ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE

SCHOOL OF PUBLIC HEALTH

SOCIOECONOMIC INEQUALITY IN CHILDHOOD UNDERNUTRITION IN ETHIOPIA; A SECONDARY ANALYSIS OF THE 2016 ETHIOPIAN DEMOGRAPHIC AND HEALTH SURVEY

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY SCHOOL OF PUBLIC HEALTH IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN HEALTH ECONOMICS

JUNE 2023

ADDIS ABABA, ETHIOPIA

ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

socioeconomic inequality in childhood undernutrition in Ethiopia; a secondary analysis of the 2016 Ethiopia demographic and health survey

Investigator: Nebiyu Maseresha (BSc)

Advisors: Dr. Anagaw Derseh (Phd)

Mrs. Berhan Tasew (MPH)

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University School of Public Health in Partial Fulfillment of the Requirements for the Degree of Masters in Science with Specialty in Health Economics

June, 2023

Addis Ababa, Ethiopia

Acknowledgement

I would like to express my deepest gratitude to my advisors Dr. Anagaw Derseh & Mrs. Berhan Tasew for their support and guidance during the whole Process of this proposal development. Furthermore, I would like to thank Addis Ababa University School of public health for providing favorable conditions for the thesis.

Table of Contents

Contents

List of Tables

List of Figures

Acronyms

CI	Concentration Index
CSA	Central Statistical Agency
EDHS	Ethiopian Demographic and health Survey
MOH	Ministry of Health
NNP	National Nutrition Plan
SD	Standard Deviation
SDG	Sustainable Development Goal
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

Abstract

According to the income position of the country, the proportion of affected children varies. More than two third of stunted children and almost three quarters of wasted children reside in lower-middle income nations, where less than half of all children under the age of five lives. Ethiopia is one of the nations that is most afflicted by child undernourishment and is not on pace to achieve SDG target 2.2 by 2030.

The study used secondary data analyses of EDHS 2016 data sets in order to assess the socioeconomic inequality in undernutrition and to explore the inequality by key socio-demographic characteristics.

The background characteristics of the population were presented via tables and graphs and descriptive statistics. Graphs were also used to depict the trend, and regional variance was also discussed. Due to the two stage sampling procedure utilized in the EDHS data set, sample weights were used in all analyses. The analysis made use of Stata version 16.

The three-stage inequality study for stunting, wasting, and underweight used the concentration curves, CIs, and decomposition of the concentration index. Concentration indices were used to explain the disparity in concentration curves after concentration curves for stunting, wasting, and underweight were shown.

In order to investigate the elements that contributed to the socioeconomic inequality in undernutrition, a socioeconomic decomposition analysis was lastly conducted.

Both the concentration curve and concentration index showed that the inequality in undernutrition by Stunting (-0.147), underweight (-0.143) and wasting (-0.054), all this indicating that undernutrition is more concentrated among the poorest than the better-off households. This inequality varies between region and residence. Therefore, FDRE should work to minimize this inequality and the variation among residence and regions.

1. Introduction

1.1. Background

To guarantee correct organ development and optimal performance, the creation of a strong immune system, and adequate mental growth and development, children's must have adequate nutrition in the early years of their life (1). A health population is necessary for both social and economic development so that people can learn new skills and contribute to their society (2).

Particularly important are the first 1000 days, beginning at conception and lasting until the infant is about two years old. Stunting, wasting and micronutrient deficiencies can result from inadequate maternal nutrition before to conception and while the child is in the womb, the absence of exclusive breast feeding for the first six months and the inability of caregivers to provide a wide and nourishing range of first foods (3). The repercussions can have significant and long lasting effects on children and their communities. Numerous detrimental effects of undernutrition include increased permanent brain damage, diminished cognitive function, and unfavorable effects on social development (4).

Child undernutrition continues to be a key public health problem in developing countries including Ethiopia. According to UNICEF, WHO, World Bank Group Joint Child Malnutrition Estimates, globally a total of 149.2 million children (22.0%) are stunted and 45.4 million (6.7 %) wasted in 2020. Two out of five stunted children and more than one quarter of wasted children lived in Africa. When we see the trend of stunting at the global level, its reduced from 32.4% in 2000 to 22.0% in 2020. Even if, the percentage is declining, the number of stunted children is risen in Africa, which was from 49.7 million in 2000 to 61.4 million in 2020 (5). In Ethiopia, the trend of stunting shows that 51% (In 2005) to 37% (in 2019); the wasting is from 33% (in 2005) to 21(in 2019) and underweight from 12% (2005) to 7 %(2019) (6).

The UN Sustainable Development Goals (SDGs) cast nutrition as the central input and outcome, building on the global nutrition targets set by the world health Assembly. Sustainable Development Goal 2 specifically calls on member state to "end hunger, achieve food security, improve nutrition, and promote sustainable agriculture." In fact, nutrition related metrics are in 12 out of the 17 SDGS. The United Nations general assembly formally declared the decade of action on nutrition (2016-2025), strengthening the global commitment to eradicating hunger and avoiding all kinds of malnutrition (5). This announcement added to the global ambition. 163

nations now have comprehensive or topic specific policies, strategies, and plans that are related to nutrition, according to World Health Organization (7).

Ethiopia's government has set a goal to eradicate undernutrition entirely by year 2030. As a result, numerous techniques and programs were established to lower the level of undernutrition. growth and transformation plan (GTP), National Nutrition Plan (NNP), the Seqota Declaration (SD), National Food Security Strategy, Nutrition Sensitive agriculture (NSa) strategy, school health and Nutrition Strategy (ShNS), the Productive Safety Net Program (PSNP), and Food Safety and Quality related regulatory activities (FDRE Food and Nutrition Policy 2018) are few strategies and programs. With the objective of eradicating hunger, achieving food security, enhancing nutrition, and promoting sustainable agriculture by 2030, the Seqota Declaration adopted Sustainable Development Goal 2 (SDG2). All of these have been developed in cooperation with various nongovernmental organizations, including Micronutrient Initiatives (MI), United Nations Children's Fund (UNICEF), and Save the Children. However, according to the Mini EDHS results, correspondingly 37%, 7%, and 21% of children under the age of five were stunted, wasted, and underweight (8-10).

Therefore, this study will assess the trend and socio economic inequality in childhood nutrition in Ethiopia using EDHS data.

1.2. Statement of the Problems

Around 45% of all childhood deaths worldwide, which largely occur in low and middle income nations, are attributed to the alarming undernutrition rate (11, 12).

To meet the goals of the sustainable development agenda and the world health assembly, which calls for a reduction of childhood stunting of 40% by 2025 and by 50% by 2020, the global progress made during the past two decades is insufficient. With the exception of low income nations, the number of children with stunting decreased across all national income group of concern. The number of stunted children also decreased across broad, with the exception of sab Saharan African, where is rose by 7 million between 2000 and 2020 (5).

According to the income position of the country, the proportion of affected children varies. More than two third of stunted children and almost three quarters of wasted children reside in lower-middle income nations, where less than half of all children under the age of five lives. India is contributing the big share of the globe stunting, 24 .2 % of world's stunted under five children live in India (5).

Ethiopia is one of the nations that is most afflicted by child undernourishment and is not on pace to achieve SDG target 2.2 by 2030. According to the 2019 mini EDHS, 7% of children are wasted, 21% of all children are underweight, and 37% of children under five are short for their age or stunted (below -2 SD). In addition, 12%, 1%, and 6% of all children under the age of five, respectively, are severely stunted, wasted, and underweight (6).

As well as accounting for around 35% of the disease burden among children the age of five and 11% of all global disability adjusted life years, it has both immediate and long term repercussions that are crucial to children's physical and intellectual development (13).

