USAID
FROM THE AMERICAN PEOPLE

DHS WORKING PAPERS

Determinants of Nutritional Status among Children under Age 5 in Ethiopia: Further Analysis of the 2016 Demographic and Health Survey

Zerihun Yohannes Amare
Mossa Endris Ahmed
Adey Belete Meharie

2019 No. 156

DEMOGRAPHIC AND HEALTH SURVEYS

July 2019

This document was produced for review by the United States Agency for International Development.

DHS Working Paper No. 156

Determinants of Nutritional Status among Children under Age 5 in Ethiopia:

Further Analysis of the 2016 Demographic and Health Survey

Zerihun Yohannes Amare[1]
Mossa Endris Ahmed[1]
Adey Belete Meharie[1]

ICF
Rockville, Maryland, USA

July 2019

[1]Institute of Disaster Risk Management and Food Security Studies, Bahir Dar University, Bahir Dar, Ethiopia

Corresponding author: Zerihun Yohannes Amare, Institute of Disaster Risk Management and Food Security Studies, Bahir Dar University, Bahir Dar, Ethiopia; phone: +25 1913450741; email zerihuny@bdu.edu.et/zerihun.yohannes19@gmail.com.

Acknowledgments: Foremost, we would like to thank USAID for funding this research project through the 2019 DHS Fellows program implemented by ICF. We give thanks to our facilitators Dr. Shireen Assaf and Dr. Wenjuan Wang. Their scholarly guidance and encouragement was the source of energy for our research. We would like to express our special thanks to our co-facilitators, Mr. Gedefaw Abeje Fekade (Assistant Professor), and Dr. Kyaw Swa Mya for their invaluable assistance to improve our research during the training. We especially appreciate the support of Dr. Sorrel Namaste for her advice and sharing valuable materials at the inception that supports our inclusion criteria during sampling procedure. We also appreciate Rukundo Benedict and Yodit Bekele for their valuable comments and their time spent in sharing related materials to improve our work.

Editor: Bryant Robey
Document Production: Joan Wardell

This study was carried out with support provided by the United States Agency for International Development (USAID) through the DHS Program (#720-OAA-18C-00083). The views expressed are those of the authors and do not necessarily reflect the views of USAID or the United States Government.

The DHS Program assists countries worldwide in the collection and use of data to monitor and evaluate population, health, and nutrition programs. For additional information about the DHS Program contact: DHS Program, ICF, 530 Gaither Road, Suite 500, Rockville, MD 20850, USA; phone: 301-572-0950; fax: 301-572-0999; fax: 301-407-6501; email: info@dhsprogram.com; internet: www.dhsprogram.com.

Recommended citation:

Amare, Zerihun Yohannes, Mossa Endris Ahmed, and Adey Belete Meharie. 2019 *Determinants of Nutritional Status among Children under Age 5 in Ethiopia: Further Analysis of the 2016 Demographic and Health Survey*. DHS Working Paper No. 156. Rockville, Maryland, USA: ICF.

CONTENTS

TABLES AND FIGURES ..... **v**
ABSTRACT ..... **vii**

1 INTRODUCTION **1**
1.1 Background 1
1.2 Literature Review 1
1.3 Rationale of the Study 2
1.4 Research Question 2
1.5 Conceptual Framework 2

2 DATA AND METHODS **5**
2.1 Data 5
2.2 Variables 5
2.2.1 Dependent variables 5
2.2.2 Independent variables 5
2.3 Statistical Analysis 6

3 RESULTS **7**
3.1 Sample Characteristics 7
3.2 Bivariate Associations of Stunting and Wasting by Background Characteristics 8
3.3 Factors Associated with Stunting 10
3.4 Factors Associated with Wasting 10

4 DISCUSSION **13**

5 STRENGTHS AND LIMITATIONS **17**

6 CONCLUSION AND POLICY LIMITATIONS **17**

TABLES AND FIGURES

Table 1	Percent distribution of sampled children age 0-59 months by child's, mother's, and household characteristics	7
Table 2	Bivariate analysis of stunting and wasting by child's, mother's, and household characteristics	9
Table 3	Prevalence of stunting and wasting among children age 0-59 months by child's, mother's, and household characteristics	11
Figure 1	Conceptual framework to study determinants of nutritional status among children under 5 in Ethiopia	3

ABSTRACT

Background: The aim of this study was to examine the determinants of nutritional status among children under age 5 (0-59 months) in Ethiopia. Child malnutrition is an underlying cause of almost half (45%) of child deaths, particularly in low socioeconomic communities of developing countries. In Ethiopia, the prevalence of stunting decreased from 47% in 2005 to 39% in 2016, but the prevalence of wasting changed little over the same time period (from 11% to 10%). Despite improvements in reducing the prevalence of malnutrition, the current rate of progress is not fast enough to reach the World Health Organization global target for reducing malnutrition 40% by 2025.

Methods: This study used data from the 2016 Ethiopia Demographic and Heath Survey (EDHS). The analysis used stunting and wasting as dependent variables, while the independent variables were characteristics of children, mothers, and households. Logistic regression was used to analyze the determinants of nutritional status among children. Bivariate analysis was also used to analyze the association between the dependent and independent variables.

Results: Study results show that child's age, sex, and perceived birth weight, mother's educational status, BMI, and maternal stature, and region, wealth quintile, type of toilet facility, and type of cooking fuel had significant associations with stunting. Child's age, sex, and perceived birth weight, mother's BMI, and residence and region showed significant associations with wasting.

Conclusions: The study found that child, maternal, and household characteristics were significantly associated with stunting and wasting among children under age 5. These findings imply that a multi-sectorial and multidimensional approach is important to address malnutrition in Ethiopia. The education sector should promote reduction of cultural and gender barriers that contribute to childhood malnutrition. The health sector should encourage positive behaviors toward childcare and infant feeding practices. More should be done to help households adopt improved types of toilet facilities and modern types of cooking fuels.

Key words: Stunting, wasting, children under age 5, Demographic and Health Survey, Ethiopia

1 INTRODUCTION

1.1 Background

Malnutrition during childhood is the outcome of insufficient food intake, diarrhea and other infections, lack of sanitation, and low parental education (Birara et al. 2014, Tibilla 2007). Poor diets and disease are due to food insecurity, inadequate maternal and child care, and poor health services and environment (UNAC 1997). These factors cause measurable adverse effects on body function and clinical outcome (WHO 2009). This problem leads to most of the anthropometric deficits found among under children under age 5 in the world's least developed countries (WHO 1995). Despite existing interventions to address child malnutrition, it is still a major global public health problem (Akombi et al. 2017). Child malnutrition is an underlying cause for almost half (45%) of child deaths, particularly in low socioeconomic communities of developing countries (Black et al. 2013). Globally in 2018, an estimated 149 million children under age 5 were stunted and 49 million children were wasted (UNICEF 2019).

In sub-Saharan Africa, the prevalence of stunting is declining but remains over 30% (UNICEF 2019). In order to address malnutrition, several African countries have updated their national nutrition policies, strategies, and action plans (African Union 2015). Among sub-Saharan countries, the prevalence of wasting in Ethiopia is 10%, and the prevalence of stunting is 38% (CSA 2016). Within Ethiopia, there is a regional variation in stunting and wasting. Amhara, Benishangul-Gumuz, Afar, and Dire Dawa are the most affected by child stunting (41-46%), whereas wasting is highest in Somali (23%), Afar (18%), and Gambella (14%) (CSA 2016). The reason may be hard-to-reach areas of Afar, Somali, Benishangul-Gumuz, and Gambella were characterized by drought-related public health and nutrition problems (UNICEF 2017). The current rate of progress is not fast enough to reach the World Health Organization (WHO) global target of a 40% reduction in the number of stunted children by 2025 (WHO 2014).

