Food & Nutrition: Current Research
FNCR, 3(1): 224-242
www.scitcentral.com

ISSN: 2638-1095

Original Research Article: Open Access

Childhood Undernutrition and Multilevel Analysis of Risk Factors: 2016 Standard DHS Survey Data

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Received August 06, 2019; Accepted September 13, 2019; Published June 25, 2020

ABSTRACT

Background: Poor nutrition is the leading risk-factor for child mortality in Sub-Saharan-Africa. Therefore, improving nutrition is critical. It requires effective multi-sectoral intervention efforts based on regular data to monitor and analyze country progress.

Objective: The aim of the present study was to determine the common risk factors associated with stunting, underweight and wasting among children 0-59 months.

Methods: Sample of data from 9,696 children aged 0-59 months was obtained from the 2016 Ethiopia Demographic and Health Survey (EDHS). IBM SPSS statistics (v21.0) based cluster multilevel logistic regression analyses were used to identify significant risk-factors associated with stunting, underweight and wasting.

Results: Overall, the national prevalence of children classified as stunting was 37.8%, underweight was 26.8% and wasting was 12.9%. However, significantly higher prevalence of child under-nutrition was recorded with increasing child-age-bracket and among those residing in rural regions of the country. Multivariable analysis revealed that the most consistent and common risk factors associated with stunting, underweight and wasting are administrative region (outside capital), household's wealth index (lowest quintile), perceived birth size (small), sex of child (male), child age (later age), place of delivery (home delivery) and exposure to media (no/less exposure to television).

Conclusion: Strategy with broad intervention approaches are required targeting risk factors to child under-nutrition including socio-economic status, maternal education, health (nutrition) of the mother and promotion of healthy environment, with emphases to rural regions.

Keywords: Undernutrition, Multilevel analysis, Children 0-59 months

Abbreviations: AOR: Adjusted Odds Ratio; BMI: Body Mass Index; CGF: Child Growth Failure; CI: Confidence Interval; COR: Crude Odds Ratio; CSA: Central Statistical Agency; DHS: Demographic and Health Survey; GBD: Global Burden of Diseases; LANEA: Leveraging Agriculture for Nutrition in East Africa; MDGs: Millennium Development Goals; PCA: Principal Component Analysis; SAS (software): Statistical Analysis System; SDG: Sustainable Development Goal; SNNPR: Southern Nation Nationality People's Region; SSA: Sub-Saharan Africa; UNFPA: United Nations Population Fund; UNICEF: United Nations Children's Fund; USAID: United States Agency for International Development

INTRODUCTION

Improvement of child survival is a long-standing international priority [1-3], as insufficient growth during childhood is associated with poor health outcomes and an increased risk of death [4]. Despite geographic differences, substantial progress has been accomplished in reducing child mortality and absolute inequalities in rates of child death across countries worldwide during the last few decades.

Yet, maternal and child undernutrition remain pervasive and damaging conditions in low-income and middle-income countries. The Millennium Development Goals (MDGs) 1990 to 2015, which aimed to reduce under-5 mortalities by

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Citation: Berra WG. (2020) Childhood Undernutrition and Multilevel Analysis of Risk Factors: 2016 Standard DHS Survey Data. Food Nutr Current Res, 3(1): 224-242.

two-thirds; but only 57 of 195 countries and territories worldwide met or exceeded the pace of progress required to achieve MDG 4 during that period [5]. The proportion of underweight children was reported to have declined globally from 25% in 1990 to 15% in 2015 [6]. However, despite narrowing disparities over time, geographic inequalities persisted among countries with the lowest and highest child mortality rates [1]. For example, nearly 90 percent of all underweight children reside in South East Asia and Sub-Saharan Africa (SSA) [7].

During MDG era, many countries in Africa also achieved marked reductions in under-5 and neonatal mortality [1]. The number of stunted children had fallen in all regions except Sub-Saharan Africa, where the numbers increased by about one third between 1990 and 2013 [7]. Although there are differences on exact reports [6,8]; findings from the Global Burden of Diseases, Injuries and Risk Factors Study 2016 (GBD 2016) shows that, an estimated of 36.6% children under five were stunted, 8.6% wasted and 19.5% underweight in SSA in the year 2015 [8].

Moreover, child growth failure (CGF) was the second leading risk factor for child mortality in SSA, accounting for more than 23% of deaths of children under five [8]. Despite striking sub-national heterogeneity in levels and trends of child growth [4], between 2000 and 2015, nearly all African countries demonstrated improvements for children under 5 years old for stunting, wasting, and underweight, the core components of child growth failure. The prevalence of malnutrition was highest within countries in East Africa and West Africa compared to the WHO Millennium development goals target for 2015 [9].

In Ethiopia, for example, national DHS report shows a slight decline in the trends of nutritional status for under five children during 2011 to 2015 [10]. This national report shows a decline in stunting from 44% in 2011 to 38% in 2016 and a decline in underweight from 29% in 2011 to 24% in 2016. However, the rate of child wasting has been remained stagnant at 10% in the country. These data suggest that despite the substantial global progress that has been achieved, under-nutrition remains unacceptably high in Ethiopia and far from being solved.

There are limited or incomplete assessments of risk factors of child growth failure (CGF), conducted at (sub)-regional level, as well as the Demographic and Health Surveys, which report at the first administrative subdivision [4]. Although the work so far has shown coarse sub-national disparities in CGF, it provides an incomplete picture on the common risk factors associated with child nutrition at national level. The factors associated with child under-nutrition are multi-factorial and interdependent [11]. A multi-stage clustered analysis that targets the distant, immediate and proximate determinants of CGF as per adopted by UNICEF [12] are required to fully determine predictors at national level.

