**Original Manuscript**

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

Amos Ochieng Okutse1\*, Henry Athiany2

1Department of Biostatistics, Brown University School of Public Health, Providence, Rhode Island, USA.

2Department of Math and Statistics, School of Physical and Mathematical Sciences, Jomo Kenyatta University of Agriculture & Technology, Nairobi, Kenya.

\*amos\_okutse@brown.edu

**Abstract**

*Introduction*: There appears to be a disconnect between Kenya's economic growth rate and health-related socioeconomic disparities.

*Objective*: To examine trends, determining factors, and their contribution towards socioeconomic inequalities in under-five child malnutrition in Kenya between 2003 and 2014.

*Methods*: We used data from the Kenya Demographic and Health Survey. Malnutrition determinants were analyzed using multiple logistic regression with stunting, underweight, and wasting as malnutrition indicators. Concentration indices were used to quantify the socioeconomic inequalities in child malnutrition. Decomposition methods were used to explore the contributions of significant determinants to the overall socioeconomic disparities.

*Results*: Socioeconomic inequalities in child malnutrition indicators worsened between 2003 and 2014. 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 associated with increased risk 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 region (Rift Valley) (AOR=2.58; 1.50–4.43) were associated with an increased risk 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 1.38% in 2003 to 1.51% in 2014 for stunting and from 1.55% in 2003 to 1.72% in 2014 for underweight.

*Conclusion*: The nutrition status of children from poor households substantially worsened between 2003 and 2014 due to poor socioeconomic status. Promoting equity in the distribution of wealth could reduce socioeconomic disparities in child malnutrition.

**Introduction**

Child Malnutrition remains a dominant public health challenge globally. In 2022, for instance, about 148.1 million (22.3%) children below 5 years were stunted, whereas 45 million (6.8%) and 37 million (5.6%) were wasted and overweight, respectively [@who2023]. While there has been some progress in the actualization of the global nutrition targets, this progress is slow, and the levels of malnutrition continue to persist. Africa and Asia account for almost half the world’s child malnutrition burden [@who2023].

In the East African region, stunting prevalence (32.6%) was higher than the global average (22.3%), whereas wasting and overweight were 5.2% and 4.0%, respectively [@IEG2022]. With the possibility of suffering from 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 experience both stunting and overweight globally [2].

In the first half of 2022, Kenya reported about 942,000 cases of acute malnutrition among children between 6 and 59 months [@Bhavnani2023]. According to the 2022 Kenya Demographic and Health Survey (KDHS) [@KNBSICF2023], 18% of children under 5 are stunted (chronically undernourished), 5% are wasted (acutely malnourished), whereas 3% and 10% are overweight and underweight, respectively. While Kenya has substantially reduced the burden of child malnutrition, undernutrition is estimated to cost the country over US$38.3 billion in Gross Domestic Product (GDP) following losses in workforce labor and productivity for 2010–2030 [6,7].

Malnutrition denotes “a state of nutrition in which a deficiency, or an excess, of energy, protein, and micronutrient causes measurable adverse effects on tissue/ body form (body shape, size, and composition), function, and clinical outcome” [8]. Malnutrition has been attributed to several diverse interlinked factors with detrimental short and long-term effects [@Pelletier1995; @Pelletier2003]. Not only does it affect the physical and cognitive development of a child, but it also drastically increases their risk of infections and contributes negatively to their mortality and morbidity [@Rice2000, 17, 20, 29, 30, 35, 36].

Stunting, underweight, and wasting remain the recommended 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 anthropometric measurements were taken. Underweight is low weight for age, resulting from a short-term lack of food. In contrast, wasting is severe undernutrition resulting from inadequate food intake and infections [17]. In children under 5 years, stunting is the most significant measure of overall health and well-being capable of highlighting salient social disparities [18]. Moreover, because stunting measures linear growth in children, it is considered an accurate measure of malnutrition in the long term due to its insensitivity to variations in food consumption [23–25].

**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]. A country's attainment of the middle-income classification status 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, indicate economic advancement. As expected of growth, such advancements are expected to impact the well-being of a country's population positively. For instance, economic advancements are expected to create employment opportunities, translating into increased disposable income, improved health, and education [37,38]. Improved living standards following economic advancement are expected to translate into exceptional and improved nutritional consequences for children and adults.

The economic status associated with a country has been shown in previous studies to result in improved health status of a population [40,41]. However, economic advancement does not necessarily translate to equitable distribution of positive prospects across the population. Often, these tend to be skewed, with some groups benefiting more than others.