Thus to achieve this global target for 2025 in Ethiopia, a situational analysis is required to determine how many children under age 5 are stunted and wasted and to assess key determinants of malnutrition in specific social and geographical locations (WHO 2014). This type of analysis will provide evidence for program intervention so that programmatic actions can be tailored to address the contextual needs in Ethiopia.

1.2 Literature Review

Among the factors that cause child malnutrition in Ethiopia are insufficient availability of food, inadequate provision of a healthy environment, such as sanitation and hygiene, women's status concerning decision-making power, and factors related to political economy (Hutton and Chase 2016, Shroff et al. 2009). Some studies have linked low birth weight, maternal short stature, household wealth quintile, place of residence, region, mother's education, child's age and sex, and perceived birth size to children's nutritional status (Mamabolo et al. 2005, Novignon et al. 2015). However, other studies (Gayle et al. 1987, Uthman 2009, Wamani et al. 2007) have found consistent disparities in the prevalence of child malnutrition in terms of children's age, sex, and birth size.

At the policy and program level, Ethiopia has many strategies and programs to reduce levels of malnutrition as part of its national development agenda. Some of the major strategies and programs include: the 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). The Seqota Declaration adopted Sustainable Development Goal 2 (SDG2), with the aim to end hunger, achieve food security, and improve nutrition, and promote sustainable agriculture by 2030 (Seqota Declaration 2016).

The Government of Ethiopia through the Ministry of Health also launched the health extension program in 2003 to achieve the country's progress in meeting the Millennium Development Goals (MDGs). The health extension workers are mainly to improve access to care in rural communities. They spend 15% of their time with infants and children under age 5 (Mangham-Jefferies et al. 2014). All of these listed efforts have brought positive impact in improving food and nutrition security (FDREFoodandNutrtionPolicy 2018). However, there was a fragmented approach leading to inadequate multi-sectorial coordination in responding to food and nutrition demand. As a result, severe malnutrition has remained a serious challenge (FDREFoodandNutrtionPolicy 2018). Therefore, the rationale of the food and nutrition policy is to use efforts and resources in integrated and clear directions and strategies, so as to bring better results. Thus, this finding will be used as a source of information to implement the newly introduced national food and nutrition policy.

1.3 Rationale of the Study

Despite efforts made by the Ethiopian government and improvements in reducing malnutrition, at the current rate of progress it will be difficult to reach the global target for reducing malnutrition by 2025. There are few comprehensive studies in Ethiopia based on nationally representative data to identify determinants of malnutrition among children under age 5. This study is designed to address the gaps in previous studies that used only some determinant variables at a time, whereas the current study uses many determinant variables at the same time, which will help to generalize the study findings at the national level. This study will help health practitioners and other policymakers to enable a multi-sectoral response to malnutrition by identifying its determinants among children under age 5. This is important to achieving the Sustainable Development Goals and to meeting the global target by 2025. Understanding the extent and the causes of the problem will allow for appropriate planning and interventions.

1.4 Research Question

This study was designed to answer the following specific research question;

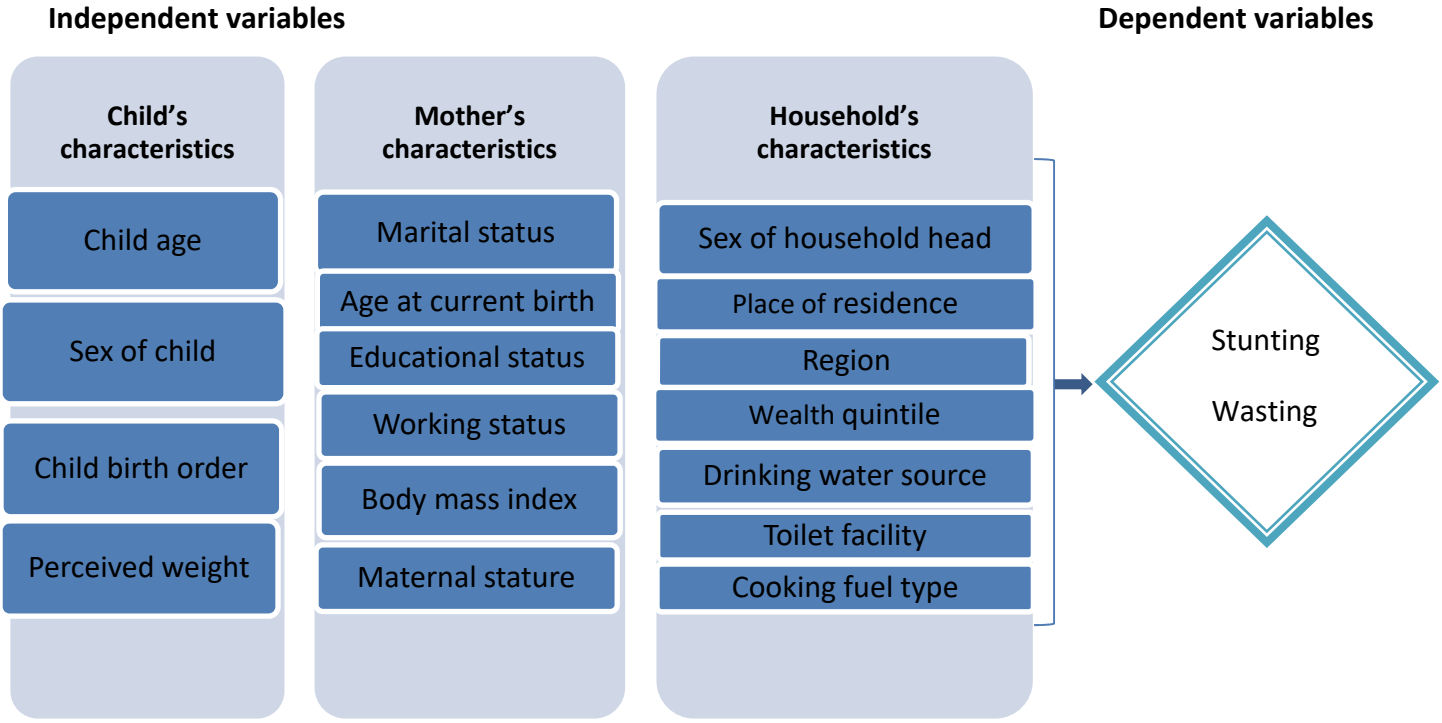
- What are the determinant factors of malnutrition in children under age 5 in 2016 in Ethiopia?

1.5 Conceptual Framework

The conceptual framework of this study (Figure 1) was developed from the related literature, including a report on the causes and consequences of stunted growth published by WHO (WHO 2017). Our study used children's characteristics (age, sex, birth order, and perceived birth weight), maternal characteristics (sex of the household head, marital status, age at current birth, educational status, working status, body mass

index, and maternal stature), and household characteristics (place of residence, region, wealth quintile, water sources, toilet facilities, and cooking fuel types) as determinant factors. The dependent variables in this study were stunting and wasting among children under age 5 in Ethiopia.

