%)	Mild Anemia (%)	Severe (%)	**Tau value**	**p-value**
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		

*Significant at p-value of 0.05

CHAPTER FIVE

DISCUSSION

5.1. Socio-demographic characteristics of the study respondents

Results from this study showed that the mean age of the mothers/caregivers was 28 years old. Majority of the study respondents (67.8%) had attained a secondary level of education with very few having completed tertiary education. This finding 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%). This is also similar to the findings of the KDHS report that stated that only about 2 out of 10 women and men have a tertiary education in Kenya (KNBS & ICF, 2023). Concerning marital status, majority of the respondents were married (67.8%). This is slightly higher than the KDHS findings that showed only about 33% of the women in Kenya were married. This high percentage of respondents categorized as married in Uasin Gishu County is probably due to the cultural definition of 'marriage' among the dominant community living in this region. Traditional marriage commonly known as '*koito*' among the Kalenjin community is classified as marriage. '*Koito*' is a traditional ceremony that entails the groom paying the bride price which is considered as the most vital part of marriage unlike the church or civil wedding. After this cultural ceremony, the couple is considered married in the eyes of the elders and the community at large. Many respondents might thus not possess a marriage certificate per se but are considered married in their communities and under the customary laws of Kenya.

Over half of the respondents (58.8%) reside in peri-urban areas also known as informal settlements. Uasin Gishu County was once a predominantly rural county, but rapid urbanization has changed this history. Urbanization has led to the simultaneous

conversion of fertile agricultural land into urban and peri-urban areas (Follmann et al, 2021). According to the United Nations, by 2050, about 67% of the world's population will reside in cities with most of this urbanization occurring in the Global South, Kenya included (UN, 2018). This rapid urbanization across the country might be the probable cause of the increased population in urban areas. Unfortunately, inadequate infrastructure and resources in housing in these urban areas have led to 56% of the urban population residing in slums and informal settlements otherwise known as periurban areas (Akoth et al, 2021).

The household size was large with slightly over half of the households (51.9%) having between 4-6 children with another 20% having more than 6 children. This large household size otherwise termed as family size is a true representation of rural and periurban areas of Kenya and other Sub-Saharan countries. Akoth et al. (2021) argue that there is still a high unmet need for contraception among the urban poor in peri-urban areas which might explain the high child parity in these areas with most households having more than 4 children. More recently, MoH seems to have focused on NCD's and COVID and less on contraceptives (Njiri et al., 2023). Similarly, in rural areas, various cultural factors are barriers to acceptance of modern contraception methods thus leading to low acceptance among women which consequently leads to higher birth rates in those areas.

5.2. Socio-economic characteristics of the study respondents

More than half of the caregivers (58%) were either self-employed or manual workers while 6% were unemployed. 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. Peri-urban areas are characterized by overcrowding, minimal resources and poor infrastructure with

many Micro and SmallScale Enterprises (MSEs) otherwise known as the *Juakali* Sector in Kenya. These MSEs and Small and Medium Scale Enterprises (SMEs) are run by individuals and are the current largest employer of youths and women in Kenya with an employability rate of 83% of the country's workforce (Gatuyu & Kinyua, 2020). This might explain the large number of caregivers in these areas who were self-employed and manual workers. Another probable reason could be the high rate of incomplete level of education among people living in those areas with the majority having either a primary level or secondary level of education. This places them at a disadvantage for permanent employment in white-collar jobs. Furthermore, the unemployment rate in Kenya stands at 16.8% and is highest among youths aged 20-24 years, this explains the percentage (6%) of caregivers who were unemployed in this study (KNBS & ICF, 2023). 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 (Murimi et al., 2019).

The household wealth index served as the study's additional socioeconomic status indicator. Just 2% of the households fell into the highest wealth quintile, while the majority (57.2%) fell into the lowest and second wealth quintiles, followed by the middle wealth quintile (28.7%). These findings are consistent with those of Gatimu & John (2020), who discovered that over half of the population in five Kenyan counties fell into the quintiles of the poorest and middle wealth index. However, the study contradicted the author's findings regarding the richest quintile. The asset-based household wealth index's shortcomings as a tool may be the cause of Uasin Gishu

County's low classification of affluent households. Regardless of their financial capacity to buy them, some researchers contend that the asset-based household wealth index classifies household wealth according to ownership of certain household items that are more prevalent in urban areas and less common in rural households (Poirier et al., 2020). As a result, this may not accurately reflect the true nature of affluent rural households. The authors contend that in order to obtain an appropriate wealth quintile in each area, the list of household assets being evaluated should ideally be specific to both urban and rural areas. (Poirier et al., 2020).

5.3. Prevalence of IDA among preschool-aged children in Uasin Gishu County

The prevalence of IDA among preschool-aged children in this study 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 similar to those of a Tanzanian study carried out by Msaki et al. (2022) who found a prevalence of 59% among children aged 6-59 months. In Pakistan, a secondary analysis of the National Nutrition Survey Data of 2011-2012, also found a high prevalence of IDA among children aged 6-59 months which stood at 33% (Habib et al., 2016). A meta-analysis that sought to determine the global pooled prevalence of IDA and ID found that the prevalence of IDA among children aged 6-59 months in Africa and Asia was 16.42% and 17.95% respectively (Gedfie et al., 2022). As of 2020, high prevalence rates of IDA among preschool-aged children have been noted across developing countries, with the highest prevalence being noted in Myanmar (72.6%), Bangladesh (64%), Libya (49.5%), Malaysia (26.7%) and Angola (23.92%) (Afreen et al., 2023). The high prevalence of IDA in developing countries has been linked to many complex causative factors. Among these factors, low birth weight, poor nutrition status, low

socio-economic status, low maternal education, poor sanitation, household food insecurity, low dietary intake of iron-rich foods and poor dietary diversity are the leading predictors of IDA among preschool-aged children (Obeagu & Obeagu, 2023). Other authors have found the age of the child, large family size, children born from an anaemic mother, living in rural areas and frequent drinking of cow's milk as other associated factors for IDA among children, particularly infants (Onyangore et al., 2016; Gedfie et al., 2022). Poor dietary intake characterized by inadequate intake of iron-rich foods stands as the main predictor of IDA in this age group. 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; Muriuki et al., 2020; Waswa et al., 2021). Furthermore, preschool-aged children are also more prone to helminthic infestation and infections which have been associated with IDA (Muriuki et al., 2020).

