TITLE PAGE

THE PREVALENCE OF MALNUTRITION IN UNDER-FIVE YEARS OLD CHILDREN BY SOCIOECONOMIC STATUS IN TURKANA, BUNGOMA AND KAKAMEGA COUNTIES, 2013 - 2014.

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A report submitted to the Dept. of Public & Global Health in partial fulfilment of the requirements for the award of the degree of Master of Science in Medical Statistics of the University of Nairobi.

UNIVERSITY OF NAIROBI

DECLARATION OF ORIGINALITY FORM

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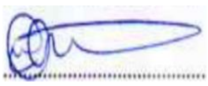
Signature…  Date: April 26, 2024

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LIST OF ABBREVIATIONS AND ACRONYMS

ARI Acute respiratory infections

CI Confidence interval

CIAF Composite Index of Anthropometric Failure

HAZ Height for age

DHS Demographic and Health Surveys

KDHS Kenya Demographic and Health Survey

KNBS Kenya National Bureau of Statistics

MICS Multiple Indicator Cluster Survey

NASSEP V National Sample Survey and Evaluation Program

OR Odds ratios

P-value Probability value

SAS Statistical analysis system

SDS standard deviation scores

UNICEF United Nations Children's Fund

WAZ Weight for age

WHZ Weight for height

WHO World health organization

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OPERATIONAL DEFINITIONS

Stunting: A condition in children in which they are shorter than they should be for their age. The condition is determined by comparing height of children based on their age to a healthy reference population.

Underweight: A condition in children in which they weigh less than they should be for their age. The condition is determined by comparing weight of children based on their age to a healthy reference population.

Wasting: A condition in children in which they weigh less than they should be for their height. The condition is determined by comparing weight of children based on their height to a healthy reference population.

Composite Index of Anthropometric Failure: Measurement method of child nutritional status that uses their physical characteristics such as height and weight.

ABSTRACT

Background. Insufficient protein or energy intake can cause malnutrition, affecting children's growth and well-being. This may lead to stunted physical and mental development, with under-five years old children facing heightened risks of illness and death. Additionally, malnutrition in childhood can impact socioeconomic status in adulthood.

Broad Objective. To examine the occurrence of malnutrition among children under the age of five in Turkana, Bungoma, and Kakamega counties. Additionally, to explore the connection between malnutrition and socioeconomic status.

Study design. This study utilized data from a cross-sectional household survey conducted during the fifth round of the MICS5 in Turkana, Kakamega, and Bungoma counties in Kenya in the period of 2013-2014.

Methodology. This study utilized data from a secondary household survey conducted in Kenya's Turkana, Kakamega, and Bungoma counties during 2013-14 by UNICEF's Multiple Indicator Cluster Survey (MICS) program. Statistical analysis involved SAS and R programming to examine the relationship between childhood malnutrition and demographic variables. Malnutrition indicators included underweight, stunting, and wasting. Logistic regression models used the Composite Index of Anthropometric Failure (CIAF) as the dependent variable, categorizing children into seven groups. Prevalence was calculated considering various factors. Malnutrition prevalence differences between counties were analysed. The study ensured the validity of logistic regression assumptions, incorporating exploratory analysis and comparison with WHO distributions.

Results. The study enrolled 2,594 under-five-year-olds in Turkana, Bungoma, and Kakamega counties, revealing a malnutrition prevalence of 48.0% (95% CI: 46.1 - 50) using the Composite Index of Anthropometric Failure (CIAF), surpassing traditional anthropometric indicators. Stunting, wasting, and underweight rates were 25.4% (95% CI: 23.8 - 27), 11.7% (95% CI: 10.6 - 13), and 18.1% (95% CI: 16.6 – 19.7), respectively. Turkana exhibited significantly higher undernutrition rates than Bungoma and Kakamega, with differences of 17.2 (95% CI: 12.67-21.74) and 12.5 (95% CI: 7.87-17.18) percentage points, respectively.

Bungoma had a lower undernutrition rate than Kakamega, but this wasn't statistically significant, showing a difference of -4.7 (95% CI: -9.57-0.21) percentage points. Children in the richest households in comparison to those in poorest, had lower malnutrition risk (AOR = 0.37, 95% CI: 0.27-0.51, p: <0.001), while females had significantly lower odds than males (AOR = 0.77, 95% CI: 0.66-0.91, p = 0.002). Malnutrition odds increased with age, particularly for children aged 24-35 months (AOR = 2.22, 95% CI: 1.61-3.08, p < 0.001) and 36-47 months (AOR = 1.94, 95% CI: 1.41-2.67, p < 0.001) in compassion to aged 0-5 months. Coughing elevated malnutrition odds (AOR = 1.21, 95% CI: 1.01-1.44, p = 0.038). Urban/rural residence and recent diarrhoea or fever showed no significant differences. Turkana children had higher malnutrition odds than Luhya (AOR = 2.28, 95% CI: 1.35-3.86, p = 0.002). Maternal education level of secondary or higher, was associated with lower malnutrition odds (AOR = 0.64, 95% CI: 0.47-0.89, p = 0.008). Socioeconomic status strongly correlated with malnutrition, indicating significantly lower odds in richer and richest households compared to poorer households.

Conclusion: This study sheds light on undernutrition in under-five-year-olds in Turkana, Bungoma, and Kakamega counties, emphasizing the need for tailored interventions. Turkana's significantly higher prevalence requires focused efforts, while Bungoma and Kakamega could benefit from similar strategies. The strong link between CIAF and socioeconomic status underscores poverty reduction's critical role in addressing child malnutrition. Targeted measures should address specific county needs while promoting equitable economic conditions for effective intervention.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background.

An inadequate intake of protein or calories leads to malnutrition, which is defined as a nutritional deficiency (Dipasquale et al., 2020). Childhood malnutrition is a serious issue in low- and middle-income countries, especially for young children under the age of five years. Among the indicators commonly used to assess a child's nutritional condition are underweight, wasting, and stunting. The WHO Child Growth Standards are used to track the physiological development of children from birth to age five years. Stunted, underweight and wasted children are defined as those whose height for age z-score, weight for age z-score, and weight for height z-score are less than two standard deviations respectively.

On children's physical and mental growth as well as their clinical outcomes, childhood malnutrition has evident negative effects (Dipasquale et al., 2020). Compared to non-malnourished children, those affected by malnutrition are more vulnerable to illnesses, making it a significant contributor to morbidity and mortality (Kien, Lee, Nam, Oh, Giang, & Minh, 2016). Moreover, malnutrition can also shape a child's socioeconomic status during their adult life (Kien, Lee, Nam, Oh, Giang, & Van Minh, 2016).

The World Bank Group, WHO and UNICEF Joint Malnutrition Estimates (2022), stated that the prevalence of stunting has decreased globally, going from 25.5% in 2013 to 22.0% in 2020. Stunting is more common in low-income nations; in 2013 it affected 39.4% of the population; by 2020, 35.1% had been affected. The prevalence of stunting decreased in middle-income nations as well, going from 26.0% in 2013 to 21.8% in 2020. Stunting prevalence in 2013 was highest in lower-middle-income countries (34.5%) and lowest in upper-middle-income countries (9.7%). Nonetheless, throughout time, the prevalence of stunting has gradually declined across all socioeconomic categories (UNICEF; WHO; World Bank Group Joint Malnutrition Estimates, 2022).

Among the World Bank regions, stunting was most prevalent in South Asia, where it affected 32.7% of the population in 2020, and Sub-Saharan Africa, where it affected 33.8% of the population in 2020. However, both regions have shown a decrease in stunting prevalence since 2013, where South Asia had a prevalence of 38.7%, and Sub-Saharan Africa had a prevalence of 41.7%. In East Asia and the Pacific, stunting prevalence has decreased from 15.5% in 2013 to 13.4% in 2020. Latin America and the Caribbean have also seen a decrease in stunting prevalence from 12.5% in 2013 to 11.3% in 2020. In Europe and Central Asia, stunting prevalence has remained relatively low over the years, ranging from 5.7% to 7.1% (UNICEF; WHO; World Bank Group Joint Malnutrition Estimates, 2022).

As per the UNICEF, WHO, and the World Bank Group Joint Malnutrition Estimates (2022), moderate to severe wasting remains a substantial public health concern on a global scale. The percentage of under five years old children affected by wasting was estimated at 6.7% in 2020, with a range from 0.3% in high-income countries to 14.7% in South Asia. In Kenya, data from various sources including the same UNICEF, WHO, and World Bank Group Joint Malnutrition Estimates shows that wasting prevalence has fluctuated over time. The estimates show that in 1987, the prevalence of wasting was 5.5%, which increased to 7.1% in 1993, and then decreased to 6.8% in 1994. The prevalence then increased to 8.6% in 1998 and then decreased to 7.4% in 2000. The estimates show that the wasting prevalence was estimated at 6.2% in 2003, and in 2005-06, it was estimated at 6.9%. It remained constant at 6.9% in 2008-09 and decreased to 6.3% in 2011. The latest estimates from 2014, 2015-16, and 2022 indicate a further decrease in wasting prevalence to 4.2%, 6.6%, and 4.3%, respectively (KNBS and ICF, 2023; UNICEF; WHO; World Bank Group Joint Malnutrition Estimates, 2022).

Similarly, the prevalence of stunting in Kenya, as per the UNICEF, the WHO, and the World Bank Group Joint Malnutrition Estimates (2022), has varied over time. From 1987 to 1998, the percentage of children under age of five years affected by stunting fluctuated between 36.8% and 41.1%. Subsequently, there was a dip in stunting prevalence to 35.5% in 2008, followed by a further reduction to 26.3% in 2011. However, the trend then plateaued, with stunting rates remaining relatively stable at around 26% to 30% between 2014 and 2016. In 2022, stunting prevalence reduced to 18% (KNBS and ICF, 2023; UNICEF; WHO; World Bank Group Joint Malnutrition Estimates, 2022).

A similar trend can be observed at county level from the available data. The prevalence of wasting in Kenya has been reducing since 2014, with the latest estimate indicating a further decrease to 4.3% in 2022. Kakamega, Bungoma, and Turkana counties, which are the counties of focus in this study, have also recorded a reduction in stunting prevalence, as per the Kenya Demographic and Health Survey (KDHS) 2014 and 2022. In 2014, Kakamega County had a stunting prevalence of 28.4%, which reduced to 12% in 2022. In the same year, Bungoma County had a stunting prevalence of 24.4%, which reduced to 19% in 2022. Turkana County had a stunting prevalence of 23.9% in 2014, which reduced to 23% in 2022.

The reduction in stunting prevalence is an indication that the nutrition interventions implemented have been effective. However, further efforts are necessary to ensure that interventions effectively reach the most vulnerable populations in the country. Obtaining additional information on identifying vulnerable populations at the county level would be a useful step towards achieving this goal.

1.2 Statement of the research problem

Child malnutrition among children below the age of five is a significant public health concern in various developing countries, including Kenya. Despite efforts to enhance food security, the prevalence of malnutrition remains a major issue at the county level. It is possible that current estimates of malnutrition prevalence underestimate the true extent of the problem. Therefore, there is a need for more comprehensive and robust tools, such as composite index of anthropometric failure (CIAF), which takes into account multiple anthropometric deficits. Although some studies have examined the determinants of childhood malnutrition in Kenya, few have specifically focused on county-level analysis utilizing CIAF. Consequently, there is a gap in the literature regarding the application of CIAF in statistical modelling of childhood malnutrition at the county level. This study aimed to bridge this gap by demonstrating how CIAF can be utilized in statistical modelling of childhood malnutrition at the county level in Kenya.