Figure 1 **Conceptual framework to study determinants of nutritional status among children under 5 in Ethiopia**



2 DATA AND METHODS

2.1 Data

This study used data from the 2016 Ethiopia Demographic and Health Survey (EDHS), which was conducted by the Central Statistical Agency (CSA) of Ethiopia, with technical support from ICF. The EDHS is a population-based household survey designed to provide representative data for the country as a whole and for nine regional states and two city administrations of Ethiopia. This study considered live children age 0-59 months with anthropometry data in the analysis of determinants of nutritional status among children under age 5 in Ethiopia. Missing values in the 2016 EDHS dataset were not included in the analyses. Not-alive children (635) and children with no anthropometry data from stunting condition (1000) or wasting condition (927) were also omitted from the analysis.

2.2 Variables

2.2.1 Dependent variables

The three anthropometric indicators mostly used for monitoring malnutrition in children are: stunting (low height-for-age); underweight (low weight-for-age); and wasting (low weight-for height). However, underweight is the composite of stunting and wasting, so this study used stunting and wasting for the analysis. They were defined using the WHO (2006) child growth standards. Stunting and wasting were coded as binary variables based on the standard definitions.

2.2.2 Independent variables

As illustrated in the conceptual framework (Figure 1), to analyze the determinants of nutritional status among children under age 5, the study considered the following characteristics as independent variables: 1) child characteristics, including age (less than 6 months, 6-11 months, 12-17 months, 18-23 months, and 24-59 months), sex (male, female), birth order (first, 2-4, 5 or higher), and perceived birth weight (very small, smaller than average, average, and very large or larger than average); 2) maternal characteristics, including marital status (never married, married, widowed/divorced/separated), age at child's birth (12-19, 20-49), educational status (no education, primary, secondary and above), working status (yes, no), body mass index (underweight, normal, overweight), and maternal stature (normal stature, short stature); 3) household characteristics, including place of residence (urban, rural), region (nine regions and two city administrations), wealth quintile (poorest, poorer, middle, rich, and richest), drinking water source (improved, non-improved), toilet type (improved, non-improved), and cooking fuel type (modern, traditional).

In the DHS, wealth quintile is calculated as an index based on consumer goods such as television, bicycle, or car. Household characteristics such as toilet facility, source of drinking water, and flooring materials are also considered in calculating the wealth index. These scores were derived using principal component analysis. Based on the 2016 EDHS, the water sources and toilet facilities were recoded as either improved or non-improved. Piped water, public taps, standpipes, tube wells, boreholes, protected dug wells and springs, and rainwater were considered as improved water sources. Non-shared toilet of the following types: flush/pour flush toilets to piped sewer systems, septic tanks, and pit latrines; ventilated improved pit (VIP)

latrines; pit latrines with slabs. Composting toilets were considered as improved toilet facilities for this analysis. For household fuel type, electricity, natural gas, biogas, and kerosene were categorized as modern fuel. Charcoal, wood, animal dung, and other agricultural crops and straw were considered as traditional fuel.

2.3 Statistical Analysis

Descriptive statistics were used to describe and illustrate the background characteristics of children age 0-59 months. Stata 15.1 version was used to analyze the data. Sample weights were applied in all analysis due to the two-stage cluster sampling design in the EDHS dataset. Multicollinearity among independent variables was checked using variance inflation factors (VIF). Due to multicollinearity, preceding birth interval was removed from the analysis. Multiple logistic regression was used to determine the associations between predictors and nutritional outcomes after adjusting for other covariates. The study also used Pearson chi-square test for bivariate analysis.

3 RESULTS

3.1 Sample Characteristics

As Table 1 shows, the majority of children (61%) were age 24-59 months, more than half (51%) were male, and 18% were first-order births. The great majority of mothers were married (95%), age 20-49 (90%), and not working (72%). About three-fourths of mothers (74%) had normal body mass index (BMI). The large majority of households (86%) were male-headed, and 89% were in the rural areas of Ethiopia. By region, over three-quarters of children were located in just three regions: 19% in Amhara; 44% in Oromia; and 21% in SNNP. Nearly half of households (46%) were in the poorest or poorer wealth quintiles, versus a third (33%) in the richer or richest quintiles.

Table 1 Percent distribution of sampled children age 0-59 months by child's, mother's, and household characteristics

Variables	N (%)
Child's characteristics	
Age	
Less than 6 months	703 (7.5)
6-11 months	1,018 (10.8)
12-17 months	1,105 (11.7)
18-23 months	831 (8.8)
24-59 months	5,762 (61)
Sex	
Male	4,832 (51.3)
Female	4,587 (48.7)
Birth order	
First	1,656 (17.6)
2 to 4	4,066 (43.2)
5 or higher	3,697 (39.3)
Perceived weight at birth	
Very small	1,474 (15.8)
Smaller than average	918 (9.8)
Average	3,894 (41.6)
Very large or larger than average	3,069 (32.8)
Mother's characteristics	
Marital status	
Never married	53 (0.6)
Married/living with partner	8,932 (94.8)
Widowed/divorced/separated	434 (4.6)
Age at child's birth	
12-19	993 (10.5)
20-49	8,427 (89.5)
Educational status	
No education	6,251 (64.6)
Primary	2,500 (26.5)
Secondary and above	668 (7.1)
Working status	
No	6,780 (72.0)
Yes	2,640 (28.0)
Mother's BMI	
Underweight	1,809 (19.7)
Normal	6,774 (73.8)
Overweight	596 (6.5)
Maternal stature	
Normal stature	8,932 (97.3)
Short stature	252 (2.7)

Continued...

Table 1—Continued

Variables	N (%)
Household characteristics	
Sex of household head	
Male	8,137 (86.4)
Female	1,282 (13.6)
Place of residence	
Urban	1,080 (11.5)
Rural	8,339 (88.5)
Region	
Tigray	620 (6.6)
Afar	94 (1.0)
Amhara	1,774 (18.8)
Oromia	4,090 (43.4)
Somali	426 (4.5)
Benishangul	100 (1.1)
SNNP	2,016 (21.4)
Gambela	23 (0.2)
Harari	22 (0.2)
Addis Ababa	215 (2.3)
Dire Dawa	39 (0.4)
Wealth quintile	
Poorest	2,237 (23.7)
Poorer	2,111 (22.4)
Middle	1,984 (21.1)
Richer	1,700 (18.0)
Richest	1,387 (14.7)
Drinking water source	
Improved water	5,347 (56.8)
Non-improved water	4,072 (43.2)
Type of toilet	
Improved toilet	976 (10.4)
Non-improved toilet	8,443 (89.6)
Type of cooking fuel	
Modern fuel	324 (3.4)
Traditional fuel	9,095 (96.6)
Total	9,419 (100)

3.2 Bivariate Associations of Stunting and Wasting by Background Characteristics

Table 2 indicates results from the bivariate analyses. Characteristics significantly associated with stunting included child's age, sex, birth order, perceived weight, maternal education, mother's BMI, place of residence, region, wealth quintile, toilet type, and fuel type. Variables associated with wasting included child's age, perceived weight, mother's BMI, region, wealth quintile, and fuel type.

