Determinants of wasting among under-five children in Ethiopia: Multilevel ordinal logistic regression analysis of EDHS 2016

Menaseb Gebrehaweria Gebremeskel¹, Lire Lemma Tirore², Habtamu Tamrat Derilo³

¹Department of Public Health, College of Medicine and Health Sciences, Adigrat University, Tigray, Departments of ²Public Health and ³Orthopedic Surgery, College of Medicine and Health Sciences, Wachemo University, Hossana, Ethiopia

ABSTRACT

Background: In Ethiopia, wasting is still a serious public health problem in under-5 children regardless of the efforts done within the country. Although studies have been conducted in Ethiopia, multilevel analysis has rarely been used to identify the factors associated with wasting among children. Therefore, this study aimed to identify the factors of wasting among under-5 children in Ethiopia using multilevel ordinal logistic regression analysis. Methods: The data were obtained from the 2016 Ethiopia Demographic and Health Survey, conducted from January to June 2016. A sample of 8,919 children under-5 years was included. Data were analyzed using STATA version 14. A multilevel logistic regression model was fitted and an adjusted odds ratio (AOR) with a 95% confidence interval (CI) was obtained. Results: The prevalence of wasting among children under-5 years was 10.1% (901), of which 8.1% (632) had moderate wasting and 3.0% (269) had severe wasting. Children aged 36–47 months (AOR = 0.5; 95% CI: 0.4, 0.63), 48–59 (AOR = 0.5; 95% CI: 0.4–0.63), girls (AOR = 0.75; 95% CI: 0.65, 0.87), smaller-than-average birth weight (AOR = 1.94; 95% CI: 1.44, 2.61), very small birth weight (AOR = 1.75; 95% CI: 1.34, 2.30) were the individual-level factors associated with wasting, whereas husband’s educational status (AOR = 0.37; 95% CI: 0.29, 0.69) was the household-level factor. Somalia (AOR = 1.72; 95% CI: 1.08, 2.74), Sothern Nations Nationalities and People (SNNP) (AOR = 0.39; 95% CI: 0.24, 0.64), and Addis Ababa (AOR = 0.43; 95% CI: 0.21, 0.88) regions were the community-level factors associated with child wasting. Conclusion: This study shows that wasting among children under-5 years is affected by individual, household, and community-level factors. Interventions should be strengthened to give attention to the child’s early age, male sex, low birth weight, and husband’s educational status. In addition, interventions should target the regions identified to have a high risk of wasting.

Keywords: Children under-5 years, multilevel analysis, wasting

Introduction

Undernutrition in children can manifest itself in a variety of ways, one of which is wasting. It describes a rapid decline in the nutritional status over a short period resulting in rapid weight loss or failure to acquire weight.¹²

Wasting can be measured using the Weight-for-Height (WFH) nutritional index or mid-upper arm circumference (MUAC). Children are classified as wasted if the Z-scores are less than −2 standard deviations of the WHO child growth standards median international reference.¹³

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

Access this article online

Quick Response Code: Website: wwwjfmpccom

DOI: 10.4103/jfmpc.jfmpc_1993_21

How to cite this article: Gebremeskel MG, Tirore LL, Derilo HT. Determinants of wasting among under-five children in Ethiopia: Multilevel ordinal logistic regression analysis of EDHS 2016. J Family Med Prim Care 2022;11:3777-83.
The current global burden of malnutrition is unacceptably high, but Africa and Asia endure the lion's share of all forms of malnutrition. In 2017, 50.5 million (7.5%) children under the age of 5 were wasted globally, with 2.4% seriously wasted, compared to 7.9% in 2012, indicating minimal progress toward the 5% objective for 2025.[9] Asia accounted for 9.7% of all wasted children under the age of 5, with 3.4% severely wasted, and Africa accounted for 7.1% of all wasted children under the age of 5, with 2.1% severely wasted.[9]

Despite the country's efforts, wasting remains a severe public health problem for children under the age of 5 in Ethiopia. In Ethiopian children under the age of 5, the prevalence of wasting was reported to be 11, 11, 10, and 10% in 2000, 2005, 2011, and 2016, respectively, with 1, 2, and 3% severely wasted. This pattern shows that the prevalence of wasting has been relatively stable over the last 15 years, with only minor progress toward the <5% goal for 2025.[10]