According to a social and economic impact research carried out in Ethiopia, undernutrition is responsible for 28% of child mortality there and accounts for an 8% decrease in the labor force. The projected yearly costs of child undernutrition in Ethiopia are 55.5 billion birr, or around 16.5% of GDP (14).

Few studies were conducted in analyzing the national representative data EDHS, their main focus were to see the prevalence at regional prevalence and contributing factors and also their variation (15-17). Whereas, the current study uses many determinant variables at the same time, which will help to generalize the study findings at the national level and mainly focuses on the socio economic inequality in undernutrition and to explore by key socio-demographic characteristics.

1.3. Significance of the Study

It will be challenging to meet the worldwide target for reducing malnutrition by 2025 at current rate of progress, notwithstanding the Ethiopian government's efforts and advancements in this area. The results of this study will be incorporated into the Ethiopian government's strategy to eradicate undernutrition by 2030.

Unlike previous studies, this study will use concentration index analyses specifically Erreygers Normalized CI to explore the socioeconomic inequality by key socio-demographic factors in the undernutrition. These could guide the design of equity sensitive health and nutrition programs

It also used as an input or reference for the future studies and nutritional programs

2. Literature Review

2.1. Theoretical Literature

2.1.1. Definition of basic concepts

Malnutrition results when the body's needs for nutrients and its use of those nutrients are out of balance. Malnutrition can take many different forms, and there are two main types: undernutrition and over nutrition (20).

Undernutrition is characterized as a person consuming insufficient amounts of nutrients and energy to meet their demands for maintaining good health (21). Suboptimal nutrition might manifest as stunting, wasting, and underweight. Under 2 standard deviations from the median height-for-age, weight-for-height, and weight-for-age, as assessed by the 2006 World Health Organization (WHO) Child Growth Standards, respectively, cause stunting, wasting, and underweight in children younger than 59 months (22).

A youngster that is too young for his or her height is considered to be stunting. These kids may have significant, irreparable physical and cognitive harm as a result of their growth being stunted. Stunting has terrible consequences that can last a lifetime and even harm future generations (5).

A child who is too thin for his or her height is referred to as "wasting." The failure to gain weight or recent fast weight loss is the causes of wasting. Although there are treatments available, a youngster who is moderately or severely wasted has a higher risk of dying (5).

Low weight for age is referred to as underweight. It is known as the indicator for evaluating changes in the severity of malnutrition over time and is a composite measure of stunting and wasting (5).

2.1.2. Child Development and undernutrition

Healthy eating begins even before birth. During pregnancy and childbirth, the child is affected by the mother's poor nutrition. Underweight and anemia in the mother raise the risk of preterm birth and low birth weight, which in turn raises the risk of stunting and wasting in the newborn (23).

Micronutrient requirements rise due to the fetus's growing needs; many pregnant mothers struggle with concealed hunger or micronutrient deficits. Anemia can result from iron deficiency. In actuality, nutritional anemia is more frequently caused by iron deficiency (24). Folate shields the developing fetus from neural-tube abnormalities such spinal bifida (25). Preeclampsia and preterm delivery are risk factors that calcium lowers (26). In particular during the third trimester, vitamin A stimulates fetal development and immunological function. Finally, low birth weight, poor fetal neural development, preterm delivery, and increased neonatal mortality are all linked to mothers' zinc deficiency (27).

Malnutrition can have a negative impact on brain development during pregnancy and the early years of children, influencing cognition, preparation for school, behavior, and productivity into the school-age years and beyond. A child's lifetime of brain function can be established by giving them the vital nutrients of glucose, protein, fatty acids, and micronutrients throughout this time. A healthy child's ability to engage with their surroundings and caregivers can promote continued brain growth (28).

Breastfeeding should be done exclusively for the first six months and then continue until the child is two years old or older, according to UNICEF and WHO. For the child, breastfeeding has several advantages, especially in the first hour of life. The initial milk a mother produces, called colostrum, shields a baby's developing immune system from inflammation and infection. It is not simply food; it is a potent medicine specifically formulated to meet the needs of the newborn that can drastically lower the chance of mortality (3).

Although complementary foods should be introduced to infants around 6 months, only about 2/3 of infants who are 6 to 8 months old do so globally. But way too many start much early. In the regions of Latin America and the Caribbean and East Asia and the Pacific, over 50% of newborns 4-5 months old and 15% of infants 2-3 months old are already eating food (29).

Children benefit most from eating foods of animal origin, such as meat, fish, eggs, and dairy products, starting at the age of six months. These foods are helpful in giving children the important minerals and vitamins A, iron, zinc, and calcium that they require between the ages of six and 23 months. ASF promotes development and physical activity while enhancing cognitive function (3, 29). ASF is densely packed with a variety of necessary micronutrients and is ideal for younger children's smaller stomachs. Early childhood stunting is also linked to low ASF

consumption. However, ASF, particularly eggs and dairy, are more expensive and consumed less in low-income rural settings (3, 29).

From the time they are 2 to 4 years old, toddlers begin to make their own food choices and frequently eat outside the home, exposing them to influences other than their parents and primary caregivers (3).

In populations that experience chronic undernourishment, a malnutrition cycle exists, and during this cycle, pregnant women's nutritional needs are not met. Therefore, babies born to these moms are underweight at birth, unable to grow to their full potential and maybe stunted, making them vulnerable to infections, illness, and early mortality. When low birth weight mothers develop into malnourished children and adults and are more likely to deliver low birth weight babies as well, the cycle is exacerbated (30).

2.1.3. Global strategies to reduce Undernutrition

The Sustainable Development Goals (SDGs) must be met in order to end hunger, achieve food security, improve nutrition, support sustainable agriculture, guarantee healthy lives, and advance well-being for all ages (SDGs 1–3), among other objectives. Malnutrition must decrease in order to accomplish these objectives (31, 32).

Governments have pledged to the global targets to reduce chronic undernutrition (stunting) by 40% by 2025 and to reduce and maintain the prevalence of acute undernutrition (wasting) to less than 5% in children under the age of five due to the impacts of childhood undernutrition (33).

2.1.4. Strategies and programs to address undernutrition in Ethiopia

As part of its national development plan, Ethiopia has a number of policies and programs in place to lower the incidence of malnutrition. The National Nutrition Plan (NNP), the Seqota Declaration (SD), the Growth and Transformation Plan (GTP), Nutrition Sensitive Agriculture (NSa) Strategy, School Health and Nutrition Strategy (ShNS), Productive Safety Net Program (PSNP), and Food Safety and Quality Related Regulatory Activities are a few of the major strategies and programs (34). In order to end hunger, ensure food security, improve nutrition, and support sustainable agriculture by 2030, the Seqota Declaration adopted Sustainable Development Goal 2 (SDG2) (8).

2.2. Empirical literature

In the absence of inescapable biological reasons, health inequality refers to a discrepancy in some defined health outcome across groups that is perceived as unjust and undesirable. The most significant causes of health disparities are racial or ethnic background, socioeconomic position, gender, and place of residence (35, 36).

Studies, which examined a substantial body of literature and data from almost 100 low- and middle-income countries, discovered that poor women and their children fared worse than those from better-off families in terms of mortality and undernutrition (37–39).

Stunting and underweight are more prevalent in children from lower socioeconomic households and those born to mothers with less education, according to the pooled data analysis of the Bangladesh DHS that looked at socioeconomic disparities in stunting and underweight among children under five among 14,602 children aged 0-59 months. Despite having low poverty rates, the eastern regions saw bigger socioeconomic disparities than the western regions (40).