Kenya has made commendable progress in reducing the burden of malnutrition as part of the Standard Development Goals (SDGs), which have considerably reduced the stunting rate. Even so, the overall prevalence of the condition remains larger than those observed for other forms of malnutrition [17,42]. Given the danger malnutrition poses to child growth, survival, and well-being, its consequences are of substantial interest to the government, public health professionals, and policymakers [7].

This study contributes significantly to the available knowledge on socioeconomic disproportions in the Kenyan child malnutrition burden, examining trends in stunting, underweight, and wasting across socioeconomic groups, geographical locations, and selected household, child, maternal, and paternal characteristics. We also examine the determinants of child malnutrition and employ standard procedures of inequality to quantify the trends [36] and decompose vicissitudes in the concentration indices to determine factors that drive socioeconomic disparities in child malnutrition in Kenya. The study utilizes current data from the Kenya Demographic Health Survey (DHS) (2014 to 2022) to comprehensively analyze the scope of the problem, specifically focusing on children below five years.

***Measurement of socioeconomic status [include under adjustment covariates]***

*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]. Traditionally, both income and expenditure have been used as measures of a household’s economic status, however, 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 data**

This study employed data from the Kenya Demographic and Health Surveys (KDHS) carried out in 2014 and 2022 (standard DHS). 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. The response rate was 99% from a sample of 39 679 households in 2014, whereas in 2022, the response rate was 98% from a sample of 38 731 occupied households [@KNBSICF2023]. We considered all live children of interviewed mothers aged between 0 and 59 months in all analytic procedures. Children with missing anthropometrical data were excluded from analyses. All data were weighted to account for non-response. This data was used with explicit permission from DHS.

**Variables**

**Outcome**

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, respectively. Stunting refers to a low height for age and reflects linear growth 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 weight) occurs as a result of insufficient food intake as well as infections with the same WHO classifications as seen above. [17,55].

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 [56].

**Adjustment covariates**

This study 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 are significant determinants of malnutrition in children [57–59]. We also investigated other variables, including the birth order, 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 malnourished children by gender and area of residence.

## Indicators of socioeconomic disparities in child malnutrition

The extent and trends of socioeconomic disparities in stunting, underweight, and wasting were quantified using concentration indices (CIs) [60–62]. We used the z-scores described earlier to estimate the concentration indices and plot the concentration curves. Concentration indices quantify the socioeconomic disparities in a health variable (malnutrition in this case) and thus allow for assessing 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. [62], the formula for CI follows:

In equation 1, *$\mu$* is the average of malnutrition (stunting, underweight, and wasting) in children under five children, $*h$* denotes observation-specific child malnutrition, and $*r$* is the rank of the socioeconomic status of a household. The CI of a given health variable usually takes values between -1 and +1, with 0 suggesting perfect equity of the health variable between the poorest and the richest socioeconomic groups. On the other hand, negative values suggest a higher concentration of malnutrition among the poorest group, and positive values suggest a higher concentration of inequity among the richest socioeconomic group [13,15,17,62]. 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 [60,62,63].

## Statistical analysis

**Descriptive statistics**

Descriptive statistics for each year were presented as frequencies and percentages for categorical variables for the three malnutrition indicators and selected demographic variables (residence and gender). Two sample tests of proportions were used to investigate the existence of statistically significant differences between the proportions of malnutrition in 2003 and 2014.

**Logistic regression modelling**

The viable determinants of child malnutrition were determined 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 constructing the wealth index were not used as variables in the model for that reason. The study also used the same model to examine the role of birth order, region of childbirth, 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) [64]. Decompositions were restricted to stunting and underweight in both 2003 and 2014. We employed the categorical 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* [62,64]. Wagstaff normalization was used to normalize the CIs.

Total differential decomposition was employed to decompose 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. 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**

**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 least 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 indicators. 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 socio-economic 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 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).

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Stunting (HAZ <2SD) | | Underweight (WAZ<2SD) | | Wasting (WHZ<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) | 0.709 |
| 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 2003 and 2014.  #p-value based on a two-tailed independence test comparing the differences in the CIs with a test value of 0. | | | | | | |

**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), lack of a religion (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 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 | 1.00 |  | 1.00 |  | 1.00 |  |
| 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 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: Adjusted Odds Ratio. Malnutrition indicators were converted into a binary form with Z-scores <2SD=1 (Yes) or 0 (No) for stunting, wasting, and underweight. | | | | | | |