Table 2 Bivariate analysis of stunting and wasting by child's, mother's, and household characteristics

Independent variables	Outcome variables					
	Stunting %	95% CI	Chi2 p-value	Wasting %	95% CI	Chi2 p-value
Children's characteristics						
Age			**<0.001**			**<0.001**
Less than 6 months	13.6	[10.0,18.3]		15.5	[11.5,20.5]	
6-11 months	17.2	[13.4,21.7]		12.9	[10.1,16.4]	
12-17 months	31.7	[27.7,36.1]		15.4	[12.3,19]	
18-23 months	48.6	[43.2,54.1]		11.3	[7.8,16.0]	
24-59 months	45.5	[42.9,48.1]		7.5	[6.5,8.6]	
Sex			**0.001**			**0.760**
Male	41.2	[38.7,43.8]		10.1	[8.8,11.6]	
Female	35.7	[33.4,38.2]		9.8	[8.4,11.4]	
Birth order			**0.039**			**0.170**
First	36.1	[31.8,40.7]		8.3	[6.4,10.7]	
2 to 4	37.0	[34.4,39.7]		9.7	[8.2,11.5]	
5 or higher	41.3	[38.5,44.3]		11.0	[9.5,12.7]	
Perceived weight at birth			**<0.001**			**0.002**
Very small	46.2	[41.5,51]		13.4	[10.9,16.5]	
Smaller than average	43.6	[38.7,48.6]		12.0	[9.2,15.6]	
Average	37.6	[34.9,40.3]		9.6	[8.2,11.2]	
Very large or larger than average	34.6	[31.8,37.5]		8.2	[6.8,9.9]	
Mother's characteristics						
Marital status			**0.771**			**0.531**
Never married	44.5	[26.8,63.8]		5.2	[0.8,28.1]	
Married/living with partner	38.4	[36.5,40.4]		9.9	[8.9,11]	
Widowed/divorced/ separated	40.6	[33.2,48.4]		12.0	[7.8,17.9]	
Age at child's birth			**0.111**			**0.478**
12-19	42.5	[37.2,48]		9.0	[6.7,12]	
20-49	38.1	[36.1,40.5]		10.1	[9.0,12.2]	
Educational status			**<0.001**			**0.051**
No education	41.7	[39.5,44]		10.8	[9.5,12.2]	
Primary	35.6	[32.5,38.8]		8.7	[7.1,10.7]	
Secondary and above	19.5	[15.3,24.4]		7.2	[4.8,10.7]	
Working status			**0.947**			**0.410**
No	38.5	[36.3,40.8]		9.7	[8.5,11.0]	
Yes	38.6	[35.7,41.7]		10.7	[8.8,12.9]	
Mother's BMI			**<0.001**			**<0.001**
Underweight	41.9	[38.5,45.5]		13.5	[11.3,16]	
Normal	38.9	[36.5,41.3]		9.5	[8.4,16]	
Overweight	24.4	[19.6,29.9]		4.6	[2.4,8.8]	
Maternal stature			**<0.001**			**0.396**
Normal stature	38.1	[36.1,40.1]		9.9	[8.8,11.1]	
Short stature	54.8	[45.5,63.7]		12.6	[7.4,20.7]	
Household characteristics						
Sex of household head			**0.220**			**0.287**
Male	38.4	[36.4,40.6]		10.1	[9.0,11.4]	
Female	39.2	[35.7,42.8]		8.8	[7.0,11.1]	
Place of residence			**<0.001**			**0.509**
Urban	26.0	[21.5,31.1]		9.1	[7.0,11.8]	
Rural	40.1	[38.1,42.2]		10.1	[9.0,11.3]	
Region			**<0.001**			**<0.001**
Tigray	39.5	[35.8,43.4]		11.5	[9.5,13.8]	
Afar	40.9	[36.5,45.5]		17.1	[13.4,21.6]	
Amhara	47.6	[43.8,51.4]		10.0	[8.0,12.5]	
Oromia	36.1	[32.8,39.5]		10.5	[8.8,12.6]	
Somali	26.5	[22.8,30.6]		22.2	[17.5,27.8]	
Benishangul	42.9	[38.2,47.6]		10.5	[7.8,14.0]	
SNNP	39.6	[35.7,43.6]		6.2	[4.8,8.0]	
Gambela	24.1	[20.3,28.4]		13.9	[10.4,18.4]	
Harari	32.1	[27.7,36.8]		10.7	[7.4,15.2]	
Addis Ababa	14.9	[11.1,19.7]		2.4	[1.3,4.6]	
Dire Dawa	40.9	[34.5,47.6]		10.2	[7.1,14.4]	

Continued...

Table 2—*Continued*

Independent variables	Outcome variables					
	Stunting %	95% CI	Chi2 p-value	Wasting %	95% CI	Chi2 p-value
Wealth quintile			**<0.001**			**0.001**
Poorest	45.6	[42.4,48.8]		13.8	[11.2,16.8]	
Poorer	42.5	[38.7,46.5]		9.6	[7.7,12.0]	
Middle	38.6	[34,43.4]		10.4	[8.2,13.1]	
Richer	34.8	[31,38.7]		6.8	[5.1,9.0]	
Richest	25.7	[22.1,29.7]		7.7	[5.7,10.2]	
Drinking water source			**0.048**			**0.098**
Improved water	37.0	[34.6,39.5]		9.2	[8.0,10.5]	
Non-Improved water	40.5	[37.8,43.3]		11.0	[9.3,12.8]	
Toilet facilities			**<0.001**			**0.222**
Improved toilet	26.8	[22.4,31.7]		8.5	[6.5,11.1]	
Non-improved toilet	39.8	[37.8,42]		10.0	[9.0,11.3]	
Type of cooking fuel			**<0.001**			**0.049**
Modern fuel	21.4	[14.9,29.9]		5.2	[2.6,10.2]	
Traditional fuel	39.1	[37.2,41.1]		10.1	[9.1,11.3]	

3.3 Factors Associated with Stunting

Table 3 shows the results of the adjusted multiple logistic regressions for stunning and wasting. Child's age had a significant association with stunting. Children in the three age groups between 12-59 months were significantly more likely to be stunted compared with children age 0-6 months, with the highest odds found among children age 18-23 months. Female children were less likely to be stunted than male children. Children perceived as very large or larger than average in weight at birth were less likely to be stunted compared with children perceived as very small. Children of mothers with secondary and above educational attainment were less likely to be stunted compared with children of mothers with no education.

Children born of overweight and normal-BMI mothers were significantly less likely to be stunted compared with children of underweight mothers. Children of short-stature mothers were more likely to be stunted compared with children of not-short-stature mothers. There was significant regional variation in stunting among children under age 5. Children from Amhara region were more likely to be stunted compared with Tigray region. In contrast, children from Addis Ababa, Gambella, and Somali regions were less likely to be stunted. Children from the richest, richer, and middle household wealth quintiles were less likely to be stunted compared with children from the poorer and poorest quintiles. Children in households with non-improved toilet facilities were more likely to be stunted compared with those with improved toilet facilities. Children in households with traditional cooking fuel type were more likely to be stunted compared with those with modern fuel type.

3.4 Factors Associated with Wasting

Table 3 also presents results of the adjusted multiple logistic regression for wasting. Children age 24-59 months were significantly less likely to be wasted compared with children age 0-6 months. Children with larger than average weight at birth and children with average perceived weight at birth were less likely to be wasted compared with children with perceived as very small at birth. Female children were less likely to be wasted than male children. Children whose mothers were overweight or of normal BMI had lower odds of being wasted compared with children of underweight mothers. Rural children were less likely to be wasted compared with urban children. Children in households in Addis Ababa and SNNP had lower odds

of being wasted compared with children in Tigray region, while children in households in Somali region had higher odds of being wasted.