1.3 Justification

Malnutrition continues to pose a significant public health challenge worldwide, particularly in low- and middle-income countries, where stunting and wasting are the most prevalent forms. Although there has been a global and national decrease in the proportion of stunting and wasting, the rates remain alarmingly high, particularly in specific regions and counties of Kenya. Obtaining accurate estimates of malnutrition prevalence at the county level is crucial for developing targeted interventions aimed at reducing malnutrition and achieving the Sustainable Development Goal of eliminating undernutrition. The CIAF is a valuable tool that can provide a more precise estimation of malnutrition prevalence by considering multiple anthropometric deficits. Hence, this study utilized the CIAF to look into the incidence of different types of malnutrition among kids under the age five-year-old in a few Kenyan counties. Additionally, it explored the potential relationship between socioeconomic status and malnutrition.

1.4 Research Questions

a) Is there a statistically significant difference in the prevalence of CIAF in under-five years old children in Turkana, Bungoma, and Kakamega counties?

b) How does socioeconomic status influence the prevalence of CIAF in under-five years old children in Turkana, Bungoma, and Kakamega counties?

1.5 Broad Objective

To examine the occurrence of malnutrition among children under the age of five years old in Turkana, Bungoma, and Kakamega counties. Additionally, to explore the connection between malnutrition and socioeconomic status.

1.5.1 Specific Objectives

1. To determine the differences in the prevalence of CIAF in under-five years old children in Turkana, Bungoma, and Kakamega counties.
2. To examine the relationship between socioeconomic status and CIAF in under-five years old children in Turkana, Bungoma, and Kakamega counties.

CHAPTER TWO

2.0 Literature Review

The significance of proper nutrition during early childhood cannot be overstated. It is vital for promoting healthy growth, optimal organ development, a robust immune system, as well as cognitive and neurological development (Hoseini et al., 2015). In 2013, undernutrition was noted to have contributed 45% of child deaths worldwide (Hoseini et al., 2015).

Particularly in children, stunting has immediate and long-term effects. It increases susceptibility to infections and non-communicable diseases, impairs learning and development, and raises the risks of morbidity and mortality. Additionally, children who are stunted are more likely to accumulate fat in their bodies, have reduced energy expenditure, be insulin resistant, and have a higher chance of acquiring diseases including dyslipidemia, diabetes, and hypertension. Additionally, stunting is linked to reduced ability to work and poor adult reproductive results. After the age of two, stunted children who acquire weight quickly are also at a higher risk of being overweight or obese in the future. Begum and Dewey (2011).

A study conducted in 2016 by Casale and Desmond focused on assessing the cognitive function of children who had experienced recovery from stunting during early childhood, in comparison to those who remained stunted. The study utilized data from the Birth to Twenty Cohort Study conducted in urban areas of South Africa and analysed the Revised Denver Pre-screening Developmental Questionnaire when the children reached the age of 5. The findings indicated that although recovery from stunting is possible, children who had recovered still exhibited lower cognitive performance on tests compared to those who did not experience early childhood malnutrition. This implies that the timing of nutritional treatments in a child's early years is crucial for their cognitive development, which may have an impact on their preparedness for school and their academic success (Casale & Desmond, 2016).

McGovern et al. (2017) searched the literature published until July 2015 for research that looked into the possible relationship between childhood stunting or other undernutrition markers and adult economic outcomes. Consistent links were found during the search between stunting or height-for-age as a measure of childhood undernutrition and unfavorable economic results in later life. It was noted that the ripple effects of health on labor markets and capital accumulation could have been substantial, despite the paucity of research examining the relationship between undernutrition and economic growth (McGovern et al., 2017).

While underweight prevalence in children under five has decreased globally between 1990 and 2013, from 25% to 15%, with greater declines in Asia (from 32% to 18%) and Latin America and the Caribbean (from 8% to 3%), Africa saw a relatively small decline (from 23% to 17%) (Hoseini et al., 2015).

A cross-sectional study conducted in Sindh, Pakistan, to find out how common malnutrition is in early childhood and what variables lead to it. The results of the study showed that 39.5% of the children were underweight, 16.2% were wasted, and 48.2% had stunted growth. (2017) Khanetal. According to estimates by Hoseini et al. (2015), there were 161.5 million stunted children under five years in the world in 2013. The proportion of wasting cases in this age group was eight percent.

In 2018, Sulaiman et al. conducted a study that concentrated on rural areas of North Sudan. The study found that among children under five years old, the prevalence of stunting, underweight, and wasting was 42.5%, 32.7%, and 21%, respectively. In another study, wasting, underweight, and stunting were found to be 2.3%, 4.8%, and 23.8%, respectively, in a location of South Sudan with plenty of rainfall and food supplies (Kiarie et al., 2021).

Undernutrition in Kenya has been the subject of numerous research examining its trends and causes. For instance, Masibo and Makoka (2012) found a decrease in the frequency of stunting and underweight by 2.7% and 4.6%, respectively, using data from the Kenya Demographic and Health Survey covering the years 1993–2008–2009. In the Western Province of Kenya, a cross-sectional survey was conducted by Dennis et al. (2014). The findings revealed a significant correlation between poverty and stunting, with a prevalence of 6.6% underweight, 1.7% wasting, and 28.9% stunting among preschoolers (6-59 months). Ndemwa et al. (2017) conducted a cross-sectional study in Kwale County, Kenya, and identified a prevalence of 29.2% stunting, 20.8% underweight, and 19.0% wasting among children under 24 months of age (Dennis et al., 2014; Masibo & Makoka, 2012; Ndemwa et al., 2017).

It is important to note that considering multiple anthropometric failures may result in an even higher prevalence of malnutrition. This is where the CIAF becomes relevant as it accounts for multiple anthropometric indicators of malnutrition.

Anthropometric measurements, such as stunting, wasting, and underweight, have commonly been used to assess the nutritional status of children. These indices, distinguished by the WHO, reflect different biological processes related to undernutrition. Stunting indicates long-term or chronic undernutrition, wasting represents acute undernutrition, and underweight combines acute and chronic undernutrition. However, these indices often occur simultaneously and are not mutually exclusive. As a result, some researchers argue that these conventional indices alone are insufficient to measure the overall prevalence of undernutrition in young children. To address this limitation, there have been proposals for the development of a new composite measure (Al-Sadeeq, Bukair, & M. Al-Saqladi, 2018).

The CIAF is a methodology used to assess the overall prevalence of undernutrition within a population. It was initially proposed by Svedberg in 2000 and comprises six sub-groups of anthropometric failure: stunting, wasting, underweight, stunting and wasting, stunting and underweight, and wasting and underweight. Subsequently, Nandy et al. introduced a seventh subgroup, known as the "Y" category, which includes children who do not fall into any of the other subgroups. To calculate the CIAF, the number of children classified under each subgroup is summed, and this total is then divided by the overall number of children in the population. This calculation yields a single value that represents the estimated prevalence of undernourished children in the population as a whole. (Nandy et al., 2005; Svedberg, 2000).

The study conducted by Al-Sadeeq et al. (2018) aimed to determine the prevalence of undernutrition in children younger than five years old. To evaluate and analyze the collected data, they used a CIAF in addition to conventional body proportion assessments. While the traditional anthropometric indices showed that 38.5% of the children were stunted, 39.9% were wasted, and 55.1% were underweight, the CIAF found that 70.1% of the children were undernourished. There was a 31.6% increase in stunting, a 30.2% increase in wasting, and a 15% increase in underweight children when the CIAF aggregate was compared to each particular conventional measure. Furthermore, according to the CIAF data, 49.2% of the children had several anthropometric failures, compared to 21% of children who had just one. Al-Sadeeq, Bukair, & M. Al-Saqladi, 2018; Svedberg, 2000) determined the Stunting Index, Wasting Index, and Underweight Index to be, respectively, 0.55, 0.57, and 0.79.

In 2019, Islam and Biswas conducted research in Bangladesh to examine the risk factors and prevalence of the CIAF in young children. To determine the prevalence of CIAF, the researchers counted the number of children who exhibited any one of the six types of anthropometric deficiencies among all children under five. According to the study's findings, 48% of the children suffered from undernutrition in one or more ways, including stunting alone (13%), underweight and stunting (18%), wasting and underweight (6%), wasting and underweight (3%), and underweight simply (3%). Interestingly, male children had a considerably higher frequency of stunting (13% vs. 11%; P <.001) than female children.

Additionally, the study discovered that while the incidence of stunting and underweight was lower in the younger age group, the joint prevalence of wasting and underweight was higher in younger children (0-23 months) compared to older children (24-59 months). Depending on the children's age, the researchers noticed notable differences in the combined prevalence of underweight, wasting, and stunting (Islam & Biswas, 2020).

In a study published in 2015, Fenta et al. investigated the prevalence of childhood CIAF and the factors that influence it in different administrative zones of Ethiopia. The Ethiopian Demographic and Health Surveys (EDHS) carried out in 2000, 2005, 2011, and 2016 provided the researchers with data on 29,599 children under five from 72 distinct zones. According to the study, Ethiopia had a 53.78% total CIAF prevalence, with the highest frequency recorded in 2000 and the lowest in 2016.The study also found that residing in rural regions, having comorbidities, being a male kid, underweight mothers, parents without formal education, living in poorly sanitary households, and having a higher order of birth were all related with a greater prevalence of CIAF. There were also significant variations in CIAF prevalence among different zones (Fenta et al., 2021).

Permatasari and Chadirin used the CIAF and its contributing factors to investigate undernutrition in the rural Bogor District, Indonesia. The results showed that 42.1% of children under five had anthropometric failure, with "underweight and stunting" being the most common form. While family income, mother's height, and child's age were found to be associated with the conventional indices of underweight, stunting, and wasting, which are typically used to assess undernutrition, the mother's height emerged as the key predictor associated with anthropometric failure. In order to combat childhood undernutrition in Indonesia's rural areas, the study emphasizes the significance of mother height and family wealth (Permatasari & Chadirin, 2022).

The causes of undernutrition in children and mothers are described by UNICEF (2020), and they are divided into three categories: enabling, underlying, and urgent factors. Diets and care are immediate factors; food, practices, and services are underlying determinants; and governance, resources, and norms are enabling determinants (UNICEF, 2020).

In a study conducted in Serbian Roma villages, Teresa Janevic and colleagues examined the risk variables connected to childhood malnutrition. The findings show that children from low-income homes are more likely to be stunted, and that household financial status is a significant predictor of malnutrition. According to the study, the lowest quintile of affluence had the highest prevalence of stunting, which was followed by the second lowest quintile and the middle quintile. In addition, stunting was found to be more common in kids left in the care of older kids, and living in an urban area was linked to a higher risk of wasting. It was also proposed that maternal literacy and education were important, with maternal literacy demonstrating a strong correlation with wasting. Nevertheless, the research did not discover any noteworthy associations among the Roma community's malnourishment, diarrhea episodes, vaccinations, and nursing (Janevic et al., 2010).

Similarly, the goal of Sumonkanti Das and Rajwanur M. Rahman's study was to identify the risk factors for malnutrition in children in Bangladesh. The analysis used ordinal logistic regression to identify a number of significant predictors of malnutrition in children, including the age of the child, the interval between births, the mother's education level, her nutrition, the wealth status of the household, the child feeding index, and the frequency of fever, acute respiratory infections (ARI), and diarrhea. Notably, the study discovered that, in comparison to other models, the Predictive Power of Ordinal Models (PPOM) produced more accurate results (S. Das & Rahman, 2011).