**Decompositions of the contributions of the significant determinants of malnutrition**

**Table 7** presents the estimated contributions of the significant determinants of malnutrition towards the observed overall inequities in child stunting in 2003 and 2014, respectively. In 2003, the household’s socioeconomic status contributed the most towards inequality in child stunting followed by maternal education, and the child’s age. In 2014, the percentage contribution of a household’s socioeconomic status rose from 1.38% in 2003 to 1.51% in 2014. Similarly, the contribution of maternal education increased from 0.14% in 2003 to 0.16% in 2014. Contrastingly, the percentage contribution of age declined from 0.03% to 0.002%.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 7. The estimated contribution of the significant determinants of under-five child malnutrition to socioeconomic inequality** | | | | |
|  | **Contributions of the significant determinants of stunting towards the disparities in the CIs (2003)** | | **Contributions of the significant determinants of stunting towards the disparities in the CIs (2014)** | |
| **Variables** | **Contribution** | **Percentage contribution** | **Contribution** | **Percentage contribution** |
| Age | -0.004 | 0.037 | 0.000 | -0.002 |
| Religion | 0.000 | 0.002 | 0.000 | -0.004 |
| Maternal education | -0.014 | 0.141 | -0.037 | 0.163 |
| Birth order | -0.002 | 0.017 | -0.009 | 0.038 |
| Socioeconomic status | -0.138 | 1.384 | -0.346 | 1.508 |
| **Note**: A high positive percentage contribution suggests that the corresponding variable increases socioeconomic inequality. | | | | |

**Table 8** shows the percentage contributions of the factors identified as significant contributors to child underweight towards socioeconomic inequality in both 2003 and 2014. A household’s socioeconomic status remained a substantial contributor towards inequality. In 2014, the percentage contribution of a household’s socioeconomic status rose to 1.72% from 1.55% in 2003. Similarly, the percentage contribution of the region in which a child was born rose from 0.09% in 2003 to 0.11% in 2014. On the other hand, the percentage contribution of maternal education declined from 0.48% in 2003 to 0.31% in 2014.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 8. Estimated contribution of significant factors to socioeconomic inequality** | | | | |
|  | **Contributions of the significant determinants of underweight towards the disparities in the CIs (2003)** | | **Contributions of the significant determinants of underweight towards the disparities in the CIs (2014)** | |
| **Variables** | **Contribution** | **Percentage contribution** | **Contribution** | **Percentage contribution** |
| Religion | -0.001 | 0.008 | 0.009 | -0.029 |
| Age | -0.003 | 0.035 | -0.000 | -0.003 |
| Maternal education | -0.044 | 0.487 | -0.099 | 0.314 |
| Birth order | -0.000 | 0.002 | -0.015 | 0.048 |
| Mother's age at first birth | -0.000 | 0.011 | 0.019 | -0.062 |
| Region | -0.009 | 0.097 | -0.034 | 0.116 |
| Socioeconomic status | -0.139 | 1.546 | -0.545 | 1.724 |
| **Note**: A high positive percentage contribution suggests that the corresponding variable increases socioeconomic inequality; CI: Concentration Index. | | | | |

**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 [15,65]. 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 and employed decompositions to examine the contributions of the significant determinants to socioeconomic disparities observed between 2003 and 2014.

We examined the prevalence of child malnutrition by socioeconomic status and found that between 2003 and 2014, the proportions of child malnutrition decreased significantly for all socioeconomic groups. The decreases in the overall percentage proportions of all child malnutrition indicators between 2003 and 2014 can be argued to be, perhaps, the result of subtle improvements in household food security, care quality, and household environments, factors which (in their absence) have been reported as major causes of child malnutrition [66].

Stunting recorded the highest percentage decrease in the proportions recorded across all socioeconomic groups whereas wasting recorded the least percentage decrease. In a similar study investigating the trends of child undernutrition in Kenya, it was found that, unlike underweight which had significantly declined between 1993 and 2008–09, wasting remained essentially stagnant [67].

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. The improvements in nutrition status from the poor to the rich socioeconomic groups can be explained to be a result of increments and improvements in purchasing power as well as access to food and quality healthcare [68].

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 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. In their paper, Jonah et al. [17] noticed that inequalities in child stunting appeared to have worsened in the year 2014 in comparison to previous years considered in their analysis. The socioeconomic disparities in malnutrition between poor and rich groups appear incessant in Kenya, despite the fact that the country recorded subtle improvements in the economy between 2003 and 2014, and even graduating to a low middle-income country status.

On a different note, this study found significant determinants of malnutrition characterized by three indicators to be maternal education level and religion for all malnutrition indicators, a child’s age, birth order, and a household’s socio-economic status for both stunting and underweight, whereas a child’s region of residence was a significant determinant of both wasting and underweight. The mother’s age at first birth was also found to be a substantial determinant of underweight. 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. Kenya has made improvements with regards to the nutrition status of its populace as part of the standard development goals, but the rapid population growth recorded over the years has not been at par 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 the welfare of the larger proportion of the population [62]. 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 [69].