The prevalence of childhood undernutrition has decreased between 2004 and 2014, according to another study carried out in Bangladesh using decomposition analysis from four rounds of the Bangladesh Demographic Health Survey (BDHS) data. However, the rate of undernutrition is higher among children of mothers who have less education, reside in rural areas, and come from the lowest wealth quintile. Nearly half of the overall disparity in childhood stunting and underweight frequency was caused by socioeconomic status, with maternal education coming in second place among the causes (41).

According to a study done in India, between 1992–1993 and 2005–2006, undernutrition in children decreased across household wealth quintiles and mother education levels. However, compared to the least wealthy categories, the rate of decline is substantially faster among the socioeconomically better off groups. In urban India, the socioeconomic inequality in childhood undernutrition has increased over the research period, according to the results of pooled logistic regression analysis (42).

In a study conducted in Iran, it was found that stunting was more common than underweight or wasting. Inequality in stunting and underweight was statistically significant, and children in the lower quintiles were more malnourished, according to the results of the concentration index at the national level, as well as in rural and urban areas and in terms of children's sex. The

concentration index value of the wasting index was not statistically significant nor was it sensitive to socioeconomic level (43).

Independent of the child's age, sex, birth order, length of breastfeeding, birth weight, mother's age at childbirth, body mass index, education, and household access to safe drinking water and hygienic toilet facilities, as well as residence and geographic region, the 2003 Ghana Demographic and Health Survey study in Ghana found that children in the poorest 20% of households are more than twice as likely to suffer from stunting as children in the richest 20% of households. In addition, children in the middle and next poorest quintiles are significantly more likely than children in the richest 20% of households to be chronically undernourished (44).

A concentration index analysis of the Nigeria Demographic and Health Survey (NDHS) from 2003 to 2013 revealed a rise in childhood stunting and underweight in Nigeria. Child age (0–23 months), mother education (no education), household wealth index (poorest family), type of residence (rural), and geopolitical zone (North East, North West) were the socioeconomic factors that contributed to the rise in child undernutrition (45).

In Ethiopia, a study on underweight using four EDHS from 2000, 2005, 2011, and 2016 revealed that, after controlling for confounders, 41, 33, 29, and 24% of the sampled under-five children were underweight, respectively. Children were more likely to be underweight in the 2016 EDHS if they were male. Compared to children whose mothers were over 45, children whose mothers were under 20 years old were more likely to be underweight. Compared to kids whose mothers had higher education, those with no education or only a primary education were more likely to be underweight (46).

According to a decomposition study on stunting performed on a nationally representative sample of 8855 children under the age of 5 from the 2016 Ethiopian Demographic and Health Survey, the prevalence of stunting overall was 38%, with a notable pro-poor socioeconomic imbalance. Stunting affected 45.1% and 26.9% of the socioeconomically poorest and richest groups, respectively. The primary factor, which alone accounted for 33% of the socioeconomic difference in stunting, was the caregivers' educational status. This was followed by the caregivers' region of residence (11%) and birth weight (6%). Stunting reduction efforts may be accelerated by equity-sensitive initiatives that give vulnerable populations priority and work to reduce socioeconomic inequality (47).

3. Objective

3.1. General Objective

- To assess the socioeconomic inequality in childhood undernutrition in Ethiopia by using decomposition Analysis of EDHS 2016.

3.2. Specific Objectives

- To assess the socioeconomic inequality in Stunting
- To Assess the socioeconomic inequality in underweight
- To assess the socioeconomic inequality in Wasting
- To explore the socioeconomic inequality by key socio-demographic factors

4. Methods

4.1. Study Area and Setting

This study used the 2016 EDHS data sets to assess the socioeconomic inequality of childhood undernutrition and its contributing factors. The government of Ethiopia is conducting the demographic health survey with 5 years apart since 2000. The 2016 EDHS was implemented by the Central Statistical Agency (CSA) under the aegis of the Ministry of Health (MOH). ICF provided technical assistance through the DHS Program, which is funded by the United States Agency for International Development (USAID) and offers support and technical assistance for the implementation of population and health surveys in countries worldwide (48).

Ethiopia is a landlocked country located in Eastern Africa with a population of more than 110 million based upon the 2007 census projected population. It borders six countries Eritrea, Djibouti, Somalia, Kenya, South Sudan and Sudan. The country occupies an area of 1.1 million square kilometers ranging from 4600 m above sea level at Ras Dashen mountain to 148m below sea level at Dankil (Dallol) depression (48,49).

Ethiopia is a federal parliamentary republic, the prime minster is serving as head of government. Administratively, Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Southern Nations Nationalities and Peoples (SNNP), Gambella, Harari, Addis Ababa, and Dire Dawa are the nine administrative regions and two administrative cities that make up Ethiopia (49,50).

4.2. Source Population

All children under 5 years of age during the data collection of the survey were used as the source population

4.3. Study Population

All children under five years of age and who are included in the sampled population of EDHS 2016.

4.4. Inclusion and exclusion

Children's with complete data set was included in the analyses, including anthropometric measurements, their personal and household characteristics. But, if they miss the data for the selected variables (weight and height of the child, sex and age of the child, and regarding the maternal characteristics includes maternal age, education, and occupation and the household characteristics includes place of residence, region and household assets/wealth status) were excluded from the analyses.

4.5. Study Design

This study used Secondary analyses of cross-sectional data from the recent 2016 Ethiopia Demographic and Health Surveys. The analysis included the data sets of 10,752 under five children included in the EDHS 2016.

4.6. Sampling Procedure

The EDHS used stratified, two-stage cluster design, and the Enumeration Areas utilized in the 2007 Census served as the sampling units for the first stage of the stratified. The list of all enumeration areas (EAs) produced for the 2007 PHC is contained in the census frame. An EA is a region that typically has 181 households within it. Information regarding the EA location, the type of dwelling (urban or rural), and the projected number of residential households are all included in the sampling frame (48).

21 sampling strata were produced after stratifying each region into urban and rural areas. In two steps, independent selections of EA samples were made in each strata. By classifying the sampling frame within each sampling stratum prior to sample selection, in accordance with administrative units at various levels, and by using a probability proportional to size selection at the first stage of sampling, implicit stratification and proportional allocation were achieved at each of the lower administrative levels (48).

The sample allocation was carried out using an equal allocation, with 25 EAs chosen from eight regions, to ensure that survey precision is equivalent across regions. However, 35 EAs for each of the three major regions—Amhara, Oromia, and SNNP—were chosen.

The second round of sampling was made up of households, and a certain number of houses per cluster were chosen randomly from the newly constructed household listing, which is an exhaustive list of all the households for the chosen EAs (48).

.

4.7. Sample Size Estimation

As was mentioned in the sampling design, there are two stages to the sampling process. At each lower level of the administrative division, implicit stratification and proportional allocation were achieved in the first stage by sorting the sampling frame within each sampling stratum prior to sample selection and using the probability proportional to size selection. In the second stage, a set number of households per cluster were chosen using equal probability systematic selection from the newly constructed house hold listing.

Finally, a national representative sample of 18,060 households were selected for the EDHS 2016(48).

4.8. Variables and Measurement

Based upon the relevant literature reviewed, selected variables were used in order to assess the inequality on childhood undernutrition and its contributing factors.

Outcome variables

Three well-respected anthropometric measures created by the World Health Organization (WHO), including the height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ), were used to measure childhood undernutrition. In accordance with the WHO child growth standard guidelines, z scores (HAZ, WAZ, and WHZ) will be computed using survey data on child heights, weights, and ages. The difference between a person's measurement and the reference population's median measurement for that person's age or height, divided by the reference population's standard deviation, is known as the Z-score or standard deviation (SD). Regardless of the indication chosen, the cut-off for Z-scores is -2 standard deviation (SD) (22).

$$\text{Z-SCORE} = \frac{\text{measured value} - \text{median of reference population}}{\text{standard deviation of the reference population}}$$

If a child's HAZ score is less than minus two (2) SD from the reference population's mean, the child is considered stunted. Similar to WAZ, WHZs that are less than 2 SD will be regarded as wasting and underweight, respectively.