In a developing Asian nation, Azizur Rahman studied the risk factors for malnutrition in children. The results showed a substantial correlation between severe underweight and stunting and mother education. Compared to children whose mothers had completed secondary school or higher education, children whose moms were illiterate were more likely to be severely underweight and stunted. While there was no statistically significant correlation between father education and stunting, children with low-educated fathers had a greater percentage of severely and moderately underweight and stunted children than children with fathers with secondary to higher education. The risk of being very underweight and moderately wasting was lower in children whose father was a skilled worker. According to the study, children who lived in households with just one child under the age of five were more likely to be severely wasted but less likely to be severely underweight or moderately stunted. Compared to children from rich households, children from poor households had a significantly higher likelihood of being stunted and severely and moderately underweight. Furthermore, compared to children from richer homes, children from middle-class households were more likely to be severely and moderately stunted as well as moderately underweight. Children who had moms who were not exposed to mass media were more likely to be severely and moderately underweight, stunted, and wasted than children whose mothers were exposed to at least two of the three media categories. This suggests that maternal mass media exposure is linked to childhood malnutrition. Finally, compared to children delivered at home, those born in hospitals receiving medical attention were less likely to be severely underweight, severely and moderately stunted, and moderately wasted (Rahman, 2016).

Khan et al.'s study found that among children under five in Sindh, Pakistan, household wealth was significantly correlated with stunting, wasting, and underweight. Compared to children from the wealthiest homes, those from the poorest households were more likely to experience stunting, wasting, and underweight. Furthermore, it was found that these kids' underweight was at danger due to the occurrence of diarrhea. Nonetheless, the investigation yielded no correlations between undernourishment and variables including mother's educational attainment, parity, and family size within the examined region. These results imply that interventions aimed at raising household wealth and lowering the frequency of diarrhea could successfully address malnutrition in children under five in Sindh, Pakistan (Khan et al., 2016).

In a study of all Bangladeshis, Mohammad et al. employed a multilevel approach to identify risk factors for malnutrition in children. The estimated overall prevalence of underweight, wasting, and stunting among the 7,568 children under the age of five who were enrolled in the study was 41.3% (95% CI 39.0-42.9). The results showed that there was a strong correlation between child malnutrition and age, sex, mother's BMI, mother's educational status, father's educational status, place of living, socioeconomic status, community status, religion, region of residence, and food security. It has been discovered that children from low-socioeconomic homes and those living in underprivileged areas are more vulnerable to malnutrition. Additionally, the study demonstrated that children from families experiencing food hardship had a higher risk of malnourishment (Chowdhury et al., 2016).

Pomati and Nandy investigated malnutrition in young children in West and Central Africa by using data from "Demographic and Health Surveys" (DHS) and MICs. The study discovered a significant relationship between maternal education and poverty as well as malnutrition. Maternal education was defined by home living conditions, while poverty was measured using the household asset index. In the study, malnutrition was measured using the CIAF (Pomati & Nandy, 2020).

Poor socioeconomic level, poor household cleanliness, big families, lack of family spacing, and abrupt weaning of newborns have all been linked to undernutrition in North Sudan (Sulaiman et al., 2018). On the other hand, Kiarie et al. (2021) discovered that non-resident status, older child age, and male gender were linked to an increased risk of wasting in South Sudan. Furthermore, a smaller household size and the age of the kid were associated with a higher risk of underweight, whereas a younger child's age and an agricultural livelihood were linked to a higher risk of stunting. To determine these risk factors, mixed-effect logistic regression analysis and logistic regression were used (Kiarie et al., 2021).

In order to determine the trends and contributing factors to undernutrition in early children, Masibo and Makoka carried out a study in Kenya. Data from the Kenya Demographic and Health Survey, which was carried out in 1993, 1998, 2003, and 2008–2009, were used in the study. After analysis, a number of noteworthy variables were found to be strongly linked to undernutrition in the research group. These included the dwelling location, the province, the wealth index, the source of drinking water, and the kind and availability of restroom facilities (Masibo & Makoka, 2012).

The study continuously showed that the proportion of kids classified as "stunted, wasted, and underweight" was higher in rural than in urban regions across all survey years. The scientists also observed a negative correlation between undernutrition and the wealth index. Particularly in the earlier survey years, children from the "poorest, poorer, and middle wealth quintiles" showed increased relative probabilities of experiencing stunting when compared to those in the wealthiest quintile. According to these results, socioeconomic variables significantly impact undernutrition in children in Kenya (Masibo & Makoka, 2012).

The authors also found that children who lived in houses without a toilet facility or in households with a toilet facility that was not upgraded had a 1.5 times higher risk of stunting, and a 2.2 times higher risk. The study found a strong correlation between undernutrition and maternal education, nutritional status, and the number of small children living with the mother. Children whose mothers had no formal education were more likely to be stunted, wasted, and underweight than children whose mothers had secondary or higher levels of education (Masibo & Makoka, 2012).

Moreover, Donald and Masibo studied the possible threshold level of maternal education required to lower child undernutrition in Malawi, Tanzania, and Zimbabwe. In all three nations, their results showed a strong correlation between maternal education level and underweight, wasting, and stunting. Maternal education levels higher were linked to decreased risk of stunting, underweight, and wasting in children. The study found that while the threshold values for underweight and wasting were lower, more than 10 years of schooling was necessary for mothers to significantly reduce stunting (Makoka & Masibo, 2015).

Furthermore, Ndemwa et al. found that Kwale county had a greater percentage of stunted male children in addition to a higher frequency of stunting and underweight among more mature children. Additionally, they identified a robust correlation between the mother's literacy level and underweight. The authors employed multiple logistic regression in their study to look into these associations (Ndemwa et al., 2017).

According to the literature, socioeconomic status is one of the risk factors for malnutrition. A common technique for determining socioeconomic class is the wealth index, which is created by principal component analysis utilizing a variety of indicators such consumer goods ownership, housing characteristics, access to clean water and sanitary facilities, and other pertinent aspects. Different levels of wealth are represented by quintiles, which are created by ranking and dividing the resulting wealth scores. It should be emphasized that the wealth index only accounts for long-term household wealth; it does not include information on absolute poverty, current income, or spending levels (UNICEF, 2015, 2016b, 2016a).

Assets including "radio, television, non-mobile telephone, refrigerator, agricultural land, and ownership of dwelling" were taken into account when calculating the wealth index in the particular setting of Bungoma County MICS (UNICEF, 2015). Similar to this, assets like non-mobile phones, land for farming, cars, trucks, motorboats, houses, farm animals, motorcycles, scooters, bicycles, animal-drawn carts, refrigerators, watches, mobile phones, televisions, and radios were taken into account in Turkana County MICS (UNICEF, 2016b). According to UNICEF (2016a), the wealth index calculation for Kakamega County MICS took into account assets like "radio, television, non-mobile telephone, refrigerator, agricultural land, farm animals/livestock, watch, mobile telephone, bicycle, motorcycle or scooter, animal-drawn cart, car or truck, boat with a motor, and ownership of dwelling."

This study, titled “The Prevalence of Malnutrition in Under-Five Years Old Children by Socioeconomic Status in Turkana, Bungoma, and Kakamega Counties, 2013-2014," aims to investigate the prevalence of malnutrition using the CIAF and explore the association between malnutrition and socioeconomic status in the selected counties.

CHAPTER THREE

3.0 Methodology

This study analyzed data obtained from the fifth round of the MICS5 done in three counties of Kenya: Turkana, Kakamega, and Bungoma, during the period of 2013-2014. The data collection process was carried out by the “Population Studies and Research Institute” at the “University of Nairobi” in collaboration with the KNBS, and with financial and technical support provided by the “United Nations Children's Fund (UNICEF)”. UNICEF designed the MICS5 survey to gather internationally comparable data on women and children. The data used in this study was obtained under the authorization of UNICEF.

3.1 Study Area

The study sites for this research are Turkana, Bungoma, and Kakamega counties in Kenya as indicated in figure 1. Turkana is part of north-west region of the country, while Bungoma and Kakamega are in the western region. These counties were selected for this study due to the availability of the most recent data from the 2013-14 round of the Multiple Indicator Cluster Survey (MICS5).

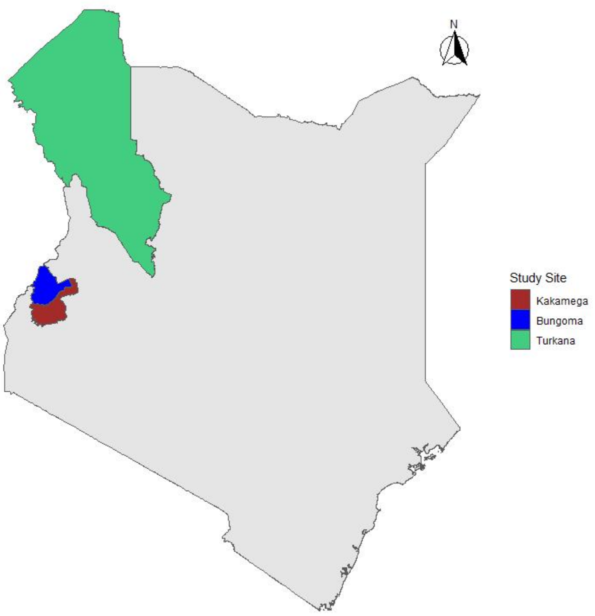

Figure 1: Location of study sites

3.2 Study design

This study utilized data from a cross-sectional household survey conducted during the fifth round of the MICS5 in Turkana, Kakamega, and Bungoma counties in Kenya in the period of 2013-2014. The MICS5 survey was specifically designed by the UNICEF with the objective of gathering data that can be compared internationally on these particular populations.

3.3 Study Population

The population of focus for the study was children under the age of five years who were living in Turkana, Bungoma, and Kakamega counties in Kenya during the period of November 1st, 2013 to February 3rd, 2014.

3.4 Case definition

In this study, three indicators of malnutrition were analysed: stunting, wasting, and underweight. The definitions for each indicator are based on guidelines for WHO for malnutrition in children under five years old.

- Underweight: defined as a weight for age z-score value of less than -2 standard deviations.
- Stunting: defined as a height for age z-score value of less than -2 standard deviations.
- Wasting: defined as a weight for height z-score value of less than -2 standard deviations.
- Anthropometric failure: defined as being underweight, stunted, or wasted.

CIAF: Composite Index of Anthropometric Failure (CIAF)

The CIAF categorizes children into seven groups based on their nutritional status. These groups include:

A: Children without anthropometric failure

B: Children with wasting only

C: Children with wasting and underweight

D: Children with wasting, underweight, and stunting

E: Children with underweight and stunting

F: Children with stunting only

Y: Children with underweight only

The total amount of malnutrition was calculated as the sum of groups B, C, D, E, F, and Y.

3.5 Inclusion and exclusion criteria

To ensure the integrity and adherence to standard guidelines, we applied specific inclusion and exclusion criteria based on the WHO anthropometric guidelines. Data points falling outside the recommended z-score ranges for various anthropometric indicators were excluded from our analysis. Specifically, we excluded height-for-age z-scores less than -6 or greater than 6, weight-for-age z-scores less than -6 or greater than 5, and weight-for-height z-scores less than -5 or greater than 5. These ranges were established to identify extreme values that indicate measurement errors or outliers, which could potentially bias our results or compromise the accuracy of our analysis.