Wasting is one of the most serious dangers to human and economic development, even though it may be prevented and treated. Children with wasting have a compromised immune system, and are more likely to experience long-term developmental deficits and more likely to die, especially if the wasting is severe.[10] Undernutrition is responsible for about 28% of all child deaths in Ethiopia. As a result of undernutrition-related child mortality, Ethiopia's workforce has shrunk by 8%.[11]

Understanding the determinants of wasting alarms the primary care physicians to screen the high-risk children while caring in the primary care centers. It also helps the physicians to plan for resources and pay special attention to high-risk group children on admission, and may eventually add an input in the struggle to reduce under 5 deaths and achieve national targets. It also helps them to teach the family of the children prevention methods. For policymakers, it helps to implement appropriate intervention programs.

Although many studies have been done in Ethiopia on the factors associated with wasting among under-5 children, only some use the nationally representative data.[12-14] Furthermore, the effect of wasting differs depending on the severity levels (normal, moderately wasted, and severely wasted), since it is an ordinal variable. The advantage of employing ordinal logistic regression over binary logistic regression is that it reduces bias in parameter estimation and increases precision and power.[15]

Thus, this study aimed to identify the factors of wasting in under-5 children in Ethiopia using multilevel ordinal logistic regression analysis.

### Methods and Materials

The data for this study were collected from Ethiopia's nine regions and two administrative cities in the 2016 Ethiopia Demographic Health Survey (EDHS). The 2016 EDHS is the fourth and most recent national representative survey conducted by the Central Statistical Agency (CSA) in collaboration with the Ministry of Health through the DHS Program with the main goal of providing timely and reliable data on health and demographic outcomes with technical assistance provided by the Inner City Fund (ICF).[9]

A population-based cross-sectional survey was used to collect the 2016 EDHS data. The study populations were children under-5 years who were living in selected enumeration areas.

All children (0–59 months) who had data on height and weight measurements were included in this study. From the total of 10,641 children under-5 years, data on wasting were available for 8,919 children. The 2016 EDHS collected data on the nutritional status of children by measuring the weight and height of children. The permission to access the data was obtained from ICF International by registering and stating the objective of the study. The dataset had no individual names or household addresses. The data were used for the registered research topic only and were not shared. The details on the sampling technique, sample size, data collection tools, data quality control, and ethical concerns are available in the 2016 EDHS report.[9]

### Study variables

#### Dependent variable

Wasting is an outcome variable. It is an ordered categorical variable categorized as not wasted, moderately wasted, and severely wasted based on WFH. The weight was measured with an electronic mother-infant scale designed for mobile use. The height was measured with a measuring board. Children younger than 24 months were measured lying down on the board (recumbent length) while standing height was measured for the older children.

WFH describes the current nutritional status. The height and weight measurements were recorded for children aged 0–59 months. A child who is below -2 standard deviation (SD) from the reference median for weight-for-height is considered moderately wasted and a child who is below -3 SD from the reference median for weight-for-height is severely wasted.[9]

#### Independent variables

After reviewing the recent literature, potential factors supposed to be associated with wasting were extracted from the dataset. These included sex, age, birth weight, religion, number of children under-5, birth order, birth interval, symptoms of acute respiratory infection (ARI), maternal anemia, child fever, diarrhea, marital status, mother's education, husband's education, mother's occupation, wealth index, toilet facility, drinking water source, mass media exposure, place of residence, region, community (cluster) women education, community women unemployment, and community mass media exposure. Variables like community women education,
community poverty, community women unemployment, and community mass media exposure were generated by aggregating the individual characteristics within the cluster. The generated variables were further categorized as low or high based on the national median values of the generated variables. These variables are measured as follows:

**Methods of data analysis**

A multilevel ordinal logistic regression (OLR) model was fitted because of the ordered nature of the outcome variable (not wasted, moderately wasted, and severely wasted). STATA software version 14 was used for the analysis of the data. In a multivariable analysis, a $P$ value <0.05 was used to identify the variables significantly associated with wasting. The AORs with 95% confidence intervals (CI) were estimated and interpreted. The variance partition coefficients (VPC) were used to quantify the proportion of variation in wasting between households and communities. At each level of the model hierarchy, the VPC calculates the percentage of the outcome variable (wasting) variation that is not explained by the predictor variables. Furthermore, it assesses the relative relevance of clusters, families, and individuals (children) as sources of wasting status variance.