Therefore, potential risk factors have been identified based on UNICEF conceptual framework model for child nutrition comprehensively for Ethiopian population to carry out clustered analysis. Analysis that fully exploits the complex nature of child under-nutrition ranging from community-, household-, environmental-, socioeconomic and cultural influences has identified for under 5 children in Ethiopia.

Hence, this study used data from the recent National Demographic and Health Survey (EDHS 2016) to determine the common risk factors for stunting, underweight and wasting among Ethiopian children aged 0-59 months. The outcome of the study will have policy implications and contributions for Ethiopia towards WHO member states broader agenda to improve nutrition by 2025 [1,4,13], including stunting, wasting, low birth weight and overweight in children under five, and further achieve Sustainable Development Goal (SDG) aimed to end all forms of malnutrition by 2030.

METHODS

Study design and data sources

This study analyzed data obtained from the 2016 Ethiopia Demographic and Health Survey (2016 EDHS) implemented by the Central Statistical Agency (CSA) from January 18, 2016 to June 27, 2016. The survey was conducted by the Central Statistical Agency (CSA) with ICF provided technical assistance through the DHS Program, a USAID-funded project providing support and technical assistance in the implementation of population and health surveys in countries worldwide [10]. The government of Ethiopia, the United States Agency for International Development (USAID), the government of the Netherlands, the Global Fund, Irish Aid, the World Bank, the United Nations Population Fund (UNFPA), the United Nations Children's Fund (UNICEF) and UN Women were sources of funding for to carry out the 2016 EDHS.

Administratively, Ethiopia has nine geographical regions and two administrative cities. The sample for the 2016 EDHS was designed to provide estimates of key indicators for the country as a whole, for urban and rural areas separately and for each of the nine regions and the two administrative cities. Sample was stratified and selected in two stages and each region was stratified into urban and rural areas, yielding sampling strata. First, a total of urban and rural areas were selected with probability proportional to enumeration areas (EAs) size and with independent selection in each sampling stratum and household listing were carried out in all the selected EAs. Then, a fixed number of households per cluster were selected with an equal probability systematic selection from the created household listing.

Accordingly, a total of 18,008 households sample were selected for the survey and of this 17,067 households were occupied. However, 16,650 were successfully interviewed

yielding a response rate of 98%. In the interviewed households, 16,583 eligible women were identified for individual interviews and interviews were completed with 15,683 women, yielding a response rate of 95%.

Of the total of 10,752 children under age 5 were eligible for height and weight measurements, 9696 children were included in our analysis. For some eligible children, however, complete or valid data were not obtained due to misclassifications or errors. Therefore, data of 8,855 children (for height-for-age), 8,919 children (for weight-for height) and 9,033 children (for weight-for-age) of eligible children with complete and credible measurement were analyzed.

Height and weight measurements were carried out on children under age 5 in all selected households. Weight measurements were obtained using lightweight SECA mother-infant scales with a digital screen designed and manufactured under the guidance of UNICEF. Height measurements were carried out using a Shorr measuring board, in recumbent position for under 2 years' old children while standing height was recorded for older children.

Dependent variables

The three main indicators used to define under-nutrition (i.e., underweight, stunting and wasting) represent different histories of nutritional insult to the child [14,15]. According to WHO Press [16], prevalence of moderate and severe stunting, underweight and wasting among children aged 0-59 months is defined as the proportion of children with a height-for-age, weight-for-height or weight-for-age z score that is more than two standard deviations below the 2006 WHO growth reference population, respectively.

Stunting (height-for-age): Height-for-age index identifies past under-nutrition or chronic malnutrition and it cannot measure short term changes in malnutrition [14]. Therefore, there is increasing agreement among the nutrition community about the use of length/height-for-age as the indicator to monitor the long-term impact of chronic nutritional deficiencies [17]. For children below 2 years of age, the term is length-for-age; above 2 years of age, the index is referred to as height-for-age. Children whose Height-for-age is below minus two standard deviations (−2SD) from the WHO Multicentre Growth Reference Study median [18] are classified as stunted.

Underweight (weight-for-age): Underweight, based on weight-for-age, is a composite measure of stunting and wasting and is recommended as the indicator to assess changes in the magnitude of malnutrition over time [14]. The advantage of this index is that it reflects both past (chronic) and/or present (acute) under-nutrition, but it cannot distinguish between the two. Children whose weight-for-age is below minus two standard deviations (−2SD) from the WHO Multicentre Growth Reference Study median [18] are classified as underweight.

Wasting (weight-for-height): The weight-for-height index measures body mass in relation to height and reflects current nutritional status [14]. The index is calculated using growth standards published by the WHO in 2006 [18]. These growth standards were generated through data collected in the WHO Multicentre Growth Reference Study [18] and expressed in standard deviation units from the Multicentre Growth Reference Study median. Children with weight-for-height Z-scores below minus two standard deviations (−2SD) from the median of the WHO reference population are considered wasted.

Independent variables

Based on the UNICEF general model for causes of malnutrition [12], the conceptual framework for child under nutrition in Ethiopia were prepared and potential risk factors were classified into five categories. These are community level factors, socio-demographic factors, environmental factors, media factors and proximate determinants, as presented in **Figure 1**. The figure also demonstrates the community level factors which included administrative zones and type of residence (urban or rural); whereas, socio-demographic, environmental and media factors were considered as household level determinants.

The national-level wealth quintiles were derived from the household wealth index, which serves as an indicator consistent with expenditure and income measures [10]. Households were given scores based on the number and kinds of consumer goods they own, ranging from a television to a bicycle or car, in addition to housing characteristics such as source of drinking water, toilet facilities, and flooring materials. These scores were derived using principal component analysis (PCA). National wealth quintiles were compiled by assigning the household score to each usual (de jure) household member, ranking each person in the household population by her (his) score and then dividing the distribution into five equal categories, each comprising 20% of the population. These five national-level wealth quintile categories are: poorest, poor, middle, rich and richest. The bottom 40% of the households was referred to as the poorest and poor households, the next 20% as the middle-class households and the top 40% as rich and richest households.