.

Major explanatory variables

Different socioeconomic and maternal factors, such as stunting, wasting, and underweight, have been linked to various forms of undernutrition, according to numerous research. The decomposition analysis will take into account a variety of explanatory variables based on the published research, including the age and sex of the children, the mother's age, education, access to electronic media, place of residence, and socioeconomic status.

Like EDHS analysis, this study also uses the wealth index variable to measure the socioeconomic status of households. It serves as an indicator of level of wealth that is consistent with expenditure and income measures. The index will be created using principal components analysis on household asset data and divides wealth into five quintiles at the national level: The poorest households were placed in the lowest 20% quintile, followed by the poorest households in the next 20% quintile, middleclass homes in the next 20% quintile, and lastly the richest and wealthiest households in the top 40% quintile.

4.9. Description of dependent and independent variables

Stunting: A child is defined as stunted If child's height-for-age z-score is less -2 standard deviations (SD) from the international median (WHO, 2006) healthy reference group.

Underweight: a child is Under-Weighted If child's weight-for-age z-score is less -2 standard deviations (SD) from the international median (WHO, 2006) healthy reference

Wasting: a child defined wasted If child's weight-for-height z-score is less -2 standard deviations (SD) from the international median (WHO, 2006) healthy reference group

Wealth Index: is used as a proxy to assess households' economic status and generated based on the principal component analysis, was divided into five quintiles: poorest, poorer, middle, richer, and richest

Place of residence: Urban and Rural (48).

Region: Ethiopia is divided into nine geographical regions and two administrative cities (48).

Maternal Education: educational status of the mother and classified in to Four, No formal education, Primary, secondary and more than secondary (48)

Maternal occupational status: currently working or not (48)

Age of the mother: Below 20 years, 20-29, 30-39 and 40-49 years (48)

Child age: Divided in to childe less than 24 months and child from 24-59 month (48)

Sex of the child: Male or Female

4.10. Measurement and analysis

Descriptive statistics, frequencies and proportions were used to describe the background characteristics of the study population and graphs and tables used to present. Prevalence/percentage were used to see the trend and presented by graph and regional variation and trend will also be presented and discussed. Due to the two-stage cluster sampling strategy used in the EDHS dataset, sample weights were used in every analyses. The analysis was conducted using Stata version 16.

For stunting, wasting, and underweight, the inequality analysis was completed in three steps: plotting the concentration curves, reviewing the CIs, and deconstructing the concentration index. Stunting, wasting, and underweight concentration curves were shown, and concentration indices explained the disparity in the concentration curves. In order to further investigate the elements that contributed to the socioeconomic discrepancy in undernutrition, a socioeconomic decomposition analysis was also conducted.

Concentration curve

The distribution of diseases among the various socioeconomic categories is shown by the concentration curve's pattern and magnitude of discriminations. As a result, the concentration curve that was created would plot the cumulative proportion of undernutrition in children

(including stunting, wasting, and underweight) against the cumulative percentage of the population from the poorest to the richest. The cumulative proportion of the samples' socioeconomic status is shown against the cumulative proportion of the health outcomes (stunting, wasting, and underweight) in the vertical axis.

The concentration curve will be above the equity line if undernutrition is more prevalent among the poor. The concentration curve will, however, be below the equity line if the health consequence (undernutrition) is more concentrated among the wealthy. However, malnutrition will be evenly distributed throughout all socioeconomic groups when the concentration curve and the equity line cross. There is complete equality in childhood malnutrition with regard to the wealth index if the concentration curve perfectly equals the 45_straight line (19).

Concentration index

The area between the concentration curves and the equity line is doubled in the CI, which summarizes the data present in each concentration curve. The distance between the concentration curves and the equity line will be measured using CIs. The negative CI shows that undernutrition is more prevalent among the lower socioeconomic strata and that the curve is over the 45_ line. The value of concentration indices would be positive if the curves were below the equity line, where malnutrition would be more prevalent among those in the upper socioeconomic strata. Additionally, a score of 0 (zero) denotes complete equality, meaning that there is no socioeconomic disparity for child undernutrition (19, 51).

The following formula for the concentration index will be used (19)

$$CI = \frac{2}{\mu} cov\,(h,r),$$

Where *CI* is the concentration index,

h is the childhood undernutrition, and

r is the fractional rank of the individual in the distribution of wealth index,

μ is the mean of the child malnutrition variables, and

cov is the covariance.

The value of the CI lies between −1 and +1 (ie, $-1 \leq CI \leq +1$), where −1 refers to the case where malnutrition is fully concentrated among the poorest quintile, and +1 refers to the case where malnutrition is fully concentrated among the richest quintile.

Decomposition of socioeconomic inequalities

Finally, the estimated CIs will be decomposed to realize the contribution of individual socioeconomic characteristics in childhood undernutrition (52). The regression model for the health outcome (y) to the set of k determinants (x_k) can be expressed as follows:

$$y = \alpha + \sum_k \beta_k x_k + \varepsilon.$$

Here, βk is the coefficient of xk, and ε is the error term. The concentration index of y denoted (C) can be written as follows:

$$C = \sum_k (\beta_k \bar{x_k} / \mu) C_k + GC_\epsilon / \mu.$$

Here, μ is the mean of health outcome variable (y); xk is the mean of xk (kth determinant variable); the concentration index of xk is denoted by C_k, and $GC\epsilon$ is the generalized concentration for the error term(ε). (β_k x_k)/ μ denotes the elasticity of the undernutrition with respect to the explanatory variables. In other words, this quantity indicates the amount of change in dependent variables (ie, height-for-age, weight-for-age, and weight-for-height) related to the one-unit change in the explanatory variables. Decomposition analyses will be done for all of the three measurements of undernutrition in the year of 2016 EDHS.

4.11. Ethical Clearance

After the proposal was reviewed and approved, the Addis Abeba University School of Public Health's IRB issued the ethical clearance. To download and utilize the EDHS 2016 data on socioeconomic inequality in children undernutrition in Ethiopia, a permission letter was obtained from the Demographic and Health Surveys (DHS) online archive (Annex 1).

4.12. Dissemination of Results

The College of Health Sciences' school of public health will receive and review the study's final report. The findings will be presented at scientific meetings and in peer-reviewed academic publications. Informed policy decisions, planning, monitoring, and evaluation of programs on child health in specific and general will be made using this information, at both the national and regional levels.

5. Result

5.1. Background characteristics

The mean age was 28.64 (SD ±17.66) months and more than half (51.28%) were males. Regarding maternal background characteristics, more than half (65.85%) were had no education, and 72.84% were not currently working.

Household characteristic of the study participants 88.93% were rural residents, and 43.86% were from Oromia region. Regarding the wealth status, around half were below the middle group, 23.83 % poorest and 23.03% were of poorer.

