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Trends of Socioeconomic Disparities in the Kenyan Child Malnutrition Statistics: An Analysis of the Demographic and Health Survey

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**Abstract**

*Introduction*: The burden of child malnutrition remains substantially high in Kenya despite commendable efforts in reducing its prevalence. Even though the country has recorded substantial economic advancements, there appears to be a disconnect between the rate of economic growth and health-related socioeconomic disparities.

*Objective*: This investigation sought to examine the trends of socioeconomic disparities in child malnutrition, determining factors, and the change in the inequalities of malnutrition in children under five years in Kenya between 2003 and 2014.

*Methods*: This study employed data from the Kenya Demographic and Health Survey (KDHS). Malnutrition determinants were analyzed using multivariable logistic regression with malnutrition indicators, stunting, underweight, and wasting used as the outcome variables. Concentration indices were used to quantify the socioeconomic inequalities in child malnutrition. Decomposition methods were used to explore the contributions of each determinant to the observed overall socioeconomic disparities in underweight and stunting.

*Results*: Socioeconomic inequalities in all child malnutrition indicators in Kenya worsened between 2003 and 2014. A child’s age (Adjusted Odds Ratio, AOR=1.12; 95%CI 1.11–1.13), irreligion (AOR=1.33; 1.04–1.70), primary maternal education (AOR=1.43; 1.04–1.96), birth order (AOR=1.02; 1.01–1.04), and household poverty (AOR=1.82; 1.49–2.20) were substantial determinants of stunting whereas other religions (AOR=18.68; 4.00–87.32), a child’s age (AOR=1.07; 1.05–1.08), limited maternal education (AOR=2.68; 1.63–4.41), birth order (AOR=1.03; 1.01–1.05), mother’s age at first birth (AOR=1.02; 1.01–1.04), region (AOR=1.65; 1.19–2.29) and poverty (AOR=1.74; 1.33–2.27) were associated with increased risk of child underweight. Other religions (AOR=15.79; 3.44–72.53), no maternal education (AOR=5.72; 2.47–13.26) and a child being from the Rift Valley region (AOR=2.58; 1.50–4.43) were significant determiners of wasting. A household’s socioeconomic status was the largest significant contributor towards socioeconomic disparities in stunting and underweight. The contribution of a household’s socioeconomic status rose from 2.17% in 2003 to 5.07% in 2014 for stunting and from 2.59% in 2003 to 9.33% in 2014 for underweight.

*Conclusion*: The nutrition status of children from poor households has substantially worsened with most of this inequality attributable to poor socioeconomic status. To tackle these inequalities the Kenyan government may be required to employ a multi-layered approach with attention to reducing the disparities in wealth distribution.

**Introduction**

Child Malnutrition remains a dominant challenge in the public health sector globally, with at least one in four kindergarten-age children remaining stunted, which translates to about 150.8 million children [1]. On the other hand, other dominant forms of malnutrition, including wasting and overweight, account for 50.5 and 38.3 million cases, respectively, based on the 2018 Global Nutrition [2]. With the possibility of suffering more than one form of malnutrition, children remain largely susceptible to the perilous effects posed by this condition. According to nutrition statistics, 3.62% of all children under the age of five years (15.95 million) have been reported as being both stunted and wasted, whereas 1.87% of all children (8.23 million) have been reported to be stunted, as well as, overweight globally [2]. In all children aged below five years of age who are either stunted, wasted or underweight, malnutrition has been implicated in at least half of their deaths in both Asia and Sub-Saharan Africa [3,4].

In Kenya, malnutrition prevalence remains tremendous and exorbitant with 26.3% of children, based on the analysis of a sample of 1119 babies from a randomized cluster trial conducted in two slums of Nairobi, being stunted whereas 6.3% and 13.16% were wasted and underweight, respectively [5]. De Vita et al. [5] also reported a higher prevalence of wasting, particularly within the early stages of life, whereas underweight and stunting were mostly captured among the older children. Based on the Kenyan nutrition profile published by the United States Agency for International Development, USAID [6], the population of children under the age of five years was at 7 million, with 1.82 million children from this extravagant number suffering from chronic and incessant malnutrition (stunting). While substantial developments have been made in Kenya with regards to improving the malnutrition indicators, it is estimated that the burden of undernutrition will cost the country in excess of US$38.3 billion in the Gross Domestic Product following losses in workforce labor and productivity for the period 2010–2030 [6,7].

**The concept of malnutrition**

Malnutrition relates to “a state of nutrition in which a deficiency, or excess, of energy, protein, and micronutrient causes measurable adverse effects on tissue/ body form (body shape, size, and composition), function, and clinical outcome” [8]. This definition of malnutrition does not put into consideration the causes of inadvertent loss of weight, predominantly in the case of undernutrition [9]. The inadvertent loss of weight is often characterized by syndromes including cachexia, starvation, and sarcopenia [10,11]. In the classification of malnutrition, the kind of nutrients absent in one's diet, the length of time with which these nutrients are missing in the diet as well as the age at which this occurs plays a crucial role. In this line, malnutrition is classified as protein-energy malnutrition or dietary vitamins and minerals [9].

**Causes and risk factors of malnutrition**

Previous literature has made substantial and considerable advancements in the presentation of the risk factors for malnutrition [12–16]. In a study set in Burkina Faso, West Africa, to examine the factors related to malnutrition, specifically among children aged below five years, using secondary population-based cross-sectional data from the Demographic Health Survey (2010), several factors were drawn in as major players in malnutrition. The study reported factors including the child's age, gender, size at birth, child morbidity, the mother's education level, the body mass index of the child, and the wealth index of the household [16].

In Kenya, Gudu et al. [14] carried out a hospital-centred, unmatched case-control study in which they investigated factors associated with under-five child malnutrition. In their findings, the authors reported significant associations between undernutrition and mother antenatal care attendance, deworming, and pre-lacteal feeding. Additionally, lack of formal education (formal paternal education) and low birth weight were reported as being independently linked with undernutrition [14].

**Malnutrition indicators**

Stunting, underweight, and wasting have been the most widely used three indicators of malnutrition [17]. Stunting refers to low height for age and reflects the growth in linear terms achieved at the age at which the measurements were taken, whereas underweight refers to low weight for age resulting from a short-term lack of food. On the other hand, wasting is a severe form of undernutrition resulting from inadequate food intake as well as infections [17]. Stunting in children under five years is considered the superlative overall gauge and indicator of the wellbeing and health of the children capable of highlighting salient social disparities [18]. Previously, stunting has been found to be related to a legion of both nutritional, demographic as well as socioeconomic elements, including the age of the child, gender, the status of the household's economy, dietary intake, the age of the mother, and food insecurity in the household [19,20]. Whilst these factors exhibit associations with stunting, the most imperative predictors to this effect have been the mother's level of education, food insecurity measure, and household income [19,21,22].

Moreover, because stunting is a measure of linear growth in children, it is considered as a correct and accurate measure of malnutrition in the long term [23–25]. In particular, this follows from the indicator's insensitivities to temporal variations in food consumption, as do the other malnutrition indicators, including underweight and wasting [25]. Snowballing investments in child health as well as nutrition, in the long run, coupled with social strategies aimed towards reducing overall poverty, are often projected to result in improvements in child growth and development, and thus, reduce the instances of stunting among children. In this way, stunting becomes a major indicator in the study or assessment of the effects of economic changes on child health as well as the wellbeing of a household [17].

**The essentiality and consequences of malnutrition**

Malnutrition in children is classified as either micronutrient deficiencies, undernutrition, or overnutrition. Undernutrition is mostly attributed to an inadequate intake of food as well as disease which manifests in children through wasting, stunting, or else underweight [26]. Overnutrition, on the contrary, results from both physical inactivity as well the excessive and superfluous intake of foods that are unhealthy and is manifested through obesity and being overweight [27]. Micronutrient deficiencies often result from insufficient intake of small nutrients and include deficiencies in iron and vitamin A, among others [28].

Nutritional deficiencies of any form are often detrimental to the health of a child in their early years of life, their growth as well as their development. For children, their development in their first two years of life bears a lot of significance for their overall wellbeing later in life and is crucial in their brain development and physiology. In this regard, these years of their lives are the most crucial for motor and cognitive growth [17]. In previous studies in which the relationship between stunted growth and cognitive development in later life were assessed, evidence of an effect of stunting on child test scores was reported, with stunted children reporting significantly lower scores compared to non-stunted children. Malnourished children in these studies were argued to have smaller amounts of energy to distribute towards their intellectual growth, physical and emotional development, thus poor learning [29,30]. The adverse effects of malnutrition on the development of a child's cognitive and intellectual capacity are also examined in depth elsewhere.