Moreover, environmental factors (includes source of drinking water and sanitation) were categorized into improved and unimproved as adapted from the WHO/UNICEF Joint Monitoring Programme report [19]. The proximate determinants were subdivided into maternal factors, delivery factors, pre/post-delivery factors and child factors.

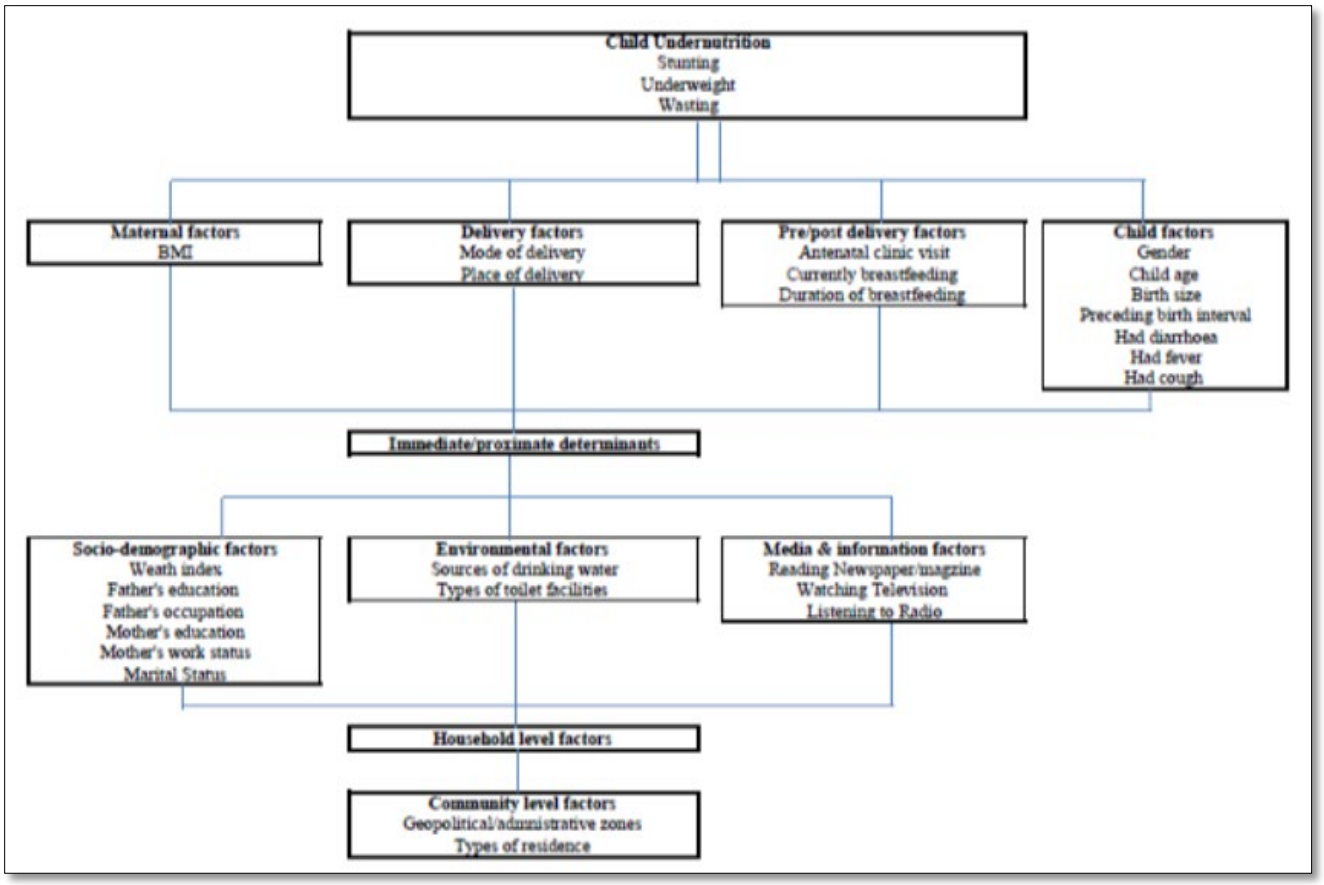

Figure 1. Conceptual framework for child under nutrition in Ethiopia, adapted from UNICEF conceptual framework [12].

STATISTICAL ANALYSIS

The index of child undernutrition including stunting, underweight and wasting were expressed as dichotomous variables. Then, these were examined against sets of independent variables in order to determine the factors associated with stunting, underweight and wasting in children under-five years in Ethiopia.

Data analyses were performed with IBM SPSS statistics (version 21.0) for Windows, taking into account the complex nature of the cluster sample design. A multivariable logistic regression analysis was conducted at multilevel, based on the conceptual framework adapted from UNICEF **(Figure 1)**. Each level factors, namely: community-level, household-level and immediate-level factors were entered into the model independently to determine their association with the outcome variables. During multivariate, a stepwise backward elimination was performed and factors significantly associated with the study outcomes were retained. In order to determine the adjusted risk of the independent variables, the odds ratios with 95% CI were calculated and those with $p<0.05$ were retained in the final model.

RESULTS

Characteristics of independent variables

Table 1 presents the characteristics of the study population. A total sample of 9696 eligible children aged 0-59 were included in the study. However, data were analyzed based on 8,855 (91%) for height-for-age, 8,919 (92%) for weight-for-height, and 9,033 (93%) for weight-for-age of eligible children with complete and credible measurement.

Table 1. Characteristics of independent variables in the study sample.