3.6 Sample size determination

According to MICs documentation, the sample size for Turkana County was 1740 households, while Bungoma and Kakamega counties were 1500 households each. Basic immunization for children aged 12-23months was the key indicator used in sample size calculation. The formula below was used.

$$n = \frac{[4(r)(1-r)(deff)]}{[(0.12r)^2(pb)(AveSize)(RR)]}$$

Where:

n is the required sample size in terms of number of households.

4 is a factor required in order to achieve 95% level confidence.

r is the predicted or anticipated value of the indicator expressed as proportion.

deff is the design effect for the indicator, estimated from the previous survey or a default value of 1.5.

0.12r is the margin of error to be tolerated at the 95% level of confidence.

pb is the proportion of total population upon which the indicator r is based.

AveSize is the average size of the household.

RR is the predicated response rate.

3.7 Sampling strategy

The study employed a two-stage sampling process, involving cluster selection and household selection. The sampling frame utilized was the fifth National Sample Survey and Evaluation Program (NASSEP V), which is maintained by the KNBS. Within this frame, the primary unit of sampling was the cluster, which consisted of one or more enumeration areas containing approximately 100 households on average. To ensure a representative sample, a specific number of enumeration areas were selected from the frame using equal probability selection within each stratum. Household listings were generated based on the selected clusters, and subsequently, a systematic sample of 30 households was drawn from each cluster. All the selected clusters were visited during the sampling process. In the regions of Kakamega and Bungoma, a total of 50 clusters were selected, while 58 clusters were chosen in Turkana.

3.8.0 Data collection plan (instruments)

For this study, the data was obtained from secondary source, specifically the MICS website (https://mics.unicef.org/surveys). The surveys conducted in Turkana (2013-14), Kakamega (2013-14), and Bungoma (2013-14) was utilized. Mothers or the primary caregivers of children under five years old were interviewed by trained fieldworkers who filled standardized questionnaires. The KNBS and the Population Studies and Research Institute worked together to collect the data. The questions were based on the MICS5 model questionnaire and were translated and altered from the original English version into regional languages like Turkana, Kiswahili, and the Luhya sub-dialect. In Trans-nzoia county, pre-testing of the questionnaires was done in four clusters that included both urban and rural areas. The wording and translation of the questionnaires were modified in light of the pre-test results. The measurements of children's weight, height, and length were conducted by the same trained measurer, assisted by a team member. The weight was recorded in kilograms with a precision of 0.1 kg, while the length (for children under two years) and height (for children aged two and above) were measured in centimetres with a precision of 0.1 cm. Face-to-face interviews were conducted to gather the data, which took place between November 1st, 2013 and February 3rd, 2014.

3.8.1 Data extraction

Data for this study was extracted from the MICS website (https://mics.unicef.org/surveys). The application for data extraction was filled and submitted through the website. The details for study title, study methodology, study design and intention upon which data was sought was filled in the application form. Once approval was received from MICS UNICEF, survey data for Turkana (2013-14), Kakamega (2013-14), and Bungoma (2013-14) were selected from https://mics.unicef.org/surveys and exported to R, for processing.

3.9 Study variables

The outcome variables in this study were under-five years old children malnutrition indicators namely, underweight, stunting, wasting and composite index of anthropometric failure. These variables were generated from z-score of anthropometrics. The z-score variables were computed in MICS survey using the WHO anthropometrics packages. The z-scores measured the deviation of the child's anthropometric measurement from the median of the standard population in terms of standard deviation units. The explanatory variables in the study were child's age in months (categorized into 0-5, 6-11, 12-23, 24-35, 36-47 and 48-59), child's sex (male/ female), child's diarrhoea status in last two weeks, child's fever status in last two weeks, child's cough status in last two weeks, living area (urban/rural), ethnicity (Turkana / non-Turkana, Luyha / non-Luyha), mother's education level (none, primary, secondary and above), and household socioeconomic status (Poor, Poorer, Middle, Rich, Richest). Socioeconomic status is proxied by wealth index computed using household assets. The explanatory variables were chosen based on previous studies which showed that these variables are important determinants of malnutrition (Masibo & Makoka, 2012; Thang & Popkin, 2003).

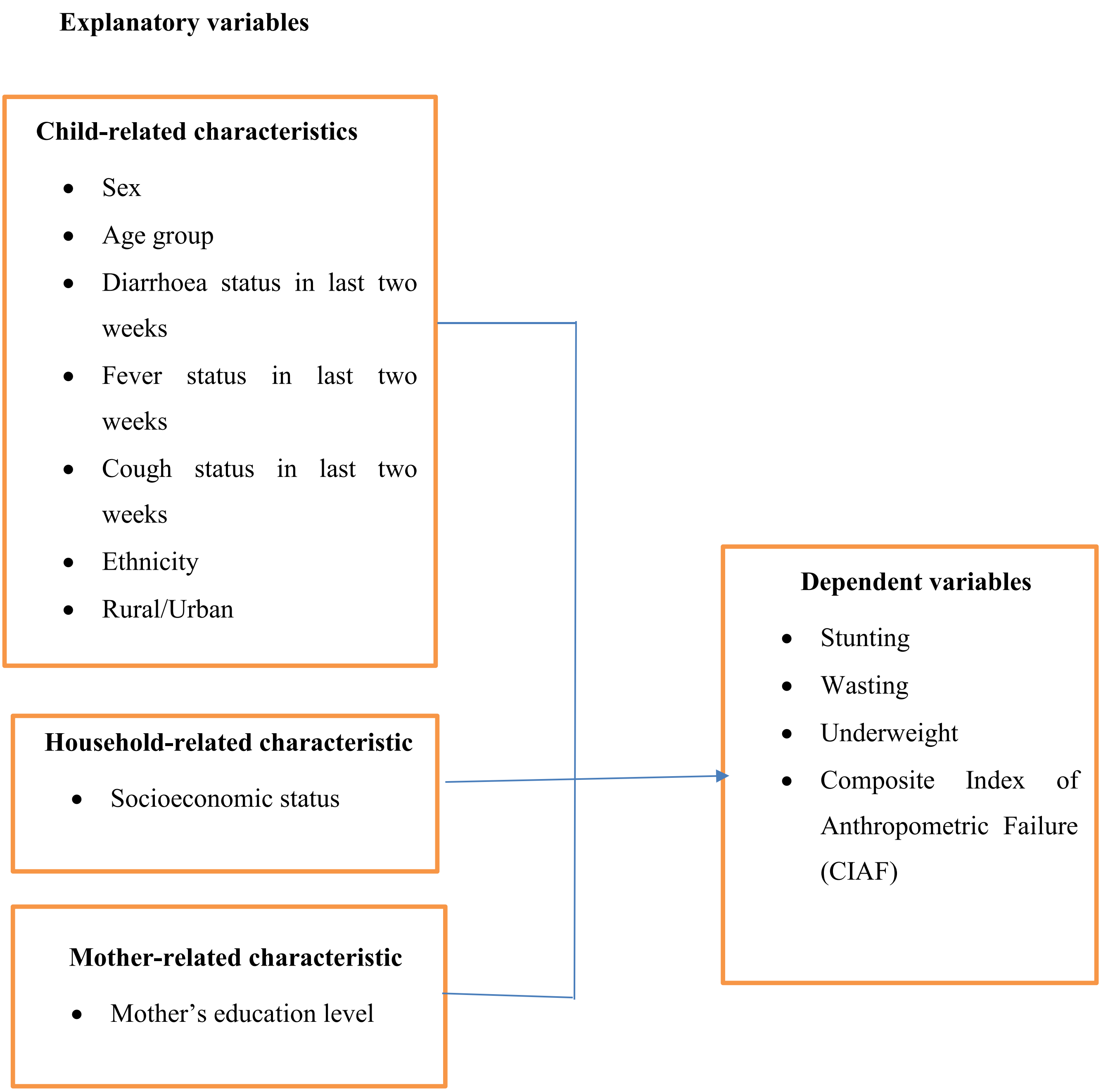

Figure 2: Conceptual frame work

3.10 Data processing and analysis plan

3.10.1 Data analysis plan

Data was extracted in SPSS format, then cleaned and coded using R statistical programming software. Data analysis was performed using SAS and R statistical programming software. Continuous variables were summarized using descriptive statistics, including mean, median, standard deviation, minimum, maximum, lower quartile, and upper quartile. These continuous variables included, height/length, weight, age (months) and weight for age, weight for height and height for age z-scores. The categorical variables were summarized through frequency counts and percentages of the population. Boxplot was used to present distribution of weight for age, weight for height and height for age z-scores. The count of children with notably low or notably high z-scores were presented by counties. The notably low z-score was defined as values less than -1.645 while notably high z-score was defined as values higher than 1.645. The value -1.645 and 1.645 corresponds to 5^{th} and 95^{th} percentiles respectively. Logistic regression was employed to model the dependent variables against the independent variables, with an investigation into the assumptions of logistic regression to check for any violations. The prevalence of stunting, wasting, and underweight was computed and presented based on socio-economic status. The prevalence difference between counties was computed and presented alongside their confidence intervals.

3.10.2 Logistic regression

Logistic Regression is a statistical model used to predict binary responses (Yes/No or Presence/Absence of a condition) against one or multiple independent variables. The model calculates coefficients for each explanatory variable to determine their contribution to the response variable. The predicted probabilities are expressed in terms of log odds ratio using the following equations:

$$\ln\left[\frac{P(Y)}{1-P(Y)}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k \qquad (1)$$

$$\frac{P(Y)}{1-P(Y)} = e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k} \qquad (2)$$

$$P(Y) = e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k} - P(Y) e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k} \qquad (3)$$

$$P(Y) = \frac{e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k}}{1 + e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k}} \qquad (4)$$

Where:

- $\ln\left[\frac{P(Y)}{1-P(Y)}\right]$ is the log odds of the response variable,
- Y is the binary response variable,
- $X_1, X_2, \ldots X_k$ are explanatory variables,
- $\beta_0, \beta_1, \beta_2, \ldots, \beta_k$ are model coefficient and β_0 is the intercept.
- The coefficients are estimated using maximum likelihood estimation.

The objective of logistic regression is to correctly predict the value of the response variable using the set of explanatory variables. The results are usually presented in terms of odds ratio, indicating the association between the explanatory variable and the response variable. The significance of the logistic regression coefficients is tested using the Wald test. The hypothesis is as follows:

$$H_0: \beta_j = 0$$

$$H_a: \beta_j \neq 0 \qquad (5)$$

Wald test statistic is computed as below:

$$X^2 = \frac{\beta^2}{SE^2} \qquad (6)$$

With 1 degree of freedom, each calculated Wald test statistic is evaluated by comparing it to a chi-square critical value. We reject H0 if the absolute value of the test statistic is greater than the critical value or if the p-value is less than the level of significance.

3.10.3 Assumptions of Logistic regression

The results of logistic regression are only valid if the following assumptions hold:

a) The dependent variable is binary.

b) There is linearity between the logit and the independent variables.

c) No multicollinearity exists.

d) The observations are independent.

e) There is a large sample size.

3.10.4 Minimisation of errors and biases

All the analysis are weighted based on the weights present in the data. The weight provide county representative results.

3.11 Study limitation

Data accuracy and completeness for this study depended on the MICs survey. This being secondary data, any missing or inaccurate data from the original survey affected this study. However, robust statistical approach such as median summary statistic was used to overcome missing data challenges.

The cross-sectional study design limited our capacity to establish causal linkages by giving a picture of the study population at the time of the survey. However, the study disclosed any relationships that were found.