Besides the noted effects of malnutrition on the cognitive development of a child, malnourishment has also been linked to reduced school attendance [31,32], school drop-out, and the repetition of grades or classes or school years [30,33,34]. Stunting has also been identified and reported as a significant risk factor for chronic infections that are nutrition-related, non-optimal child development and growth, poor health as well as reduced productivity throughout life [35,36]. De Vita et al. [5] also reported the significant contribution of wasting to childhood illnesses, including cough and diarrhoea. In understanding the socioeconomic disparities that exist in the Kenyan child malnutrition burden, the knowledge of the Kenyan socio-economics and their relationship with stunting as an indicator of child malnutrition suffices.

**Socioeconomic disparities in child malnutrition**

Kenya falls under middle-income countries based on the global classification using the Gross National Income (GNI) per capita, in which countries are classified into three categories based on their incomes as either low, middle, or high-income countries [17]. The attainment of the middle-income classification status by a country is often seen as an indication of progress resulting from such activities as heightened investments across all government sectors and improved productivity. Shifts in a country's classification from low to middle, then to high-income classification are thus regarded as an indication of economic advancement. As expected of positive growth, such advancements in the country's classification are expected to positively impact the wellbeing of a country's population. For instance, economic advancements are expected to create employment opportunities, which translate into increases in the amount of disposable income, improved health, and education [37,38]. Improvements in the standards of living following economic advancements are expected to translate into exceptional and improved nutritional consequences for both children as well as adults. Even so, whilst economic growth—the upward shift of a country from low to middle and high-income status—has been regarded as an indicator of a country's overall wellbeing, with 70% of the world's most impoverished individuals living in middle-income countries, the reality could not be further from the truth, which points to a lack of equity in the distribution of the prospects of economic growth [39].

Even though the economic status associated with a country has been shown in previous studies to result in the improved health status of a population [40,41], being economically advanced does not translate to equitable distribution of the positive prospects, which more often than not tend to be skewed where some parts or groups of people tend to benefit over and above others. Evidence suggests that the incidence of socioeconomic disparities in the context of developing countries has become increasingly persistent for countries including Nigeria [20] and Kenya, where stunting prevalence remains considerably high in comparison to other malnutrition indicators, (underweight and wasting) despite notable advancements aimed at improving the status quo [42].

Kenya has made some recommendable efforts in reducing the burden of malnutrition as part of the Standard Development Goals (SDGs), which have considerably reduced the rate of stunting, even so, the overall prevalence of the condition remains larger than those observed for other forms of malnutrition [17,42]. With about 25% of the child population of Kenya suffering from acute malnutrition as of 2015, coupled with the danger posed on child growth and survival as well as wellbeing, the consequences of malnutrition should be of substantial interest to the government, public health professionals as well as policymakers [7]. Moreover, even though there is a substantial fund of knowledge with regards to the socioeconomic disparities in child malnutrition, papers that pay significant attention to the status of Kenya as a country are deficient. Most of the available literature examines the area through the employment of a comparative approach, which makes the findings relatively obscured or did not use updated data [17,43–45]. On the other hand, even though literature examines the crucial determinants of stunting among children, including poverty, gender, household wealth index, sanitation access, and infections [46–48], it is not apparent whether the determinants hold, specifically for Kenya as an independent country.

This study makes a significant contribution to the available fund of knowledge on the trends of socioeconomic disproportions in the Kenyan malnutrition burden, with a bias in examining trends in stunting across socioeconomic groups and geographical locations. We also examine the determinants of stunting disparities in Kenya and how these changes vary through time. We employ standard procedures of inequality to quantify the trends [36] and decompose vicissitudes in the concentration index to determine the factors that explain the detected subtleties exhaustively, that is, the factors that drive the socioeconomic disparities in stunting in Kenya. The study utilizes data from the Kenya Demographic Health Survey (DHS) spanning twelve years (2003 to 2015) to analyze the scope of the problem comprehensively, specifically focusing on children below the age of five years.

**Measurement of socioeconomic status**

Since the Demographic Health Surveys do not collect data related to income as well as expenditure, we employed a wealth index as a proxy for socioeconomic status. The wealth index was calculated through the employment of principal component analysis (PCA) applied to collective wealth variables [49]. This estimation methodology relies on the postulation of the existence of a latent variable (or an unobserved variable) which is largely correlated with the measured variables which in this case imply the asset variables [50]. The asset variables employed in this study can be broadly classified into possession of durable goods, housing characteristics, access to essential services as well as water and sanitation. More specifically, we employed measured variables (or asset variables) including the source of drinking water, time to the source of drinking water, toilet facility, electricity, possession of a radio, a TV, a refrigerator, a bicycle, a motorcycle, a car/a truck, floor, and roofing material. The calculated scores were weighted based on the weights derived from each DHS data file, ranked, and grouped into 5 socioeconomic quintiles from the poorest to the richest. Wealth index estimation has been described comprehensively elsewhere [51,52]. Even though both income and expenditure have traditionally been used as measures of a household’s economic status, using the wealth index provides a viable alternative which is crucial and pivotal particularly in the case of absence of data related to income and expenditure as is often the case with DHS related data.

**Methodology**

**Study region**

Kenya has a total population of 51.39 million based on the recent (2018) national census and data reported in the World Development Indicators Database. The country has a population density of 90.3 people per km2 of land area. With a steady population growth rate of 2.3% per annum and about 36.1% of the total population headcount living below the poverty line, poverty and social deprivation remain one of the major bottlenecks the country is tackling [17].

**Data source**

This study employed data from the Kenya Demographic and Health Surveys (KDHS) carried out in 2003 and 2014 (standard DHS). DHS was carried out by the national Kenyan statistical agency with technical and procedural support from ICF International via the DHS program and was used in analyses with permission from ICF-DHS. The KDHS is a population-based household survey that provides representative data for all the Kenyan regions. The surveys employ stratified cluster sampling design in two stages with clusters employed at the first sampling stage and households selected at the second stage. In the 2003 survey, the response rate was 96.3% from 8, 889 households. In 2014, the realized response rate was 99% from a sample of 39, 679 households [53]. We considered all live children of interviewed mothers of ages between 0 and 59 months in all analytic procedures and all children with missing anthropometrical data were excluded from analyses. All data were weighted to account for variations in sample proportions.

**Variables and statistical modeling**

The response variable used in this study was malnutrition in children under the age of five years. Malnutrition was classified into stunting, underweight, and wasting using height for age z scores, weight for age z scores, and height for weight z scores. Stunting refers to a low height for age and reflects linear growth that has been achieved at the age of measurement. Children below the age of five years are said to be normal or moderately stunted if their height for age z scores (HAZ) are -2 and -3 standard deviations (SD) below the median and severely stunted if the height for age z scores is less than -3 SD below the World Health Organization’s (WHO) child growth standards median. Underweight refers to low weight for age as a result of a lack of food over the short term, whereas wasting (low height for age) occurs as a result of insufficient food intake as well as infections with the same WHO classifications as seen above [17,54].

We classified all children with height for age, weight for age, and height for weight z scores less than -2SD of WHO growth standard median as stunted, underweight, and wasted, respectively. Stunted children below the age of five years suggest chronic undernutrition whereas wasted and underweight suggest acute malnutrition and an indicator of both acute and chronic malnutrition, respectively [55]. This paper also employed the child’s age (in months), the child’s gender, place of residence (urban or rural), the religion of the household, the education level of the mother, and the household’s socioeconomic status as explanatory variables which have been shown to be significant determinants of malnutrition in children [56–58]. We also investigated other variables including birth order number, region, place of delivery, birth interval and the mother’s age at first birth. Descriptive statistics for selected categorical variables were calculated as frequencies and percentages to explore the proportions of children that were malnourished by gender and residence.