5.4. Nutrition status of the preschool-aged children

5.4.1. Stunting

The prevalence of stunting in this study was 29.4% which can be further divided into severely stunted (14.9%) and moderately stunted (14.5%). This was higher than that reported in the KDHS report which indicated that the prevalence of stunting in Uasin Gishu County was 14% (KNBS & ICF, 2023). This finding is similar to that of a study carried out in Eastern Kenya that found that the prevalence of stunting among children below 2 years of age was 23% (Guyatt et al., 2020). In Ethiopia, a study among children aged 6-59 months found that the prevalence of moderate stunting was 24.9% while those severely stunted were 7.9% (Dake et al., 2019). In Zambia, the prevalence of stunting among preschool-aged children remains high at 40% (Mzumara

et al., 2018). Many studies have deduced that this high prevalence of stunting is mainly due to; low birth weight, poor water and sanitation practices and inadequate infant and young child feeding practices (Balalian et al., 2017; Berhanu et al., 2018; Dake et al., 2019; Guyatt et al., 2020; Mzumara et al., 2018; Nyamasege et al., 2021). Notably, other predictors such as food insecurity in resource-poor areas and lack of nutrition knowledge among caregivers/mothers have been shown to contribute significantly to the deterioration of a child's nutritional status (Guyatt et al., 2020).

5.4.2. Underweight

This study revealed that the overall prevalence of underweight was 9.7%. This prevalence mirrors the findings of the KDHS report which showed that the prevalence of underweight among children in Kenya under the age of 5 years was 10% (KNBS & ICF, 2023). In Uasin Gishu County, as per the 2018 CIDP report, the prevalence of underweight in the county was 11% (Uasin Gishu County Government, 2019). Recent studies in many other developing countries have shown that underweight among preschool-aged children persists, for instance, in Ghana (11%), Ethiopia (24%), Pakistan (44.6%), Indonesia (20.3%) (Acquah et al., 2019; Fenta et al., 2020; Li et al., 2020; Yunitasari et al., 2020). Fenta et al. (2020) in a study in Ethiopia, found that the child's age, birth weight, maternal education status and the child's gender were the major predictors of underweight among preschool-aged children. Other studies have also shown that household wealth status, maternal age, subscription to health insurance and unimproved toilet as significant contributors to being underweight (Acquah et al., 2019; Moshi et al., 2022; Yunitasari et al., 2020).

5.4.3. Wasting

This study's findings revealed that 4.3% of the children were wasted, while 16.9% were either obese or overweight. This showed an interesting coexistence of over-nutrition and under-nutrition among preschool-aged children in this county. This finding concurs with the findings of Sawe et al. (2022) who found that 23% of children in Kisumu County were underweight while 30% were overweight. In Bangladesh, wasting has been associated with low maternal education, low household income, poor sanitation practices and high parity of children below 5 years (Chowdhury et al., 2020). Wasting persists in developing countries; in Niakhr, Senegal, the prevalence of wasting was found to be 16.3%, Bangladesh (11%) and Ghana (27.5%) (Chowdhury et al., 2020; Danso & Appiah, 2023; Garenne et al., 2019).

5.4.4. Relationship between nutrition status and residence of preschoolers

In this study, majority of the underweight children were from the peri-urban areas, this could probably be due to; inadequate economic access to proper dietary intake as a result of high poverty rates in these areas, poor water and sanitation practices, inadequate access to proper health care and lack of proper infant and young child feeding practices. Informal settlements have been associated with poor nutrition and health outcomes of children due to their living standards (Wanyama et al., 2019). High poverty rates and high rates of food insecurity in peri-urban areas are likely to contribute to wasting and being underweight among children. This study findings on the high rates of overweight and obesity in rural areas may be explained by the fact that children are being fed diets high in calories rather than nutrients. Childhood obesity in rural areas is also greatly influenced by culture, as local communities view overweight and obese children as "healthy." In rural areas, parents often overfeed their

children to make them appear physically "healthy" because fat, chubby kids are seen as a sign of wealth and contentment in African communities, and Kenya is no exception (Akusala, 2014). The prevalence of childhood obesity in rural areas has gradually increased as a result of these beliefs. Children in urban centers have access to processed snacks, sweets, and condiments that are high in calories, as well as sedentary lifestyles that involve spending a lot of time in front of a television or other electronic device and doing very little exercise (Sawe et al., 2022). This plays a significant role in the rising incidence of childhood obesity in these cities.

5.4.5. Relationship between nutrition status and child's gender

This study unveiled that there was no association (p-value) between nutrition status and gender, this is despite male children having a higher prevalence of stunting than female children. This outcome differs from the findings of various authors, who found a significant relationship between nutrition status and gender (Chowdhury et al., 2020; Danso & Appiah, 2023; Garenne et al., 2019; Karlsson et al., 2022; Masibo et al., 2020; Moshi et al., 2022; Sawe et al., 2022). Danso & Appiah (2023) argue that boys are at a greater risk of malnutrition due to their higher metabolism and consequently a higher nutrient need. Masibo et al. (2020) also explain that gender disparities in nutrition status are mainly attributed to; selection bias, parental preferences of one gender over the other and cultural beliefs and practices. The authors elaborate on how some communities due to culture, perceive male children as heavy feeders compared to female children and thus introduce complementary feeding very early at 3 months of age as they believe the male child is hungrier and breast milk is not sufficient for them. This early introduction of solid foods has been noted to compromise the infant's immunity due to potential exposure to pathogens and thus increase infections and

consequently lower the long-term nutrition status of the male child (Masibo et al., 2020).

5.4.6. Relationship between nutrition status and child's age group

This study revealed a significant relationship between stunting and the child's age group with children between the ages of 12-23 months being the most affected by stunting at a prevalence of 46.8%. This study's findings are consistent with a study carried out in Uganda that found that children between the ages of 12-23 months and those between 24-35 months were the most affected by stunting (Nsubuga et al., 2022). This finding also concurs with that of a study in Ghana which also concluded that the child's age is a significant predictor of stunting (Danso & Appiah, 2023). The authors found that older children were more likely to be stunted compared to their counterparts who were below 1 year. Children in this critical window of 12-23 months could be more affected with stunting due to their increased energy need which if not met puts them at risk of macro- and micronutrient deficiencies (Berhanu et al., 2018). This stage is also characterized by a lot of physical and skills developmental milestones which in turn exposes the child to the surrounding environment and pathogens that might lead to infections and consequently malnutrition (Danso & Appiah, 2023). Poor complementary feeding practices usually start at 6 months and the effects are seen from 12 months.