3.12 Ethical considerations

The Kenyatta National Hospital - University of Nairobi Ethics and Research Committee (KNH-UoN ERC) gave its clearance before this study was carried out (KNH-UoN ERC No: P579/07/2023). In addition, this study used secondary data collected by Multiple Indicator Cluster Survey (MICS). Initial MICS study obtained informed consent from respondents and safeguarded respondent privacy through data de-identification. In this study, waiver of respondent consent was requested because MICS already had the necessary agreement from respondents. However, MICS permission was sought before data for this study was extracted.

CHAPTER FOUR

4.0 RESULTS

4.0.1 Child, maternal and household characteristics

In this subsection, we present child, maternal and household characteristics for the study population. The study had a total of 2819 children, distributed as 874 from Bungoma county, 828 from Kakamega county and 1117 from Turkana County. The mean age across all counties was 29.7 months (SD = 16.96), with a median of 31 months. The age distribution exhibited similar patterns across the counties.

Table 1: Age distribution of the children in months

County	n	Mean(SD)	Median	Q1	Q3	Min	Max
Bungoma (N = 874)	846	29.9 (16.88)	32	15	44	0	59
Kakamega (N = 828)	806	29.8 (16.69)	30	16	44	0	59
Turkana (N = 1117)	1067	29.5 (17.25)	30	14	45	0	59
Total (N = 2819)	2719	29.7 (16.96)	31	15	44	0	59

Note: In instances where children are listed with an age of zero, it denotes that they had not yet completed their first month of life at the time of interview, which may represent ages as low as 22 days.

Table 2 below gives sociodemographic and child characteristics. The three counties showed a relatively even split between male and female children. In Bungoma, there were 432 (51.1%) female children and 414 (48.9%) male children. In Kakamega, there were 418 (51.9%) female children and 388 (48.1%) male children. In Turkana, there were 530 (49.7%) female children and 537 (50.3%) male children. The age group of 36-47 months had the highest proportion of children across the three counties, while the age group of 0-5 months had the least proportion. Diarrhoea status in the last two weeks prior to the survey was also reported. In Bungoma county, 11.9% of the children reported having experienced diarrhoea, while 17.8% in Kakamega county reported the same. For Turkana county, 17.4% of the children reported experiencing diarrhoea. A majority of the children in all counties reported not experiencing diarrhoea during this period. However, a small percentage of respondents in each county were unsure or did not respond to this question. A similar trend was observed for fever status. In Kakamega, 27.4% of children had a fever in the last two weeks, compared to 19.8% in Bungoma and 18.6% in Turkana. The majority of children did not experience fever during this time. Similarly, coughing status in the last two weeks prior to interview was reported as 45.7%, 37% and 32.2% in Bungoma, Kakamega and Turkana counties respectively. Children in this study were evenly distributed between rural and urban area. Bungoma had 55.5% of children living in rural areas, while Kakamega and Turkana had 49.8% and 48.8% respectively.

Table 2:Sociodemographic and child characteristics

Variables	**Label**	**BUNGOMA Total = 846 n(%)**	**KAKAMEGA Total = 806 n(%)**	**TURKANA Total= 1067 n(%)**
Child-related characteristic				
Sex	Male	414 (48.9)	388 (48.1)	537 (50.3)
	Female	432 (51.1)	418 (51.9)	530 (49.7)
Age group (Months)	0 – 5	83 (9.9)	70 (8.7)	107 (10.0)
	6- 11	84 (9.9)	82 (10.0)	120 (11.2)
	12 – 23	152 (17.9)	161 (19.9)	196 (18.3)
	24 – 35	160 (18.9)	150 (18.6)	205 (19.2)
	36 – 47	215 (25.4)	205 (25.4)	222 (20.8)
	48 – 59	152 (18.0)	140 (17.3)	217 (20.4)
Diarrhoea status in last two weeks	Yes	100 (11.9)	143 (17.8)	186 (17.4)
	No	740 (87.5)	652 (80.9)	880 (82.5)
	Don't know	5 (0.6)	11 (1.3)	0

Variables	Label	BUNGOMA Total = 846 n(%)	KAKAMEGA Total = 806 n(%)	TURKANA Total= 1067 n(%)
Fever status in last two weeks	Yes	168 (19.8)	221 (27.4)	198 (18.6)
	No	674 (79.7)	582 (72.2)	869 (81.4)
	Don't know	4 (0.5)	3 (0.4)	0
Area	Urban	376 (44.5)	405 (50.2)	546 (51.2)
	Rural	470 (55.5)	401 (49.8)	521 (48.8)
Cough status in last two weeks	Yes	415 (49.1)	295 (36.6)	385 (36.1)
	No	427 (50.5)	506 (62.8)	682 (63.9)
	Don't know	3 (0.4)	4 (0.6)	0
Ethnicity	Luyha	762 (90.0)	764 (94.8)	
	Turkana			898 (84.2)
	Other ethnic group	84 (9.9)	42 (5.2)	167 (15.7)
	Missing/DK			1 (0.1)

Table 3 below shows Mother-related and household characteristics. In terms of mother's education level, the majority of women in Turkana (71.1%) reported having no formal education, while a sizable proportion of women in Bungoma (60.8%) and Kakamega (64.8%) reported having completed primary education. The survey also gathered data on the socio-economic status of households in the three counties. In Bungoma County, nearly half of the households fell into the "poorest" and "poorer" categories, comprising a total of 45.4% of households. In contrast, the "richer" and "richest" categories combined made up 35.4% of households. A smaller proportion, 19.2%, belonged to the "middle" category. For Kakamega County, 47.6%, were classified as "poorest" and "poorer." Meanwhile, the "richer" and "richest" categories represented thirty three percent of households. The "middle" category accounted for 19.1% of households.

In Turkana County, households in the "poorest" and "poorer" categories made up 43.2%, while the "richer" and "richest" categories combined constituted 36.5% of households. The "middle" category represented 20.3% of households.

Table 3:Mother-related and household characteristics

Variables	**Label**	**BUNGOMA Total = 846 n(%)**	**KAKAMEGA Total = 806 n(%)**	**TURKANA Total= 1067 n(%)**
Mother-related characteristic				
Mother's education level				
	None	34 (4.0)	62 (7.7)	758 (71.1)
	Primary	514 (60.8)	522 (64.8)	207 (19.4)
	Secondary and higher	298 (35.2)	222 (27.5)	99 (9.3)
	Missing/DK	0	0	3 (0.3)
Household-related characteristic				
Socioeconomic status	Poorest	199 (23.6)	207 (25.7)	216 (20.3)
	Poorer	184 (21.8)	176 (21.9)	244 (22.9)
	Middle	162 (19.2)	154 (19.1)	217 (20.3)
	Richer	157 (18.5)	158 (19.6)	227 (21.3)
	Richest	143 (16.9)	111 (13.7	163 (15.2)

4.0.2 Anthropometric measurements

Table 4 below shows summary statistics for anthropometric measurements. The mean height of children across the three counties was relatively similar. Bungoma, Kakamega and

Turkana had a mean height of 83.8 cm (13.67), 83.5 cm (13.73) and 85.0 cm (14.49) respectively. The mean weight across the counties were 11.6 kg (Bungoma), 11.5 kg (Kakamega), and 10.8 kg (Turkana). Median weight ranged from 10.7 kg to 11.8 kg. Table 5 also shows summary statistics of weight for height standard deviation scores (WHZ SDS), weight for age standard deviation scores (WAZ SDS) and height for age standard deviation scores (HAZ SDS). Turkana county had the least mean WHZ SDS of -1.0, while Bungoma and Kakamega counties both had mean WHZ SDS of 0.1. Similarly, Turkana county had the least mean WAZ SDS of -1.2, while Bungoma and Kakamega had -0.6 and -0.7 respectively.

Children in Kakamega county had the least mean HAZ SDS of -1.3, while Bungoma and Turkana had -1.2 and -0.8 respectively.

Table 4: Summary statistics for anthropometric measurements

Variable	Statistics	Bungoma	Kakamega	Turkana	Total
Height(cm)	n	811	751	1031	2593
Height(cm)	Mean(SD)	83.8 (13.67)	83.5(13.73)	85.0 (14.49)	84.2 (14.03)
Height(cm)	Median	84.50	85.00	85.30	85.00
Height(cm)	Q1	74.20	74.20	73.50	73.90
Height(cm)	Q3	93.41	93.67	96.50	94.50
Height(cm)	Min	45.00	40.00	36.00	36.00
Height(cm)	Max	125.00	120.00	131.00	131.00
Weight(kg)	n	802	759	1030	2591
Weight(kg)	Mean(SD)	11.5 (3.37)	11.5 (3.45)	10.9 (3.36)	11.3 (3.41)
Weight(kg)	Median	11.60	11.80	10.80	11.30
Weight(kg)	Q1	9.20	9.10	8.40	8.70
Weight(kg)	Q3	14.00	14.10	13.20	13.79
Weight(kg)	Min	3.0	2.0	2.0	2.0
Weight(kg)	Max	25.0	20.0	28.0	28.0

Variable	Statistics	Bungoma	Kakamega	Turkana	Total
Weight for height SDS	n	778	730	1001	2509
Weight for height SDS	Mean(SD)	0.1 (1.38)	0.1 (1.29)	-0.9 (1.58)	-0.3 (1.53)
Weight for height SDS	Median	0.07	0.15	-0.97	-0.26
Weight for height SDS	Q1	-0.68	-0.62	-1.91	-1.19
Weight for height SDS	Q3	0.91	0.95	-0.04	0.65
Weight for height SDS	Min	-5.00	-4.00	-5.00	-5.00
Weight for height SDS	Max	5.00	5.00	5.00	5.00
Weight for age SDS	n	787	746	895	2428
Weight for age SDS	Mean(SD)	-0.7 (1.39)	-0.7 (1.19)	-1.2 (1.34)	-0.9 (1.33)
Weight for age SDS	Median	-0.62	-0.71	-1.21	-0.83
Weight for age SDS	Q1	-1.44	-1.38	-2.00	-1.63
Weight for age SDS	Q3	0.19	0.04	-0.39	-0.02
Weight for age SDS	Min	-5.00	-5.00	-6.00	-6.00
Weight for age SDS	Max	5.00	4.00	4.00	5.00
Height for age SDS	n	779	725	876	2380
Height for age SDS	Mean(SD)	-1.2 (1.71)	-1.3 (1.66)	-0.8 (1.78)	-1.1 (1.74)
Height for age SDS	Median	-1.15	-1.48	-0.90	-1.14
Height for age SDS	Q1	-2.26	-2.41	-1.92	-2.24
Height for age SDS	Q3	-0.13	-0.37	0.17	-0.08
Height for age SDS	Min	-6	-6	-6	-6
Height for age SDS	Max	6	5	6	6

*SDS: Standard deviation z-scores

4.0.2 Distribution of weight for age, weight for height and height for age z-scores by socio- economic status.

Boxplots were produced to examine the weight for age z-score, weight for height z-score, and height for age z-score for under-five years old children in Bungoma, Kakamega, and Turkana counties by different socioeconomic status groups.

Figure 3 below shows distribution of height for age z-scores. The poorest and poorer categories across all the counties had substantially lower z-scores, indicating poorer growth outcomes, as compared to the WHO reference value. The middle, richer, and richest categories showed less pronounced negative differences from the WHO reference value.