The mixed-effects OLR (proportional odds) mode was fitted and it can be written in terms of the cumulative logits as:

$$\log \left( \frac{p_{ijkc}}{1-p_{ijkc}} \right) = \beta_c + X_{ij} \beta + U_{ij} + \epsilon_{ijkc}$$

where $p_{ijkc}$ is a cumulative probability of being in “$c$” category of wasting for $k^{th}$ individual in $j^{th}$ household and $i^{th}$ cluster.

$\gamma$ is a model threshold or intercept for $C-1$ level of wasting and it is a fixed parameter. It represents the cumulative logits of being at or below the $C-1$ level of wasting when the covariates and random effects equal zero. It is strictly increasing (i.e., $\gamma_1 < \gamma_2 < \cdots < \gamma_C - 1$).

$C = \text{number of categories of wasting which is equal to 3.}$

$\beta$ is a coefficient (fixed effect of explanatory variable).

$X_{ij}$ is a covariate vector for $k^{th}$ individual in $j^{th}$ household and $i^{th}$ cluster.

$U_{ij}$ is a level-2 (household) random effect and it is assumed to be normally distributed with variance $\sigma^2_{(v2)}$.

$\epsilon_{ijkc}$ is a level-3 (cluster) random effect and it is assumed to be normally distributed with variance $\sigma^2_{(v3)}$.

**Random effects**

VPC were used to quantify the proportion of the variation in wasting odds between households and communities. At each level of the model hierarchy, the VPC calculate the percentage of the outcome variable (wasting) variation that is not explained by the predictor variables. Furthermore, they assess the relative relevance of clusters, families, and individuals (children) as sources of wasting status variance.

Both household and cluster random effect variances were expressed in terms of VPC.

$VPC_{(3)}$ is a proportion of the total variation on wasting attributable to cluster random effect.

It is given as:

$$VPC_{(3)} = \frac{\sigma^2_{(v3)}}{\sigma^2_{(v2)} + \sigma^2_{(v3)}}$$

$\sigma^2_{(v3)}$ is a proportion of the total variation on wasting attributable to cluster random effect.

$\sigma^2_{(v2)}$ is a household (level-2) random effect variance.

$\sigma^2_{(v3)}$ is a cluster (level-3) random effect variance.

VPC for levels-2 and -3 clustering effects (VPC_{(2 + 3)}) is a proportion of the total variation on wasting attributable to both household- and cluster-level random effects. It is given as:

$$VPC_{(2 + 3)} = \frac{\sigma^2_{(v2)} + \sigma^2_{(v3)}}{\sigma^2_{(v2)} + \sigma^2_{(v3)} + \sigma^2_{(v1)}}$$

VPC for levels 1 to 3 clustering effects (VPC_{(1 + 2 + 3)}) is a proportion of the total variation on wasting attributable to the household-level random effect.

VPC_{(1 + 2 + 3)} = \frac{\sigma^2_{(v1)} + \sigma^2_{(v2)} + \sigma^2_{(v3)}}{\sigma^2_{(v1)} + \sigma^2_{(v2)} + \sigma^2_{(v3)} + \sigma^2_{(v0)}}$$

Multicollinearity was checked by using a variation inflation factor (VIF) with a cut-off point of 10. Accordingly, there was no statistically significant multicollinearity among the predictors in the final model. An Akaike information criterion (AIC) was used to select the final model which best-fitted the data compared to other fitted models. The AIC of all models were compared and the model with the lowest AIC was considered as the best model that fits the data.

**Results**

**Individual-level characteristics of study subjects**

The prevalence of wasting among children under-5 was 10.1% (901), of which 8.1% (632) had moderate wasting and 3.0% (269) had severe wasting. The mean ± SD age of the children was 28 ± 17 months. More than half (51.3%) of the children were males. Regarding birth weight, 42.12% (3,756) of children had an average birth weight and 15.73% (1,403) children was 28 ± 17 months. More than half (51.3%) of the children had an average birth weight and 15.73% (1,403) of children had an average birth weight and 15.73% (1,403) had a very small birth weight. About twelve and 14.77% of children had an average birth weight and 15.73% (1,403) had a very small birth weight. About twelve and 14.77% of children had an average birth weight and 15.73% (1,403) had a very small birth weight. About twelve and 14.77% of children had an average birth weight and 15.73% (1,403) had a very small birth weight.
breastfed, 3.54% never breastfed, and 47.21% were currently breastfeeding [Table 1].