The poverty rates in Kenya 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 [69], 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 to those found elsewhere where children from poor households were reported to have significantly poor nutrition outcomes in comparison to those from richer households [13,70,71]. 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 [72–75]. 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 [33,76–79].

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 [12,80,81]. 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 was reported [82–86]. 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. Secondly, through education, women are able to get jobs from which they are able to afford a healthy lifestyle for their children in which they are free from illnesses. Lastly, through formal education, mothers are able to acquire knowledge on the efficacy of modern medications and thus become more receptive to their use. In this line, maternal formal education becomes a substantial way through which health outcomes in children can be improved. The explanations on the link between maternal formal education and child health are described in detail elsewhere [87].

Additionally, we also found evidence of a strong link between the order of birth and the likelihood of a child being stunted or underweight. In previous studies, birth order has been implicated as a major predictor of a child being stunted with higher-order children (>fifth order) being more likely to be stunted [88]. The high chance of higher-order children being malnourished has been explained to be as a result of these children being unwanted, an aspect that then translates into less attention and care from their parents [88] . In other words, high birth order children experience reduced health check-ups as well as postnatal care [88]. Additionally, with births spaced in quick succession, high order children are likely to receive limited lacteal feeding, a factor that predisposes them to malnutrition as noted elsewhere [14].

The association between a child’s age and the likelihood of malnutrition can also be explained in terms of the limited attention that mothers pay on higher-order children such that their likelihood of being malnourished remains higher. These results conform to those found in a separate study in which a child’s age was also found to be a significant predictor of malnourishment [16,89].

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. Children from poor households were negatively impacted relative to those from rich households. 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 [15,17]. In stunting, the percentage contribution of the mother’s level of education and socioeconomic inequality towards the total socioeconomic disparities in child stunting increased. 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 [69].

For underweight, decomposition results showed a decrease in the percentage contribution of maternal education between 2003 and 2014. The decrease in the contribution of maternal education towards inequity can be explained in terms of subtle improvements in maternal educational outcomes. Improvements in maternal education means that women are able to access better-paying jobs which translates into their ability to provide quality healthcare for their children. In this way, maternal education impacts child health as well as survival [68,82,83,90]. On the other hand, the percentage contribution of socioeconomic status of the household to the observed socioeconomic inequalities in child underweight increased between 2003 and 2014.

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 [13,91].

## Study strengths and limitations

The findings presented here bear a lot of merit and significance. The burden of child malnutrition shows many 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 for 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 for the agricultural sector to enhance food security and enhance equity

Despite these benefits, 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. However, the method is approved and widely used. 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.

**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 fuelled 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.

**References**

1. De Onis M, Blössner M, Borghi E. Prevalence and trends of stunting among pre-school children, 1990-2020. Public Health Nutr. 2012;15: 142–148. doi:10.1017/S1368980011001315

2. Global Nutrition Report. The burden of malnutrition at a glance. In: Global Nutrition Report | Country Nutrition Profiles [Internet]. 2021 [cited 12 Feb 2021]. Available: https://globalnutritionreport.org/resources/nutrition-profiles/asia/south-eastern-asia/indonesia/

3. The United Nations Children’s Fund. Malnutrition in Children: Current Status and Progress. In: Malnutrition [Internet]. 2020 [cited 12 Feb 2021]. Available: https://data.unicef.org/topic/nutrition/malnutrition/

4. Demissie S. Magnitude and Factors Associated with Malnutrition in Children 6-59 Months of Age in Pastoral Community of Dollo Ado District, Somali Region, Ethiopia. Sci J Public Heal. 2013;1: 175. doi:10.11648/j.sjph.20130104.12

5. De Vita MV, Scolfaro C, Santini B, Lezo A, Gobbi F, Buonfrate D, et al. Malnutrition, morbidity and infection in the informal settlements of Nairobi, Kenya: An epidemiological study. Ital J Pediatr. 2019;45. doi:10.1186/s13052-019-0607-0

6. USAID. Kenya: Nutrition Profile. In: Kenya Nutrition Profile [Internet]. 2018 [cited 12 Feb 2021] pp. 1–6. Available: https://www.usaid.gov/sites/default/files/documents/1864/Kenya-Nutrition-Profile-Mar2018-508.pdf

7. USAID. Country Profile Kenya | Feed the Future. In: USAID-Feed the Future [Internet]. 2017 [cited 12 Feb 2021]. Available: https://www.feedthefuture.gov/country/kenya/

8. Stratton R, Green C, Elia M. Disease-related malnutrition: an evidence-based approach to treatment. London: CABI; 2003.