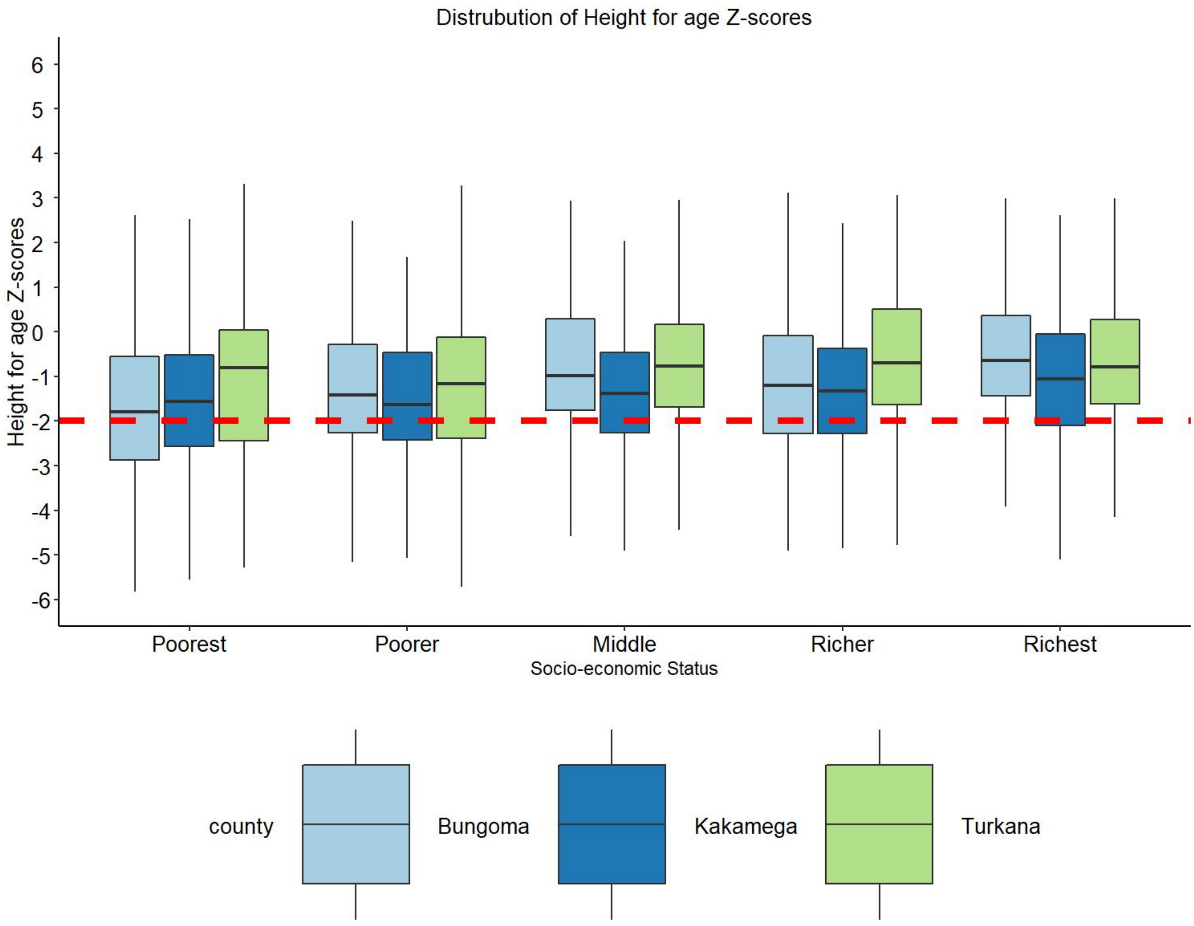

Figure 3: Distribution of Height for age by socio- economic status

Figure 4 below shows distribution of weight for height z-scores. The boxplots indicate that the median of weight for height z-scores for all counties and socio-economic groups falls within the "normal" range as defined by WHO. However, the lower quartile of the boxplot for Turkana county in the poorer and poorest households falls below the WHO reference line.

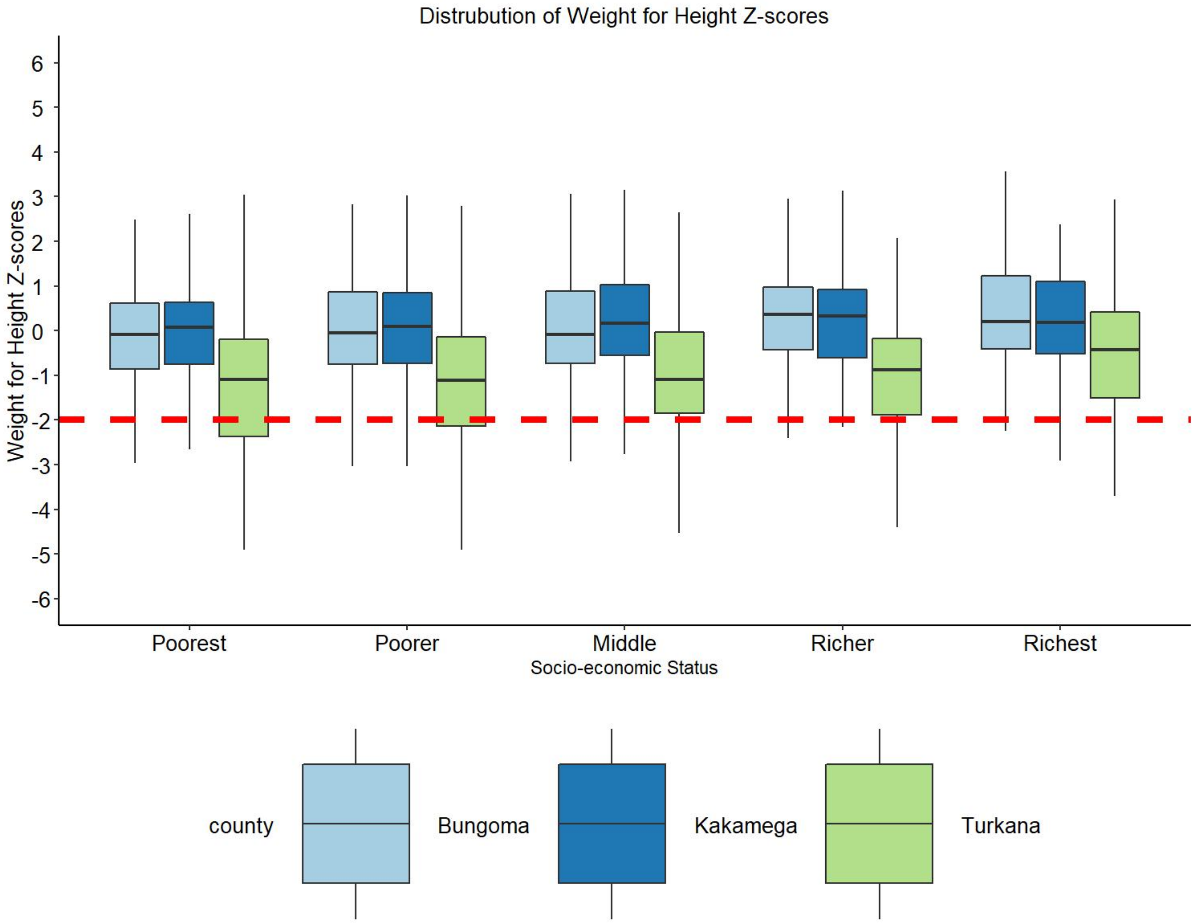

Figure 4:Distribution of Weight for height by socio- economic status

Figure 5 below shows distribution of weight for age z-scores. The median weight for age z score across all counties in all socio-economic groups was within the "normal" range, according to the WHO definition of underweight (z score less than -2 standard deviations from the median). However, for poorer and poorest households in Turkana county, the lower quartile fell below the WHO reference line. Turkana county had the least median weight for age z score across all socio-economic groups.

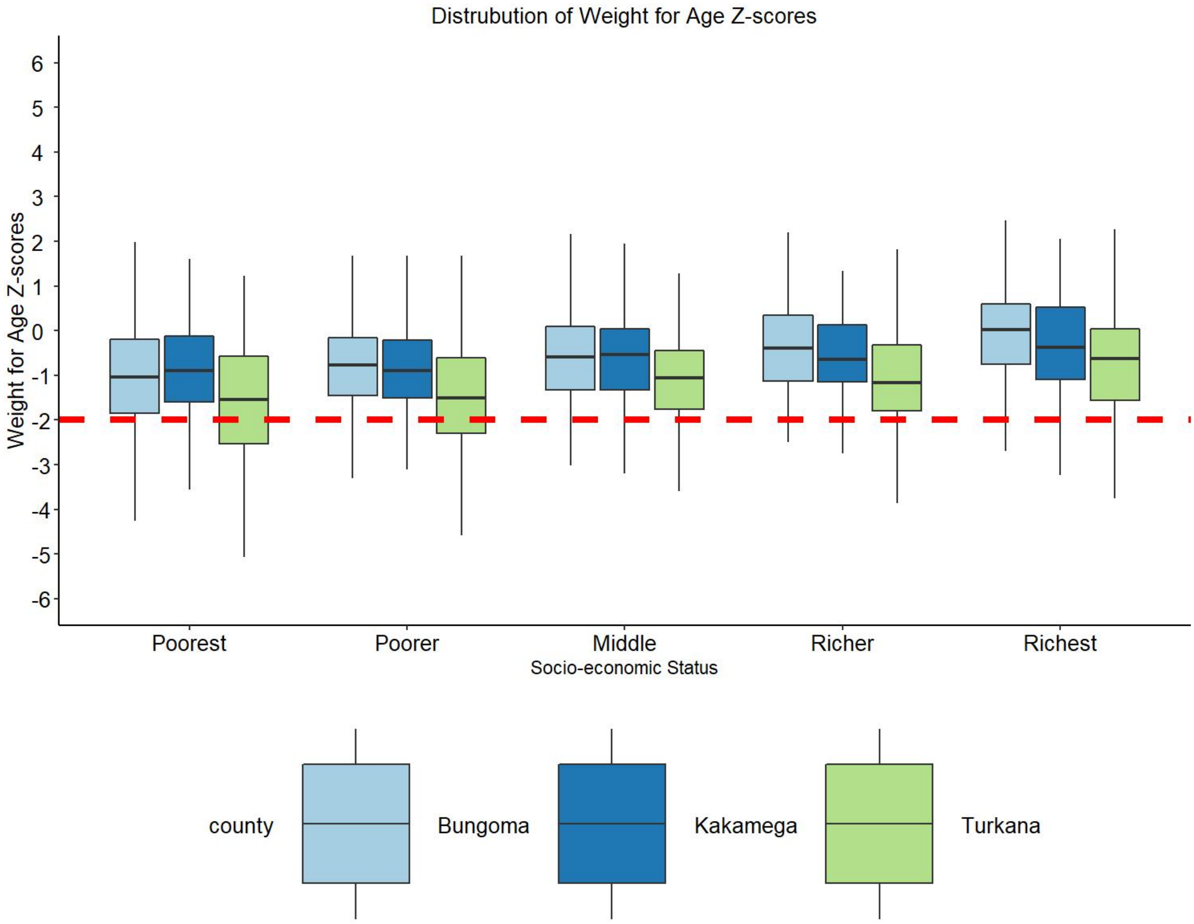

Figure 5: Distribution of Weight for age by socio- economic status

4.0.3 Prevalence of different form of anthropometric failure by child, mother, and household socio-economic characteristics

Table 5 below presents the prevalence of undernutrition and 95% Confidence Intervals (CI) stratified by child-related characteristics. In the overall population, the prevalence of undernutrition is much higher when measured by CIAF, at 46.8% (95% CI: 44.0 - 49.0), compared to the values for stunting (30.2%, 95% CI: 28.0 - 33.0), wasting (12.6%, 95% CI: 11.0 - 15.0), and underweight (17.8%, 95% CI: 16.0 - 20.0). The prevalence was also analysed by child characteristics. Male children exhibited a notably higher prevalence of undernutrition (CIAF: 49.5%, 95% CI: 46.0 - 53.0) than their female counterparts (CIAF: 44.3%, 95% CI: 41.0 – 47.0). In terms of age groups, children aged 24 to 35 months had the highest prevalence of undernutrition (CIAF: 55.5%, 95% CI: 50.0 - 61.0) compared to other age groups. Children who reported recent episodes of cough (CIAF: 47.6%, 95% CI: 44.0-51.0) in the last two weeks displayed higher rates of undernutrition compared to those who did not. Moreover, children in rural settings had a significantly higher prevalence of undernutrition (CIAF: 51.8%, 95% CI: 48.0 - 55.0) compared to their urban counterparts.