**Analysis of socioeconomic disparities in child malnutrition**

The extent and trends of socioeconomic disparities in stunting, underweight, and wasting were quantified using concentration indices (CIs) [59–61]. We used the z-scores described earlier in the estimation of the concentration index as well as in plotting concentration curves. Concentration indices quantify the socioeconomic disparities in a health variable (malnutrition in this case) and thus allow for the assessment of the extent and levels of disproportions and discrepancies in the health variable of interest. CIs were calculated as double the area between the concentration curve and the line of equality, that is, the 45° line. According to definitions presented by O’Donnell et al. [61], the formula for CI follows as:

In equation 1, *µ* is the average of malnutrition in under-five children (stunting, underweight as well as wasting) whereas *h* denotes observation-specific child malnutrition, and *r* is the rank of the socioeconomic status of a household. The CI of a given health variable most usually takes values between -1 and +1 with 0 suggesting perfect equity of the health variable between the poorest and the richest socioeconomic groups, whereas negative values suggest a higher concentration of malnutrition among the poorest group, and positive values suggest a higher concentration of inequity amongst the richest socioeconomic groups [13,15,17,61]. As in Kien et al. [15] the continuous forms of the variables for stunting, underweight, and wasting were employed to enhance precision. Concentration curves which plot the collective percentages of a health variable as well as the population ranked by standards of living from the poorest to the richest were also plotted using the z scores. This plot aids in the identification of the existence of inequalities of a socioeconomic sense in a health variable and whether these disparities (if they exist) vary by time and space [59,61,62].

**Determinants of malnutrition**

The viable determinants of child malnutrition were determined in this study using a logistic regression model. The calculations of the percentages of under-five malnourished children were calculated after conversion of the outcome variables, that is, stunting, underweight, and wasting into binary form with z scores <-2SD coded as 1 and 0 otherwise. The variables analyzed in the logit model were the child’s age, gender, area of residence, religion, mother’s highest level of education as well as the household’s socioeconomic status all of which have been shown to be substantial in determining child malnutrition in previous studies. Asset variables used in the construction of the wealth index were not used as variables in the model for that reason. The study also examined the role of birth order, region of child birth, a child’s place of delivery, birth interval, and the mother’s age at first birth in contributing towards stunting, underweight, and wasting among children aged below five in Kenya.

**Decomposition of socioeconomic disparities and their change**

We aimed to explore the contribution of the variables determining malnutrition in children to the observed socioeconomic disparities in the outcome variables (height for age, weight for age, and height for weight in continuous form) [63]. Decompositions were restricted to stunting and underweight in both 2003 and 2014. We employed the continuous forms of our response variables, and thus for the decompositions, we considered a linear regression model in which the response variable (*y*) is expressed as a linear combination of the *k* determinants (*Xk*) expressed as:

In Equation 2, *βk* denotes the coefficient of *xk* (the set of explanatory variables) whereas ε denotes the error term of the linear model. Equation 2 can be re-written as an expression of the concentration index (CI) for the response variable, *y* which takes the form:

In Equation 3, μ denotes the average of the response variable, *(y)* whereas *x̅k* denotes the mean of the kth determinant variable, *βk* denotes the coefficient of each determinant of child malnutrition, *CIk* denotes the concentration index of each of the regressors in the linear model, and the term *GCIϵ* denotes the generalized concentration index for the error term, *ϵ*. Equation 3 has two components to it, the explained component *((βkx̅k)/μ)CIk* as well as the unexplained component, *GCI∈/ μ*. The term *βkx̅k)/μ* denotes elasticity which brings out the effect of each *CIk* on the overall CI of the outcome variable, *y* [61,63].

Total differential decomposition was employed to decompose the changes in the CIs as well as elucidate the contributions of the determinants to the observed variations in the CIs. The decomposition applied to the CIs here follows from that suggested by Wagstaff et al. [65] and permits the approximation of the effects on child malnutrition disparities on variations in regression coefficients, variations in means of child malnutrition determinants, and variations in the extent of inequity in child malnutrition determinants. These decompositions were applied to height for age and weight for age z scores. The formula for the decomposition applied was:

In Equation 4, *dC* denotes the overall change in the CI, *dα* constant value, *dβk* the coefficients of the determinants, *dx̅k* mean values of the determinants, *dCIk*determinant-specific CI and *d(GCI/μ)ε*, the error term [65].

**Software and data availability**

All statistical analyses were performed in Stata® 16.0 (StataCorp, College Station, TX, USA). Two sample tests of proportions were used to investigate the existence of statistically significant differences between the proportions of malnutrition in 2003 and 2014. The command ***digini*** from the Distributive Analysis Stata Package (DASP) was used to calculate the CIs of malnutrition as well as testing whether the following results for subsequent years were statistically different from a test value of 0. The analysis employed survey-related commands with weights in each DHS dataset employed. All p-values below 0.05 were considered significant, statistically. Data used in this analysis was obtained from and used with written permission from the KDHS and is available from <https://www.dhsprogram.com/data/> on request.

**Results**

**Sample description and descriptive statistics**

**Table 1** presents the descriptive statistics. The 2003 Kenya DHS dataset had a total of 5,949 observations comprising 22.10% of the total observations employed in analysis whereas the 2014 DHS dataset comprised 20,964 observations which accounted for 77.90% of the total observations. The total combined dataset resulted in a total sample size of n=26,913. In 2003, there were a total of 1,653 stunted children (34.43%) whereas 3 148 children were not stunted (65.57%). Similarly, a greater proportion of the children in 2003 were not underweight (83.70%, n=4,139 underweight children) compared to only 16.30% (n=806) underweight children below the age of five years. Wasted children accounted for 7.20% (n=344) of the total number of children below the age of 59 months whereas non-wasted children accounted for 92.80% (n=4 436). In 2003, the most dominant form of malnutrition was stunting (34.43%) whereas the least frequent indicator of malnutrition was wasting (7.20%).

On the other hand, 27.07% (n=5,050) of all children in 2014 were stunted, a reduction in comparison to the values recorded in 2003 whereas 72.93% (n=13,607) was normal. The count of underweight children in 2014 was 2,462 (13.20%) whereas normal children accounted for the larger proportion of the dataset (n= 16,195; 86.80%). The count of all wasted children in 2014 also dropped to 5.48% relative to the value recorded in 2003 (7.20%). In 2014, all indicators of malnutrition decreased relative to the value recorded in 2003. 74.21% of children resided in rural areas in 2003 whereas 67.43% of children resided in rural areas in 2014. On the other hand, 25.79% of children under the age of five years lived in urban areas in 2003 whereas 32.57% stayed in urban areas in 2014, an increase of 6.78% in the total number of children under 59 months staying in urban areas.

**Table 1. Descriptive statistics of children under five years by malnutrition indicator, gender, and area of residence**

| **Year** | **2003** | | **2014** | |
| --- | --- | --- | --- | --- |
|  | **Frequency** | **Percent (%)** | **Frequency** | **Percent (%)** |
| **Sample size (n)** | 5 949 | 22.10 | 20 964 | 77.90 |
| **Stunting** |  |  |  |  |
| No | 3 148 | 65.57 | 13 607 | 72.93 |
| Yes | 1 653 | 34.43 | 5 050 | 27.07 |
| **Underweight** |  |  |  |  |
| No | 4139 | 83.70 | 16195 | 86.80 |
| Yes | 806 | 16.30 | 2462 | 13.20 |
| **Wasting** |  |  |  |  |
| No | 4436 | 92.80 | 17635 | 94.52 |
| Yes | 344 | 7.20 | 1022 | 5.48 |
| **Sex** |  |  |  |  |
| Male | 3015 | 50.68 | 10633 | 50.72 |
| Female | 2934 | 49.32 | 10331 | 49.28 |
| **Residence** |  |  |  |  |
| Urban | 1534 | 25.79 | 6828 | 32.57 |
| Rural | 4415 | 74.21 | 14136 | 67.43 |

**Trends in child malnutrition and socioeconomic disparities**

**Table 2** presents a summary of the prevalence of malnutrition among children under the age of five years in Kenya by socioeconomic groups between 2003 and 2014. The prevalence of all indicators of under-five child malnutrition in Kenya, that is, stunting, underweight, and wasting reduced substantially between 2003 and 2014. The percentage reductions in these indicators were 7.36%, 3.10%, and 1.72% for stunting, underweight, and wasting, respectively. The highest percentages decrease across all socioeconomic groups was observed for stunting (7.36%) whereas the least percentage decreases were observed for wasting (1.72%). The prevalence of stunting between 2003 and 2014 decreased significantly across all socioeconomic groups from the poorest to the richest whereas the proportions of underweight declined significantly for all the other socioeconomic quintiles apart from the lest affluent group. Similarly, the percentage reductions in wasting proportions were significant for all the other socioeconomic quintiles except for the least affluent category.