9. Saghir Ahmad KY. Malnutrition: Causes and Strategies. J Food Process Technol. 2015;06. doi:10.4172/2157-7110.1000434

10. Chapman IM. Weight Loss in Older Persons. Medical Clinics of North America. 2011. pp. 579–593. doi:10.1016/j.mcna.2011.02.004

11. Thomas DR. Loss of skeletal muscle mass in aging: Examining the relationship of starvation, sarcopenia and cachexia. Clinical Nutrition. 2007. pp. 389–399. doi:10.1016/j.clnu.2007.03.008

12. Akombi BJ, Agho KE, Merom D, Hall JJ, Renzaho AM. Multilevel analysis of factors associated with wasting and underweight among children under-five years in Nigeria. Nutrients. 2017;9. doi:10.3390/nu9010044

13. Akombi BJ, Agho KE, Renzaho AM, Hall JJ, Merom DR. Trends in socioeconomic inequalities in child undernutrition: Evidence from Nigeria demographic and health survey (2003 – 2013). PLoS One. 2019;14. doi:10.1371/journal.pone.0211883

14. Gudu E, Obonyo M, Omballa V, Oyugi E, Kiilu C, Githuku J, et al. Factors associated with malnutrition in children < 5 years in western Kenya: a hospital-based unmatched case control study. BMC Nutr. 2020;6. doi:10.1186/s40795-020-00357-4

15. Kien VD, Lee HY, Nam YS, Oh J, Giang KB, Van Minh H. Trends in socioeconomic inequalities in child malnutrition in Vietnam: Findings from the Multiple Indicator Cluster Surveys, 2000-2011. Glob Health Action. 2016;9. doi:10.3402/gha.v9.29263

16. Poda GG, Hsu CY, Chao JCJ. Factors associated with malnutrition among children <5 years old in Burkina Faso: Evidence from the Demographic and Health Surveys IV 2010. Int J Qual Heal Care. 2017;29: 901–908. doi:10.1093/intqhc/mzx129

17. Jonah CMP, Sambu WC, May JD. A comparative analysis of socioeconomic inequities in stunting: A case of three middle-income African countries. Arch Public Heal. 2018;76. doi:10.1186/s13690-018-0320-2

18. De Onis M, Branca F. Childhood stunting: A global perspective. Matern Child Nutr. 2016;12: 12–26. doi:10.1111/mcn.12231

19. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, Ezzati M, et al. Maternal and child undernutrition: global and regional exposures and health consequences. The Lancet. 2008. doi:10.1016/S0140-6736(07)61690-0

20. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. The Lancet. 2008. doi:10.1016/S0140-6736(07)61692-4

21. Angdembe MR, Dulal BP, Bhattarai K, Karn S. Trends and predictors of inequality in childhood stunting in Nepal from 1996 to 2016. Int J Equity Health. 2019;18. doi:10.1186/s12939-019-0944-z

22. Devkota MD, Adhikari RK, Upreti SR. Stunting in Nepal: Looking back, looking ahead. Maternal and Child Nutrition. 2016. pp. 257–259. doi:10.1111/mcn.12286

23. Hoddinott J, Alderman H, Behrman JR, Haddad L, Horton S. The economic rationale for investing in stunting reduction. Matern Child Nutr. 2013;9: 69–82. doi:10.1111/mcn.12080

24. World Health Organization (WHO). Nutrition Landscape Information System (‎‎NLIS)‎‎ country profile indicators: interpretation guide. Geneva; 2019. Available: https://www.who.int/publications/i/item/9789241516952

25. Zere E, McIntyre D. Inequities in under-five child malnutrition in South Africa. Int J Equity Health. 2003;2. doi:10.1186/1475-9276-2-7

26. United Nations Childrens Fund (UNICEF). Strategy for improved nutrition of children and women in developing countries. New York; 1990. Available: https://digitallibrary.un.org/record/132779?ln=en

27. Bhadoria A, Sahoo K, Sahoo B, Choudhury A, Sufi N, Kumar R. Childhood obesity: Causes and consequences. J Fam Med Prim Care. 2015;4: 187. doi:10.4103/2249-4863.154628

28. von Grebmer K, Saltzman A, Birol E, Wiesmann D, Prasai N, Yin S, et al. Synopsis of 2014 Global hunger index: The challenge of hidden hunger: Issue briefs. 2014.