Table 1 Distribution of socio demographic characteristics among children in Ethiopia, EDHS 2016

No	Variable	Weighted Percentage
1	**Wealth Index**	
	Poorest	23.87
	poorer	23.03
	Middle	20.81
	Rich	17.81
	Richest	14.48
2	**Region**	
	Tigray	6.66
	Afar	0.99
	Amhara	19.03
	Oromia	43.86
	Somali	4.49
	Beninshangul	1.09
	SNNPR	20.76
	Gambella	0.23
	Harari	0.23
	Addis Ababa	2.23
	Diredawa	0.42
3	**Place of residence**	
	Rural	11.07

	Urban	88.93
4	**Maternal Educational Level**	
	No Education	65.85
	Primary	26.93
	Secondary	4.78
	Higher	2.44
5	**Husband's Educational Level**	
	No Education	47.67
	Primary	39.37
	Secondary	7.82
	Higher	4.42
	Don't know	0.72
6	**Occupational status**	
	Not Working	72.84
	Working	27.16
7	**Sex of the child**	
	Male	51.28
	Female	48.72
8	**Age of child**	
	Less than 6 month	11.78
	6-11	10..48
	12-23	19.6
	24-35	18.51
	36.-47	19.06
	48-59	20.56
9	**Maternal age in year**	
	15-19 years	3.46
	20-29	71.85
	30-39	23.38
	40-49	1.31

Totally A weighted sample of 8855, 9033 and 8919 were considered for stunting, underweight and wasting analyses respectively and of them 38.39%, 23.73% and 10.09% of children were stunted, underweight and wasted, respectively.

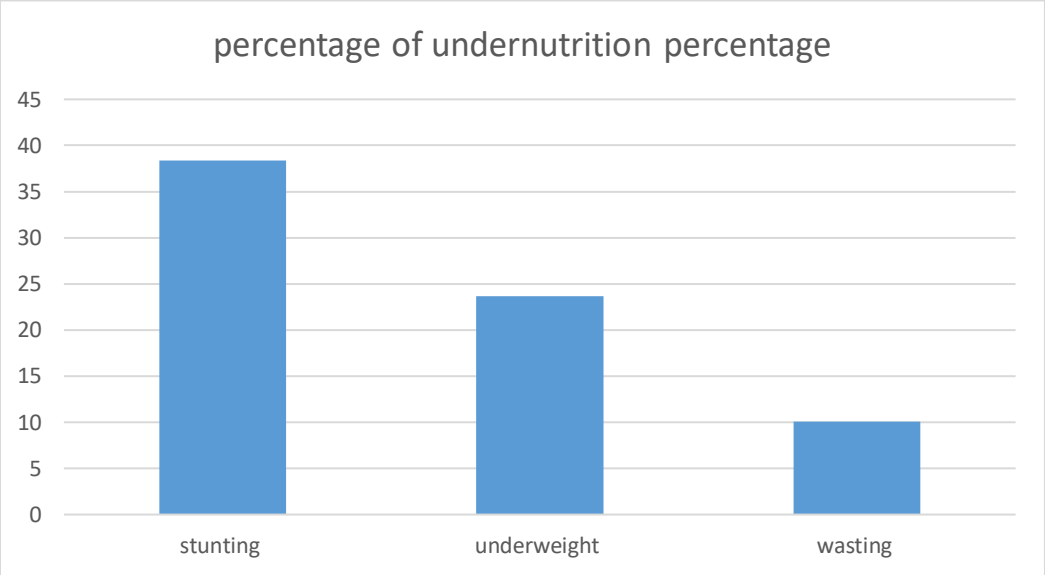

Figure 1: percentage of undernutrition of children under 5 years of age of 2016 EDHS

the result of showed that the rate of undernutrition differs by some sociodemographic characteristic like wealth status, region, residence and maternal education.

Regarding stunting, it is higher in Amhara (47.2%) and lower in Addis Ababa (14.7%) among regions and higher among rural residents (39.9%). The prevalence in poorest wealth quantile is 45.1%) which is the highest from other groups. Mother's with no education is also with 41.63% highest rate of stunting.

As stunting, poorest wealth quantile group (31%) and rural residents (24.9%) holds higher prevalence of underweight. The prevalence of stunting is higher in Afar (36.2%) and lower in Addis Ababa (5.2%) among regions. When we see the educational and working status of mothers, Underweight is higher among mother with no Education (27.4%) and currently not working (24.2%).

Among the five wealth quantile groups, Wasting is higher among the poorest wealth quantile group (14%) and lower among the richer group (7%). Somali (23.1%), Afar (18.2%) and Gambella (14%) are the three top regions in the prevalence of wasting.

Table 2 Weighted distribution of undernutrition (stunting, underweight and wasting) in Ethiopia disaggregated by key socio-demographic characteristics of 2016 DHS

No	Variable	Stunting no.(%)	underweight no.(%)	Wasting no.(%)
1	**Wealth Index**			
	Poorest	921 (45.09)	653 (30.95)	290 (13.96)
	poorer	895 (43.06)	579 (27.37)	205 (9.79)
	Middle	703 (37.73)	437 (23.22)	195 (10.39)
	Richer	559 (34.72)	282 (17.23)	112 (7.00)
	Richest	322 (25.54)	192 (14.93)	98 (7.74)
2	**Region**			
	Tigray	233 (38.85)	138 (22.61)	69 (11.39)
	Afar	34 (40.66)	31 (36.20)	16 (18.21)
	Amhara	819 (47.17)	511 (29.10)	173 (9.98)
	Oromia	1,407 (36.25)	892 (22.50)	415 (10.60)
	Somali	99 (26.95)	106 (28.00)	87 (23.13)
	Beninshangul	40 (42.83)	33 (34.47)	10 (10.81)
	SNNPR	715 (39.12)	406 (21.67)	114 (6.23)
	Gambella	5 (23.33)	4 (18.28)	3 (13.96)
	Harari	6 (31.85)	4 (20.14)	2 (10.95)
	Addis Ababa	29 (14.68)	10 (5.17)	7 (3.06)
	Dire Dawa	14 (41.22)	10 (27.65)	3 (10.42)
3	**Place of residence**			
	Urban	253 (26.15)	138 (14.05)	90 (9.28)
	Rural	3,146 (39.89)	2,006 (24.91)	810 (10.19)
4	**Educational Level**			
	No Education	2,420 (41.63)	1,627 (27.44)	637 (10.86)
	Primary	854 (35.34)	447 (18.09)	217 (8.94)
	Secondary	91 (21.40)	49 (11.31)	31 (7.35)
	Higher	35 (17.42)	21 (10.47)	15 (7.45)
6	**working status**			
	Not Working		1,595 (24.17)	642 (9.86)
	working		549 (22.55)	258 (10.72)

7	**Sex of the child**			
	Male	1,863 (41.23)	1,173 (25.32)	473 (10.33)
	Female	1,536 (35.43)	970 (22.06)	428 (9.85)
8	**Child Age in month**			
	Less than 6 month	162 (16.110	131 (12.44)	149 (15.18)
	6-11	163 (17.19)	149 (15.46)	130 (13.66)
	12-23	722 (41.01)	426 (23.81)	226 (12.73)
	24-35	804 (48.42)	445 (26.33)	156 (9.32)
	36.-47	796 (47.00)	452 (26.28)	117 (6.80)
	48-59	753 (42.06)	540 (29.74)	122 (6.72)
9	**Maternal age**			
	15-19 years	115 (38.91)	72 (23.28)	36 (12.31)
	20-29	2,410 (37.64)	1,525 (23.40)	622 (9.65)
	30-39	816 (39.96)	518 (24.77)	237 (11.49)
	40-49	58 (51.33)	29 (25.27)	5 (4.28)

5.2. Inequality in children undernutrition

This study has utilized both the concentration curve and concentration index to assess the socioeconomic inequality in undernutrition for the three indicators separately and decomposition analyses to further see the factors which contributed for the inequality. All the three concentration graphs showed that there is inequality as the concentration curve lies above the line of equality. This indicates that undernutrition is more concentrated among the poor than the better off (Fig .2,3 and 4).