Results from this study indicated that there was a significant relationship between underweight and the child's age group. According to this study, children aged 6 to 12 months had the lowest prevalence of underweight, while those aged 48 to 59 months had the highest prevalence. This result is in line with that of Moshi et al. (2022), who also discovered that older children had a higher prevalence of underweight after the 12-month mark. This could be explained by the child becoming more active after

turning one year old and beginning to walk and run. The reduction in maternal care for older children because of the belief that they are grown and do not need more attention could be another likely reason. Few mothers follow the advised practice of growth monitoring until the child is five years old. Instead, mothers typically bring their children to the Child Welfare Clinic (CWC) for growth monitoring, supplementation, vaccinations, and deworming until the child is two years old. Because weight monitoring, supplementation, and deworming are not done in these CWCs, the older child is at risk of malnutrition without the mother's knowledge. Furthermore, these older kids are frequently sent to daycare facilities, which typically provide subpar care because of a lack of funding and the caregivers' insufficient understanding of nutrition. For instance, a study carried out among daycare centres in Nairobi showed a low caregiver-to-children ratio resulting in non-responsive care practices as well as poor hygiene which are a threat to the child's nutrition status and overall wellbeing (Mwase et al., 2016).

Findings from this study indicated that the younger children had the highest prevalence of obesity and overweight, with 20.4% of the children aged 6-12 months being obese. This could be attributed to the introduction of calorie-dense starchy foods during complementary feeding. During this stage, the child is yet to be fully physically active thus resulting in a positive energy balance. The study results also revealed that, despite the high prevalence of obesity among children aged 6-12 months, wasting prevalence was also highest in this age group (7.41%). This is probably due to the critical transition that occurs during this stage from exclusive breastfeeding to complementary feeding. LMICs, Kenya included, have been associated with suboptimal complementary feeding practices which is likely to be the major contributor of wasting in this age group (6-12 months) (Masibo et al., 2020). Suboptimal infant and young

child feeding practices have been associated with growth faltering and poor nutrition outcomes in preschoolaged children (Adhikari et al., 2019; Berhanu et al., 2018; Hughes et al., 2020; Mzumara et al., 2018).

5.5. Dietary diversity of the preschool-aged children

This study revealed that 67% of the preschool-aged children had a low dietary diversity characterized by consuming less than three food groups the previous day. This concurs with the finding of a study carried out in Sri Lanka which also found that children had a mean DDS of 4.56 with less than 20% of the preschoolers meeting their daily recommendations (Sirasa et al., 2020). This is also consistent with the statistics in Ethiopia, which has been categorized by UNICEF as the country with the least diverse diets among children with only 12.5% of the children aged 6-23 months consuming a minimum dietary diversity (Woldegebriel et al., 2020). Similarly, in Tanzania, a study by Khamis et al. (2019) showed that 74% of children did not reach the minimum dietary diversity, a similar trend like that observed in this current study is that 91% of the children consumed food items under the cereals, roots and tubers food group. This differs from the finding of Sekartaji et al. (2021) who found that 63.15% of the children had a DDS of more than 4. The authors noted an increase in dietary diversity with an increase in the age of the child, most of the mothers with children older than 12 months were noted to have a more diverse diet than those below 12 months. Many mothers due to cultural and religious practices, believe that children below the age of 12 months should avoid eggs and flesh foods. Aside from culture and religion, other factors have been associated with a child's DDS are; maternal education, the child's age, household wealth index, household food security status and the child's residence (Ba et al., 2022; Gassara & Chen, 2021; Kuche et al., 2020; Woldegebriel et al., 2020).

All (100%) of the children consumed food items from the cereals, roots and tubers food group, this is attributed to the over-reliance on starchy staples by most of the households in the diet of preschool-aged children. This corresponds to the finding by Modjadji et al. (2020) among South African children who found that cereals accounted for 100% of the main food group consumed while animal-source foods (ASF) were least consumed.

Various authors have argued that in developing countries, Kenya included, childrens' diets are monotonous and are dominated by cereal flours which are rich in phytates and other iron-binding phenols (Kumar et al., 2021; Onyangore et al., 2016; Othoo et al., 2021; Waswa et al., 2021). In this study, low consumption of fruits and vegetables was also noted among the children, this could be probably due to the seasonal variations in availability of most fruits in Uasin Gishu County. The county CIPD report shows that Uasin Gishu is a major producer of grains such as maize and wheat with very minimal production of fruits, thus much of the fruits in the county are gotten from neighbouring counties depending on the seasons. Waswa et al. (2021) agree with this finding as they also noted in their longitudinal study that seasonal variations in food availability and accessibility are among the major contributors to inadequate dietary and nutrient intake in LMICs. The authors deduced that in Kenya, fluctuating food prices due to seasonal scarcity of fruits and vegetables lead to the low consumption of foods in these food groups. It was also noted that most of the children consumed legumes with very few ASF which are rich in highly bioavailable iron. This has also been distinguished in resource-limited countries where children have limited access to ASF due to their high costs and other cultural and/or religious beliefs that prevent children from consuming these foods (Onyangore et al. 2016; Wanyama et al. 2019).

5.5.1. Relationship between DDS and residence of preschool-aged children

Despite the results showing that children from peri-urban areas had the least dietary diversity, there was no statistically significant relationship between DDS and the residence of preschool-aged children. This finding differs from that of Kundu et al. (2022) who found statistically significant disparities between the DDS of children in peri-urban areas and rural areas. The high number of children in peri-urban areas with a low DDS could probably be due to the high poverty rates and food insecurity experienced among these informal settlements. Wanyama et al. (2019) in their analysis of food security and dietary quality in slums in Nairobi and Kampala found that people residing in peri-urban areas are vulnerable to food insecurity, low DDS and poor health. These peri-urban households unlike their counterparts in rural areas who grow food for subsistence, their food security is solely dependent on the household's purchasing power otherwise defined as the household's ability to purchase food (Mahmood et al., 2021). Therefore, the maternal/ caregiver occupation status and cash income are likely to be the main contributors to a low DDS in these areas. Furthermore, peri-urban areas are characterized by crowded and poor living standards with limited access to basic public facilities and services including health care and nutrition education on proper infant and youth child feeding practices.

5.6. Predictors of IDA among preschool-aged children

5.6.1. Relationship between IDA and socio-demographic characteristics of preschool-aged children

Children from households with married parents were less likely to be affected by IDA, unlike their counterparts from single-parent households. This is consistent with the

findings of Laksono et al. (2022) 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 (Amadu et al., 2021). 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). It is also important to note that the type of marriage can also be a significant contributor to the overall well-being and nutrition status of the child. For instance, a study by Yaya et al. (2019) who carried out a secondary analysis of the DHS data of 35 Sub-Saharan countries found that children from polygamous families were more likely to be malnourished compared to children from monogamous families

The present study found that children from poor households were more likely to be suffering 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 the 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 (Bharati, 2015; Du et al., 2022; Mantadakis et al., 2020; Msaki et al., 2022; Zanin et al., 2015). 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 (Kumar et al., 2021; Muriuki 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 (Issa, 2021). 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 ASF 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 child care leading to the cessation of breastfeeding, early introduction of complementary feeding, poor adherence to vaccination/immunization schedule and supplementation schedule for supplements like Vitamin A which eventually puts the child at a 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 as a whole (Chipili et al, 2018).