29. Kar BR, Rao SL, Chandramouli BA. Cognitive development in children with chronic protein energy malnutrition. Behav Brain Funct. 2008;4. doi:10.1186/1744-9081-4-31

30. Mendez MA, Adair LS. Severity and timing of stunting in the first two years of life affect performance on cognitive tests in late childhood. J Nutr. 1999;129: 1555–1562. doi:10.1093/jn/129.8.1555

31. Heckman JJ. The economics, technology, and neuroscience of human capability formation. Proc Natl Acad Sci U S A. 2007;104: 13250–13255. doi:10.1073/pnas.0701362104

32. Hoddinott J, Maluccio JA, Behrman JR, Flores R, Martorell R. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. Lancet. 2008;371: 411–416. doi:10.1016/S0140-6736(08)60205-6

33. Perignon M, Fiorentino M, Kuong K, Burja K, Parker M, Sisokhom S, et al. Stunting, poor iron status and parasite infection are significant risk factors for lower cognitive performance in Cambodian school-aged children. PLoS One. 2014;9. doi:10.1371/journal.pone.0112605

34. Walker SP, Chang SM, Wright A, Osmond C, Grantham-McGregor SM. Early childhood stunting is associated with lower developmental levels in the subsequent generation of children. J Nutr. 2015;145: 823–828. doi:10.3945/jn.114.200261

35. Walker SP, Chang SM, Powell CA, Simonoff E, Grantham-McGregor SM. Early childhood stunting is associated with poor psychological functioning in late adolescence and effects are reduced by psychosocial stimulation. J Nutr. 2007;137: 2464–2469. doi:10.1093/jn/137.11.2464

36. Rabbani A, Khan A, Yusuf S, Adams A. Trends and determinants of inequities in childhood stunting in Bangladesh from 1996/7 to 2014. Int J Equity Health. 2016;15. doi:10.1186/s12939-016-0477-7

37. Bloom DE, Canning D, Sevilla J. The effect of health on economic growth: A production function approach. World Dev. 2004;32: 1–13. doi:10.1016/j.worlddev.2003.07.002

38. Ranis G, Stewart F, Ramirez A. Economic growth and human development. World Dev. 2000;28: 197–219. doi:10.1016/S0305-750X(99)00131-X

39. Kanbur R, Sumner A. Poor countries or poor people? Development assistance and the new geography of global poverty. J Int Dev. 2012;24: 686–695. doi:10.1002/jid.2861

40. Ettner SL. New evidence on the relationship between income and health. J Health Econ. 1996;15: 67–85. doi:10.1016/0167-6296(95)00032-1

41. Marmot M. The influence of income on health: Views of an epidemiologist. Health Aff. 2002;21: 31–46. doi:10.1377/hlthaff.21.2.31

42. Haddad L, Achadi E, Bendech MA, Ahuja A, Bhatia K, Bhutta Z, et al. The global nutrition report 2014: Actions and accountability to accelerate the world’s progress on nutrition. J Nutr. 2015;145: 663–671. doi:10.3945/jn.114.206078

43. Baye K, Laillou A, Chitweke S. Socio-economic inequalities in child stunting reduction in sub-Saharan Africa. Nutrients. 2020;12. doi:10.3390/nu12010253

44. Garcia V. Children Malnutrition and Horizontal Inequalities in Sub-Saharan Africa : A Focus on Contrasting Domestic Trajectories. undp.org. 2012. Available: https://www.undp.org/content/dam/rba/docs/Working Papers/Child Malnutrition and Inequality.pdf

45. Reinbold GW. Economic inequality and child stunting in Bangladesh and Kenya: An investigation of six hypotheses. Popul Dev Rev. 2011;37: 691–719. doi:10.1111/j.1728-4457.2011.00453.x

46. Headey D, Hoddinott J, Ali D, Tesfaye R, Dereje M. The Other Asian Enigma: Explaining the Rapid Reduction of Undernutrition in Bangladesh. World Dev. 2015;66: 749–761. doi:10.1016/j.worlddev.2014.09.022

47. Heltberg R. Malnutrition, poverty, and economic growth. Health Econ. 2009;18. doi:10.1002/hec.1462

48. Walker SP, Wachs TD, Grantham-Mcgregor S, Black MM, Nelson CA, Huffman SL, et al. Inequality in early childhood: Risk and protective factors for early child development. The Lancet. 2011. pp. 1325–1338. doi:10.1016/S0140-6736(11)60555-2

49. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: An application to educational enrollments in states of India. Demography. 2001;38: 115–132. doi:10.1353/dem.2001.0003