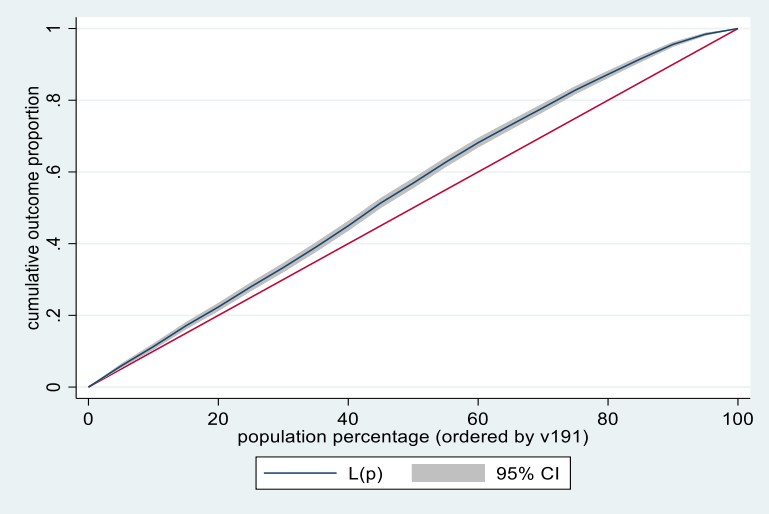

Figure 2Concentration curve for level of wealth index based inequality in Stunting in Ethiopia, DHS 2016

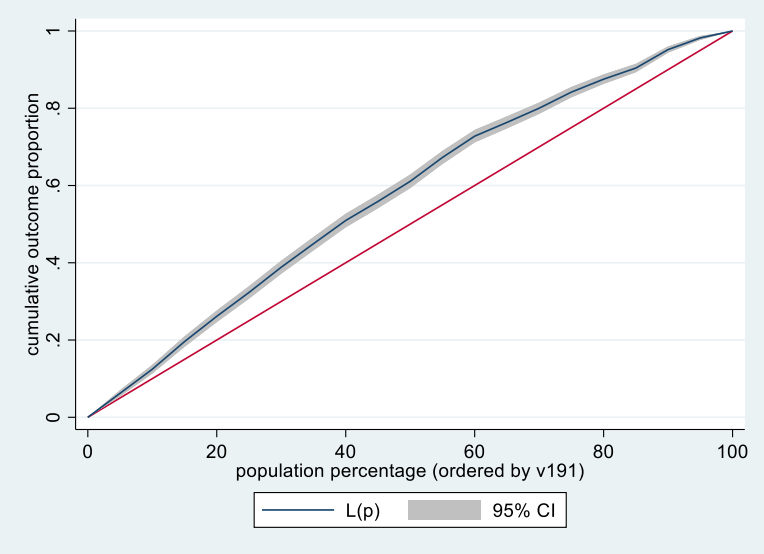

Figure 3Concentration curve for level of wealth index based inequality in underweight in Ethiopia, DHS 2016

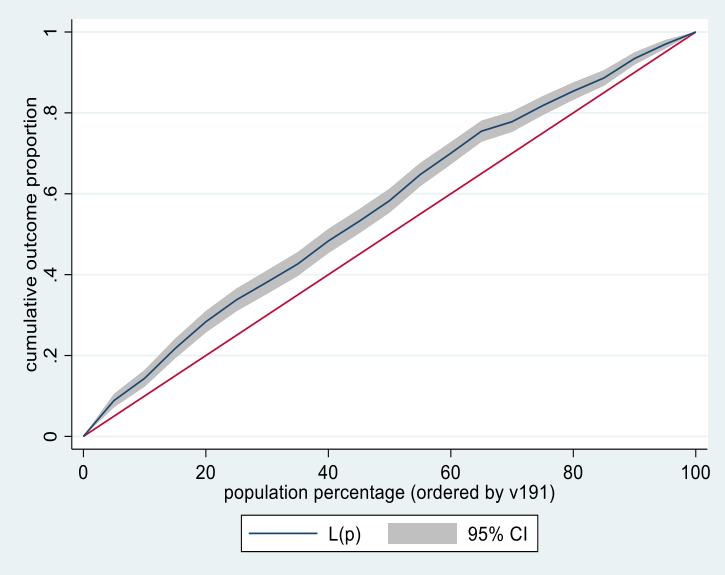

Figure 4Concentration curve for level of wealth index based inequality in wasting in Ethiopia, DHS 2016

As all the three indicators are binary, the study used Erreygers norm.CI and the result described for each indicator below (Table 6). Like the concentration curve, the concentration index also showed that children from poor households were more likely to be stunted, underweight or wasted when compared to the children from the better-off household

Table 3Result of concentration Index for wealth status and undernutrition in Ethiopia EDHA 2016

Index	No of observations	Index value	St. Error	P-Value
Erreygers Norm. CI for Stunting	8855	-0.147	0.0118	<0.001
Erreygers Norm. CI for underweight	9033	-0.143	0.010	<0.001
Erreygers Norm. CI for Wasting	8919	-0.054	0.007	<0.001

The Inequality varies by different socio-demographic characteristics, Regarding Inequality in stunting is higher in Dire Dawa and Lower in Afar among regions, Urban Residence is higher in inequality in all forms of under nutrition when compared to Rural residence. Being currently working also holds higher inequality in all forms of under nutrition.

Regarding Inequality in Underweight, It's higher in Dire Dawa and lower in Addis Ababa. Currently working and urban residence also holds higher Inequality when compared to their counterparts.

Addis Ababa had higher Inequality in Wasting and Gambella is the lowest from other regions. Urban residence when compared to the rural and currently not working compared to currently working had higher Inequality in Wasting.

Table 4 concentration Index by different sociodemographic characteristics of respondents in Ethiopia EDHA 2016

No	Variable	CI in Stunting (SE)	CI in underweight (SE)	CI in Wasting (SE)
1	**Region**			
	Tigray (Ref)	-0.076 (0.036)	-0.123 (0.031)	-0.053 (0.023)
	Afar	-0.050 (0.039)	-0.117 (0.037)	-0.05689(0.030)
	Amhara	-0.150 (0.038)	-0.130(0.034)	-0.021 (0..023)
	Oromia	-0.164 (0.029)	-0.130 (0.025)	-0.013 (0.019)
	Somali	-0.114 (0.030)	-0.125 (0.029)	-0.053 (0.028)
	Beninshangul	-0.168 (0.041)	-0.206 (0.039)	-0.026 (0.026)
	SNNPR	-0.138 (0.033)	-0.121 (0.028)	-0.056 (0.016)
	Gambella	-0.100 (0.041)	-0.083 (0.037)	-0.007(0.033)
	Harari	-0.182 (0.049)	-0.204 (0.041)	-0.093 (0.033)
	Addis Ababa	-0.135 (0.040)	-0.069 (0.025)	-0.112 (0.021)
	Dire Dawa	-0.340 (0.053)	-0.300 (0.047)	-0.045 (0.034)
3	**Place of residence**			
	Urban	-0.317 (0.024)	-0.163 (0.019)	-0.08 (0.016)
	Rural	-0.096 (0.013)	-0.125 (0.041)	-0.05 (0.008)
4	**Educational Level**			
	No Education	-0.087 (0.015)	-0.105 (0.013)	-0.052 (0.009)
	Primary	-0.142 (0.022)	-0.107 (0.018)	-0.049 (0.013)
	Secondary	-0.144 (0.037)	-0.116 (0.029)	0.026 (0.024)
	Higher	-0.0410.049)	-0.009 (0.039)	-0.113 (0.033)
6	**working status**			
	Not Working	-0.124 (0.014)	-0.142 (0.012)	-0.058 (0.008)
	Working	-0.221 (0.023)	-0.145 (0.019)	-0.051 (0.014)
7	**Sex of the child**			
	Male	-0.137 (0.016)	-0.139 (0.015)	-0.056 (0.010
	Female	-0.156 (0.016)	-0.147 (0.014)	-0.050 (0.010)
8	**Child Age in month**			
	Less than 6 month	0.002 (0.028)	-0.012 (0.023)	-0.041 (0.027)