**Household-level characteristics**

More than one-fifth (23.27%) of the respondents were living in the poorest households and 23.51% were living in poor households [Table 2]. Nearly two-thirds (65.79%) of the mothers of the children had no education and 27.23% of the mothers had primary education. More than half (55.17%) of the mothers were unemployed in the last 12 months before the survey, and 82.18% had never been exposed to the newspaper, radio, or television. Nearly half of the mothers (49.11%) were in the age group of 20–29 years. More than three-fourths (82.32%) of the households had less than three under-5-year-old children [Table 2].

**Community-level characteristics of study subjects**

About 9–10 (89%) of the respondents were rural residents. The majority of the respondents were from Oromia (43.95%) followed by Southern Nations Nationalities and People (SNNP) (20.57%), and Amhara (19.48%) regions. More than half (51.43%) of the respondents were living in a community with a high proportion of women unemployed. About half (52.0%) of the mothers were living in communities with high poverty status. More than half of the mothers (57.79%) were from communities with a high proportion of educated women [Table 3].

**Multivariable multilevel OLR results**

**Random effects**

About 18% (18.36%) (VPC_{2+3}), 5.40% (VPC_{3}), and 12.90% (VPC_{2}) of the unexplained variation in wasting could be attributable to the unobserved community- and household-level factors together, community-level factors alone, and household-level factors alone, respectively [Table 4].

VPC_{(i)} = Variance partition coefficient for cluster, VPC_{(2 + 3)} = Variance partition coefficient for household and cluster, VPC_{(2)} = Variance partition coefficient for household.

Model 1: Model with no independent variable; Model 5: model adjusted for the individual-, household-, and community-level variables simultaneously.

### Table 1: Individual-level characteristics of children in Ethiopia, 2016 EDHS, 2021

| Variable                                | Frequency (weighted) | Percentage |
|-----------------------------------------|----------------------|------------|
| Child Sex                               |                      |            |
| Male                                    | 4574                 | 51.29      |
| Female                                  | 4345                 | 48.7       |
| Child age                               |                      |            |
| 0-11                                    | 1935                 | 21.7       |
| 12-23                                   | 1779                 | 20         |
| 24-35                                   | 1673                 | 60.4       |
| 36-47                                   | 1714                 | 19.2       |
| 48-59                                   | 1817                 | 20.4       |
| Birth weight                            |                      |            |
| Very large                              | 1567                 | 17.6       |
| Average                                 | 3757                 | 42.1       |
| Larger than average                     | 1237                 | 14         |
| Smaller-than-average                    | 896                  | 10.0       |
| Do not know                             | 58                   | 0.66       |
| Very small                              | 1403                 | 15.7       |
| Diarrhea                                |                      |            |
| No                                      | 7844                 | 87.1       |
| Yes                                     | 1075                 | 12.1       |
| Fever                                   |                      |            |
| No                                      | 2034                 | 85.2       |
| Yes                                     | 1318                 | 14.8       |
| Symptoms of acute respiratory infection |                      |            |
| No                                      | 6986                 | 78.3       |
| Yes                                     | 1933                 | 21.7       |
The reason might be that wasting was 50% (95% CI: 0.40, 0.63), 61% (95% CI: 0.30, 0.49), and 75% (95% CI: 0.24, 0.30) higher odds of having worse wasting, respectively, than very large children. Children whose fathers had secondary education were 0.37 times less likely to be wasted compared to children of fathers with no education.

The odds of having higher levels of wasting were 1.72 times greater for children from the Somali region as compared to the children from the Tigray region. Children living in SNNP and Addis Ababa had 61 and 57% lesser odds of wasting as compared to the children living in the Tigray region [Table 5].

### Discussion

This study aimed to identify the factors associated with wasting among under-5 children by employing multilevel OLR analysis. At the individual level, factors such as child sex, age, and size were significantly associated with wasting. At the household level, the fathers’ educational level was found as a significant factor. At the community level, the region had a significant association with wasting. This study also indicated that there is observed heterogeneity in the odds of wasting between household and community.