Characteristics of population (n=9696)	n	%
Administrative regions		
Addis Ababa	428	4.4
Afar	935	9.6
Amhara	911	9.4
Oromia	1457	15.0
Somalia	1337	13.8
Benishangul	798	8.2
SNNPR	1171	12.1
Gambela	631	6.5
Harari	552	5.7
Tigray	977	10.1
Dire Dawa	499	5.1
Residence		
Urban	1825	18.8
Rural	7871	81.2
Highest education level (respondent's/mother's)		
No education	6200	63.9
Primary	2459	25.4
Secondary	675	7.0
Higher	362	3.7
Types of toilet facility		
Improved	1662	17.1
Unimproved	7903	81.5
Others	131	1.4
Sources of drinking water		
Improved	5837	60.2
Unimproved	3762	38.8
Others	97	1.0
Religion		
Orthodox	2866	29.6
Catholic	60	0.6
Protestant	1708	17.6
Muslim	4898	50.5
Traditional	90	0.9
Other	74	0.8

Frequency of reading newspaper/magazine		
No/less than once a week	9525	98.2
At least once a week	171	1.8
Frequency of listening to radio		
No/less than once a week	8535	88.0
At least once a week	1161	12.0
Frequency of watching TV		
No/less than once a week	8435	87.0
At least once a week	1261	13.0
Wealth index		
Poorest	3577	36.9
Poor	1633	16.8
Middle	1358	14.0
Richer	1189	12.3
Richest	1939	20.0
Last birth in a caesarean section		
No	9403	97.0
Yes	293	3.0
Body mass index (BMI)		
Thin (BMI<18.5)	2221	23.8
Normal (BMI 8.5-24.9)	6227	66.9
Overweight/ obese (BMI $\geq$ 25.0)	890	9.5
Current marital status		
Married/living with partner	9160	94.5
Widowed/divorced/separated or never in union	536	5.5
Husband/partner's educational level		
No education	4474	49.2
Primary	2972	32.7
Secondary	934	10.3
Higher	708	7.8
Respondent work (last 12 months)		
Non-working	7000	77.2
Working	2696	27.8
Sex of child		
Male	4940	50.9
Female	4756	49.1
Child age (months)		

0-11 months	2112	21.8
12-23 months	1905	19.6
24-35 months	1863	19.2
36-47 months	1836	18.9
48-59 months	1980	20.4
Preceding in birth interval (months)		
No	1935	20.0
Less than 24 months	1838	19.0
24 months and above	5923	61.1
Duration of breastfeeding		
Never breastfed	367	3.8
Ever breastfed, not currently breastfeeding	5098	52.6
Still breastfeeding	4231	43.6
Number of antenatal visits during pregnancy (weeks)		
No antenatal visits	2266	33.7
1-3 times	1996	29.6
4+ times	2472	33.7
Place of delivery		
Home	6442	66.4
Health facility	3144	32.4
Others	110	1.1
Delivery by caesarean option		
No	9414	97.1
Yes	282	2.9
Perceived size of child at birth		
Small	2603	27.1
Average	4081	42.5
Large	2912	30.3
Had diarrhea recently		
No	8605	88.9
Yes, last two weeks	1076	11.1
Had fever (last two weeks)		
No	8348	86.2
Yes	1341	13.8
Had cough (last two weeks)		
No	8134	83.9
Yes, last two weeks	1560	16.1

Dependent variables

Table 2 shows prevalence rate of undernutrition categorized by child age and types of residence in the study setting. Despite there exists differences by geographic area and child age, the overall prevalence of stunting, underweight and wasting were found to be 37.8%, 26.8% and 12.9%, respectively. Higher prevalence of stunting (26.5%) and underweight (18.0%) has been observed among children in the later-age group (24-59 months) when compared with children under 2 years of age. Moreover, the prevalence of stunting and underweight was nearly two-fold higher among children residing in rural as compared to those in urban.

Table 2. Prevalence of stunting, underweight and wasting among children aged 0-59 months in Ethiopia.

Variables	Proportion of child malnutrition*		
	n (%), Stunted (moderate and sever)	n (%), Underweight (moderate and sever)	n (%), Wasted (moderate and sever)
Age of child (months)			
0-11	285 (3.2)	299 (3.3)	332 (3.7)
12-23	706 (8.0)	495 (5.5)	279 (3.1)
24-35	844 (9.5)	541 (6.0)	189 (2.1)
36-47	810 (9.1)	523 (5.8)	149 (1.7)
48-59	703 (7.9)	562 (6.2)	200 (2.2)
Type of residence			
Urban	407 (25.0)	248 (15.0)	170 (10.5)
Rural	2941 (40.7)	2172 (29.4)	979 (13.4)
Overall	3348 (37.8)	2420 (26.8)	1149 (12.9)

** Number of children included in to analysis (n) was 8855, 9033 and 8919 for stunting, underweight and wasting, respectively. There is a highly significant difference in stunting, underweight and wasting by child age and place of residence at p vales ≤ 0.001*

Common risk factors associated with under-nutrition

Table 3 presents multiple level analysis (COR/AOR: 95% CI) of common risk factors associated with stunted, underweight and wasted children aged 0-59 months in Ethiopia. Children living outside the capital (Addis Ababa) were significantly more predisposed to stunting, underweight and wasting than those in the capital. Children of uneducated parents and residing in rural areas had significantly higher odds of being stunned and underweight compared with those of educated parents and dwelling in urban areas.

Table 3. Multiple level analysis (COR/AOR: 95% CI) of common risk factors associated with stunted, underweight and wasted children aged 0-59 months in Ethiopia.