	6-11	-0.119 (0.028)	-0.122 (0.026)	-0.066 (0.025)
	12-23	-0.175 (0.027)	-0.166 (0.022)	-0.086 (0.018)
	24-35	-0.092 (0.028)	-0.157 (0.024)	-0.025 (0.016)
	36.-47	-0.203 (0.028)	-0.186(0.024)	-0.044 (0.014)
	48-59	-0.173 (0.027)	-0.143 (0.025)	-0.062 (0.013)
9	**Maternal age**			
	15-19 years	-0.080 (0.063)	-0.170 (0.053)	-0.097 (0.042)
	20-29	-0.157 (0.013)	-0.153 (0.011)	-0.065 (0.008)
	30-39	-0.123 (0.025)	-0.106 (0.021)	-0.010 (0.016)
	40-49	-0.105 (0.123)	-0.183 (0.105)	-0.047 (0.049)

6. Discussion

This study was conducted to examine the socio-economic inequality in undernutrition and its contributing factors in Ethiopia by using EDHS 2016. First of all, all the three indicators of undernutrition, stunting, underweight and wasting were assessed by using descriptive statistics and then used concentration curve and concentration index to examine the inequality.

Based upon the finding, undernutrition is decreasing when compared to the previous two EDHS results, EDHS 2005 and EDHS 2011, but still needs focus as there are a number of children are still living with stunting, weighting and/or wasting. The prevalence of Stunting was reduced from 51 in 2005 to 38 now (2016). Similarly, underweight and stunting were reduced from 33 and 12 (in 2005) to 24 and 10 respectively (53).

There is variation of prevalence among region, residence, maternal education and working status. All the three indicators were having high prevalence among the poorest group of wealth index. Which is almost similar with other studies conducted in Zimbabwe (54), Nigeria (45), India (32), Iran (55), and in Bangladesh (40).

Regarding residence also, rural residence had higher rate of stunting, underweight and wasting.

Regarding region variation, Amhara (47.2), Benishangul (42.8%) and Dire Dawa (41.2%) were the three higher rate of stunting among regions and Addis Ababa (14.7%) is the lower. Underweight were scored higher in Afar (36.2%), Beninshangul (34.5%) and Amhara (29.10%). Somali (23.1%) is leading in the prevalence of wasting followed by Afar (18.2%) and Gambella (13.9%). Addis Ababa scored the least in all the three indicators of undernutrition, stunting (14.7%), underweight (5.2%) and wasting (3.1%).

The concentration curve and concentration index showed that all the three indicators were more concentrated among the lowest socioeconomic group. This finding is almost similar with a study conducted in Zimbabwe (54), Nigeria (45), India (32), Iran (55), and in Bangladesh (40).

The socioeconomic inequality shows difference between regions. The inequality in Stunting and underweight showed higher in DireDawa and lower in Afar and Addis Ababa in Stunting and Underweight respectively. Regarding the inequality in Wasting, it is higher in Addis Ababa and lower in Gambella.

Regarding residence, all inequality in all forms of undernutrition is higher in urban residence when compared to their rural counterparts.

Occupational status is the other showed difference in inequality of undernutrition. Being currently working holds higher inequality in Stunting and wasting. Whereas, mother's currently not working is higher in inequality in Wasting.

6.1. Strength and limitation

The strength of this study is Using EDHS data which have standardized data collection procedures with good response rate and nationally representative. The study used recommended Inequality analyses.

7. Conclusion and recommendation

This study has showed that there is a socioeconomic inequality in all forms of undernutrition. This inequality differs from region to region and urban to rural residence. So, the FDRE has to give more emphases to reduce this inequality and attention has to be given for those regions with higher rate of socioeconomic inequality.

8. References

1. Black RE, Allen LH, Bhutta ZA, et al. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet. 2008;371(9608):243-260. https://doi.org/10.1016/S0140-6736(07)61690-0
2. 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. Lancet 2008;371(9609):340-357.
3. UNICEF (2019). *The State of the World's Children 2019.Children, Food and Nutrition: Growing well in a changing world*. UNICEF, New York.
4. R. E. Black, L. H. Allen, Z. A. Bhutta et al., "Maternal and child undernutrition: global and regional exposures and health consequences," The Lancet, vol. 371, no. 9608, pp. 243–260, 2008
5. United Nations Children's Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. *Levels and trends in child malnutrition: key findings of the 2021 edition of the joint child malnutrition estimates.* Geneva: World Health Organization; 2021.
6. Ethiopian Public Health Institute (EPHI) [Ethiopia] and ICF. 2019. *Ethiopia Mini Demographic and Health Survey 2019: Key Indicators*. Rockville, Maryland, USA: EPHI and ICF
7. FAO, IFAD, UNICEF, WFP and WHO (2019). *The State of Food Security and Nutrition in the World 2019*
8. Seqota Declaration. Federal Democratic Republic of Ethiopia (FDRE). Seqota declaration implementation plan (2016–2030): Summary program approach document. Addis Ababa: FDRE; 2016
9. Federal MOH. Health sector transformation plan 2015/16-2019/20. Addis Ababa 2015
10. GOVERNMENT OF ETHIOPIA. NATIONAL NUTRITION PROGRAM 2016-2020. Addis Ababa
11. WHO. Malnutrition. WHO Fact Sheets. http://www.who.int/news-room/fact-sheets/detail/malnutrition. Published 2018. Accessed June 9, 2018.

12. International Food Policy Research Institute. 2016. Global Nutrition Report 2016. From Promise to Impact: Ending Malnutritionby 2030. Washington, DC.; 2016. https://doi.org/10.2499/978089629584.
13. UNICEF. Progress for children: a report card on nutrition: UNICEF; 2006.
14. EPHI and MOH, the cost of hunger in Ethiopia: Implications for the growth and transformation of Ethiopia. 2012
15. Tekile *et al.* Prevalence of malnutrition and associated factors among under-five children in Ethiopia: evidence from the 2016 Ethiopia Demographic and Health Survey *BMC Res Notes (2019) 12:391* https://doi.org/10.1186/s13104-019-4444-4
16. Berhanu Teshome Woldeamanuel and Tigist Tigabie Tesfaye. Risk Factors Associated with Under-Five Stunting, Wasting, and Underweight Based on Ethiopian Demographic Health Survey Datasets in Tigray Region, Ethiopia. Journal of Nutrition and Metabolism. 2019
17. Dawit kebede and yidnekachew merkeb. Prevalence of Malnutrition and Associated Risk Factors Among Children Under Five Years of age in Amhara Region, Ethiopia: Evidence from 2016 Ethiopian Demographic and Health Survey. Research square. 2018. DOI: https://doi.org/10.21203/rs.3.rs-54072/v1
18. Griggs D, Stafford-Smith M, Gaffney O, Rockström J, Öhman MC, Shyamsundar P, Steffen W, Glaser G, Kanie N, Noble I. Policy: sustainable development goals for people and planet. Nature. 2013;495(7441):305.
19. O'Donnell O, Van Doorslaer E, Wagstaff A, Lindelow M. Analyzing health equity using household survey data: a guide to techniques and their implementation. Washington: The World Bank; 2007
20. World Health Organization (WHO). Malnutrition [Internet] 2019. Available from: https://www.who.int/newsroom/fact-sheets/detail/malnutrition
21. UNICEF, Progress for children, in UNICEF. 2016.
22. WHO. WHO child growth standards: length/height-for-age,weight-for-age, weight-for-length, weight-for-height and body mass indexfor- age: methods and development; 2006.
23. Catalano, P. M. and Kartik, S. (2017). 'Obesity and pregnancy: mechanisms of short-term and long-term adverse consequences for mother and child', *BMJ,* 356, j

24. Stevens, G. A., Finucane, M. M., De-Regil, L. M., Paciorek, C. J., Flaxman, S. R., Branca, F. et al. (2013). 'Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data', *The Lancet Global Health*, 1(1), e16–25.