Table 3 Prevalence of stunting and wasting among children age 0-59 months by children's, mother's, and household characteristics

Independent variables		Outcome variables	
		Stunting	Wasting
		AOR (95%CI)	AOR (95%CI)
Children's characteristics			
Age	Less than 6 months	**1**	1
	6-11 months	1.34 (0.97 - 1.86)	1.10 (0.82 - 1.50)
	12-17 months	3.50*** (2.59 - 4.74)	1.13 (0.84 - 1.52)
	18-23 months	7.81*** (5.73 - 10.65)	0.87 (0.62 - 1.21)
	24-59 months	6.59*** (5.00 - 8.68)	0.56*** (0.43 - 0.73)
Sex	Male	**1**	1
	Female	0.82*** (0.74 - 0.90)	0.77*** (0.67 - 0.88)
Birth order	First	**1**	1
	2 to 4	1.02 (0.87 - 1.20)	1.02 (0.80 - 1.29)
	5 or higher	1.16 (0.97 - 1.39)	1.16 (0.90 - 1.50)
Perceived weight at birth	Very small	**1**	1
	Smaller than average	0.82* (0.67 - 0.99)	1.07 (0.83 - 1.37)
	Average	0.68*** (0.59 - 0.78)	0.71*** (0.59 - 0.86)
	Very large or larger than average	0.54*** (0.47 - 0.63)	0.60*** (0.49 - 0.74)
Mother's characteristics			
Marital status	Never in union	1	1
	Married/living with partner	0.72 (0.38-1.39)	2.16 (0.51 - 9.14)
	Widowed/divorced/ separated	0.64 (0.32 - 1.26)	2.48 (0.57 - 10.76)
Age	12-19	1	1
	20-49	0.97 (0.81 - 1.16)	0.96 (0.74 - 1.25)
Educational status	No education		
	Primary	0.97 (0.86 - 1.10)	0.92 (0.76 - 1.11)
	Secondary and above	0.66*** (0.52 - 0.84)	0.80 (0.57 - 1.13)
Working status	No	1	1
	Yes	1.02 (0.91 - 1.14)	1.08 (0.91 - 1.28)
Mother's BMI	Underweight		
	Normal	0.84** (0.74 - 0.94)	0.67*** (0.57 - 0.78)
	Overweight	0.57*** (0.45 - 0.71)	0.39*** (0.28 - 0.55)
Maternal stature	Normal stature	1	1
	Short stature	2.03*** (1.44 - 2.86)	1.08 (0.65 - 1.80)
Households characteristics			
Sex of household head	Male	1	1
	Female	1.07 (0.94 - 1.23)	0.97 (0.81 - 1.17)
Place of Residence	Urban	1	1
	Rural	0.86 (0.69 - 1.07)	0.61 (0.64 – 1.10)
Region	Tigray	1	1
	Afar	0.87 (0.69 - 1.10)	1.33 (0.97 - 1.81)
	Amhara	1.27* (1.03 - 1.58)	0.87 (0.62 - 1.20)
	Oromia	0.83 (0.68 - 1.01)	1.00 (0.75 - 1.34)
	Somali	0.52*** (0.42 - 0.65)	2.02*** (1.51 - 2.68)
	Benishangul	1.13 (0.90 - 1.43)	0.97 (0.69 - 1.37)
	SNNP	0.99 (0.80 - 1.21)	0.60** (0.43 - 0.85)
	Gambela	0.51*** (0.39 - 0.66)	1.19 (0.84 - 1.67)
	Harari	0.87 (0.67 - 1.15)	1.20 (0.81 - 1.76)
	Addis Ababa	0.64* (0.43 - 0.94)	0.35** (0.17 - 0.76)
	Dire Dawa	1.09 (0.83 - 1.43)	0.83 (0.55 - 1.27)

Continued...

Table 3—*Continued*

Independent variables		Outcome variables	
		Stunting	Wasting
		AOR (95%CI)	AOR (95%CI)
Wealth quintile	Poorest	1	1
	Poorer	1.01 (0.86 - 1.17)	0.88 (0.71 - 1.10)
	Middle	0.77** (0.65 - 0.91)	0.92 (0.72 - 1.16)
	Richer	0.69*** (0.58 - 0.82)	0.66** (0.50 - 0.87)
	Richest	0.62*** (0.49 - 0.79)	0.58** (0.40 - 0.83)
Drinking water source	Improved water	1	1
	Non-improved water	0.91 (0.81 - 1.01)	1.00 (0.86 - 1.17)
Type of toilet facilities	Improved toilet	1	1
	Non-improved toilet	1.28** (1.07 - 1.53)	1.06 (0.83 - 1.36)
Type of cooking fuel	Modern fuel	1	1
	Traditional fuel	1.66** (1.18 - 2.32)	1.28 (0.74 - 2.21)

*** p<0.001, ** p<0.01, * p<0.05, AOR: adjusted odds ratio

4 DISCUSSION

This study assessed the determinants of nutritional status among children under age 5 in Ethiopia. Study results show that child's age, sex, and perceived birth weight, mother's educational status, BMI, and maternal stature, and region, wealth quintile, type of toilet facility, and type of cooking fuel had significant associations with stunting. Child's age, sex, and perceived birth weight, mother's BMI, and residence and region showed significant associations with wasting.

This study shows that the risk of stunting increased with age of child. Previous studies in Ethiopia have shown similar results (Asfaw and Giotom 2000; Genebo et al. 1998; Yimer 2000). The reason might that as children grow older they have greater energy needs. Besides, stunting reflects chronic malnutrition that can be manifested after long-term nutritional deficiency, while wasting reflects acute undernutrition. As child's age increase, there is the probability that the child will receive childhood vaccinations, which reduce exposure to disease. For example, Mekonnen et al. (2005) found that children vaccinated against measles are less likely to be wasted.

In Ethiopia as in many developing countries, complementary feeding is a challenge for children age 6-23 months (Abeshu et al. 2016). Studies in other developing countries by Caulfield et al. (1999), Mora and Nestel (2000), and Abeshu et al. (2016) found that complementary foods given to infants in the second six months of age and beyond are often inadequate in energy density.

In our study, female children were less likely to be stunted and wasted than boys. This finding is consistent with a meta-analysis in sub-Saharan Africa (Wamani et al. 2007), a study in the Northern Ethiopia (Alemayehu et al. 2015), and research in Myanmar (Mya et al. 2019). However, it is contrary to findings of studies in Tanzania (Mbago and Namfua 1992), Pakistan (Baig-Ansari et al. 2006), India (Mittal et al. 2007), and Kenya (Gewa and Yandell 2012) that girls had a higher prevalence of stunting than boys. Garenne (2003), Bork and Diallo (2017), and Wamani et al. (2007) found that sex differences in nutritional status might be due to biological differences in morbidity between boys and girls in their early life. This may also apply to our findings on wasting. A review of complementary feeding reported that boys have higher birth weights than girls and grow faster during infancy, resulting in greater energy needs (Bork and Diallo 2017). Furthermore, another study on Guatemalan infants reported that women perceived male children to be hungrier and less likely to be satisfied by breastfeeding alone (Tumilowicz et al. 2015), placing them at increased risk of infections.

Regarding our findings on perceived weight of child at birth, the risks of stunting and wasting were higher among children perceived to have low birth weight. These findings are consistent with previous studies in Zambia (Masiye et al. 2010), Bangladesh (Dhar et al. 2002; Islam et al. 2013; Jesmin et al. 2011), India (Mishra et al. 2014), Malaysia (Wong et al. 2014), and Indonesia (Rahman et al. 2016), and may be due to the poor nutrition of mothers during pregnancy. This finding is supported by our results of the association between mother's BMI and stunting and wasting in children. Ramakrishnan (2004) reported that children born of overweight mothers are less likely to be stunted and wasted due to adequacy of protein and energy intakes of mothers during pregnancy (Ramakrishnan 2004). A similar study in Nepal (Pramod Singh et al. 2009) also showed that as maternal BMI increased there was a reduction in children's stunting, and wasting.