The mothers with lower 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). Likewise, IDA in children aged 6-59 months was linked to low maternal education, according to a Tanzanian study (Msaki et al., 2022). As the primary caregivers in the majority of households, mothers make all the decisions regarding breastfeeding, supplemental feeding, health-seeking behavior, and sanitation practices for their children (Chipili et al, 2018). As a result, decisions regarding child feeding practices are directly impacted by a lower level of 74 education, which in turn impacts the nutrition status of the child. Kenya, like many other developing nations, views education as a critical issue, particularly in rural and peri-urban areas where the rate of educational completion is still too low. Higher education is a strong predictor of better health outcomes, according to numerous studies (Chipili et al, 2018; Laksono et al, 2022; Rashad & Sharaf, 2019; Nankinga et al, 2019). Due to a lack of knowledge about nutrition, poor health-seeking behavior, and deeply ingrained cultural beliefs and practices, a low level of education can hinder improved health and nutrition outcomes. Additionally, a low level of education is typically associated with manual labor or unemployment, which results in a poor socioeconomic status, limited access to healthy food and medical care, and ultimately an increased risk of IDA (Msaki et al, 2022). On the other hand, educated mothers have been found to carry out improved child feeding and childcare practices as they tend to be well-informed and exposed (Chipili et al., 2018).

5.6.2. Relationship between IDA and gender of the preschool-aged children

This study showed no significant differences in the occurrence of IDA among boys and girls. This finding is similar to 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 the ages of 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 enhanced metabolism causing younger boys to have a higher nutrient requirement than girls during the pre-puberty stage (Melku et al., 2018). On the other hand, under-nutrition persists among children in Sub-Saharan Africa including Kenya leading to the development of IDA in both male and female children as in the case of this study. In a meta-analysis carried out by Melku et al. (2018), stunted and wasted children were more likely to have anaemia compared to the children with an optimum nutrition status (OR=1.95; 95% CI: 1.66, 2.51). In developing countries, where food insecurity remains a major problem the coexistence of both macro- and micronutrient deficiencies is a common public health problem. Besides, malnutrition leads to an impaired immune system among children causing them to be more susceptible to infectious diseases. This disease state may lead to the loss of nutrients (through diarrhoea/vomiting); malabsorption; underutilization of nutrients from the diet; blood loss and the immune-mediated destruction of red blood cells which have all been strongly associated with low Hb levels and consequently anemia and IDA.

5.6.3. Relationship between IDA and the age of the children

In this study, the prevalence of IDA was highest among children aged 6-12 months and 24-35 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 below 12 months of age were more likely to be anaemic compared to older children. This observation could be backed up 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 to replenish their iron stores (Onyangore et al., 2016). Therefore, inadequate dietary intake of iron-rich foods may give rise to IDA especially in this younger age group (Habib et al., 2016). 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. Moreover, 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).

5.6.4. Relationship between IDA and residence of the preschool-aged children

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 (p-value) significant differences were noted. 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). Similarly, an Egyptian study among children aged 6 months to 12 years found that children from rural areas had a significantly higher risk for IDA than those in urban areas (Al Ghwass et al., 2015). In most African countries the rural population are characterized by small-holder farmers and households within the lower socioeconomic status with very low nutrition knowledge (Ogunniyi et al., 2021). This could explain why most studies show that children in rural areas are most affected by IDA.

However, in Uasin Gishu County, 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-source foods due to the presence of kitchen gardens and backyard livestock keeping in the majority of the households. This consequently leads to a better intake of iron-rich foods compared to their counterparts in urban areas especially those in periurban areas. Due to the high rate of poverty and substandard living conditions, children from these peri-urban areas are typically the most vulnerable to IDA and other micronutrient deficiencies. These households, also known as the urban poor, make less than $1 per day (Wanyama et al, 2019). Additionally, they frequently lack the financial means to obtain adequate healthcare and food (Issa, 2021). This could help to explain why IDA is more common in these peri-urban areas. Lower prevalence rates of IDA in rural areas have also been reported by other studies conducted in Bangladesh,77 Cambodia, and the Democratic Republic of the Congo (Donahue Angel et al, 2017). High levels of iron in ground water have been found in Bangladeshs rural areas, according to additional research, and this has greatly increased the amount of iron that children consume through their diet.

5.6.5. Relationship between IDA and the nutrition status of the preschool-aged children

This study revealed that 16.4% of the children who were severely stunted also had severe IDA while 20.3% of the moderately stunted children also had severe IDA. This finding is consistent with that of a study in Pakistan that showed an increase in the odds of IDA when the child was stunted (Habib et al., 2016). Similarly, Msaki et al (2021) found that stunting was significantly associated with IDA among preschool-aged children in Tanzania. This suggests that undernutrition is among the contributing factors of IDA. This may also be attributed to the fact that undernourished children often have underlying micronutrient deficiencies. Furthermore, low Hb concentration has been shown to compromise linear growth (Msaki et al., 2022). This synergistic association between micronutrient deficiencies such as IDA and stunting shows that efforts to combat stunting may have a ripple effect in reducing micronutrient deficiencies such as IDA in preschool-aged children.

On the other hand, 3% of the severely underweight children also had severe IDA while 5.1% of the moderately underweight children had IDA. The underweight status of a child shows a long-term deprivation of adequate dietary intake and this may stand as a probable cause for the occurrence of both underweight (low weight for age) and IDA among the preschool children in this study. Especially since the majority of the children who were underweight and wasted in this study were from peri-urban areas where food insecurity remains a major hindrance to proper nutrition.