**Table 2. Proportions of child malnutrition, 2003 and 2014**

|  | **Malnutrition statistics in Kenya by household socioeconomic status (% Standard Error)** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Poorest** | **Poorer** | **Middle** | **Richer** | **Richest** | **All** |
| **Stunting ( height for age, <2SD)** |  |  |  |  |  |  |
| 2003 | 41.59(1.76) | 38.76(1.77) | 38.43(1.87) | 36.13(1.79) | 30.92(1.77) | 34.43(0.68) |
| 2014 | 34.18(0.59) | 30.23(0.73) | 24.87(0.77) | 20.64(0.77) | 12.92(0.68) | 27.07(0.33) |
| Difference-1 | 7.41(1.86)\* | 1.91(1.84)\* | 13.56(2.03)\* | 15.49(1.96)\* | 17.99(1.91)\* | 7.36(0.76)\* |
| **Underweight (weight for age, <2SD)** |  |  |  |  |  |  |
| 2003 | 23.19(1.49) | 19.62(1.42) | 17.03(1.43) | 15.45(1.33) | 15.77(1.38) | 16.29(0.53) |
| 2014 | 21.23(0.51) | 12.69(0.53) | 9.29(0.52) | 7.41(0.50) | 4.14(0.41) | 13.19(0.25) |
| Difference-2 | 1.96(1.57) | 6.93(1.51)\* | 7.74(1.53)\* | 8.03(1.42)\* | 11.64(1.44)\* | 3.10(0.58)\* |
| **Wasting (weight for height, <2SD)** |  |  |  |  |  |  |
| 2003 | 11.31(1.14) | 6.34(0.88) | 6.38(0.94) | 6.62(0.93) | 9.38(1.13) | 7.19(0.37) |
| 2014 | 9.38(0.36) | 3.56(0.29) | 3.79(0.34) | 3.21(0.33) | 2.93(0.34) | 5.47(0.16) |
| Difference-3 | 1.93(1.19) | 2.78(0.93)\* | 2.58(1.00)\* | 3.41(0.82)\* | 6.46(1.17)\* | 1.72(0.41)\* |
| Difference-1, Difference-2, Difference-3: the differences in the percentage proportions of stunting, underweight, and wasting, respectively between 2003 and 2014. SD: standard deviation. \*indicates that the difference between the malnutrition indicator in 2003 and 2014, is statistically significantly different from 0 based on the two-sample proportions test. | | | | | | |

**Table 3** presents the concentration indices of the different malnutrition indices. The results indicate that the CIs of stunting and underweight differed significantly from zero whereas the CI for wasting did not differ significantly from zero between 2003 and 2014. However, all CIs were negative suggesting that the problem of malnutrition characterized by stunting, underweight, and wasting is worse among children from the lowest wealth quintiles. That is, the likelihood of a child from a poor socioeconomic background being stunted, underweight or wasted is substantially higher than that of a child from a rich socioeconomic background. Additionally, the absolute values of CIs for stunting and underweight in 2014 were substantially greater than those recorded for 2003 a suggestion that the disparities in stunting and underweight for children aged below five years in Kenya increased significantly between the two time periods. Even though the difference in absolute CI for wasting in 2014 was smaller than that recorded in 2003, the difference was not statistically significantly different from 0 (CI=0.82, p=0.963). On the other hand, the changes in the CIs for underweight and stunting between 2003 and 2014 were significant (CI=-0.58, p=0.001; CI=-0.74, p=0.001, respectively). The worsening of the nutrition status as evidenced by the significant increases in the values of the concentration index (in absolute values) is also supported by **Fig 1**.

**Table 3. Under-five child malnutrition concentration indices (CIs), 2003 and 2014**

|  | Stunting (HAZ <2SD) | | Underweight (WAZ<2SD) | | Wasting (WAZ<2SD) | |
| --- | --- | --- | --- | --- | --- | --- |
|  | CI (SE) | P-value# | CI (SE) | P-value# | CI (SE) | P-value# |
| Year 2003 | -0.09(0.01) | <0.001 | -0.14(0.01) | <0.001 | -6.62(17.80) | >0.001 |
| Year 2014 | -0.67(0.01) | <0.001 | -0.88(0.02) | <0.001 | -5.80(0.54) | <0.001 |
| Diff | -0.58(0.02) | <0.001 | -0.74(0.02) | <0.001 | 0.82(17.81) | 0.963 |
| CI: concentration index; SE: standard error; Diff: the difference in (under five) child malnutrition concentration indices between 2004 and 2014.  #p-value based on a two-tailed independence test to compare the differences in the CIs with a test value of 0. | | | | | | |

**Fig 1. Concentration curves depicting the disparities in underweight, stunting, and wasting for children under five years between 2003 and 2014 in Kenya by Socioeconomic status (SES).**

(A) Disparities in underweight (WAZ), stunting (HAZ), and wasting (WHZ) in 2003. (B) Disparities in underweight (WAZ), stunting (HAZ), and wasting (WHZ) 2014.

**Determinants of child malnutrition**

**Tables 4-6** present a summary of the results from the multiple logistic regression models fitted to the data. A child’s age (Adjusted Odds Ratio, AOR=1.12; 95%CI 1.11–1.13), irreligion (AOR=1.33; 1.04–1.70), primary level maternal education (AOR=1.43; 1.04–1.96), birth order (AOR=1.02; 1.01–1.04), poorest (AOR=1.82; 1.49–2.20), poorer (AOR=1.59; 1.31–1.92], and middle socioeconomic status (AOR=1.42; 1.17–1.72) were significantly associated with increased risk of stunting whereas other household religions (AOR=18.68; 4.00–87.32), a child’s age (AOR=1.07; 1.05–1.08), limited maternal education (AOR=2.68; 1.63–4.41), birth order (AOR=1.03; 1.01–1.05), mother’s age at first birth (AOR=1.02; 1.01–1.04), a child being from the Rift Valley region (AOR=1.65; 1.19–2.29), Nyanza region (AOR=1.47; 1.16–1.85), and high rates of household poverty (AOR=1.74; 1.33–2.27) were associated with increased risk of child underweight. Religion (other religions), maternal education (no education (AOR=5.72; 2.47-13.26, primary (AOR=2.85; 1.26-6.48), secondary (AOR=3.02; 1.32-6.88)), region (Nyanza (AOR=2.21; 1.43-3.42), Central (AOR=1.71; 1.15-2.56), Coast (1.68; 1.06-2.67), and Rift Valley (2.58; 1.50-4.43)) were significantly associated with an increased likelihood of wasting in children under five years.

**Table 4. The determinants of malnutrition in children aged below 5 years in Kenya between 2003 and 2014 based on binary logistic regression analysis**

|  | **Stunting(height for age, <2SD)** | | **Underweight(weight for age, <2SD)** | | **Wasting(weight for height, <2SD)** | |
| --- | --- | --- | --- | --- | --- | --- |
|  | **AOR (95%CI)** | **p-value** | **AOR (95%CI)** | **p-value** | **AOR (95%CI)** | **p-value** |
| **Year (2003 vs 2014)** | 0.57(0.51-0.64) | <0.001 | 0.67(0.57-0.77) | <0.001 | 0.71(0.56-0.90) | 0.005 |
| **Age months** | 1.12(1.10-1.13) | <0.001 | 1.07(1.06-1.08) | <0.001 | 0.99(0.97-1.01) | 0.159 |
| **Age squared** | 0.99(0.99-0.99) | <0.001 | 0.99(0.99-0.99) | <0.001 | 1.00(1.00-1.00) | 0.931 |
| **Sex** |  |  |  |  |  |  |
| Female | 0.67(0.62-0.73) | <0.001 | 0.75(0.67-0.84) | <0.001 | 0.74(0.63-0.89) | <0.001 |
| Male | 1.00 |  | 1.00 |  | 1.00 |  |
| **Residence** |  |  |  |  |  |  |
| Rural | 0.93(0.82-1.05) | 0.244 | 1.04(0.88-1.24) | 0.653 | 0.90(0.69-1.17) | 0.442 |
| Urban | 1.00 |  | 1.00 |  | 1.00 |  |
| **Religion** |  |  |  |  |  |  |
| Protestant/Other Christian | 1.08(0.96-1.21) | 0.197 | 0.93(0.81-1.07) | 0.309 | 0.83(0.67-1.04) | 0.109 |
| Muslim | 0.75(0.62-0.90) | 0.003 | 0.94(0.75-1.18) | 0.599 | 1.28(0.90-1.83) | 0.172 |
| No religion | 1.33(1.04-1.70) | 0.023 | 1.01(0.76-1.34) | 0.933 | 0.90(0.57-1.42) | 0.648 |
| Other | 2.22(0.44-11.32) | 0.337 | 18.69(4.00-87.32) | <0.001 | 15.80(3.44-72.53) | <0.001 |
| Roman catholic | 1.00 |  | 1.00 |  | 1.00 |  |
| **Mother’s education level** |  |  |  |  |  |  |
| No education/preschool | 1.29(0.93-1.81) | 0.129 | 2.68(1.63-4.41) | <0.001 | 5.72(2.47-13.26) | <0.001 |
| Primary | 1.43(1.04-1.96) | 0.027 | 1.79(1.11-2.90) | 0.018 | 2.85(1.26-6.48) | 0.012 |
| Secondary | 1.02(0.74-1.41) | 0.901 | 1.19(0.73-1.96) | 0.488 | 3.02(1.32-6.88) | 0.009 |
| Higher | 1.00 |  | 1.00 |  | 1.00 |  |
| **Birth order** | 1.02(1.01-1.04) | 0.023 | 1.03(1.01-1.05) | 0.026 | 1.00(0.96-1.04) | 0.951 |
| SD: standard deviation; AOR: Adjusted Odds Ratio. Malnutrition indicators were converted into a binary form with Z-scores <2SD=1 (Yes) or 0 (No) for all stunting, wasting, and underweight. | | | | | | |