Characteristics	STUNTED CHILDREN 0-59 MONTHS				UNDERWEIGHT CHILDREN 0-59 MONTHS				WASTED CHILDREN 0-59 MONTHS			
	Unadjusted Odd Ratio (95% CI)	*p*	Adjusted Odd Ratio (95% CI)	*p*	Unadjusted Odd Ratio (95% CI)	*p*	Adjusted Odd Ratio (95% CI)	*p*	Unadjusted Odd Ratio (95% CI)	*p*	Adjusted Odd Ratio (95% CI)	*p*
3(a): Community level predictors												
Administrative regions												
Addis Ababa	1.00		1.00		1.00		1.00		1.00		1.00	

Afar	4.52 [3.33, 6.13]	<0.001	2.86 [2.05, 3.98]	<0.001	13.9 [8.63, 22.6]	<0.001	7.90 [4.78, 13.1]	<0.001	6.02 [3.55, 10.2]	<0.001	5.19 [2.98, 9.05]	<0.001
Amhara	5.39 [3.98, 7.30]	<0.001	3.41 [2.46, 4.74]	<0.001	8.83 [5.45, 14.3]	<0.001	4.99 [3.02, 8.27]	<0.001	2.70 [1.57, 4.66]	<0.001	2.33 [1.31, 4.13]	<0.001
Oromia	3.31 [2.47, 4.44]	<0.001	2.04 [1.48, 2.82]	<0.001	6.37 [3.96, 10.3]	<0.001	3.51 [2.13, 5.79]	<0.001	3.10 [1.83, 5.25]	<0.001	2.65 [1.52, 4.63]	<0.001
Somali	2.16 [1.60, 2.92]	<0.001	1.43 [1.04, 1.98]	0.03	7.82 [4.85, 12.6]	<0.001	4.73 [2.88, 7.76]	<0.001	6.86 [4.08, 11.5]	<0.001	6.02 [3.50, 10.3]	<0.001
Benishangul	4.60 [3.37, 6.26]	<0.001	2.86 [2.04, 4.01]	<0.001	11.2 [6.86, 18.1]	<0.001	6.19 [3.72, 10.3]	<0.001	2.96 [1.71, 5.14]	<0.001	2.54 [1.42, 4.54]	<0.001
SNNPR	3.61 [2.68, 4.87]	<0.001	2.26 [1.63, 3.14]	<0.001	6.00 [3.71, 9.71]	<0.001	3.36 [2.03, 5.56]	<0.001	1.71 [0.99, 2.98]	0.06	1.47 [0.82, 2.63]	0.19
Gambela	2.11 [1.52, 2.94]	<0.001	1.45 [1.03, 2.05]	0.04	5.56 [3.36, 9.17]	<0.001	3.47 [2.07, 5.83]	<0.001	4.09 [2.36, 7.10]	<0.001	3.62 [2.05, 6.41]	<0.001
Harari	2.74 [1.96, 3.83]	<0.001	1.93 [1.36, 2.75]	<0.001	5.50 [3.30, 9.17]	<0.001	3.53 [2.09, 5.97]	<0.001	3.14 [1.77, 5.59]	<0.001	2.81 [1.56, 5.07]	<0.001
Tigray	3.91 [2.89, 5.29]	<0.001	2.57 [1.85, 3.55]	<0.001	7.18 [4.43, 11.6]	<0.001	4.23 [2.56, 6.99]	<0.001	3.22 [1.88, 5.51]	<0.001	2.81 [1.60, 4.92]	<0.001
Dire Dawa	3.86 [2.76, 5.40]	<0.001	2.92 [2.07, 4.12]	<0.001	7.94 [4.79, 13.2]	<0.001	5.52 [3.29, 9.24]	<0.001	2.77 [1.54, 5.00]	<0.001	2.53 [1.39, 4.61]	<0.001
Types of residence												
Urban	1.00		1.00		1.00		1.00		1.00		1.00	
Rural	2.05 [1.82, 2.32]	<0.001	1.65 [1.44, 1.90]	<0.001	2.37 [2.05, 2.73]	<0.001	1.86 [1.59, 2.18]	<0.001	1.32 [1.11, 1.57]	<0.001	1.18 [0.97, 1.42]	0.10

Administrative regions and types of residence were community-level variables adjusted in the model; COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; CI: Confidence Interval

Characteristics	STUNTED CHILDREN 0-59 MONTHS				UNDERWEIGHT CHILDREN 0-59 MONTHS				WASTED CHILDREN 0-59 MONTHS			
	Unadjusted Odd Ratio (95% CI)	***p***	**Adjusted Odd Ratio (95% CI)**	***p***	**Unadjusted Odd Ratio (95% CI)**	***p***	**Adjusted Odd Ratio (95% CI)**	***p***	**Unadjusted Odd Ratio (95% CI)**	***p***	**Adjusted Odd Ratio (95% CI)**	***p***
3 (b): Household level: predictors												
Mothers' higher education level												
No education	1.00		1.00		1.00		1.00		1.00		1.00	
Primary	3.92 [2.88, 5.34]	<0.001	0.92 [0.82, 1.04]	0.18	0.58 [0.52, 0.65]	<0.001	0.75 [0.66, 0.861	<0.001	0.72 [0.61, 0.83]	<0.001	0.85 [0.72, 1.02]	0.08
Secondary	3.03 [2.21, 4.16]	<0.001	0.65 [0.51, 0.82]	<0.001	0.32 [0.25, 0.41]	<0.001	0.55 [0.41, 0.731	<0.001	0.59 [0.44, 0.79]	<0.001	0.84 [0.59, 1.19]	0.32
Higher	1.58 [1.10, 2.26]	0.01	0.53 [0.36, 0.77]	<0.001	0.18 [0.12, 0.27]	<0.001	0.41 [0.25, 0.671	<0.001	0.46 [0.30, 0.71]	<0.001	0.78 [0.46, 1.34]	0.37
Sources of drinking water												
Improved sources	1.00		1.00		1.00		1.00		1.00		1.00	
Unimproved sources	0.79 [0.51, 1.20]	0.26	0.88 [0.79, 0.97]	0.01	1.30 [1.18, 1.43]	<0.001	0.88 [0.80, 0.981	0.02	1.30 [1.15, 1.48]	<0.001	1.04 [0.91, 1.20]	0.58
Others	0.90 [0.59, 1.38]	0.64	1.16 [0.73, 1.85]	0.53	1.30 [0.83, 2.06]	0.25	1.12 [0.67, 1.891	0.66	0.96 [0.49, 1.85]	0.89	0.84 [0.40, 1.75]	0.64
Frequency of reading newspaper or magazine												
No/less than once a week	1.00		1.00		1.00		1.00		1.00		1.00	
At least once a week	2.26 [1.53, 3.32]	<0.001	1.05 [0.69, 1.59]	0.83	0.37 [0.23, 0.61]	<0.001	1.09 [0.64, 1.851	0.75	0.62 [0.35, 1.10]	0.10	1.13 [0.60, 2.12]	0.70
Frequency of listening radio												
Not at all/less than once a week	1.00		1.00		1.00		1.00		1.00		1.00	
At least once a week	1.56 [1.36, 1.79]	<0.001	0.90 [0.78, 1.05]	0.20	0.57 [0.49, 0.67]	<0.001	0.91 [0.77, 1.09]	0.33	0.67 [0.54, 0.83]	<0.001	0.95 [0.75, 1.20]	0.68
Frequency of watching television												