This study also noted the double burden of malnutrition with the coexistence of overnutrition and under-nutrition among preschool-aged children. This was indicated by 8.9% of the children who were obese also having IDA while 5.1% of the children

who were overweight also had IDA. Various factors lead to the coexistence of obesity and undernutrition in the form of micronutrient deficiencies. Engle-stone et al. (2020) categorize these factors into two; population-level factors and intraindividual-level factors. The coexistence of IDA and obesity at the population level may be explained by regional variations in dietary habits and lifestyles. For example, sedentary lifestyles and the consumption of energy-dense foods may make urban populations more likely to be obese, while food insecurity and undernutrition may make peri-urban areas more likely to experience micronutrient deficiencies (Blankenship et al., 2020). We discovered that some of the obese kids also had IDA at the intraindividual level, as this study illustrates. This may be because the majority of the children in this study ate a diet high in starchy foods, which are high in energy but low in micronutrients like iron. Another potential cause is the prevalence of obesity and IDA in preschool-aged children due to their frequent consumption of processed snacks and sugar-sweetened beverages, the majority of which are high in calories and low in healthy micronutrients (Venkatesh et al., 2021). Additionally, studies have demonstrated that obesity can impact the body's metabolism of micronutrients, putting a person at risk for deficiencies. For example, obesity raises the amount of hepcidin in the blood. An adipokine called hepcidin is essential for regulating the gut's absorption of iron and the release of iron from macrophages (Rodríguez-Mortera et al., 2021). Consequently, it is essential to produce red blood cells. Obese people have been found to have high hepcidin concentrations despite having low iron levels. This implies that a hepcidin-related mechanism may be the cause of the iron deficiency seen in obese individuals (Engle-stone et al., 2020).

Despite the triple burden of malnutrition noted in this study with under-nutrition, overnutrition and micronutrient deficiency (IDA) in a relatively high number of

preschool aged children, statistical tests showed no significant relationship between nutritional status and IDA. This is probably due to the presence of IDA even in children who anthropometrically were classified under the normal nutrition status. Anthropometric assessment of nutrition status is limited to the weight and height of a child and is thus limited as it cannot assess micronutrient deficiencies such as IDA. Therefore, a need for biochemical tests that can give a true picture of the nutritional status of an individual. This explains why a child can be classified as normal anthropometrically but upon biochemical tests still be suffering from IDA.

5.6.6. Association between DDS and IDA among preschool-aged children

The study results exposed that 77.2% of the children who had a low DDS also had severe IDA. This is perhaps because DDS stands as a good representation of dietary quality and micronutrient density in children (Khamis et al., 2019). In this study, the food groups consumed show that the children had minimal intake of iron-rich foods and that could explain the high rate of IDA among the children with low DDS. In addition, the diets of the children were notably low in Vitamin A and C-rich fruits and vegetables which are categorized as enhancers and promotors of the absorption of non-heme iron, this puts the children at risk of IDA (Onyangore et al., 2016; Othoo et al., 2021). There was a significant association between DDS and the occurrence of IDA among preschool-aged children. This finding corresponds to the finding of Modjadji et al. (2020) who also found that low DDS was associated with poor nutrition outcomes. Khamis et al. (2019) in Tanzania also found that intake of a diverse diet among children was significantly associated with better nutrition outcomes and lesser micronutrient deficiencies such as IDA. A meta-analysis by Belachew & Tewabe (2020) found that low DDS was the main predictor of IDA among children in Ethiopia. The authors

further elaborated that children who consumed less than 4 food groups per day were 1.71 times more likely to have IDA compared to children with a higher DDS.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

This study shows that iron deficiency anemia is a major public health concern among pre-school aged children in Uasin Gishu County, with nearly half of the children affected. Children living in peri-urban areas emerge as the most vulnerable, likely due to disparities in access to nutrient-dense foods and essential health services. The youngest age group, particularly those between 6 and 12 months, appears to be the most susceptible, suggesting that the complementary feeding period is a critical stage during which nutritional inadequacies strongly contribute to anemia.

The findings further show that a considerable proportion of children experience other forms of malnutrition, including stunting, wasting, underweight, and overweight or obesity. This coexistence of under- and over-nutrition points to the double burden of malnutrition in this population. Dietary patterns among preschool children remain inadequate, with low dietary diversity and diets dominated by starchy staples, accompanied by minimal intake of animal-source foods, fruits, and vegetables.

Additionally, the results indicate that poor nutritional status, low maternal education level, low dietary diversity, and low household wealth index are the major predictors of iron deficiency anemia in this population. These findings demonstrate that iron deficiency anemia among pre-school aged children in Uasin Gishu County is influenced by a combination of nutritional, socio-economic, and maternal-related factors, emphasizing the need for coordinated and multisectoral strategies to address this complex public health issue.

6.2. Recommendations

6.2.1. Recommendations for Policy

The high prevalence of iron deficiency anemia revealed in this study highlights the need for strengthened policy action in Uasin Gishu County and nationally. The Ministry of Health should prioritize prophylactic iron supplementation for children most at risk, particularly those aged 6–12 months. In addition, routine screening for micronutrient deficiencies, including iron deficiency anemia, should be institutionalized as part of child welfare clinic visits to ensure early detection and prompt intervention. Strengthening nutrition and health outreach services in peri-urban areas is also essential, given that children in these settings appear most affected by both macro- and micronutrient deficiencies. Policy frameworks that support community-level implementation of iron supplementation, deworming, and integrated nutrition programs would contribute significantly to addressing the double burden of malnutrition observed in this study.

6.2.2. Recommendations for training and practice

To address gaps in dietary intake and child feeding practices, focused nutrition education interventions at household and community levels are necessary. Caregivers and communities, particularly in peri-urban areas, should be sensitized on the importance of dietary diversity, with emphasis on incorporating animal-source foods, as well as fruits and vegetables rich in vitamin A and vitamin C, which enhance iron absorption. Strengthening caregiver knowledge and skills in complementary feeding will support improved nutrient intake among preschool-aged children. Furthermore, because maternal education and household socio-economic status are key determinants of iron deficiency anemia, interventions that empower women through education and

economic strengthening programs have the potential to substantially reduce childhood anemia and improve long-term nutrition outcomes.

6.2.3. Recommendations for Future Research

Future studies should aim to build on the findings of this research by including larger and more diverse study populations and employing longitudinal designs to better capture patterns and determinants of iron deficiency anemia over time. Further research using biochemical markers such as serum ferritin and serum transferrin, beyond hemoglobin alone, would provide more comprehensive assessment of iron status and iron deficiency anemia. Comparative studies assessing the accuracy of rapid hemoglobin testing methods, such as HemoCue, against laboratory-based methods like high-performance liquid chromatography (HPLC) are also warranted, particularly with regard to the influence of timing of blood collection on hemoglobin results. Additionally, intervention studies exploring affordable, locally available iron-rich food products and practical strategies for incorporating them into young children's diets would help inform sustainable nutrition solutions tailored to rural and peri-urban Kenyan households.