**Table 5. The determinants of malnutrition in children aged below 5 years in Kenya between 2003 and 2014 based on binary logistic regression analysis**

|  | **Stunting(height for age, <2SD)** | | **Underweight(weight for age, <2SD)** | | **Wasting(weight for height, <2SD)** | |
| --- | --- | --- | --- | --- | --- | --- |
|  | **AOR (95%CI)** | **p-value** | **AOR (95%CI)** | **p-value** | **AOR (95%CI)** | **p-value** |
| **Region** |  |  |  |  |  |  |
| Central | 0.82(0.66-1.00) | 0.060 | 0.91(0.70-1.19) | 0.509 | 1.71(1.15-2.56) | 0.009 |
| Coast | 1.08(0.89-1.29) | 0.437 | 1.28(0.99-1.64) | 0.055 | 1.68(1.06-2.67) | 0.029 |
| Eastern | 0.85(0.69-1.06) | 0.149 | 1.01(0.74-1.38) | 0.939 | 1.16(0.65-2.08) | 0.622 |
| Nyanza | 0.97(0.82-1.15) | 0.733 | 1.47(1.16-1.85) | <0.001 | 2.21(1.43-3.42) | <0.001 |
| Rift Valley | 0.88(0.68-1.14) | 0.336 | 1.65(1.19-2.29) | 0.003 | 2.58(1.50-4.43) | 0.001 |
| Western | 0.69(0.56-0.84) | <0.001 | 0.85(0.63-1.13) | 0.252 | 1.36(0.82-2.25) | 0.228 |
| North Eastern | 0.63(0.52-0.76) | <0.001 | 0.88(0.67-1.14) | 0.331 | 1.24(0.79-1.96) | 0.348 |
| Nairobi | 1.00 |  | 1.00 |  | 1.00 |  |
| **Delivery place** |  |  |  |  |  |  |
| Respondent’s home | 0.29(0.17-0.51) | <0.001 | 0.03()0.01-0.06 | <0.001 | 0.02(0.01-0.06) | <0.001 |
| Other home | 0.30(0.17-0.53) | <0.001 | 0.02()0.01-0.05 | <0.001 | 0.01(0.00-0.05) | <0.001 |
| Govt. hospital | 0.24(0.14-0.41) | <0.001 | 0.02(0.01-0.05) | <0.001 | 0.01(0.00-0.04) | <0.001 |
| Govt. health center | 0.27(0.15-0.46) | <0.001 | 0.02(0.01-0.05) | <0.001 | 0.01(0.00-0.05) | <0.001 |
| Govt. health post | 0.22(0.12-0.39) | <0.001 | 0.02(0.01-0.05) | <0.001 | 0.02(0.01-0.08) | <0.001 |
| Govt. dispensary | 0.19(0.07-0.49) | <0.001 | 0.01(0.00-0.05) | <0.001 | 1.00 |  |
| Other public | 0.78(0.22-2.86) | 0.718 | 0.07(0.02-0.32) | 0.001 | 0.03(0.00-0.22) | 0.001 |
| Private hospital/clinic | 0.21(0.12-0.36) | <0.001 | 0.02(0.01-0.04) | <0.001 | 0.01(0.00-0.03) | <0.001 |
| Mission Hospital/clinic | 0.26(0.14-0.45) | <0.001 | 0.02(0.01-0.04) | <0.001 | 0.01(0.00-0.04) | <0.001 |
| Nursing/maternity home | 0.27(0.11-0.64) | <0.003 | 0.01(0.00-0.05) | <0.001 | 0.00(0.00-0.00) | <0.001 |
| Other private medica | 0.35(0.05-2.51) | 0.294 | 0.01(0.00-0.07) | <0.001 | 1.00 |  |
| OTHER | 0.26(0.13-0.51) | <0.000 | 0.02(0.01-0.06) | <0.001 | 0.01(0.00-0.07) | <0.001 |
| SD: standard deviation; AOR: Odds Ratio. Malnutrition indicators were converted into a binary form with Z-scores <2SD=1 (Yes) or 0 (No) for all stunting, wasting, and underweight. | | | | | | |

**Table 6. The determinants of malnutrition in children aged below 5 years in Kenya between 2003 and 2014 based on binary logistic regression analysis**

|  | **Stunting(height for age, <2SD)** | | **Underweight(weight for age, <2SD)** | | **Wasting(weight for height, <2SD)** | |
| --- | --- | --- | --- | --- | --- | --- |
|  | **AOR (95%CI)** | **p-value** | **AOR (95%CI)** | **p-value** | **AOR (95%CI)** | **p-value** |
| **Birth interval** | 0.99(0.99-0.99) | <0.001 | 0.99(0.99-0.99) | <0.001 | 1.00(0.99-1.00) | 0.411 |
| **Mother’s age at first birth** | 0.96(0.96-0.98) | <0.001 | 1.02(1.01-1.04) | 0.012 | 1.03(1.00-1.06) | 0.075 |
| **Wealth index** |  |  |  |  |  |  |
| Poorest | 1.82(1.49-2.20) | <0.001 | 1.74(1.33-2.27) | <0.001 | 1.16(0.80-1.68) | 0.428 |
| Poorer | 1.59(1.31-1.92) | <0.001 | 1.29(0.99-1.69) | 0.062 | 0.71(0.47-1.07) | 0.097 |
| Middle | 1.42(1.17-1.72) | <0.001 | 1.10(0.84-1.45) | 0.490 | 0.95(0.63-1.42) | 0.793 |
| Richer | 1.09(0.89-1.32) | 0.390 | 0.89(0.67-1.17) | 0.410 | 0.68(0.46-1.00) | 0.052 |
| Richest | 1.00 |  | 1.00 |  | 1.00 |  |
| SD: standard deviation; AOR: Odds Ratio. Malnutrition indicators were converted into a binary form with Z-scores <2SD=1 (Yes) or 0 (No) for all stunting, wasting, and underweight. | | | | | | |

**Decomposition of the socioeconomic disparities in child malnutrition**

The Oaxaca-Blinder decomposition results revealed the existence of a gap in the nutrition status of children depending on their parent’s socioeconomic status. In particular, with regards to the height for age scores which were multiplied by -1 with larger values suggesting more malnourishment, the gap in the malnutrition status was 0.00 in 2003 but increased to 0.55 in 2014. As seen earlier, the nutrition status of children under five years in Kenya significantly worsened between 2003 and 2014. If children from poor socio-economic backgrounds had the same endowment (or characteristics related to mother’s level of education, residential area, religion, education level, and socioeconomic status) the height for age scores for poor children would increase by at least 0.00 in 2003 and 0.13 in 2014. Applying the coefficients of the rich children to the poor children would result in a significant improvement in the height for age scores in 2014 whereas the following change was not significant in 2003. Similarly, the simultaneous effects of differences in endowment between the rich and the poor children’s households as well as the coefficients were negligible in 2003 but became substantial in 2014. The effect of socioeconomic status remained significant in 2014.

As shown in **Table 7**, the coefficients of the variables characterizing disparities in endowments between the richest and poorest under-five children’s groups increased (in absolute values) from 2003 to 2014 although the increments did not substantially affect the gap in nutrition status between the rich and poor. The mother’s level of education and the socioeconomic status of the household statistically significantly contributed to the increments in the gap in nutrition status between children from the poor and the rich in 2014 whereas only the mother’s level of education contributed significantly to the gap in the nutrition status of the children from the poor backgrounds.