Not at all/less than once a week	1.00		1.00		1.00		1.00		1.00		1.00	
At least once a week	2.45 [2.11, 2.84]	<0.001	0.78 [0.63, 0.96]	0.02	0.29 [0.24, 0.36]	<0.001	0.65 [0.50, 0.841	<0.001	0.37 [0.28, 0.48]	<0.001	0.45 [0.32, 0.62]	<0.001
Wealth index												
Poorest	1.00		1.00		1.00		1.00		1.00		1.00	
Poorer	2.26 [1.98, 2.57]	<0.001	1.09 [0.96, 1.24]	0.19	0.90 [0.79, 1.02]	0.10	0.94 [0.82, 1.07]	0.33	0.60 [0.50, 0.72]	<0.001	0.62 [0.52, 0.75]	<0.001
Middle	2.55 [2.19, 2.95]	<0.001	0.88 [0.77, 1.02]	0.08	0.66 [0.57, 0.76]	<0.001	0.71 [0.61, 0.821	<0.001	0.60 [0.49, 0.73]	<0.001	0.59 [0.48, 0.73]	<0.001
Richer	1.97 [1.68, 2.30]	<0.001	0.74 [0.64, 0.87]	<0.001	0.44 [0.37, 0.52]	<0.001	0.48 [0.40, 0.57]	<0.001	0.46 [0.36, 0.57]	<0.001	0.48 [0.38, 0.60]	<0.001
Richest	1.70 [1.44, 2.00]	<0.001	0.70 [0.58, 0.84]	<0.001	0.30 [0.26, 0.35]	<0.001	0.53 [0.42, 0.651	<0.001	0.42 [0.35, 0.51]	<0.001	0.62 [0.48, 0.80]	<0.001

3 (b) continued….

Character-istics	UNDERWEIGHT CHILDREN 0-59 MONTHS								
	Unadjusted Odd Ratio (95% CI)	***p***	**Unadjusted Odd Ratio (95% CI)**	***p***	**Adjusted Odd Ratio (95% CI)**	***p***	***p***	**Adjusted Odd Ratio (95% CI)**	***p***
Husband/partner's education level									
No education	1.00		1.00		1.00			1.00	
Primary	0.79 [0.72, 0.87]	<0.001	0.62 [0.56, 0.70]	<0.001	0.80 [0.71, 0.90]	<0.001	<0.001	0.84 [0.72, 0.98]	0.02
Secondary	0.56 [0.48, 0.66]	<0.001	0.50 [0.42, 0.60]	<0.001	0.96 [0.78, 1.18]	0.71	0.13	1.23 [0.97, 1.56]	0.08
Higher	0.35 [0.28, 0.42]	<0.001	0.31 [0.24, 0.39]	<0.001	0.80 [0.60, 1.07]	0.13	<0.001	1.00 [0.74, 1.34]	0.97
Husband/partner's occupation									
Did not work	1.00		1.00		1.00			1.00	
Agricultural	1.54 [1.32, 1.80]	<0.001	1.23 [1.04, 1.45]	0.01	1.30 [1.10, 1.54]	<0.001	0.51	1.03 [0.83, 1.28]	0.77
Non-agriculture	0.90 [0.76, 1.06]	0.21	0.71 [0.59, 0.85]	<0.001	1.10 [0.91, 1.33]	0.31	0.18	1.20 [0.95, 1.51]	0.14
Mothers' worked in the last 12 months									
Non-working	1.00		1.00		1.00			1.00	
Working	1.03 [0.93, 1.13]	0.60	0.91 [0.82, 1.01]	0.08	1.08 [0.96, 1.21]	0.21	0.03	0.92 [0.79, 1.08]	0.32

Marital status									
Married/living with partner	1.00		1.00						
Widowed/divorced/separated/never in union	0.98 [0.82, 1.19]	0.87	0.99 [0.81, 1.22]	0.95			0.60		

Mother's education, sources of drinking water, media (newspaper, radio, television), wealth index, husband's/partner's education/occupation, and mother's work were household-level variables adjusted in the model; AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