The female children were less likely to be at higher levels of wasting than the males. This result is in line with the studies done in Ethiopia, Burkina Faso, South Asia, Bangladesh, and Karamoja (Uganda).[13,18-20] The biological difference between sexes could explain the difference in the odds of wasting. Studies depict that both morbidity and mortality are higher in males than in females in early life. This is due to the specific sex-chromosome factors that boys are more vulnerable to infections and environmental stress than males.[21] An infection can induce immunodeficiency in otherwise healthy children, increasing susceptibility to diarrhea and other infections. This can lead to a vicious cycle of repeated infections, reduced immunity, and deteriorating nutritional status.[22] However, this finding is inconsistent with the finding of Papua New Guinea where the male children had lower odds of wasting than females.[23]

The child's age was negatively associated with wasting. Children aged 24–35, 36–47, and 48–59 months old were less likely to be at the higher levels of wasting compared to children 0–11 months old. These results are in agreement with the studies done in Ethiopia, South Asia, and Ghana.[20,24,25] These are also consistent with the findings in the Karsa district of Ethiopia where children aged 6–17 months had higher odds of wasting compared with those aged 36–59 months.[26] The reason might be that wasting reflects acute undernutrition. So, as the child's age increases, there is a probability that the child will receive adequate complementary foods and vaccinations, which reduce exposure to a disease. For example, Mekonnen et al. found that children vaccinated against measles are less likely to be wasted.[27]

Very small and smaller-than-average children had higher odds of worse wasting than very large children. This finding

### Table 3: Community-level characteristics of children in Ethiopia, 2016 EDHS, 2021

| Region    | Frequency (weighted) | Percentage |
|-----------|----------------------|------------|
| Tigray    | 602                  | 6.75       |
| Afar      | 86                   | 0.96       |
| Amhara    | 1737                 | 19.48      |
| Oromia    | 3,919                | 44.00      |
| SNNP      | 1,835                | 20.57      |
| Benishangul Gumuz | 94 | 1.05 |
| Gambela   | 21                   | 0.23       |
| Somali    | 99                   | 1.08       |
| Harari    | 18                   | 0.21       |
| Addis Ababa | 195              | 2.20       |
| Dire Dawa | 34                   | 0.38       |

| Place of residence | Frequency (weighted) | Percentage |
|-------------------|----------------------|------------|
| Rural             | 7,946                | 89         |
| Urban             | 973                  | 11         |

| Community women education | Frequency (weighted) | Percentage |
|---------------------------|----------------------|------------|
| Low                       | 5,154                | 57.79      |
| High                      | 3,765                | 42.21      |

| Community women unemployment | Frequency (weighted) | Percentage |
|-------------------------------|----------------------|------------|
| Low                           | 4,332                | 48.57      |
| High                          | 4,587                | 51.43      |

| Community poverty | Frequency (weighted) | Percentage |
|-------------------|----------------------|------------|
| Low               | 4,281                | 48         |
| High              | 4,638                | 52         |

| Community media exposure | Frequency (weighted) | Percentage |
|--------------------------|----------------------|------------|
| Low                      | 2,633                | 29.52      |
| High                     | 6,286                | 70.48      |

| Key | | |
|--- | | |
| SNNP: Southern Nations Nationalities and People | | |

| Table 4: Random intercept variances and model fit statistics of three-level mixed effect models |
|---|---|---|
| Random effects | Model 1 | Model 5 |
| $\sigma^2_{(y)}$ | 0.48* | 0.22* |
| $\sigma^2_{(z)}$ | 0.35* | 0.52* |
| $\nu^2$ | 0.35 | 0.52 |
| VPC $\nu^2$ | 20.33 | 18.36 |
| VPC $\sigma^2_{(z)}$ | 11.86 | 5.40 |
| VPC $\sigma^2_{(y)}$ | 8.47 | 12.90 |

$\sigma^2_{(y)}$ and $\sigma^2_{(z)}$ are community and household random intercept variances, respectively; *P<0.001

Hint: Models 2, 3, and 4 are not presented

### Factors associated with wasting

Table 5 presents factors associated with wasting among under-5 children. The same OR was used and interpreted comparing higher versus the lower level of wasting (severe vs. moderate and below, moderate and severe vs. no wasting).