Our study found that children born to mothers with short stature were more likely to be stunted. This result is in line with previous studies in South Africa (Mamabolo et al. 2005; and Ghana Novignon et al. 2015). This association reflects the fact that women who were stunted during their own childhood are more likely to give birth to stunted children (Reynaldo Martorell and Zongrone 2012).

Higher level of mothers' educational attainment was positively associated with stunting in children. This is in line with previous related studies in the Philippines (Aguillon et al. 1982), Libya (Popkin and Bisgrove 1988), Ethiopia (Yimer 2000), Uganda (Wamani et al. 2004), Mozambique (Burchi 2010), and Ghana (Novignon et al. 2015). As stated in different studies, the reasons include that educated women are better informed about optimal child care practices (Oyekale 2012), have better hygiene practices (Keats 2018, Smith and Haddad 2000), feeding (Mukabutera et al. 2016), and childcare during illness (Bhutta et al. 2008; Iannotti et al. 2013; Mukabutera et al. 2016), have a greater ability to use the health system (Sunguya et al. 2014), and are more empowered to make decisions (Keats 2018). In our study, however, in about two-thirds of cases (65%), the mothers had not attended formal education, and as a result their knowledge on childcare may not have been enough.

Our study found regional variation in stunting and wasting in Ethiopia. Compared with Tigray, the reference region, children from Addis Ababa were less likely to be either stunted or wasted, while children in Gambella were less likely to be stunted, and children in SNNP were less likely to be wasted. Interestingly, children in the Somali region were less likely to be stunted but more likely to be wasted compared with Tigray. This could be because wasting is characterized by acute malnutrition that can be caused by temporary increased food insecurity from extreme weather events, drought, and shifts in agricultural practices (McCarthy et al. 2001, Swinburn 2019). Previous research in Ethiopia (Pelletier et al. 1995) showed the association between malnutrition varied across regions due to variation in cultivated area.

We found that children from the richest, richer, and middle household wealth quintiles were less likely to be stunted compared with children from the poorer and poorest quintiles. As mentioned, in the DHS surveys household wealth is measured as an index reflecting household material living standards, which include the types of water sources and sanitation facilities used by the household. Our study found that children in households with non-improved toilet facilities and traditional fuel types were more likely to be stunted. Previous studies in Nepal (Headey and Hoddinott 2015) and other Asian countries (Headey et al. 2016) have found that household asset accumulation is an important predictor of nutritional improvement.

Environmental factors such as unimproved water, unimproved sanitation, and biomass fuel are the second largest global attributable burden as cause of child stunting (Danaei et al. 2016). A study of 137 developing countries reported that an estimated 7.2 million cases of stunting were attributable to unimproved sanitation (Danaei et al. 2016). In Ethiopia, more than half of rural households (56%) use unimproved toilet facilities (CSA 2016). In rural areas of Ethiopia, more than one in three households (39%) have no toilet facility, versus 7% in urban areas (CSA 2016). Related studies in Sri Lanka (De Silva et al. 1994; Gunawardena et al. 2004; Gunawardena et al. 2011; Sorensen et al. 1996) revealed that malnutrition among children is still a major health problem associated with poor sanitation and personal hygiene. However, a study conducted in rural Zimbabwe (Humphrey et al. 2018) found improved water, sanitation, and hygiene interventions in rural areas in low-income countries were unlikely to reduce stunting more than the effect of improved infant and child feeding alone. This implies integration of improved infant diets with improved water, sanitation, and hygiene is a logical approach to improve nutritional status of under-five children.

The great majority of Ethiopian households (93%) use traditional fuels such as wood, charcoal, and dung cake to meet their daily needs, and most households (59%) cook food outside (CSA 2016). Ramakrishnan (2004) found that indoor air pollution and smoking are causes of low birth weight and could possibly impact stunting. Another study in India reported associations between air pollution and stunting (Mishra and Retherford 2007); children living in households using biofuel were more likely to be stunted compared with children living in households using cleaner fuels.

5 STRENGTHS AND LIMITATIONS

The strength of this study was that it used nationally representative data, which allow generalization of the results; it also applied all of the DHS data principles, like weighting. Regarding limitations, the cross-sectional data cannot examine causation or seasonal variation of nutritional outcomes. The other limitation is that during DHS data collection measurements of children's height obtained by laying down children under age 2 may considered as a source of human error.

6 CONCLUSION AND POLICY LIMITATIONS

Our study found that child, maternal, and household characteristics were significantly associated with stunting and wasting among of children under age 5. Despite efforts made by the Ethiopian government and improvements in reducing malnutrition, rates of stunting and wasting remain high. The consequences of child malnutrition are grave and include poor performance in school and low adult economic productivity. The findings imply that a multi-sectorial and multidimensional approach is important to address malnutrition in Ethiopia. The education sector should promote maternal education and policies to reduce cultural and gender barriers. The health sector should provide health education to families to encourage positive behaviors toward childcare and infant feeding practices. In addition, the health and human services sectors can promote use of improved toilets. To reduce stunting due to traditional fuel usage in households, the energy sector should help households to access clean energy. Further research is suggested to explore the impact of seasonal food insecurity and climatic events on stunting and wasting and to examine the associated factors affecting nutritional status among children over time, using decomposition analysis.

REFERENCES

Abeshu, M. A., A. Lelisa, and B. Geleta. 2016. "Complementary Feeding: Review of Recommendations, Feeding Practices, and Adequacy of Homemade Complementary Food Preparations in Developing Countries - Lessons from Ethiopia." *Frontiers in Nutrition* 3: 41.

African Union. 2015. "African Regional Nutrition Strategy 2015–2025." Addis Ababa: Ethiopia.

Aguillon, D. B., Caedo, M. M., Arnold, J. C. and Engel, R. W. 1982. "The Relationship of Family Characteristics to the Nutritional Status of Pre-school Children." *Food and Nutrition Bulletin* 4(4): 1-8.

Akombi, B. J.,K. E. Agho, D. Merom, A. M. Renzaho, and J. J. Hall. 2017. "Child Malnutrition in sub-Saharan Africa: A Meta-analysis of Demographic and Health Surveys (2006-2016)." *PloS One* 12(5): e0177338.

Alemayehu, M., F. Tinsae, K. Haileslassie, O. Seid, G. Gebregziabher, and H. Yebyo. 2015. "Undernutrition Status and Associated Factors in Under-5 Children, in Tigray, Northern Ethiopia." *Nutrition* 31(7-8): 964-970.

Asfaw, S. T. and L. Giotom. 2000. "Malnutrition and Enteric Parasitoses among Under-five Children in Aynalem Village, Tigray." *Ethiopian Journal of Health Development* 14(1): 67-75.

Baig-Ansari, N., M. H. Rahbar, Z. A. Bhutta, and S. H. Badruddin. 2006. "Child's Gender and Household Food Insecurity Are Associated with Stunting among Young Pakistani Children Residing in Urban Squatter Settlements." *Food and Nutrition Bulletin* 27(2): 114-127.

Bhutta, Z. A., T. Ahmed, R. E. Black, S. Cousens, K. Dewey, E. Giugliani, B. A. Haider, B. Kirkwood, S. S. Morris, H. P. Sachdev, and M. Shekar. 2008. "What Works? Interventions for Maternal and Child Undernutrition and Survival." *The Lancet* 371(9610): 417-440.

Birara, M.. 2014. "Prevalence and Factors Associated with Stunting, Underweight and Wasting: A Community Based Cross Sectional Study among Children Age 6-59 Months at Lalibela Town, Northern Ethiopia." *Journal of Nutrition Disorders & Therapy* 04. 10.4172/2161-0509.1000147.