Characteristics	**STUNTED CHILDREN 0-59 MONTHS**				**UNDERWEIGHT CHILDREN 0-59 MONTHS**				**WASTED CHILDREN 0-59 MONTHS**			
	Unadjusted Odd Ratio [95% CI]	***p***	**Adjusted Odd Ratio [95% CI]**	***p***	**Unadjusted Odd Ratio [95% CI]**	***p***	**Adjusted Odd Ratio [95% CI]**	***p***	**Unadjusted Odd Ratio [95% CI]**	***p***	**Adjusted Odd Ratio [95% CI]**	***p***
3 (c): Proximate/Immediate level												
Currently breastfeeding												
No	1.00		1.00		1.00		1.00		1.00		1.00	
Yes	0.89 [0.81, 0.97]	0.01	1.49 [1.29, 1.73]	<0.001	0.96 [0.87, 1.06]	0.40	1.08 [0.74, 1.58]	0.67	1.29 [1.13, 1.48]	<0.001	1.05 [0.85, 1.29]	0.68
Body Mass Index												
Thin (BMI <18.5)	1.00				1.00		1.00		1.00		1.00	
Normal (BMI 18.5-24.9)	0.84 [0.76, 0.93]	<0.001	0.00 [0.80, 0.70]	0.92	0.61 [0.54, 0.67]	<0.001	0.56 [0.49, 0.64]	<0.001	0.57 [0.50, 0.66]	<0.001	0.67 [0.57, 0.80]	<0.001
Overweight/Obese (BMI >=25.0)	0.37 [0.30, 0.44]	<0.001	0.00 [0.46, 0.36]	0.59	0.23 [0.18, 0.29]	<0.001	0.29 [0.22, 0.39]	<0.001	0.34 [0.25, 0.45]	<0.001	0.47 [0.34, 0.66]	<0.001
Sex of child												
Male	1.00		1.00		1.00		1.00		1.00		1.00	
Female	0.88 [0.81, 0.96]	<0.001	0.84 [0.75, 0.94]	<0.001	0.86 [0.79, 0.95]	<0.001	0.79 [0.70, 0.89]	<0.001	0.81 [0.72, 0.92]	<0.001	0.77 [0.66, 0.89]	<0.001
Current age of a child												
0-11+ months	1.00		1.00		1.00		1.00		1.00		1.00	
12-23+ months	3.71 [3.17, 4.35]	<0.001	4.11 [3.48, 4.85]	<0.001	2.11 [1.80, 2.48]	<0.001	2.17 [1.83, 2.57]	<0.001	0.87 [0.73, 1.03]	0.10	0.88 [0.74, 1.06]	0.17

24-35+ months	5.55 [4.74, 6.49]	<0.001	8.61 [7.11, 10.43]	<0.001	2.53 [2.16, 2.97]	<0.001	3.19 [2.63, 3.87]	<0.001	0.57 [0.47, 0.69]	<0.001	0.52 [0.42, 0.65]	<0.001
36-47+ months	5.32 [4.54, 6.24]	<0.001	8.73 [6.95, 10.95]	<0.001	2.51 [2.14, 2.95]	<0.001	3.12 [2.46, 3.94]	<0.001	0.45 [0.37, 0.55]	<0.001	0.37 [0.27, 0.50]	<0.001
48-59 months	3.76 [3.21, 4.40]	<0.001	5.29 [4.10, 6.82]	<0.001	2.59 [2.21, 3.04]	<0.001	2.84 [2.18, 3.70]	<0.001	0.59 [0.49, 0.71]	<0.001	0.44 [0.32, 0.60]	<0.001
Preceding birth interval												
No	1.00		1.00		1.00		1.00		1.00		1.00	
Less than 24 months	1.43 [1.24, 1.64]	<0.001	1.24 [1.02, 1.51]	0.03	1.84 [1.58, 2.14]	<0.001	1.73 [1.40, 2.13]	<0.001	1.48 [1.22, 1.80]	<0.001	1.30 [1.01, 1.68]	0.04
24 months and above	1.15 [1.03, 1.28]	0.02	1.06 [0.91, 1.24]	0.42	1.28 [1.13, 1.45]	<0.001	1.31 [1.11, 1.56]	<0.001	1.11 [0.94, 1.31]	0.23	1.08 [0.88, 1.33]	0.47
Number of antenatal visit during pregnancy												
No antenatal visits	1.00		1.00		1.00		1.00		1.00		1.00	
1-3 times	0.84 [0.74, 0.96]	0.01	0.99 [0.85, 1.14]	0.85	0.79 [0.69, 0.91]	<0.001	0.96 [0.83, 1.12]	0.60	1.00 [0.84, 1.19]	0.97	1.11 [0.92, 1.34]	0.26
4+ times	0.64 [0.57, 0.73]	<0.001	0.83 [0.71, 0.97]	0.02	0.51 [0.45, 0.59]	<0.001	0.72 [0.61, 0.85]	<0.001	0.63 [0.53, 0.76]	<0.001	0.80 [0.65, 0.99]	0.04
Don't know	1.45 [0.51, 4.16]	0.49	1.87 [0.58, 5.97]	0.29	0.15 [0.02, 1.13]	0.07	0.16 [0.02, 1.23]	0.08	0.00 [0.00, --]	1.00	0.00 [0.00, - -]	1.00

3 (c): continued …

Characteristics	**UNDERWEIGHT CHILDREN 0-59 MONTHS**									
	Unadjusted Odd Ratio [95% CI]	***p***	**Adjusted Odd Ratio [95% CI]**	**Unadjusted Odd Ratio [95% CI]**	***p***	**Adjusted Odd Ratio [95% CI]**	**Unadjusted Odd Ratio [95% CI]**	***p***	**Adjusted Odd Ratio [95% CI]**	***p***
Place of delivery										
Home	1.00		1.00	1.00		1.00	1.00		1.00	