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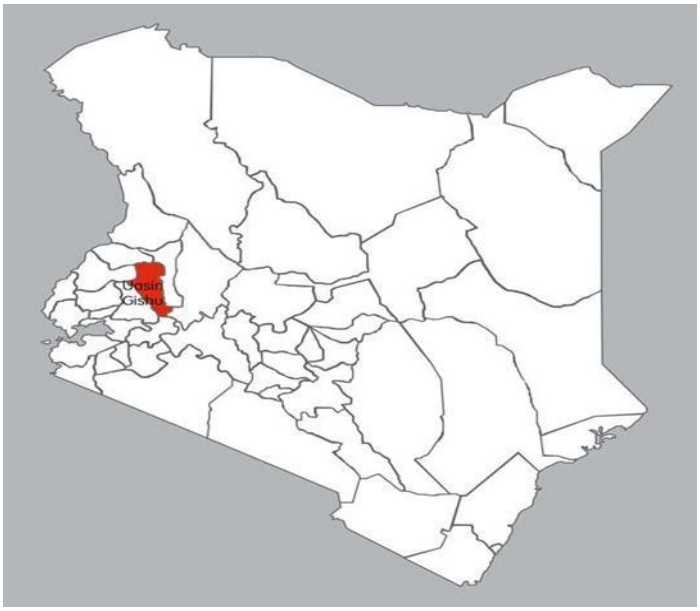
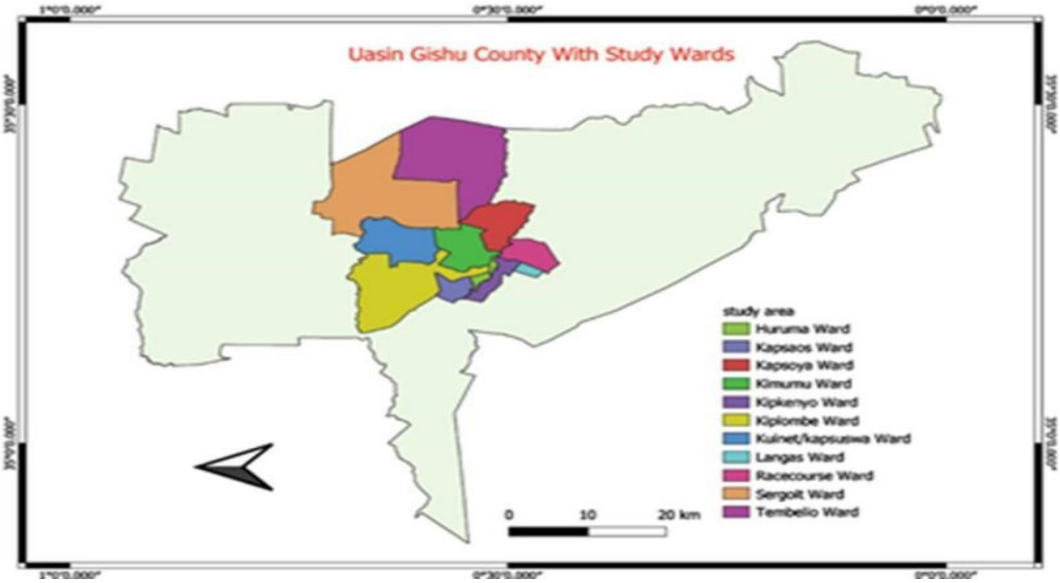
APPENDICES

APPENDIX I: MAP OF KENYA SHOWING POSITION OF UASIN GISHU COUNTY AND THE MAP OF UASIN GISHU COUNTY SHOWING THE SELECTED STUDY WARDS.





Source: UGCIP, 2017.

APPENDIX II: INFORMED CONSENT

University of Eldoret

School of Environmental Studies,
University of Eldoret
P. O. Box 1125-30100. Eldoret, Kenya
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ROYAL HOLLOWAY UNIVERSITY OF LONDON

Department of Geography
Royal Holloway University of London
Egham, Surrey TW20 0EX
www.royalholloway.ac.uk

20 May 2021

Dear respondents/participants,

We are a team of researchers from the UK (Royal Holloway University of London) and Kenya (University of Eldoret). We are interested in how animals that families raise themselves, and which are raised in the local community, are linked to childhood nutrition. We would further want to study role of the wet market in the diets of pre-school children. To understand this, we would like to learn more about what children eat, and where the food is obtained. We understand the challenges of bringing up a child and appreciate the task that you parents and guardians have to ensure that your children grow healthily. These challenges are faced by every parent or guardian worldwide.

We will be grateful if you would share with us your experience with regards to feeding your child. We would like to hear your experiences of the type of food your child eats, how much is eaten and if you think this food has sufficient key nutrients to keep them healthy.

We have prepared data collection tools that have been approved to be ethical and appropriate. We will collect information on dietary intake and collect data on health status of the targeted study pre-school children or children under five years old. We are requesting you to participate in this study so that we can understand your child's diet and how the food they eat is obtained. None of the collection techniques will be invasive. We will collect data on children's height/length, weight, and history of affliction with common health problems e.g. diarrohea, itch, respiratory illness, or fever. We would also like to check if the blood of the children contains enough iron.

We will let you see the results of these measurements for your child and will write the results down for you if you would like to keep a record. We will advise you of healthcare professionals with whom you can discuss these if you think this is necessary, and we will help you to contact appropriate healthcare providers.

Your participation in the research is voluntary and at any stage of the data collection you have the freedom to withdraw or stop the process. Your identity and that of your pre-school age child will be confidential and will not be revealed to anyone at any stage of the research. Your cooperation will assist in obtaining data that will assist us understand the importance of the wet markets in your neighbourhood. The information we get from you will help us compile a report which, among other things, will assist us to inform policy on the best way to support child nutrition, operate and manage the wet markets and explain their roles to the community, with a view to ensuring the safe and healthy supply of animal-based protein diet to society.

The project itself cannot provide any direct nutritional support to participating families. However, expected long-term interventions of the project may include launching public education and providing necessary health care. We could also learn from you good practices that could be replicated in other families and communities. We kindly request you to spend time with us and help us gather the pieces

of information we require for this research. We assure you of utmost confidence in the manner that we will treat any information obtained from you.

Thank you so much and if you have any questions regarding this, please do not hesitate to ask.

Yours sincerely,

Jennifer Cole, PhD
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Odipo Osano, PhD
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I have read the above information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to participate in this study.