Surprisingly, children who reported having fever episode in last two weeks had a lower prevalence of undernutrition (CIAF 44.4%, 95% CI: 39.0 - 50.0) compared to those without fever (CIAF 47.5%, 95% CI: 45.0 - 55.0).

Table 5: Prevalence and 95% CI stratified by child-related characteristics

Variables	**Total**	**CIAF (95% CI)**	**Stunting (95% CI)**	**Wasting (95% CI)**	**Underweight (95% CI)**
Overall	2719	46.8(44.0-49.0)	30.2 (28 - 33)	12.6(11.0- 15.0)	17.8(16.0-20.0)
Child information					
Sex					
Female	1381	44.3 (41.0 - 47.0)	28.1(25.0- 31.0)	11.4(9.3-14.0)	17.0(15.0- 20.0)
Male	1338	49.5(46.0-53.0)	32.4(29.0-36.0)	13.9 (12-16.0)	18.6(16.0- 22.0)
AGE					
0 – 5	260	38.0 (31 – 45.0)	15.7(11.0- 22.0)	16.8(12.0-24.0)	10.6 (7.3 - 15)
6 – 11	285	38.4(32.0-45.0)	15.2(11.0-21.0)	21.5 (16.0-28.0)	19.2(14.0- 26.0)
12 – 23	508	46.7(40.0-53.0)	31.7(27.0- 37.0)	15.2 (12.0-19.0)	16.7 (13.0–21.0)
24 – 35	515	55.5(50.0-61.0)	40.5(35.0-46.0)	12.1 (9.1 - 16.0)	26.0(21.0- 31.0)
36 – 47	642	50.2 (45.0-56.0)	38.7(33.0-45.0)	7.5 (5.5 - 10.0)	16.4(12.0- 21.0)
48 – 59	509	43.4 (39.0 – 48.0)	23.6 (19.0 – 29.0)	10.1 (6.9 – 14.0)	15.0(11.0- 19.0)
Diarrhoea					
Yes	418	46.4(41.0-52.0)	31.0(26.3- 36.1)	15.0(11.0- 20.0)	18.2(14.4 - 22.5)
No	2284	46.9(44.0-50.0)	30.5(28.4- 32.5)	12.2(10.0- 14.0)	18.1(16.4 - 19.8)
Don't know	16	51.3 (21.0 - 81.0)	28.6 (3.7 - 71)	13.4 (2.3 – 50.0)	14.3 (0.4 - 57.9)

Fever					
Yes	582	44.4(39.0- 50.0)	29.6(25.7- 33.7)	12.6 (9.6 – 16.0)	16.0 (13 - 19.4)
No	2130	47.5(45.0- 50.0)	30.8 (28.7 - 33)	12.6(11.0– 15.0)	18.7(16.9- 20.5)
Cough					
Yes	1065	47.6(44.0- 51.0)	31.9 (29 - 35)	12.7(11.0 - 15.0)	18.9(16.5 - 21.6)
No	1647	46.3(43.0- 50.0)	29.6(27.2- 32.1)	12.5(10.0- 15.0)	17.5(15.6 - 19.6)
Area					
Urban	1122	41.7(38.0- 45.0)	26.8 (24 - 29.7)	11.2 (9.2 – 13.0)	15.1(12.9 - 17.5)
Rural	1697	51.8(48.0- 55.0)	33.1(30.6- 35.7)	14.0(11.0 - 18.0)	20.2(18.1 - 22.3)
Ethnicity					
Luyha	1502	42.7(39.0- 47.0)	32.8(30.3- 35.4)	6.0 (4.6 - 7.7)	14.0(12.2 - 15.9)
Turkana	978	57.1(53.0- 61.0)	26.6 (23.4 - 30)	24.6 (22 - 28.0)	28.9(25.7 - 32.4)
Other	335	36.5(30.0- 44.0)	29.9(24.8- 35.4)	9.9 (5.5 – 17.0)	10.3 (7.1 - 14.3)
Missing/DK	4	42.1 (8.6 - 85.0)	33.3 (0.8 - 90.6)	NA	NA

Table 6 shows prevalence of undernutrition alongside 95% CI stratified by mother-related and household characteristics. Children whose mothers had no education had highest prevalence of undernutrition (CIAF 57.3%, 95% CI: 53.0 - 62.0), whereas children with mothers who attained secondary or higher education exhibited the lowest prevalence (CIAF 32.6%, 95% CI: 28.0 - 38.0). Children in the "poorest" households experienced the highest prevalence of undernutrition (CIAF 59.6%, 95% CI: 54.0 - 65.0), while those in the "richest" households had the lowest prevalence (CIAF 33.3%, 95% CI: 27.0 - 40.0). Moreover, when data was analysed by county, Turkana stands out with the highest undernutrition prevalence (CIAF 53.6%, 95% CI: 49.0 - 58.0), while Bungoma had the lowest prevalence (CIAF 39.9%, 95% CI: 35.0 - 45.0). Additionally, stunting prevalence was notably lower in Turkana (24.1%, 95% CI: 21.0 - 28.0), contradicting the higher undernutrition rates found in this county when considering the CIAF. Wasting and underweight was also recorded to be highest in Turkana compared to Kakamega and Bungoma.

Table 6: Prevalence of undernutrition by mother and household related characteristics

Variables	**Total**	**CIAF (95% CI)**	**Stunting(95% CI)**	**Wasting (95% CI)**	**Underweight (95% CI)**
Mother-related characteristic					
Mother's education level					
None	854	57.3(53.0-62.0)	28.4(25.0- 33.0)	21.1(18.0-25.0)	25.9(22.0-30)
Primary	1244	46.5(43.0-50.0)	35.0 (31.0 - 39.0)	9.0 (7.2 - 11.0)	16.4(14.0-19.0)
Secondary and higher	619	32.6(28.0-38.0)	22.4(18.0- 27.0)	7.8 (5.1 - 11.0)	10.7(7.6-15.0)
Missing/DK	3	50.0(50.0 - 50.0)	NA	50.0 (50.0 – 50.0)	NA
Household-related characteristic					
Socioeconomic status					
Poorest	623	59.6(54.0-65.0)	40.7(35.0- 46.0)	15.0(12.0- 19.0)	23.8(19.0 - 29.0)
Poorer	605	54.7(50.0-59.0)	35.2(31.0- 40.0)	15.8(12.0- 21.0)	22.1 (18.0 - 26)
Middle	532	38.9 (33.0 - 46)	23.8(19.0- 30.0)	10.8 (8.3 - 14.0)	15.7 (12.0 – 21.0)
Richer	542	41.3(36.0-46.0)	27.0(23.0- 32.0)	12.1 (8.8 - 16.0)	12.6 (9.3 - 17.0)
Richest	417	33.3(27.0-40.0)	21.1(16.0- 28.0)	7.6 (4.7 – 12.0)	12.6 (8.7 - 18.0)
County					
Kakamega	806	45.2 (40.0 – 50.0)	37.2(32.0- 43.0)	5.6 (4.0 - 7.7)	12.1(9.5 - 15.0)
Bungoma	846	39.9(35.0-45.0)	30.5(27.0- 35.0)	5.9 (4.1 - 8.5)	14.8(12.0 - 19.0)
Turkana	1067	53.6 (49.0 - 58.0)	24.1(21.0- 28.0)	23.0 (20.0 – 26.0)	25.0(21.0 - 29.0)

4.0.4 Difference in Prevalence of CIAF in under-five year old children in Turkana, Kakamega, and Bungoma Counties.

The prevalence difference of CIAF between the three counties was calculated using the R function "risk difference" from the "fmsb" package. Table 7 below shows difference in prevalence among Kakamega, Bungoma and Turkana counties as calculated using R. Turkana had a significantly higher undernutrition rate than Bungoma, with a difference of 13.5 percentage points (95% CI: 9.02 to 17.9). Similarly, Turkana had a notably higher undernutrition rate compared to Kakamega, with a difference of 9.1 percentage points (95% CI: 4.54 to 13.63). In contrast, Bungoma displayed a lower undernutrition rate compared to Kakamega, with a difference of -4.4 percentage points (95% CI: -9.11 to 0.35). However, the difference in prevalence between Bungoma and Kakamega was not statistically significant.

Table 7: Prevalence difference among Kakamega, Bungoma and Turkana counties

County	Estimate	95% Confidence interval
Turkana vs Bungoma	13.5	9.02 to 17.9
Turkana vs Kakamega	9.1	4.54 to 13.63
Bungoma vs Kakamega	-4.4	-9.11 to 0.35

4.0.5 Effects of Socioeconomic Status on the Prevalence of CIAF.

The logistic regression model was employed to determine the effect of socioeconomic status on malnutrition, specifically using the CIAF as the outcome variable. This analysis considered child, mother, and household-related characteristics as covariates. The resulting adjusted odds ratios (AOR), 95% confidence intervals (CI), and p-values for each variable is reported in Table 8. The analysis assessed the relationship between socioeconomic status and CIAF, adjusting for various factors. On child-related characteristics, it was observed that female children had significantly lower odds of malnutrition compared to male children (AOR = 0.78, (95% CI: 0.67, 0.92), p = 0.003). Children in older age groups exhibited significantly higher odds of experiencing malnutrition compared to those aged 0-5 months. Children aged 12-23 months had AOR of 1.70 (95% CI: 1.12, 2.59; p < 0.014). Children aged 24-35 months had an AOR of 2.18 (95% CI: 1.52, 3.13; p < 0.001), and children aged 36-47 months had an AOR of 1.84 (95% CI: 1.18, 2.87; p = 0.008).

Children who experienced cough had significantly higher odds of malnutrition compared to those who did not experience cough (AOR: 1.22; 95% CI: 1.03, 1.44; p = 0.025).

The area of residence (urban vs. rural) and having experienced diarrhoea or fever did not show statistically significant difference in odds of malnutrition. Ethnicity showed association with malnutrition. Turkana children had significantly higher odds of malnutrition (AOR: 1.80; 95% CI: 1.01, 3.21; p = 0.047) compared to Luhya children. Other ethnic groups did not exhibit statistical significance.

On mother-related characteristics, maternal education level and socioeconomic status significantly associated with malnutrition. Children of mothers with secondary or higher education had a lower odd of malnutrition compared to children of mothers with no education (AOR: 0.66; 95% CI: 0.48, 0.90; p = 0.010). Socioeconomic status was highly associated with malnutrition. Children in the middle, richer and richest households had substantially lower odds of malnutrition compared to children in poor households.