50. Jolliffe IT. Principal Component Analysis, Second Edition. Encycl Stat Behav Sci. 2002;30: 487. doi:10.2307/1270093

51. Hjelm L, Mathiassen A, Miller D, Wadhwa A. Fighting Hunger Worldwide : Creation of a Wealth Index. 2017. Available: https://docs.wfp.org/api/documents/WFP-0000022418/download/

52. The DHS Program. Wealth-Index-Construction. In: Wealth Index Construction [Internet]. 2016 [cited 17 May 2021]. Available: https://www.dhsprogram.com/topics/wealth-index/Wealth-Index-Construction.cfm

53. Kenya National Bureau of Statistics (KNBS). 2019 Kenya Population and Housing Census Volume I: Population by County and Sub-County . Nairobi; 2019 Nov. Available: https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county

54. National Bureau of Statistics Nairobi K. Republic of Kenya Kenya Demographic and Health Survey 2014. 2015. Available: www.DHSprogram.com.

55. De Onis M, Frongillo EA, Blössner M. Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980. Bull World Health Organ. 2000;78: 1222–1233. doi:10.1590/S0042-96862000001000008

56. Group WHOW. Use and interpretation of anthropometric indicators of nutritional status. Bull World Health Organ. 1986;64: 929–941.

57. Nguyen CK, Le DT, Tran XN, Phan HD, Ha HK. Reduction in childhood malnutrition in Vietnam from 1990 to 2004. Asia Pac J Clin Nutr. 2007;16: 274–278. doi:10.6133/apjcn.2007.16.2.11

58. Nguyen MT, Popkin BM. In an era of economic growth, is inequity holding back reductions in child malnutrition in Vietnam? Asia Pacific Journal of Clinical Nutrition. 2003. pp. 405–410.

59. Thang NM, Popkin B. Child malnutrition in Vietnam and its transition in an era of economic growth. J Hum Nutr Diet. 2003;16: 233–244. doi:10.1046/j.1365-277X.2003.00449.x

60. Kakwani N, Wagstaff A, Van Doorslaer E. Socioeconomic inequalities in health: Measurement, computation, and statistical inference. J Econom. 1997;77: 87–103. doi:10.1016/S0304-4076(96)01807-6

61. Wagstaff A, Paci P, van Doorslaer E. On the measurement of inequalities in health. Soc Sci Med. 1991;33: 545–557. doi:10.1016/0277-9536(91)90212-U

62. O’Donnell O, van Doorslaer E, Wagstaff A, Lindelow M. Measurement of Living Standards. Analyzing Health Equity Using Household Survey Data: A Guide to Techniques and Their Implementation. World Bank, Washington, DC. 2008.

63. Wagstaff A, van Doorslaer E. Chapter 34 Equity in health care finance and delivery. Handbook of Health Economics. 2000. pp. 1803–1862. doi:10.1016/S1574-0064(00)80047-5

64. Wagstaff A, Van Doorslaer E, Watanabe N. On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. J Econom. 2003;112: 207–223. doi:10.1016/S0304-4076(02)00161-6

65. Fotso JC. Child health inequities in developing countries: Differences across urban and rural areas. Int J Equity Health. 2006;5. doi:10.1186/1475-9276-5-9

66. Tette EMA, Sifah EK, Nartey ET. Factors affecting malnutrition in children and the uptake of interventions to prevent the condition. BMC Pediatr. 2015;15. doi:10.1186/s12887-015-0496-3

67. Matanda DJ, Mittelmark MB, Kigaru DMD. Child undernutrition in Kenya: Trend analyses from 1993 to 2008-09. BMC Pediatr. 2014;14. doi:10.1186/1471-2431-14-5

68. Abuya BA, Ciera J, Kimani-Murage E. Effect of mother’s education on child’s nutritional status in the slums of Nairobi. BMC Pediatr. 2012. doi:10.1186/1471-2431-12-80

69. Pape U, Mejia-Mantilla C. More than just growth: Accelerating poverty reduction in Kenya. In: Africa Can End Poverty [Internet]. 12 Feb 2019 [cited 20 May 2021]. Available: https://blogs.worldbank.org/africacan/more-than-just-growth-accelerating-poverty-reduction-in-kenya

70. Braveman P, Tarimo E. Social inequalities in health within countries: Not only an issue for affluent nations. Social Science and Medicine. 2002. pp. 1621–1635. doi:10.1016/S0277-9536(01)00331-8

71. Van De Poel E, Hosseinpoor AR, Speybroeck N, Van Ourti T, Vega J. Socioeconomic inequality in malnutrition in developing countries. Bull World Health Organ. 2008;86: 282–291. doi:10.2471/BLT.07.044800

72. Bain LE, Awah PK, Geraldine N, Kindong NP, Sigal Y, Bernard N, et al. Malnutrition in Sub - Saharan Africa: Burden, causes and prospects. Pan African Medical Journal. 2013. doi:10.11604/pamj.2013.15.120.2535

73. Masiye F, Chama C, Chitah B, Jonsson D. Determinants of Child Nutritional Status in Zambia: An Analysis of a National Survey. Zambia Soc Sci J. 2010;1: 4.