Black,.R. E., C. G. Victora, S. P. Walker, Z. A. Bhutta, P. Christian, M. de Onis, M. Ezzati, S. Gratham-McGregor, J. Katz, R. Martorell, and R. Uauy. 2013. "Maternal and Child Undernutrition and Overweight in Low-income and Middle-income Countries." *The Lancet* 382 (9890):427-451.

Bork, K. A., and A. Diallo. 2017. "Boys Are More Stunted than Girls from Early Infancy to 3 Years of Age in Rural Senegal." *The Journal of Nutrition* 147(5): 940-947.

Burchi, F. 2010. "Child Nutrition in Mozambique in 2003: The Role of Mother's Schooling and Nutrition Knowledge." *Economics & Human Biology* 8(3): 331-345.

Caulfield, L. E., S. L. Huffman, and E. G. Piwoz. 1999. “Interventions to Improve Intake of Complementary Foods by Infants 6 to 12 Months of Age in Developing Countries: Impact on Growth and on the Prevalence of Malnutrition and Potential Contribution to Child Survival.” *Food and Nutrition Bulletin* 20(2): 183-200.

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

Danaei, G., K. G. Andrews, C. R. Sudfeld, G. Fink, D. C. McCoy, E. Peet, A. Sania, M. C. Smith Fawzi, M. Ezzati, and W. W. Fawzi. 2016. “Risk Factors for Childhood Stunting in 137 Developing Countries: A Comparative Risk Assessment Analysis at Global, Regional, and Country Levels.” *PLoS Medicine* 13(11): e1002164.

de Silva, N., H. J. de Silva, and V. P. Jayapani. 1994. “Intestinal Parasitoses in the Kandy Area, Sri Lanka.” *Southeast Asian Journal of Tropical Medicine and Public Health* 25: 469-469.

Dhar, B., G. Mowlah, S.Nahar, and N. Islam. 2002. “Birth-weight Status of Newborns and its Relationship with Other Anthropometric Parameters in a Public Maternity Hospital in Dhaka, Bangladesh.” *Journal of Health, Population and Nutrition*: 36-41.

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

Garenne, M. 2003. “Sex Differences in Health Indicators among Children in African DHS Surveys.” *Journal of Biosocial Science* 35(4): 601-614.

Gayle, H. D., M. J. Dibley, J. S. Marks, and F. L. Trowbridge. 1987. “Malnutrition in the First Two Years of Life: The Contribution of Low Birth Weight to Population Estimates in the United States.” *American Journal of Diseases of Children* 141(5): 531-534.

Genebo, T., G. Woldemariam, J. Haider, and D. Tsegaye. 1998. “Factors Contributing to Positive and Negative Deviances in Child Nutrition.” *Ethiopian Journal of Health Development* 12(2): 69-74.

Gewa, C. A. and N. Yandell 2012. “Undernutrition among Kenyan children: Contribution of Child, Maternal and Household Factors.” *Public Health Nutrition* 15(6): 1029-1038.

Gunawardena, G., N.D., Karunaweera and M.Ismali. 2004. “Socio–economic and behavioural factors affecting the prevalence of Ascaris infection in a low-country tea plantation in Sri Lanka.” *Annals of Tropical Medicine & Parasitology* 98(6): 615-621.

Gunawardena K, Kumarendran B, Ebenezer R, Gunasingha MS, Pathmeswaran A, and Nilanthi de Silvaal. 2011. “Soil-Transmitted Helminth Infections among Plantation Sector Schoolchildren in Sri Lanka: Prevalence after Ten Years of Preventive Chemotherapy. *PLoS Negl Trop Dis* 5(9): e1341.

Headey, D., Hoddinott, and Seollee Park. 2016. “Drivers of nutritional change in four South Asian countries: a dynamic observational analysis.” *Maternal & child nutrition* 12: 210-218.

Headey, D. D. and J. Hoddinott 2015. “Understanding the rapid reduction of undernutrition in Nepal, 2001–2011.” *PloS one* 10(12): e0145738.

Humphrey,J., Mduduzi N N Mbuya, Robert Ntozini, Lawrence H Moulton, Rebecca J Stoltzfus, Naume V Tavengwa, Kuda Mutasa, Florence Majo, Batsirai Mutasa, Goldberg Mangwadu, Cynthia M Chasokela, Ancikaria Chigumira, Bernard Chasekwa, Laura E Smith, James M Tielsch, Andrew D Jones, Amee R Manges, John A Maluccio, Andrew J Prendergast“. 2018. Independent and combined effects of improved water, sanitation, and hygiene, and improved complementary feeding, on child stunting and anaemia in rural Zimbabwe: a cluster-randomised trial for the Sanitation Hygiene Infant Nutrition Efficacy.” *The Lancet Global Health*” 7(1): 4-7

Hutton, G. and C. Chase 2016. “The knowledge base for achieving the sustainable development goal targets on water supply, sanitation and hygiene.” *International Journal of Environmental Research and Public Health* 13(6): 536.

Iannotti, L. L., Sherlie Jean Louis Dulience, Jamie Green, Saminetha Joseph, Judith Franc ̧ois, Marie-Lucie Antenor,Carolyn Lesorogol, Jacqueline Mounce, and Nathan M Nickerson.2013. “Linear growth increased in young children in an urban slum of Haiti: a randomized controlled trial of a lipid-based nutrient supplement.” *The American journal of clinical nutrition* 99(1): 198-208.

Islam M.M, Alam M, Tariquzaman M, Kabir MA, Pervin R, Begum M, and Khan M.M.013. “Predictors of the number of under-five malnourished children in Bangladesh: application of the generalized poisson regression model.” *BMC public health* 13(1): 11.

Jesmin,A., Shelby Suzanne Yamamoto, Ahmad Azam Malik, and M.d. Aminul Haque.2011. “Prevalence and determinants of chronic malnutrition among preschool children: a cross-sectional study in Dhaka City, Bangladesh.” *Journal of health, population, and nutrition* 29(5): 494.

Keats, A. 2018. “Women’s schooling, fertility, and child health outcomes: Evidence from Uganda’s free primary education program.” Journal of Development Economics 135: 142-159.

Mamabolo, R.L, Alberts M, Steyn N.P, Delemarre-van de Waal HA, Levitt NS. 2005.“Prevalence and determinants of stunting and overweight in 3-year-old black South African children residing in the Central Region of Limpopo Province, South Africa.” *Public health nutrition* 8(5): 501-508.

Mangham-Jefferies, Mathewos. B, Russell.J and Bekele.A.2014. “How do health extension workers in Ethiopia allocate their time?” *Human resources for health* 12(1): 61.

Masiye, Felix; Chama, Chitalu; Chitah, Bona; and Jonsson, Dick.2010. "Determinants of Child Nutritional Status in Zambia: An Analysis of a National Survey," *Zambia Social Science Journal*: 1(1):4:

Mbago, M. C. and P. P. Namfua 1992. “Some determinants of nutritional status of one-to four-year-old children in low income urban areas in Tanzania.” Journal of tropical pediatrics 38(6): 299-306.

McCarthy, J. J. Osvaldo F. Canziani Neil A. Leary David J. Dokken Kasey S. White. 2001. Climate change impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change, *Cambridge University Press*.

Mekonnen, A., Nicola, J and Tefera,B. 2005. Tackling Child Malnutrition in Ethiopia: Do the Sustainable Development Poverty Reduction Programme's underlying policy assumptions reflect local realities? W O R K I N G P A P E R N O . 1 9.