The weight for age scores for children from poor socio-economic backgrounds was 0.009 in 2003 and 0.822 in 2014. The weight for age z scores (WAZ) was multiplied by -1 with larger values suggesting more malnutrition (underweight). The differences in WAZ attributable to differing endowments between the rich and the poor increased significantly between 2003 and 2014. In 2003, the difference in weight for age z scores was 0.002 whereas the difference increased to 0.522 in 2014. The increase in weight for age z scores in 2003 if both the poor and the rich had the same characteristics in terms of the mother’s level of education, age, residential area, religion as well as wealth were negligible in 2003 whereas these effects were would result in substantial increments in the scores in 2014. Applying the rich children’s coefficients to the poor children’s characteristics did not result in substantial changes in weight for age scores for poor children for both 2003 and 2014 (p>0.05).

Similarly, the simultaneous effects of differences in endowment between the rich and the poor children’s households as well as the coefficients were negligible in both 2003 and 2014. The coefficients of the determinants of underweight increased from 2003 to 2014 with mother’s education level and the socioeconomic status of the household in which the child is born remaining substantial factors contributing to the increase in the gap in nutrition status between the rich and the poor. The decompositions of the weight for age z scores and the subsequent changes in the coefficients of the determinants of underweight are presented in **Table 8**. We did not observe substantial and statistically significant differences in wasting concentration indices between 2003 and 2014. As such, the study did not decompose the effects of the determinants in contributing to the observed differences in the recorded scores.

**Table 7. Decompositions of the socioeconomic disparities in under-five child malnutrition**

|  | **Decomposition of height for age z scores for 2003** | | | **Decomposition of height for age z scores for 2014** | | |
| --- | --- | --- | --- | --- | --- | --- |
|  |
|  |  | **Robust** |  |  | **Robust** |  |
| **Stunting** | **Coef.** | **Std. Err.** | **P-value** | **Coef.** | **Std. Err.** | **P-value** |
| **Overall** |  |  |  |  |  |  |
| Group 1 | 0.0161 | 0.0004 | <0.001 | 1.3373 | 0.0155 | <0.001 |
| Group 2 | 0.0131 | 0.0005 | <0.001 | 0.7862 | 0.0258 | <0.001 |
| Difference | 0.0030 | 0.0006 | <0.001 | 0.5512 | 0.0301 | <0.001 |
| Endowments | 0.0011 | 0.0024 | 0.642 | 1.0131 | 0.1314 | <0.001 |
| Coefficients | 0.0016 | 0.0012 | 0.189 | 0.1759 | 0.0608 | 0.004 |
| Interaction | 0.0003 | 0.0026 | 0.908 | -0.6378 | 0.1417 | <0.001 |
| **Endowments** |  |  |  |  |  |  |
| Age(months) | 0.0012 | 0.0007 | 0.082 | 0.0096 | 0.0244 | 0.692 |
| Age-squared | -0.0011 | 0.0006 | 0.070 | -0.0137 | 0.0212 | 0.519 |
| Sex | -0.0001 | 0.0001 | 0.449 | 0.0021 | 0.0026 | 0.415 |
| Residence | -0.0001 | 0.0001 | 0.445 | 0.0547 | 0.0290 | 0.059 |
| Religion | 0.0000 | 0.0000 | 0.877 | -0.0074 | 0.0060 | 0.222 |
| Education lev. | 0.0003 | 0.0001 | 0.002 | 0.1247 | 0.0228 | <0.001 |
| Wealth index | 0.0008 | 0.0024 | 0.736 | 0.8431 | 0.1421 | <0.001 |
| **Coefficients** |  |  |  |  |  |  |
| Age (months) | 0.0047 | 0.0038 | 0.216 | 0.4488 | 0.2163 | 0.038 |
| Age squared | -0.0027 | 0.0024 | 0.252 | -0.2171 | 0.1319 | 0.100 |
| Sex | 0.0019 | 0.0017 | 0.265 | -0.0461 | 0.0860 | 0.592 |
| Residence | 0.0048 | 0.0035 | 0.174 | -0.1705 | 0.0844 | 0.043 |
| Religion | 0.0000 | 0.0016 | 0.991 | 0.1436 | 0.1020 | 0.159 |
| Education lev. | 0.0012 | 0.0011 | 0.245 | 0.3827 | 0.0729 | <0.001 |
| Wealth index | -0.0003 | 0.0047 | 0.948 | 0.7195 | 0.2626 | 0.006 |
| **Interaction** |  |  |  |  |  |  |
| Age (months) | 0.0002 | 0.0002 | 0.311 | 0.0023 | 0.0059 | 0.697 |
| Age squared | -0.0002 | 0.0002 | 0.329 | -0.0028 | 0.0047 | 0.547 |
| Sex | 0.0000 | 0.0000 | 0.525 | 0.0003 | 0.0006 | 0.653 |
| Residence | 0.0002 | 0.0002 | 0.180 | -0.0738 | 0.0366 | 0.044 |
| Religion | 0.0000 | 0.0000 | 0.991 | 0.0096 | 0.0069 | 0.163 |
| Education lev. | -0.0001 | 0.0001 | 0.257 | -0.1574 | 0.0302 | <0.001 |
| Wealth index | 0.0002 | 0.0026 | 0.948 | -0.4159 | 0.1518 | 0.006 |
| **Note:** HAZ scores used were in their continuous form and were multiplied by -1. Coef.: Coefficient; Std. Err.: Standard Error. | | | | | | |

**Table 8. Decompositions of the weight for age z scores and the subsequent changes in the coefficients of the determinants of malnutrition**

|  | **Underweight in 2003** |  |  | **Underweight in 2014** |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Robust** |  |  |  |  |
| **Underweight** | **Coef.** | **Std. Err.** | **P-value** | **Coef.** | **Std Err.** | **P-value** |
| **overall** |  |  |  |  |  |  |
| Group 1 | 0.0100 | 0.0003 | 0.000 | 0.8217 | 0.0131 | 0.000 |
| Group 2 | 0.0077 | 0.0004 | 0.000 | 0.2996 | 0.0211 | 0.000 |
| difference | 0.0022 | 0.0005 | 0.000 | 0.5221 | 0.0248 | 0.000 |
| endowments | 0.0002 | 0.0019 | 0.936 | 0.7253 | 0.1097 | 0.000 |
| coefficients | 0.0000 | 0.0010 | 0.996 | -0.0546 | 0.0525 | 0.299 |
| interaction | 0.0021 | 0.0021 | 0.316 | -0.1486 | 0.1192 | 0.213 |
| **Endowments** |  |  |  |  |  |  |
| Age(months) | 0.0005 | 0.0003 | 0.089 | 0.0058 | 0.0146 | 0.692 |
| Age squared | -0.0004 | 0.0003 | 0.082 | -0.0070 | 0.0109 | 0.520 |
| sex | 0.0000 | 0.0001 | 0.570 | 0.0004 | 0.0006 | 0.531 |
| residence | 0.0001 | 0.0001 | 0.310 | 0.0071 | 0.0251 | 0.778 |
| religion | 0.0000 | 0.0000 | 0.624 | -0.0028 | 0.0047 | 0.550 |
| Education lev. | 0.0005 | 0.0001 | 0.000 | 0.1475 | 0.0182 | 0.000 |
| Wealth index | -0.0005 | 0.0019 | 0.797 | 0.5744 | 0.1204 | 0.000 |
| **Coefficients** |  |  |  |  |  |  |
| Age months | 0.0062 | 0.0029 | 0.033 | 0.2832 | 0.1736 | 0.103 |
| Age squared | -0.0033 | 0.0018 | 0.061 | -0.1360 | 0.1056 | 0.198 |
| sex | 0.0011 | 0.0014 | 0.416 | -0.1489 | 0.0715 | 0.037 |
| residence | 0.0029 | 0.0028 | 0.302 | -0.0192 | 0.0742 | 0.795 |
| religion | 0.0021 | 0.0014 | 0.118 | 0.1041 | 0.0824 | 0.206 |
| education | 0.0009 | 0.0009 | 0.317 | 0.1488 | 0.0622 | 0.017 |
| Wealth index | -0.0035 | 0.0038 | 0.346 | 0.1498 | 0.2218 | 0.499 |
| **Interaction** |  |  |  |  |  |  |
| Age months | 0.0003 | 0.0002 | 0.169 | 0.0014 | 0.0037 | 0.700 |
| Age squared | -0.0002 | 0.0002 | 0.181 | -0.0018 | 0.0031 | 0.563 |
| Sex | 0.0000 | 0.0000 | 0.639 | 0.0009 | 0.0012 | 0.441 |
| residence | 0.0002 | 0.0001 | 0.306 | -0.0083 | 0.0321 | 0.795 |
| religion | 0.0000 | 0.0000 | 0.446 | 0.0069 | 0.0055 | 0.209 |
| Education | -0.0001 | 0.0001 | 0.325 | -0.0612 | 0.0256 | 0.017 |
| Wealth index | 0.0020 | 0.0021 | 0.346 | -0.0866 | 0.1282 | 0.499 |
| **Note:** HAZ scores used were in their continuous form and were multiplied by -1. Coef.: Coefficient; Std. Err.: Standard Error. | | | | | | |