74. Masuku M, Selepe M, Ngcobo N. The Socio-economic Status as a Factor Affecting Food (In) Security in Rural Areas, uThungulu District Municipality, Kwa-Zulu Natal, South Africa. J Hum Ecol. 2017;58: 57–66. doi:10.1080/09709274.2017.1305615

75. Pathak PK, Singh A. Trends in malnutrition among children in India: Growing inequalities across different economic groups. Soc Sci Med. 2011;73: 576–585. doi:10.1016/j.socscimed.2011.06.024

76. Bryan J, Osendarp S, Hughes D, Calvaresi E, Baghurst K, Klinken J-W. Nutrients for Cognitive Development in School-aged Children. Nutr Rev. 2004;62: 295–306. doi:10.1111/j.1753-4887.2004.tb00055.x

77. Hackett M, Melgar-Quiñonez H, Álvarez MC. Household food insecurity associated with stunting and underweight among preschool children in Antioquia, Colombia. Rev Panam Salud Publica/Pan Am J Public Heal. 2009;25: 506–510. doi:10.1590/S1020-49892009000600006

78. Mutisya M, Kandala NB, Ngware MW, Kabiru CW. Household food (in)security and nutritional status of urban poor children aged 6 to 23 months in Kenya Global health. BMC Public Health. 2015;15. doi:10.1186/s12889-015-2403-0

79. Saxena NC. Hunger, under-nutrition and food security in India. Poverty, Chronic Poverty and Poverty Dynamics: Policy Imperatives. 2018. pp. 55–92. doi:10.1007/978-981-13-0677-8\_4

80. Aheto JMK, Keegan TJ, Taylor BM, Diggle PJ. Childhood Malnutrition and Its Determinants among Under-Five Children in Ghana. Paediatr Perinat Epidemiol. 2015;29: 552–561. doi:10.1111/ppe.12222

81. Akombi BJ, Agho KE, Hall JJ, Merom D, Astell-Burt T, Renzaho AMN. Stunting and severe stunting among children under-5 years in Nigeria: A multilevel analysis. BMC Pediatr. 2017;17. doi:10.1186/s12887-016-0770-z

82. Abuya BA, Onsomu EO, Kimani JK, Moore D. Influence of maternal education on child immunization and stunting in Kenya. Matern Child Health J. 2011;15: 1389–1399. doi:10.1007/s10995-010-0670-z

83. Frost MB, Forste R, Haas DW. Maternal education and child nutritional status in Bolivia: Finding the links. Soc Sci Med. 2005;60: 395–407. doi:10.1016/j.socscimed.2004.05.010

84. Handa S. Maternal education and child height. Econ Dev Cult Change. 1999;47: 420–439. doi:10.1086/452408

85. Iftikhar A, Bari A, Bano I, Masood Q. Impact of maternal education, employment and family size on nutritional status of children. Pakistan J Med Sci. 2017;33. doi:10.12669/pjms.336.13689

86. Kabubo-Mariara J, Ndenge GK, Mwabu DK. Determinants of children’s nutritional status in Kenya: Evidence from Demographic and Health Surveys. J Afr Econ. 2009;18: 363–387. doi:10.1093/jae/ejn024

87. Glewwe P. Why does mother’s schooling raise child health in developing countries? Evidence from Morocco. J Hum Resour. 1999;34: 124–159. doi:10.2307/146305

88. Rahman M. Associação entre ordem de nascimento e desnutrição crônica em crianças: Estudo de uma amostra nacional representativa em Bangladesh. Cad Saude Publica. 2016;32. doi:10.1590/0102-311X00011215

89. Kinyoki DK, Berkley JA, Moloney GM, Kandala NB, Noor AM. Predictors of the risk of malnutrition among children under the age of 5 years in Somalia. Public Health Nutr. 2015;18: 3125–3133. doi:10.1017/S1368980015001913

90. Desai S, Alva S. Maternal education and child health: Is there a strong causal relationship? Demography. 1998;35: 71–81. doi:10.2307/3004028

91. Matsumura M, Gubhaju B. Women’s status, household structure and the utilization of maternal health services in Nepal. Asia-Pacific Popul J. 2001;16: 23–44. doi:10.18356/e8a4c9ed-en