The female children were 25% (95% CI: 0.65, 0.87) less likely to be at higher levels of wasting as compared to the males. Children in the age groups of 24–35, 36–47, and 45–49 months were 50% (95% CI: 0.40, 0.63), 61% (95% CI: 0.30, 0.49), and 50% (95% CI: 0.40, 0.63) less likely to be at higher levels of wasting as compared to children in the age group of 6–11 months.
is similar to a study reported in Tigray. This relationship between low-birth-weight and childhood wasting maybe because low-birth-weight children are at an increased risk of infection. Infections exacerbate wasting by reducing appetite, reducing absorption, inducing catabolism, and increasing excretion due to vomiting and diarrhea.

The region was found to be significantly associated with anemia. This finding is supported by other studies from South Asia. The odds of having higher levels of wasting were greater for children from the Somali region as compared to the children from the Tigray region. Children living in SNNP and Addis Ababa had lesser odds of wasting as compared to the children living in the Tigray region. This might be because Ethiopia suffered from the 2015–2016 El Niño-induced drought, especially in the southern and southeastern parts of the country. This resulted in 2.7 million children and pregnant and lactating mothers requiring supplementary feeding, 9.2 million people needing support to access safe drinking water, 1.9 million households needing livestock support, and 300,000 children between 6 and 59 months targeting for treatment for severe acute malnutrition in 2017.

To our knowledge, this is the first study to apply a three-level (individual, household, and community) analysis. It is the only study to quantify the respective contribution of the individual-, household-, and community-level factors for wasting. The application of OLR for this national study makes this study noble.

**Key points:**

- Wasting is determined by individual-, household-, and community-level factors.
- About 18% (18.36%) (VPC2 + 3) of the unexplained variation in wasting could be attributable to the unobserved community- and household-level factors together.
- The trend of wasting has been relatively stable over the last 15 years.
- Child sex, age, and size; fathers' educational level, and region had a significant association with wasting.

**Limitations**

The limitations of this study include not controlling variables of dietary intake and child feeding practices due to missing values. Other possible child-related explanatory variables such as parasitic infection and chronic illness were not included in the analysis because these variables are not in the EDHS data. The data based on self-reporting are limited by recall and misclassification biases, and only children living at the time of the survey were included. In addition, the community variability in the combined model was 7.03%. This indicates that there are still other variables that are not controlled. These variables could be parasitic infection, immunization history, chronic infections, dietary intake, and child-feeding practices.

**Conclusion**

Wasting among children under-5 is affected by individual-, household-, and community-level factors. Interventions should be strengthened to give attention to the child’s early age, male sex, low birth weight, and husband’s educational status. In addition, interventions should be strengthened in the target regions identified to have a high risk of wasting.

**Acknowledgments**

The authors would like to thank ICF International for allowing accessing the data set.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.
References