**Decomposition of the variations in socioeconomic inequalities in the Kenyan child malnutrition statistics**

Decompositions of the changes in the concentration indices between 2003 and 2014 using total differential decomposition for the height for age z scores suggest substantial disproportionate effects of age, residence, gender, religion, and socioeconomic status, with children from poor socio-economic backgrounds being disfavored. In 2003, the contribution of socioeconomic inequality towards the overall disparities in height for age z scores between the rich and poor children was 2.17%. In 2014, this contribution increased substantially to 5.07%. The mother’s level of education had a significantly higher contribution to the overall disparities in stunting in 2003 as compared to the decline observed in 2014 (1.02% in 2003 vs 0.85% in 2014). The effect of the gender of the child disfavored the children from the poorest economic backgrounds in 2003. However, this effect became negligible in 2014. The mother’s level of education, as well as the socioeconomic status of the household (proxied by the wealth index), remained the greatest contributors to the disparities in stunting (height for age z scores) in both 2003 and 2014. In 2014, there was a notable shift in the effects of age and gender, which became negligible. **Table 9** presents a summary of the change in determinant-specific CIs for stunting between 2003 and 2014, and their contributions to the total observed disparities.

As observed for stunting, the contributions of the socioeconomic status and mother’s level of education remained substantial contributors to the observed variations in underweight in 2003. The contribution of the mother’s level of education was, however, greater (3.63%) compared to that recorded for the socioeconomic status (2.59%). Apart from age and gender, the other determinants of underweight contributed to the worsening nutrition status for the impoverished groups of children. In 2014, the contribution of the socioeconomic status of a child increased to 9.33% whereas the percentage contribution of the level of mother’s education declined to 2.63%. All of the factors included in the model for malnutrition determinants as well as in the decomposition of the concentration indices were observed to worsen the nutrition status of children from the poorest socioeconomic status including increasing age, gender, residential area, religion, the mother’s education level, and the socioeconomic status. The decompositions of the changes in the concentration indices for the determinants allude to the substantial and significant effect of inequalities in the socioeconomic status contributing to worsening the nutrition status of children, particularly those from disadvantaged backgrounds. The results of the decomposition of the changes in concentration indices of the determinants of underweight between 2003 and 2014 are summarized in **Table 10**.

**Table 9. Decompositions of the contributions of the determinants of under-five child malnutrition to overall disparities in the concentration indices: stunting**

|  | **The contribution of the determinants of stunting in 2003 to observed inequalities** | | | **The contribution of the determinants of stunting in 2014 to observed inequalities** | | |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Concentration Index (CIs)** | **Contribution** | **Percentage (%) Contribution** | **Concentration Index (CIs)** | **Contribution** | **Percentage (%) Contribution** |
| Age (in months) | -0.003 | -0.03 | 0.26 | 0.00 | 0.01 | -0.04 |
| Age squared | -0.006 | 0.03 | -0.34 | 0.00 | -0.001 | 0.01 |
| Sex | -0.004 | 0.01 | -0.05 | 0.00 | -0.00 | 0.00 |
| Residence | -0.040 | 0.02 | -0.19 | -0.09 | 0.01 | -0.06 |
| Religion | -0.010 | 0.00 | -0.01 | -0.03 | 0.00 | -0.01 |
| Mother’s education level | 0.090 | -0.09 | 1.02 | 0.19 | -0.14 | 0.85 |
| Socioeconomic status | -1.030 | -0.21 | 2.17 | 0.28 | -0.85 | 5.07 |
| **Note**: The results here follow from the total differential decomposition of the concentration indices separately for 2003 and 2014 to examine the changes in CIs using height for age Z-scores following guidelines by Wagstaff et al. (2003). A positive sign suggests that the corresponding variable increases the socioeconomic inequality. | | | | | | |

**Table 10. Decompositions of the contributions of the determinants of under-five child malnutrition to overall disparities in the concentration indices: underweight**

|  | **The contribution of the determinants of underweight in 2003 to observed inequalities** | | | **The contribution of the determinants of underweight in 2014 to observed inequalities** | | |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Concentration Index (CIs)** | **Contribution** | **Percentage (%) Contribution** | **Concentration Index (CIs)** | **Contribution** | **Percentage (%) Contribution** |
| Age (in months) | -0.00 | -0.03 | 0.25 | 0.00 | 0.01 | -0.03 |
| Age squared | -0.01 | 0.04 | -0.34 | 0.00 | -0.00 | 0.01 |
| Sex | -0.00 | 0.02 | -0.15 | 0.00 | -0.00 | 0.00 |
| Residence | -0.04 | -0.09 | 0.68 | -0.09 | 0.02 | -0.07 |
| Religion | -0.01 | -0.00 | 0.01 | -0.03 | 0.01 | -0.05 |
| Mother’s education level | 0.09 | -0.46 | 3.63 | 0.18 | -0.74 | 2.63 |
| Socioeconomic status | 0.20 | -0.33 | 2.59 | 0.28 | -2.63 | 9.33 |
| **Note**: The results here follow from the total differential decomposition of the concentration indices separately for 2003 and 2014 to examine the changes in CIs using weight for age Z-scores following guidelines by Wagstaff et al. (2003). A positive sign suggests that the corresponding variable increases the socioeconomic inequality. | | | | | | |

**Discussion**

The main objective of this research was to examine the trends of socioeconomic disparities in child malnutrition in Kenya using data obtained from the DHS. Malnutrition tends to exhibit substantial and hefty variations across different socioeconomic groups ranging from the poorest to the richest [15,64]. We have employed standard statistical procedures of understanding inequalities in health variables to examine the trends of socioeconomic disparities in malnutrition in children below the age of five years. We also examined the determinants of child malnutrition in Kenya and employed decompositions to examine the contributions of these determinants to the observed variations, the change in the regression coefficients of these determinants, and the variations that have occurred with regards to the socioeconomic disparities observed between 2003 and 2014.

This study began by examining the prevalence of child malnutrition by socioeconomic status and found that between 2003 and 2014, the proportions of child malnutrition decreased significantly. Stunting recorded the highest percentage decrease in the proportions recorded across all socioeconomic groups whereas wasting recorded the least percentage decrease. The prevalence of child malnutrition was higher in children from impoverished households and reduced substantially as the socioeconomic status of the household improved from the poorest to the richest household. These patterns were the same across all indicators of malnutrition, that is, stunting, underweight, and wasting. Additionally, concentration indices (in absolute values) between 2003 and 2014 for stunting and underweight significantly increased suggesting that the socioeconomic disparities in these malnutrition indicators worsened between these years. The CI for wasting, despite being observed to have reduced between 2003 and 2014 suggesting reductions in acute forms of undernutrition, there were no statistically significant differences in the CIs between the two time periods. All the CIs were negative suggesting the disproportionate effect of socioeconomic disparities on child malnutrition where children from poor economic backgrounds are relatively disadvantaged relative to children from the richest economic groups.

The worsening socio-economic patterns in malnutrition in Kenya between 2003 and 2014 were also reported in a previous study in which a comparative investigation and analysis of socioeconomic inequalities in child stunting were investigated, with a bias on low middle-income nationalities in Africa (Kenya, Zambia, and Ghana). In their paper, Jonah et al. [17] note how inequalities in stunting appeared to have worsened in the year 2014 in comparison to previous years considered in their analysis. Even though Kenya has recorded subtle improvements in the economy between 2003 and 2014, even graduating to a low middle-income country status, the socioeconomic disparities in malnutrition between poor and rich groups appear incessant and affecting children in urban areas more compared to those in rural areas. This finding is quite unexpected even though previous research studies have reported the poverty levels in urban areas to have increased urban poverty rates in Kenya between 2005 and 2015–16. Poverty levels in Kenyan urban areas have remained unchanged with the number of poor households increasing from 2.3–3.8 million following the high rate of growth of the population [65]. Even so, rural areas often have reduced access to essential services and would generally be expected to have a higher share of the national poverty indices [17]. Similarly, the number of children residing in urban areas had increased between 2003 and 2014 alluding to possible shifts in residential preferences of parents to urban areas [66].