Print name of Subject	[at least forename and surname]
Signature of Subject	
DD/MM/YYYY	

If visually impaired, physically impaired, mentally impaired or illiterate

I have witnessed the accurate reading of the Consent Form to the potential study subject, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print Name of Subject	[at least forename and surname]
Thumb/Foot print of Subject	
Signature of Witness	[A literate witness must sign and should be selected by the study subject and MUST have no connection to the research team.
DD/MM/YYYY	

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20 May 2021

Wapendwa wahojiwa / washiriki,

Sisi ni timu ya watafiti kutoka Uingereza (Chuo Kikuu cha Royal Holloway cha London) na Kenya (Chuo Kikuu cha Eldoret). Tunavutiwa na jinsi wanyama ambao familia huzilea wenyewe, na ambao wanalelewa katika jamii ya karibu, na jinsi wanauhusiano na lishe ya watoto. Tungependa zaidi kutaka kusoma jukumu la soko lenye nyama za mifugo wa nyumbani katika lishe ya watoto wa shule ya mapema. Ili kuelewa hili, tungependa kujifunza zaidi juu ya kile watoto wanachokula, na chakula kinapatikana wapi. Tunaelewa changamoto za kulea mtoto na tunathamini jukumu ambalo ninyi wazazi na walezi mnayo kuhakikisha kuwa watoto wenu wanakua na afya. Changamoto hizi zinakabiliwa na kila mzazi au mlezi ulimwenguni.

Tutashukuru ikiwa utashiriki nasi uzoefu wako kuhusu kulisha mtoto wako. Tungependa kusikia uzoefu wako wa aina ya chakula anachokula mtoto wako, ni kiasi gani cha kuliwa na ikiwa unafikiria chakula hiki kina virutubisho muhimu vya kutosha kuwaweka kiafya.

Tumeandaa zana za kukusanya data ambazo zimeidhinishwa kuwa za maadili na zinazofaa. Tutakusanya habari juu ya ulaji wa lishe na kukusanya data juu ya hali ya kiafya ya kutafiti watoto wa shule ya mapema au watoto chini ya miaka mitano. Tunakuomba ushiriki katika utafiti huu ili tuweze kuelewa lishe ya mtoto wako na jinsi chakula anachokula kinapatikana. Hakuna mbinu yoyote ya ukusanyaji ambayo itakuwa vamizi. Tutakusanya data juu ya urefu / urefu wa watoto, uzito, na historia ya shida na shida za kawaida za kiafya kama vile kuhara, kuwasha, ugonjwa wa kupumua, au homa. Tungependa pia kuangalia ikiwa damu ya watoto ina madini ya kutosha.

Tutakuruhusu uone matokeo ya vipimo hivi kwa mtoto wako na tutakuandikia matokeo ikiwa ungependa kuweka rekodi. Tutakushauri kwa wataalamu wa afya ambao unaweza kujadiliana nao ikiwa unafikiria hii ni muhimu, na tutakusaidia kuwasiliana na wafanyakazi wa huduma wa afya wanaofaa.

Ushiriki wako katika utafiti ni wa hiari na katika hatua yoyote ya ukusanyaji wa data unayo uhuru wa kuondoa au kusimamisha mchakato huo. Utambulisho wako na wa mtoto wako wa umri wa kabla ya kwenda shule itakuwa ya siri na haitafunuliwa kwa mtu yeyote katika hatua yoyote ya utafiti. Ushirikiano wako utasaidia kupata data ambayo itatusaidia kuelewa umuhimu wa masoko ya mifugo ya wanyama katika eneo lako. Habari tunayopata kutoka kwako itatusaidia kukusanya ripoti ambayo, pamoja na mambo mengine, itatusaidia kutoa sera juu ya

njia bora ya kusaidia lishe ya watoto, kuendesha na kusimamia masoko ya mvua na kuelezea majukumu yao kwa jamii, kwa mtazamo kuhakikisha upatikanaji salama na salama wa lishe inayotokana na wanyama kwa jamii.

Mradi wenyewe hauwezi kutoa msaada wowote wa moja kwa moja wa lishe kwa familia zinazoshiriki. Walakini, hatua za muda mrefu zinazotarajiwa za mradi huo zinaweza kujumuisha kuzindua elimu kwa umma na kutoa huduma muhimu za kiafya. Tunaweza pia kujifunza kutoka kwako mazoea mazuri ambayo yanaweza kuigwa katika familia zingine na jamii. Tunakuomba utumie wakati na sisi na utusaidie kukusanya vipande vya habari tunavyohitaji kwa utafiti huu. Tunakuhakikishia kujiamini kabisa kwa njia ambayo tutashughulikia habari yoyote iliyopatikana kutoka kwako.

Asante sana na ikiwa una maswali yoyote kuhusu hili, tafadhali usisite kuuliza.

Wako mwaminifu,

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APPENDIX III: HOUSEHOLD SURVEY QUESTIONNAIRE

Household Survey QS

Section 1:QS details

Survey code:	__/__/___/___ (County/Subcounty /Ward /HH Sn)
Interviewer's name:	First name Family name
Interview date:	__/__/____ (DD/MM/YEAR)
HH address:	Subcounty Ward Village
GPS:	N: ° ' " E: ° ' "
Consent obtained:	1=Yes 2=No *(if no, request a replacement farm from the field work team leader)*

Section 2: Interviewee details

Interviewee's name (*Optional*):	(First name) (Family name)
Interviewee's age	_____/Years
Interviewee's gender:	1=Male 2=Female 3=Others
Level of education: KDHS grading for education	1= No education 2 = Incomplete primary 3 = Complete primary 4 = Incomplete secondary 5 = Complete secondary 6 = Higher education
Interviewee's ethnic group:	_____
Contact details:	Mob. No:
Position in the HH	1=Head, 2=Spouse, 3=Daughter/daughter-in-law, 4=Son/son-in-law, 5=Other: (Specify_____)

Section 3: Visited HH characteristics

1. How many people live in this HH including yourself?

HH members	Male	Female
Less than 5 years		
5 to 14 years		
15 to 18 years		
More than 18 years		

2. For children less than 5 years, please complete the following table

Child	Gender (1=Male 2=Female)	Age (in months)

3. What are the sources of your household income?*(Please list the sources and what % each source contribute to the total income)*

Sources of HH income	% of the total HH income
Agricultural activity-not livestock	
Livestock production including poultry	
Employment	
Other ( )	
Other ( )	

4. Which of the following does your household own?

Items/description	1=Yes 2=No
Stove	
Gas cooker	
Electric cooker	
Jiko	
Fridge	
Freezer	
Watch	
Phone (mobile)	
Radio	
Television	
Bicycle	
Motorcycle/scooter	
Car	
Truck	
Animal-drawn cart	
Boat with a motor	

Boat without a motor	

5. What is the source of energy in your house (*Choose all that apply*)?

	1=Yes 2=No
1= Electric main	
2=Generator	
3= Lantern,	
4= Tin lamp	
5= Candle	
6 = Solar Power	
7=Biogas digester	
8=Fire wood	
9=Charcoal	
10=Other	