1. WHO. Interpretation guide. Nutrition landscape information system (NLIS) Country Profile. 2017. 50 p. Available from: www.who.int/nutrition. [Last accessed on 2021 Sep 10]
2. WHO. Fact Sheets: Malnutrition. Fact Sheets: Malnutrition. 2020. p. 1.
3. de Onis M, Onyango AW, Borghi E, Garza C, Yang H. Comparison of the World Health Organization (WHO) Child Growth Standards and the National Center for Health Statistics/WHO international growth reference: Implications for child health programmes. Public Health Nutr 2006;9:942–7.
4. Unicef, WHO. Joint UNICEF – WHO – The World Bank Child Malnutrition Database : Estimates for 2012 and Launch of Interactive Data Dashboards. New York United Nations Child Fund; Geneva World Heal Organ. 2013. p. 2–4.
5. UNICEF. Levels and trends in child malnutrition: Report 2020. 2020. p. 21–5. Available from: https://www.unicef.org/njasia/79371/file/UN-IGME-child-mortality-report-2020.pdf.
6. Central Statistical Agency. Ethiopia DHS 2000. 2001. p. 1–299. Available from: http://www.dhsprogram.com/pubs/pdf/FR118/FR118.pdf. [Last accessed on 2021 Aug 10]
7. Central Statistical Agency/Ethiopia and ORC Macro. 2006. Ethiopia Demographic and Health Survey 2005. Addis Ababa, Ethiopia: Central Statistical Agency/Ethiopia and ORC Macro.
8. Central Statistical Agency/Ethiopia, MEASURE DHS-ICF Macro. Ethiopia Demographic and Health Survey 2011: Preliminary Report. Edhs. 2011. p. 1-29.
9. Central Statistical Agency/CSA/Ethiopia and ICF. 2016. Ethiopia Demographic and Health Survey 2016. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.
10. Federal Democratic Republic of Ethiopia. National Nutrition Program 2016-2020. Published. 2016;(June 2013):88. Available from: www.unicef.org/ethiopia/National_Nutrition_Programme.pdf. [Last accessed on 2021 Aug 07]
11. Federal Ministry of Health (FMoH) and the Ethiopian Health and Nutrition Research Institute (EHNRI). The Cost of Hunger in Ethiopia: Implications for the Growth and Transformation of Ethiopia, The Social and Economic Impact of Child Undernutrition in Ethiopia Child Undernutrition in Ethiopia Summary Report Summary Report, 2013.
12. Motbainor A, Taye A. Wasting in under five children is significantly varied between rice producing and non-producing households of Libokemkem district, Amhara region, Ethiopia. BMC Pediatr 2019;19:300.
13. Woldeamanuel BT, Tesfaye TT. Risk factors associated with under-five stunting, wasting, and underweight based on ethiopian demographic health survey datasets in tigray region, Ethiopia. J Nutr Metab 2019;1-11. doi: 10.1155/2019/6967170.
14. Fentahun W, Wubshet M, Tariku A. Undernutrition and associated factors among children aged 6-59 months in East Belesa District, northwest Ethiopia: A community based cross-sectional study. BMC Public Health 2016;16:506.
15. Wete AT, Zerfu TA, Anbese AT. Magnitude and associated factors of wasting among under five orphans in Dilla town, southern Ethiopia: 2018: A cross-sectional study. BMC Nutr 2019;5:33.
16. Raman R, Hedeker D. A mixed-effects regression model for three-level ordinal response data. Stat Med 2005;24:3331-45.
17. George Leckie and Rob French (2013). Three-Level Multilevel Models – MLwiN Practical. LEMMA VLE Module 11, 1-50. Available from: http://www.bristol.ac.uk/cmm/learning/course.html. [Last accessed on 2021 Sep 05]
18. Odei Obeng-Amoako GA, Karamagi CAS, Nangendo J, Okiring J, Kiirya Y, Areyeetey R, et al. Factors associated with concurrent wasting and stunting among children 6-59 months in Karamoja, Uganda. Matern Child Nutr 2021;17:e13074.
19. Paré BC, Dahourou DL, Kabore A, Sana A, Kinda R, Ouaro B, et al. Prevalence of wasting and associated factors among 6 to 23 months old children in the sahel region of Burkina Faso. Pan Afr Med J 2019;34:164.
20. Harding KL, Aguayo VM, Webb P. Factors associated with wasting among children under five years old in South Asia: Implications for action. PLoS One 2018;13:0198749.
21. Muenchhoff M, Goulder PJR. Sex differences in pediatric infectious diseases. J Infect Dis 2014;209(Suppl 3):S120-6.
22. World Health Organization. Malnutrition-emergencies and disasters, 2020. [Last accessed on 2021 Jul 20]
23. Pham BN, Silas VD, Okely AD, Pomat W. Measuring wasting and stunting prevalence among children under 5 years of age and associated risk factors in Papua New Guinea: New evidence from the comprehensive health and epidemiological surveillance system. Front Nutr 2021;8:622660.
24. Boah M, Azupogo F, AmporFro DA, Abada LA. The epidemiology of undernutrition and its determinants in children under five years in Ghana. PLoS One 2019;14:1-23.
25. W T, B T, M D. Prevalence of Acute malnutrition (Wasting) and associated factors among preschool children aged 36-60 months at Hawassa Zuria, South Ethiopia: A community based cross-sectional study. J Nutr Food Sci 2016;6:4-7.
26. Roba AA, Assefa N, Dessie Y, Tolera A, Elena H, et al. Prevalence and determinants of concurrent wasting and stunting and other indicators of malnutrition among children 6-59 months old in Kersa, Ethiopia. Matern Child Nutr 2021;17:e13172.
27. Derso T, Tariku A, Biks GA, Wassie MM. Stunting, wasting and associated factors among children aged 6-24 months in Dabat health and demographic surveillance system site: A community based cross-sectional study in Ethiopia. BMC Pediatr 2017;17:96.
28. Sjoukje Philip, Sarah F. Kew, Geert Jan van Oldenborgh, et al. The drought in Ethiopia, 2015. Climate and Development Knowledge Network. 2017.