On a different note, this paper has found significant determinants of malnutrition characterized by three indicators to be the child’s age, household irreligion, maternal primary level education, birth order and the wealth index for stunting, child’s age, other household religions, no education (primary maternal level education), birth order, being from the rift valley and Nyanza region, mother’s age at first birth, and the household’s socioeconomic status (poorest). On the other hand, other religions, no maternal education, and the household’s region of residence (Rift Valley, Nyanza, Coast, and Central regions) were found to be substantial determinants of wasting in children under five years. The determinants of child malnutrition as found in this study conform with those found elsewhere [13,15,36].

The socioeconomic status of a household is a substantial factor impacting the nutrition status of children in Kenya as observed from this investigation. Even though Kenya has made improvements with regards to improving the nutrition status of its populace as part of the standard development goals, the rapid population growth recorded over the years has not been at a level with the rate of the growth of the economy. The result of this has been that a much larger subset of the population has remained in poverty. In recent times, statistical estimates have shown a disconnect between the rapid growth of the economy and the improvement of welfare for the larger proportion of the population [61]. As a result of a much lesser proportion of the general population reaping the benefits associated with economic growth, the disparities in the economic status of the population have worked to reduce access to essential services for the poor and other marginalized groups. While the rich have access to high-quality education, healthcare, and food, the poor struggle to access even their basic needs. Elsewhere, the non-similar distribution of the benefits following the impressive Kenyan economic growth has also been reported with the poor being disproportionately impacted [65].

The poverty rates in the country declined between 2005–06 from 50% to about 38.8% between 2015–16 in the rural areas, reductions which were largely reflected at the national level. According to Pape and Mejia-Mantilla, the reductions in the poverty levels were a result of increased emphasis on commerce and other forms of non-agricultural income to complement income from agricultural produce particularly for households in the rural areas. This has been aided by the revolutionization of the tech industry and the extensive use of mobile money. The findings in this study with regards to socioeconomic disparities in malnutrition relate with those found elsewhere where children from poor households were reported to have significantly poor nutrition outcomes in comparison to those from richer households [13,67,68]. A household’s socioeconomic status impacts its ability to have access to basic and essential services including food, water, quality sanitation, and basic healthcare amenities [69–72]. With limited finances, a household’s ability to afford a stable supply of food is significantly reduced, effects of which include adverse effects on child growth as well as cognitive development [33,73–76].

Additionally, impoverished households tend to have limited access to clean water and the levels of sanitation are also substantially poor. Improper environmental sanitation most often experienced by impoverished households has been implicated as being one major cause of diarrhea, a major determining factor of malnutrition [12,77,78]. The government through the health sector should work towards reducing the effect of poverty on the nutrition status of children through enhancing equitable access to and distribution of resources including clean water, sanitation, and healthcare access.

The mother’s level of education was also found to be a significant determinant of child stunting. These results conform with previous studies in which evidence of a strong link between maternal education and a child’s health were reported [79–83]. The mechanism explaining the linkage between maternal education and child health is in three forms. Through formal education, future mothers are able to acquire knowledge related to various health issues through which they are able to recognize illnesses and thus seek medical attention for their children. Lastly, through formal education, mothers become more receptive to western medication. In this line, maternal formal education becomes a substantial way through which health outcomes in children can be improved. These explanations on the link between maternal formal education and child health are described in detail elsewhere [84].

Decompositions of concentration indices revealed that most of the determinants of child malnutrition worked to reinforce the gap in socioeconomic disparity in malnutrition of children below the age of five years with children from poor households being negatively impacted than those from a rich household. The prevalence of malnutrition in this way can be attributed to the occurrence of determinants favoring malnutrition in the poorest socioeconomic groups or the occurrence of determinants that favor improved nutrition among the richest socioeconomic group. In stunting, the percentage contribution of the mother’s level of education to the total socioeconomic disparities observed in child stunting decreased from 1.02% in 2003 to 0.85% in 2014. On the other hand, the percentage contribution of socioeconomic status rose from 2.17% in 2003 to 5.07% in 2014. The results from this decomposition suggest that between 2003 and 2014, the level of education of mothers on various health issues improved whereas the gap in the wealth held between the rich and the poor significantly increased following inequitable distribution of the benefits reaped from rapid economic growth as described elsewhere [65]. A similar trend was observed for underweight where the contribution of the mother’s level of education, though higher, decreased from 3.63% in 2003 to 2.63% in 2014. The percentage contribution of socioeconomic status of the household to the observed socioeconomic inequalities in child underweight similarly rose from 2.59% in 2003 to 9.33% in 2014.

However, the mother’s level of education and socioeconomic status remained the most substantial contributors to the observed wealth-related inequalities in child underweight and stunting. In previous studies in which the contributions of the determinants of child malnutrition were explored and in particular relation to the nature, level, and quantity of their effect on the cumulative socioeconomic inequality, it was observed that the effect of socioeconomic status accounted for the most of the socioeconomic disparity in child stunting and child underweight [15]. Elsewhere, the greater contribution of maternal education has been linked to the role that it plays in relation to making decisions related to health and the allocation of food-related resources within the home [13,85].

A limitation of this study lies in its cross-sectional design. As in all cross-sectional study designs, the results cannot be interpreted as suggesting a causal relationship between the socioeconomic indices and child malnutrition. Additionally, the residence of the households was classified as either urban or rural. The classification of these variables into these two localities might pose a problem following the heterogeneity associated with large cities and the unavailability of data to quantify these dissimilarities. DHS does not collect data on income and expenditure. We employed a wealth index as a proxy for socioeconomic status, a situation that might have impacted the influence of the variables analyzed on the outcome variables. In this study, we observed great sample size differences between the 2003 KDHS data and the 2014 KDHS data. Even though the surveys were weighted to reflect the population of Kenya, analyses of the trend and patterns of socioeconomic inequity may mirror the differences in the power of tests across the different survey years.

Even though this study had quite a number of limitations, the findings presented bear a lot of merit and significance. The burden of child malnutrition shows a great deal of dissimilarities across income groups in developing countries. In this line, this study utilizes population-based survey data to examine the socioeconomic disparities in child malnutrition and provides crucial insight in the design of strategies to keep the inequalities under check. The survey data employed in this study presents the advantage of relatively large sample sizes as well as commendable response rates in both surveys (response rates greater than 90%). The study has also decomposed the contributions of each of the determinants of child underweight, stunting, and wasting to decipher the nature of the contributions of the variables to the observed socioeconomic disparities in child stunting and underweight. Our paper breaks ground and fosters the extent of knowledge on the causes and changes observed across socioeconomic groups for Kenyan children under the age of five years and goes on to highlight the associations between these inequalities and malnutrition in children and is, therefore, essential in informing public health strategies related to child nutrition.

The results from this investigation provide pivotal insights and implications towards public health policies. For instance, the paper has found that maternal education, as well as the household’s socioeconomic status, are the greatest contributors to the observed income-related gaps in the nutrition of children below the age of five years in Kenya. This finding will enable public health policymakers to strategically target maternal education as well as socioeconomic differences to develop effectively and throughput childhood nutrition interventions through policies targeted at improving the educational outcomes of female children while also bridging the gap between rural and urban development through equitable distribution of resources. Similarly, the public health sector can adopt strategies including the provision of easily accessible medical care, improved sanitation, and provision of clean drinking water. Additionally, the government should consider strategies to reduce the migration of people from the rural areas to the urban areas through job creation schemes in the rural areas, providing child support to the households in poverty, diversifying the source of livelihoods for people in the rural areas through provisions of viable alternatives such as commerce, provision of unemployment benefits as well as taking insurance the agricultural sector to enhance food security and enhance equity.

**Conclusion**

Malnutrition in children below the age of five years in Kenya shows a great deal of dissimilarities across various socioeconomic groups. As a result of this, understanding the nature of childhood malnutrition as well as the disparities that exist based on socioeconomic groups will play a crucial role in the design of strategies that target the individuals who are most affected by malnutrition and in keeping the existing disparities under check. Between 2003 and 2014, the socioeconomic disparities in under-five child malnutrition, characterized by child stunting, underweight, and wasting have substantially increased. This study has found that the inequalities between the rich and the poor are fueled by differences in endowments, a great proportion of which is held by the maternal level of education and the socioeconomic status of the household. Despite the economic growth that the country has experienced in the recent past, there is a disconnect between this growth and income distribution between social classes. To tackle the problem posed by the increase in the gap between the endowments possessed by the rich and the poor, the Kenyan government should work in the direction of implementing mechanisms to enhance educational outcomes for the girl child while also enhancing the socioeconomic status of poor households and focusing on older children. Specifically, the government should enhance access to food, education, as well as essential resources for poor households.

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