25. De-Regil, L. M., Pena-Rosas, J. P., Fernandez- Gaxiola, A. C. and Rayco-Solon, P. (2015). 'Effects and safety of periconceptional oral folate supplementation for preventing birth defects', *Cochrane Database of Systematic Reviews*, 12, CD007950.

26. Mackillop, L. (2015). 'Pre-eclampsia: reducing the risk with calcium supplements', *BMJ Clinical Evidence*, 1402

27. McCauley, M. E., Broek, N., Dou, L. and Othman, M. (2015). 'Vitamin A supplementation during pregnancy for maternal and newborn outcomes', *Cochrane Database of Systematic Reviews*, 10, CD008666.

28. Prado, E. L. and Dewey, K. G. (2014). 'Nutrition and brain development in early life', *Nutrition Reviews*, 72(4), pp. 267–284

29. White, J. M., Bégin, F., Kumapley, R., Murray, C. and Krasevec, J. (2017). 'Complementary feeding practices: Current global and regional estimates',*Maternal & Child Nutrition*, 13 (Supplement 2),e12505

30. Nutrition and South Africa's Children [Internet]. nd. Available from: http:// .www.soulcity.org.za/projects/soulbuddyz/ soul-buddyz-series-3/literaturereview/ nutrition-literature-review

31. Rosa W, editor. Transforming our world: the 2030 agenda for sustainable development. In: A new era in global health [Internet]. New York, NY: Springer Publishing Company; 2017. http://connect.springerpub.com/ lookup/doi/10.1891/9780826190123.ap02.

32. Kumar S, Kumar N, Vivekadhish S. Millennium development goals (MDGs) to sustainable development goals (SDGs): addressing unfinished agenda and strengthening sustainable development and partnership. Indian J Community Med Off Publ Indian Assoc Prev Soc Med. 2016;41(1):1.

33. de Onis M, Dewey KG, Borghi E, Onyango AW, Blössner M, Daelmans B,et al. The World Health Organization's global target for reducing childhood stunting by 2025: rationale and proposed actions. Matern Child Nutr. 2013; 9(Suppl 2):6–26.

34. FDRE Food and Nutrtion Policy. Federal Democratic Republic of Ethiopia, Food and Nutrtion Policy , Addis Ababa, Ethiopia. 2018.

35. Demographic N. Health Survey. 2013. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International. National Population Commission (NPC)[Nigeria] and ICF International. 2014:127-54.

36. World health Organization. Reaching every newborn national 2020 milestones: country progress, plans and moving forward. 2017.

37. Barros Fernando C, Cesar G Victora, Robert Scherpbier, and Davidson Gwatkin. 2010. Socioeconomic inequities in the health and nutrition of children in low/middle income countries. Rev Saúde Pública 2010;44(1):1-16

38. Quentin, W., O. Abosede, J. Aka, P. Akweongo, K. Dinard, A. Ezeh and L. Sundmacher. 2014. Inequalities in child mortality in ten major African cities. BMC Medicine, 12: 95.

39. McKinnon, B., S. Harper, J.S. Kaufman and Y. Bergevin. 2014. Socioeconomic inequality in neonatal mortality in countries of low and middle income: a multi-country analysis. The Lancet Global Health, 2(3): e165 - e173.

40. Mohammad Monirul Hasan, Jalal Uddin, Mohammad Habibullah Pulok, Nabila Zaman and Mohammad Hajizadeh. Socioeconomic Inequalities in Child Malnutrition in Bangladesh: Do They Di_er by Region? Int. J. Environ. Res. Public Health 2020, 17, 1079; doi:10.3390/ijerph17031079

41. Sarker AR, Sultana M, Sheikh N, et al. Inequality of childhood undernutrition in Bangladesh: A decomposition approach. *Int J Health Plann Mgmt*. 2019;1–28. https://doi.org/10.1002/hpm.2918

42. Abhishek Kumar, Divya Kumari1 and Aditya Singh. INEQUALITY IN CHILDHOOD UNDERNUTRITION IN URBAN INDIA Health Policy and Planning 2015; 30:1003–1016 doi:10.1093/heapol/czu104 october 2014

43. Ekholuenetale et al. Socioeconomic inequalities in hidden hunger, undernutrition, and overweight among under-five children in 35 sub-Saharan Africa countriesJournal of the Egyptian Public Health Association (2020) 95:9 https://doi.org/10.1186/s42506-019-0034-5

44. Rathavuth Hong. Effect of economic inequality on chronic childhood undernutrition in Ghana Public Health Nutrition: 10(4), 371–378 2006 DOI: .1017/S1368980007226035

45. Akombi BJ, Agho KE, Renzaho AM, Hall JJ, Merom DR (2019) Trends in socioeconomic inequalities in child undernutrition: Evidence from Nigeria Demographic and Health Survey (2003 –2013). PLoS ONE 14(2): e0211883. https://doi.org/10.1371/journal.pone.0211883

46. Haile Mekonnen Fenta , Lijalem Melie Tesfaw , and Muluwerk Ayele Derebe Trends and Determinants of Underweight among Under-Five Children in Ethiopia: Data from EDHS. Hindawi International Journal of Pediatrics Volume 2020, Article ID 3291654, 9 pages https://doi.org/10.1155/2020/3291654

47. Mohammed *et al.* Socioeconomic inequality in stunting among under-5 children in Ethiopia: a decomposition analysis *BMC Res Notes (2019) 12:184* https://doi.org/10.1186/s13104-019-4229-9

48. Central Statistical Agency (CSA) [Ethiopia] and ICF. 2016. *Ethiopia Demographic and Health Survey 2016*. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.

49. Central sttistics agency. Population projection for Ethiopia 2007-2037. Addis ababa 2013

50. Federal MOH. Health sector transformation plan 2015/16-2019/20. Addis Ababa 2015

51. Jenkins S. Calculating Indices. *Natl Tax J*. 1988;41(1)

52. 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(1):207-223. https://doi.org/10.1016/S0304-4076(02)00161-

53. Central Statistical Agency [Ethiopia] and ORC Macro. 2006. *Ethiopia Demographic and Health Survey 2005.*Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistical Agency and ORC Macro.

54. Lukwa et al. 1199Socioeconomic inequalities in food insecurity and malnutrition among underfive children: within and between-group inequalities in Zimbabwe. BMC Public Health (2020) 20:

55. Abdollah Almasian Kia**1 et. Al.** Socioeconomic Inequality in Malnutrition in Under-5 Children in Iran: Evidence From the Multiple Indicator Demographic and Health Survey, 2010. J Prev Med Public Health 2017;50:201-209

Annex I

Feb 18, 2021

Nebiyu Maseresha
Addis Ababa University
Ethiopia
Phone: +2519 11796966
Email: nmaseresha@gmail.com
Request Date: 02/18/2021

Dear Nebiyu Maseresha:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: "Trends and socioeconomic inequalities in childhood undernutrition: Analysis of Ethiopian demographic health survey (2010– 2021)":

Ethiopia

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

Bridgette Wellington
Data Archivist
The Demographic and Health Surveys (DHS) Program