6. What type of toilet facility does your household use?
   1 = Flush toilet
   2 = Improved latrine
   3 = Unimproved latrine (without slab/open pit)
   4 = No facility/open bush
   5 = Other

7. Does your household share the toilet facility with other households?
   1= Yes
   2= No

8. What is the main water source for the household?
   1 = Tap/pipe
   2 = Well
   3 = Spring
   4 = River, lake or other body of water
   5 = Vendor/truck
   6 = Rain water
   7=Other

APPENDIX IV: 24 HOUR RECALL TOOL

I would like to ask you questions about what your child has eaten in the past day. Please feel free to tell me about any food that he/she has taken over that period no matter how tiny in amount it was. Please remember that all food that he/she has taken will be accounted for, such as food prepared and grown at home or purchased from outside. Remember that all food has a certain (nutrient) value no matter what the price of that food may be or wherever you acquire it from. There is nothing called "good" or "bad" food. Our discussion will take approximately 25 minutes. All information collected will remain confidential and will only be seen by the survey team. You do not have to take part, but we hope you will participate, as your views are important. You can stop the interview at any time if you wish. If any question makes you uncomfortable, you do not have to answer. Do you have any questions? May I begin the interview now?

Preliminaries: Age (in months): ……Weight (kgs): …… Height (cm):…... Hb (g/dl):……

First pass				Second Pass			Third Pass		
#	Time	Name of Food, Drink or Dish	Source of Food	Description of food	Food Code	Form of Prep	Measurement method		
							Volume (ml)	*Size*	*Number*
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									

Time
1 = Morning *(00:01-12.00)*
2 = Afternoon *(12.01-17:00)*
3 = Evening *(17:01-19:00)*
4 = Night *(19:01-00:00)*

SOURCE OF FOOD:
01 = Home-prepared
02 = Meal/snack prepared outside the home, e.g. chips, take-away)
03 = Local production / wild / raw foods (e.g. banana)
04 = Processed, manufactured food (e.g. bread, biscuits)
05 = Food aid or exchange for work
06= Other (Specify)
99 = Don't know

Form when prepared:
01 = Raw
02 = No prep
03 = Boiled, not drained
04 = Boiled, drained
05 = Steamed
06 = Stir fried in oil
07 = Deep fried in oil
08 = Roasted/toasted
09 = Baked
10 = Other
99 = Don't know
**if multiple, include

Size
Small
Medium
Large

APPENDIX V: CHILD DIETARY DIVERSITY SCORE TOOL

(*Go through the food items listed in the 24-Hour Recall. Place a '1' in the box if the child ate the food in question, place a '0' in the box if the child did not eat any of the food items in that food group*).

Food group	**Examples of food items**	**YES = 1** **NO = 0**
Cereals, roots and tubers	*Ugali, rice, chapatti, sorghum, millet, bread, porridge, potatoes, yams, arrow roots, cassava + any other locally available cereals and roots*	
Vitamin A rich fruits and vegetables	*Pumpkin, carrots, squash, orange sweet potatoes, ripe mangoes, ripe pawpaw, watermelon + any other Vit A rich fruits/vegetables*	
Other fruits and vegetables	*Cabbage, lettuce, wild fruits, apples, pears, guavas, thorn melon, plums etc.*	

Flesh foods	*Beef, pork, mutton, chicken, organ meat*	
Legumes, nuts and seeds	*Beans, lentils, green grams, peas, peanuts, cashew nuts etc.*	
Eggs	*Chicken, quail, duck, guinea fowl or any other*	
Milk and dairy products	*Milk, ghee, cheese, yoghurt, mala etc.*	
Oils and Fats	*Oil, fat, butter, margarine etc.*	
Overall score	-	

APPENDIX VI: ETHICAL APPROVAL FROM AMREF ETHICS AND SCIENTIFIC REVIEW COMMITTEE

amref health africa

Amref Health Africa in Kenya

REF: AMREF – ESRC P1009/2021

July 13, 2021

Odipo Osano
University of Eldoret
P.O. Box 1125 -3010
Eldoret, Kenya
Email: odipoosano@gmail.com / odipoosano@uoeld.ac.ke

Dear Prof. Osano,

RESEARCH PROTOCOL: THE ROLE OF WET MARKETS AND BACKYARD LIVESTOCK IN SUPPORTING NUTRITION OF PRESCHOOL-AGED CHILDREN IN ELDORET, KENYA: CHALLENGES FROM COVID19 INFLUENCED CLOSURE

Thank you for submitting your protocol to the Amref Ethics and Scientific Review Committee (ESRC).

This is to inform you that the ESRC has reviewed and approved your protocol. The approval period is from July 13, 2021 to July 12, 2022, and is subject to compliance with the following requirements:

a) Only approved documents (including informed consents, study instruments, advertising materials, material transfer agreements etc.) will be used.
b) All changes including (amendments, deviations, violations etc.) are submitted for review and approval by Amref ESRC before implementation.
c) Death and life-threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the Amref ESRC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to Amref ESRC within 72 hours.
e) Clearance for export of biological specimen must be obtained from the relevant government authorities for each batch of shipment/export.
f) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
g) In case of late renewal, the Amref ESRC shall not be held responsible for any severe adverse events (SAEs) that may occur as a result of research activities that were carried out after the expiry of approval.
h) Submission of an executive summary report within 90 days upon completion of the study to the Amref ESRC.
i) All government regulations for prevention and control of the spread of COVID-19 including social distancing, provision of personal protective equipment for participants and research assistants should be adhered to during data collection. All research assistants should be monitored for COVID 19 symptoms and referred for testing in case they present with symptoms.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and innovation (NACOSTI) https://oris.nacosti.go.ke/ and obtain other clearances needed.

Please do not hesitate to contact the ESRC Secretariat (esrc.kenya@amref.org) for any clarification or query.

amref health africa

Amref Health Africa in Kenya

Yours sincerely,

AMREF - ESRC
13 JUL 2021
P.O. Box 30125 - 00100 NAIROBI

Prof. Mohamed Karama
Chair, Amref ESRC

CC: Samuel Mumia, Monitoring & Evaluation and Research Manager, Amref Health Africa in Kenya

P O Box 30125-00100 Nairobi, Tel: +254 (0)20 699 4000, Fax: +254 (0)20 699 2531, www.amref.org

APPENDIX VII: SIMILARITY REPORT

University of Eldoret

University of Eldoret
Certificate of Plagiarism Check for Thesis

Author Name	SHEILA CHEBICHII KOSGEI SAGR/FCS/ M/008/20
Course of Study	Type here..
Name of Guide	Type here...
Department	Type here...
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