Table 8: Covariates Associated with CIAF

Characteristic	**AOR**[1]	**95% CI**[1]	**p-value**
Sex			
Male (reference)	—	—	
Female	0.78	0.67, 0.92	**0.003**
Age group			
0-5 (reference)	—	—	
6-11	1.05	0.67, 1.63	0.833
12-23	1.70	1.12, 2.59	**0.014**
24-35	2.18	1.52, 3.13	**<0.001**
36-47	1.84	1.18, 2.87	**0.008**
48-59	1.29	0.90, 1.85	**0.169**
Diarrhea Status			
No (reference)	—	—	
Yes	0.97	0.72, 1.32	0.867
Fever Status			
No (reference)	—	—	

Characteristic	AOR[1]	95% CI[1]	p-value
Yes	0.86	0.65, 1.12	0.254
Cough			
No (reference)	—	—	
Yes	1.22	1.03, 1.44	**0.025**
Area			
Urban (reference)	—	—	
Rural	1.22	0.98, 1.53	0.075
Ethnicity			
Luhya (reference)	—	—	
Turkana	1.80	1.01, 3.21	**0.047**
Other ethnic group	1.09	0.73, 1.63	0.654
Missing/DK	0.63	0.11, 3.72	0.609
Mother's Education Level			
None (reference)	—	—	
Primary	0.97	0.74, 1.26	0.796
Secondary+	0.66	0.48, 0.90	**0.010**
Socioeconomic status			
Poorest (reference)	—	—	
Poorer	0.79	0.61, 1.02	**0.067**
Middle	0.44	0.32, 0.62	**<0.001**
Richer	0.51	0.37, 0.72	**<0.001**
Richest	0.42	0.30, 0.59	**<0.001**
County			
Bungoma (reference)	—	—	
Kakamega	1.24	0.96, 1.59	0.094
Turkana	1.05	0.62, 1.77	0.865

[1]AOR = Adjusted Odds Ratio, CI = Confidence Interval

CHAPTER FIVE

5.0 DISCUSSION

The study examined differences in the prevalence of composite anthropometric failures (CIAF) in under-five years old children in Turkana, Bungoma and Kakamega counties. Turkana county exhibited the highest prevalence of CIAF when compared to Bungoma and Kakamega, a result consistent with the reported stunting prevalence in the Kenya Demographic and Health Survey (KDHS) of 2022. According to the KDHS 2022, stunting prevalence was reported as 19% in Bungoma, 23% in Turkana, and 12% in Kakamega (KNBS and ICF, 2023). The findings indicated significant difference in the prevalence of CIAF, with particularly noteworthy distinctions observed when comparing Turkana to Bungoma and Kakamega. Notably, the difference in the prevalence of CIAF was higher when comparing Turkana to Bungoma, in contrast to the comparison between Turkana and Kakamega. Additionally, the study showed that the contrast in the prevalence of CIAF between Bungoma and Kakamega was not statistically significant, suggesting that these two counties exhibited more comparable prevalence of child undernutrition.

The study also compared prevalence of undernutrition using CIAF, stunting, wasting and underweight indicators. Notably, the findings revealed a higher prevalence when using CIAF compared to the traditional anthropometric indicators of stunting, wasting and underweight. This aligns with the results of a study by Al-Sadeeq et al. (2018), which similarly reported elevated undernutrition prevalence with CIAF compared to individual indicators (Al-Sadeeq, Bukair, & Al-Saqladi, 2018). The consistency of this trend was further emphasized in the study by Das et al.(2022), focusing on maternal underweight and its association with CIAF among children under two years of age with diarrhoea in Bangladesh, indicating a potential underestimation of undernutrition when relying solely on individual anthropometric indicators (R. Das et al., 2022). This phenomenon was notably evident when analysing the prevalence of undernutrition across the three counties. In the comparative assessment of three counties, Turkana, Bungoma, and Kakamega, it became evident that Turkana had the lowest stunting prevalence. However, using stunting alone as an indicator for undernutrition might be misleading for county comparisons in this study. In contrast, when CIAF was used, it effectively revealed that Turkana County had the highest undernutrition prevalence when compared to Kakamega and Bungoma. This highlights the importance of selecting the most appropriate indicator to accurately assess and compare undernutrition levels.

The study also examined the relationship between socioeconomic status and CIAF in under-five years old children in Turkana, Bungoma, and Kakamega counties. This was done using logistic regression while controlling for other factors. The study found significant association between CIAF and socioeconomic status. The children in poorest households were more likely to be undernourished as measured by CIAF compared to children in richest households. This aligns with the observation made by Permatasari and Chadirin (2022), who reported a comparable trend in their study on assessment of undernutrition using the composite index of anthropometric failure (CIAF) and its determinants: a cross-sectional study in the rural area of the Bogor District in Indonesia. They found out that family income was significantly associated with CIAF (Permatasari & Chadirin, 2022). A parallel finding was noted by Workie and Tesfaw (2021), who conducted a bivariate binary analysis on the composite index of anthropometric failure among under-five children and household wealth index. They concluded that a high CIAF was strongly associated with the household wealth index (Workie & Tesfaw, 2021). These findings underscore the importance of addressing poverty in the efforts to address undernutrition.

In addition, sex of a child was significantly associated with CIAF. Female children were less likely to be undernourished compared to male. The finding was consistent with reported result by Permatasari and Chadirin (2022), who found sex of a child to be significantly associated with CIAF (Permatasari & Chadirin, 2022). The age of a child was significantly associated with CIAF. The study observed an interesting pattern on likelihood of undernutrition as the child age increases. The younger children of age 0-5 months were less likely to be undernourished as compared to older children. The likelihood of undernutrition increased as the age increased and was at peak on age 24-35 months before it started to decline from age 36-47 months and 48-59 months. These results align with the findings reported by Chowdhury et al. (2022), who highlighted an increased likelihood of undernutrition in the 24-35 months age group (Chowdhury et al., 2022). Additionally, Salazar Burgos et al. (2023) observed a reduction in the prevalence of CIAF from 12.5% in children aged 0-2.99 years to 9.7% in those aged 3-4.99 years. These consistent findings underscore the importance of age-specific strategies in addressing and reducing undernutrition, emphasizing the need for tailored interventions at different stages of early childhood (Salazar Burgos et al., 2023).

Children who experienced a cough within the past two weeks displayed a higher likelihood of being undernourished in comparison to those who did not report such episodes. Conversely, the presence or absence of diarrhoea or fever episode in last two weeks did not exhibit any notable associations with undernutrition.

This study did not identify any significant associations between undernutrition, as measured by CIAF, and either the county or the type of area of residence (urban or rural). Furthermore, the study found that children born to mothers with a secondary education or higher exhibited a significantly lower risk of undernutrition when compared to children of mothers with no education. These results are consistent with the findings reported by Chowdhury et al. (2022), who observed an elevated risk of undernutrition among children whose parents lacked formal education. This alignment in outcomes reinforces the critical role of maternal education in mitigating the risk of undernutrition among children, emphasizing the need for educational interventions as part of comprehensive strategies to address childhood malnutrition (Chowdhury et al., 2022). Conversely, it was observed that children of mothers with a primary education level did not show a significant association with undernutrition.

5.1 Conclusion & Recommendation

This study has unveiled critical insights into the measurement of undernutrition in under-five-year-old children within Turkana, Bungoma, and Kakamega counties. The findings underscore the superiority of the Composite Index of Anthropometric Failure (CIAF) in capturing the multifaceted nature of undernutrition. This aligns with the conclusions drawn by Sen and Mondal (2012), who similarly emphasized the precision of CIAF in identifying segments of the population vulnerable to nutritional challenges (Sen & Mondal, 2012). In addition Porwal et al.(2021) also concluded that CIAF provided a broader understanding of the extent and pattern of undernutrition among children (Porwal et al., 2021). In our study, significantly varying prevalence rates of CIAF were identified, with a striking distinction between Turkana and both Bungoma and Kakamega. This emphasizes the need for a robust metric like CIAF for comprehensive undernutrition assessment.

Comparing CIAF to conventional anthropometric indicators, such as stunting, wasting, and underweight, revealed a pertinent concern. It became evident that these traditional metrics may underestimate the true extent of undernutrition when used separately. In contrast, CIAF, by amalgamating stunting, wasting, and underweight into a singular composite index, offered a more comprehensive perspective on undernutrition. The prevalence disparities across the three counties offered a clear illustration. While stunting suggested lower undernutrition rates in Turkana, CIAF brought to light the stark reality of the situation, highlighting Turkana as having the highest undernutrition levels among the three counties. However, it is essential to acknowledge a limitation in using CIAF, namely the potential for multiple counting of the same child with multiple anthropometric failures.

The observed significant association between CIAF and socioeconomic status underscores the heightened risk of undernutrition among children in the poorest households. As a crucial strategy in the fight against child undernutrition, it is imperative for both national and county governments to prioritize initiatives aimed at poverty reduction and the promotion of equitable economic conditions. The study further identifies age groups 12-23, 24-35, 36-47, and 48-59 as being at a higher risk of undernutrition. To address this, nutrition programmers should focus on creating awareness about age-specific feeding interventions. Additionally, the significant association between cough and CIAF highlights the importance of healthcare workers in raising awareness among caregivers on prompt treatment and prevention of cough to reduce the incidence of undernutrition. Lastly, the strong association between mothers' education and CIAF suggests that promoting education for female students and facilitating adult learning for women could be key interventions at the national level.

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APPENDICES

APPENDIX I: DATA ABSTRACTION FORM

Study Title: The prevalence of malnutrition in under-five years old children by socioeconomic status in Turkana, Bungoma and Kakamega counties, 2013 - 2014.

ID	Variable Name	Values
Child's line number	Children's sample weight	
1	Ethnicity	
1	Height for age z-score WHO	
1	Height for age flag WHO	
1	Weight for age flag WHO	
1	Weight for age z-score WHO	
1	Child had diarrhoea in last 2 weeks	
1	Child ill with fever in last 2 weeks	
1	Weight for height flag WHO	
1	Weight for height z-score WHO	
1	Wealth index quintile	
1	Sex	
1	Area	
1	Region	
1	Mother's education level	
1	Age (months)	
1	Age of child	
1	Age	
1	Child ill with cough in last 2 weeks	
1	County	
1	Stunted	
1	Under weight	

1	Wasted	
1	Composite Index of Anthropometric Failure	

APPENDIX II: ANTI-PLAGIARISM REPORT

THE PREVALENCE OF MALNUTRITION IN UNDER-FIVE YEARS OLD CHILDREN BY SOCIOECONOMIC STATUS IN TURKANA, BUNGOMA AND KAKAMEGA COUNTIES, 2013 - 2014.

Eric_Owino_Report_Apr_2024_2.docx

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APPENDIX III: ETHICAL APPROVAL LETTER

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17th November, 2023

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Reg No. W62/35506/2019
Dept. of Public & Global Health
Faculty of Health Sciences
University of Nairobi

KENYATTA NATIONAL HOSPITAL APPROVED 17 NOV 2023 KNH/UoN-ERC

Dear Eric,

ETHICAL APPROVAL-RESEARCH PROPOSAL: THE PREVALENCE OF MALNUTRITION IN UNDER-FIVE YEARS OLD CHILDREN BY SOCIOECONOMIC STATUS IN TURKANA, BUNGOMA AND KAKAMEGA COUNTIES, 2013-2014 (P579/07/2023)

This is to inform you that KNH-UoN ERC has reviewed and approved your above research proposal. Your application approval number is **P579/07/2023.** The approval period is 17th November 2023 16th November 2024.

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by KNH-UoN ERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KNH-UoN ERC 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH-UoN ERC within 72 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. 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.
vii. Submission of an executive summary report within 90 days upon completion of the study to KNH-UoN ERC.

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

Yours sincerely,

PROF. BEATRICE K.M. AMUGUNE
SECRETARY, KNH- UoN ERC

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