Mishra K , Kumar P , Basu S ,Rai K , Aneja S. 2014. "Risk factors for severe acute malnutrition in children below 5 y of age in India: A case-control study." *The Indian Journal of Pediatrics* 81(8): 762-765.

Mittal A, Singh J, Ahluwalia S K.2007." Effect of maternal factors on nutritional status of 1-5-year-old children in urban slum population". *Indian J Community Med* icine; 32(4): 264.

Mora, J. O. and P. S. Nestel 2000. "Improving prenatal nutrition in developing countries: strategies, prospects, and challenges." The American journal of clinical nutrition 71(5): 1353S-1363S.

Mukabutera, A., Thomson, D.R., Hedt.G. Basinga.P, Nyirazinyoye, L. and Murray.M.2016. "Risk factors associated with underweight status in children under five: an analysis of the 2010 Rwanda Demographic Health Survey (RDHS)." *BMC Nutrition* 2(1): 40.

Mya, K. S., A. T. Kyaw, and T. Tun. 2019. Feeding Practices and Nutritional Status of Children Age 6-23 Months in Myanmar: A Secondary Analysis of the 2015-16 Demographic and Health Survey. *PLoS One* 14(1): e0209044.

Novignon, J., E. Aboagye, O. S. Agyemang. and G. Aryeetey. 2015. "Socioeconomic-related Inequalities in Child Malnutrition: Evidence from the Ghana Multiple Indicator Cluster Survey." *Health Economics Review* 5(1):34.

Oyekale, A. S. 2012. "Factors Explaining Acute Malnutrition among Under-five Children in Sub-Sahara Africa (SSA)." *Life Sci J* 9: 2101-2107.

Pelletier, D. L., K. Deneke,Y. Kidane, B. Haile, and F. Negussie. 1995. "The Food-first Bias and Nutrition Policy: Lessons from Ethiopia." *Food Policy* 20(4): 279-298.

Popkin, B. M., and E. Z. Bisgrove. 1988. "Nutrition and Urbanization (Part 2): Urbanization and Nutrition in Low-Income Countries." *Food and Nutrition Bulletin* 10(1): 1-22.

Pramod Singh, G. C., Nair, M., Grubesic, R. B., and Connell, F. A. (2009). Factors Associated With Underweight and Stunting Among Children in Rural Terai of Eastern Nepal. *Asia Pacific Journal of Public Health,* 21(2), 144–152.

Rahman, M. S., T. Howlader, M. S. Masud, and M. L. Rahman. 2016. "Association of Low-birth Weight with Malnutrition in Children under Five Years in Bangladesh: Do Mother's Education, Socio-economic Status, and Birth Interval Matter?" *PloS One* 11(6): e0157814.

Ramakrishnan, U. 2004. "Nutrition and Low Birth Weight: from Research to Practice." *American Journal of clinical Nutrition* 79(1): 17-21.

Martorell, R. and A. Zongrone. 2012. “Intergenerational Influences on Child Growth and Undernutrition.” *Paediatric and Perinatal Epidemiology*. https://doi.org/10.1111/j.1365-3016.2012.01298.x.

Federal Democratic Republic of Ethiopia (FDRE). 2016. “Seqota Declaration Implementation Plan (2016–2030): Summary Programme Approach Document.” FDRE: Addis Ababa, Ethiopia.”

Shroff, M., P. Griffiths, L. Adair, C. Suchindran, and M. Bentley. 2009. “Maternal Autonomy is Inversely Related to Child Stunting in Andhra Pradesh, India.” *Maternal and Child Nutrition* 5(1): 64-74.

Smith, L. C., and L. J. Haddad. 2000. “Explaining Child Malnutrition in Developing Countries: A Cross-country Analysis.” Intl Food Policy Res Institute.

Sorensen, E., M. Ismail, D. K. Amarasinghe, T. S. Dassenaieke. 1996. “The Prevalence and Control of Soil-Transmitted Nematode Infections among Children and Women in the Plantations in Sri Lanka.” *The Ceylon Medical Journal* 41(2): 37-41.

Sunguya, B. F., K. C. Poudel, L. B. Mlunde, D. P. Urassa, J. Yasuoka, and M. Jimba. 2014. “Poor Nutrition Status and Associated Feeding Practices among HIV-Positive Children in a Food Secure Region in Tanzania: A Call for Tailored Nutrition Training.” *PLOS ONE* 9(5): e98308.

Swinburn, B. A., V. I. Kraak, S. Allender, V. J. Atkins, P. I. Baker, J. R. Bogard, and M. Ezzati. 2019. “The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report.” *Lancet.* London, England.

Tibilla, M. A. 2009. “The Nutritional Impact of the World Food Programme-supported Supplementary Feeding Programme on Children less than Five Years in Rural Tamale, Ghana 17-18.” Ethiopian Health and Nutrition Research Institute (EHNRI).

Tumilowicz, A., J. P. Habicht, G. Pelto, and D. L. Pelletier. 2015. Gender Perceptions Predict Sex Differences in Growth Patterns of Indigenous Guatemalan Infants and Young Children. *The American Journal of Clinical Nutrition,* 102(5), 1249–1258.

United Nations Administrative Committee (UNAC) on Co-ordination, Sub-committee on Nutrition. 1997. “3rd Report on the World Nutrition Situation.” ACC/SCN Secretariat, United Nations.

UNICEF. 2017. “UNICEF Annual Report 2017 Ethiopia.” UNICEF.

UNICEF. 2019. “Levels and Trends in Child Malnutrition: UNICEF, WHO / World Bank Group Joint Child Malnutrition Estimates, Key Findings of the 2019 edition.” Geneva: World Health Organization; 2019 License: CC BY-NC-SA 3.0 IGO.

Uthman, O. A. 2009. “Decomposing Socio-economic Inequality in Childhood Malnutrition in Nigeria.” *Maternal & Child Nutrition* 5(4): 358-367.

Vinod, Mishra, and R. Retherford. 2007. “Children Living in Households Using Only Biofuels Than among Children Living in Households Using Only Cleaner Fuels.” *International Journal of Epidemiology* 2007;36:117–129.

Wamani, H., A. N. Astrøm, S. Peterson, J. K. Tumwine, and T. Tylleskär. “Boys Are More Stunted than Girls in sub-Saharan Africa: A Meta-analysis of 16 Demographic and Health Surveys.” *BMC Pediatrics* 7(1): 17.

Wamani, H., T. Tylleskär, A. N. Astrøm, J. K. Tumwine, and S. Peterson. 2004. Mothers' Education but not Fathers' Education, Household Assets or Land Ownership is the Best Predictor of Child Health Inequalities in Rural Uganda. *International Journal for Equity in Health*, 3(1).

WHO and UNICEF. 1995. “Global Prevalence of Vitamin A Deficiency: Micronutrient Deficiency Information System Working Paper No. 2.” Geneva: World Health Organization.

WHO. 2009. “World Health Organization Child Growth Standards and the Identification of Severe Acute Malnutrition in Infants and Children: Joint Statement by the World Health Organization and the United Nations Children’s Fund.” World Health Organization.

WHO. 2014. “World Health Organization Global Nutrition Targets 2025: Stunting Policy Brief.” World Health Organization.

WHO. 2017. “Stunted Growth and Development, Context, Causes and Consequences.” World Health Organization.

Wong, H. J., F. Ming Moy, and S. Nair. 2014. “Risk Factors of Malnutrition among Preschool Children in Terengganu, Malaysia: A Case Control Study.” *BMC Public Health* 14(1): 785.

Yimer, G. 2000. “Malnutrition among Children in Southern Ethiopia: Levels and Risk Factors.” *Ethiopian Journal of Health Development* 14(3).