Health facility	0.57 [0.52, 0.63]	<0.001	0.78 [0.67, 0.90]	0.47 [0.42, 0.52]	<0.001	0.72 [0.61, 0.84]	0.66 [0.57, 0.76]	<0.001	0.76 [0.63, 0.92]	0.01
Others	1.12 [0.76, 1.66]	0.57	1.31 [0.83, 2.08]	0.94 [0.62, 1.42]	0.77	1.17 [0.73, 1.88]	0.69 [0.37, 1.30]	0.25	0.78 [0.41, 1.50]	0.46
Delivery by caesarian section										
No	1.00		1.00	1.00		1.00	1.00		1.00	
Yes	0.40 [0.29, 0.55]	<0.001	0.73 [0.51, 1.06]	0.34 [0.23, 0.50]	<0.001	0.78 [0.50, 1.22]	0.76 [0.50, 1.14]	0.19	1.16 [0.72, 1.88]	0.54
Size of a child at birth										
Small	1.00		1.00	1.00		1.00	1.00		1.00	
Average	0.75 [0.68, 0.84]	<0.001	0.66 [0.57, 0.75]	0.61 [0.54, 0.68]	<0.001	0.59 [0.51, 0.68]	0.63 [0.55, 0.73]	<0.001	0.73 [0.61, 0.86]	<0.001
Large	0.62 [0.55, 0.69]	<0.001	0.53 [0.45, 0.61]	0.47 [0.42, 0.54]	<0.001	0.45 [0.38, 0.52]	0.54 [0.46, 0.63]	<0.001	0.61 [0.50, 0.74]	<0.001
Had diarrhea recently										
No	1.00		1.00	1.00		1.00	1.00		1.00	
Yes, last two weeks	1.09 [0.96, 1.25]	0.19	1.25 [1.03, 1.52]	1.27 [1.10, 1.46]	<0.001	1.28 [1.07, 1.53]	1.23 [1.03, 1.48]	0.03	1.08 [0.87, 1.35]	0.48
Had fever in last two weeks										
No	1.00		1.00	1.00		1.00	1.00		1.00	
Yes	1.12 [1.00, 1.27]	0.06	1.15 [0.99, 1.34]	1.20 [1.06, 1.37]	0.01	1.11 [0.94, 1.32]	1.31 [1.11, 1.55]	<0.001	1.23 [1.02, 1.49]	0.03
Had cough in last two weeks										
No	1.00			1.00		1.00	1.00		1.00	
Yes, last two weeks	1.09 [0.97, 1.22]	0.15		1.04 [0.92, 1.18]	0.52	0.96 [0.82, 1.12]	1.08 [0.91, 1.27]	0.38	0.94 [0.75, 1.17]	0.56
Duration of breastfeeding										
Never breastfed	1.00			1.00		1.00	1.00		1.00	

Ever breastfed, not currently breastfeeding	1.24 [0.99, 1.55]	0.07		1.08 [0.84, 1.38]	0.55	0.79 [0.67, 0.92]	0.86 [0.61, 1.20]	0.36	1.07 [0.64, 1.82]	0.79
Still breastfeeding	0.82 [0.65, 1.03]	0.09		0.80 [0.62, 1.02]	0.07		1.30 [0.93, 1.81]	0.13		

Breastfeeding status, mother's BMI; sex of child, age of child; birth interval, antenatal visit; place (types) of delivery, and Child health status (diarrhea, fever) were proximate-level variables adjusted in the model
BMI: Body Mass Index; AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio

Taking into account household wealth index as an indicator consistent with expenditure and income measures; children living in households categorized to lowest national-level wealth quintiles and that do not/least watch television had significantly higher odds of their children being stunted, underweight and wasted as compared with those residing in higher wealth quintile and exposed to the media frequently.

Moreover, children of Mothers with BMI less than 18.5 kg/m^2 were significantly more susceptible to underweight and wasting than mothers with BMI greater than 18.5 kg/m^2. Male children were significantly more predisposed to stunting, underweight and wasting than those of female children. Children in the late-aged group (≥ 12 months) had significantly higher odds of being stunned and underweight compared with those under 12 months of age; while, the later had significantly higher odds of being wasted.

Lastly, children who were delivered at home/other places and children who were perceived to be small by their mothers at birth were more likely to be stunned, underweight and wasted than those delivered at a health facility and perceived to have been average/large. Child's health status was also significantly associated with underweight. Children who had diarrhea in the two weeks preceding the survey were more likely to be underweight compared with children who had not been contracted diarrhea.

DISCUSSION

This study has explored the updated national-level prevalence of undernutrition among under five years' children, and common risk factors associated with stunting, underweight and wasting in Ethiopia. Our analysis reported higher national-level of undernutrition among children under age five; with 37.8% stunted, 26.8% underweight and 12.9% wasted. However, there exist some clear geographic inequalities (urban-rural) and variations by child's age. Children age 24-59 months were the most affected by stunting, underweight and wasting; whereas, relatively lower rates were observed among under 1 year infants **(Table 2)**. It's even very interestingly to note that the rate of stunting and underweight among the three child-age brackets (i.e., 0-11 months, 12-23 months and 24-59 months) has increased geometrically with an increased child-age bracket, almost by double and triple, respectively.

The prevalence rate of child undernutrition recorded in our study is still higher than the Joint Child Malnutrition Estimates by UNICEF/WHO/World Bank Group for African in 2017 [20], which reported 31.2% stunting, 5.2% underweight and 7.4% wasting in the region. Despite moving in the right direction, our finding reveals that Ethiopia has been making insufficient progress to reach the World Health Assembly targets set for 2025 and the Sustainable Development Goals set for 2030. Therefore, the country need to put more effort in improving children's nutrition, which requires effective and sustained multi-sectoral nutrition programming over the long-term. This makes our finding important to monitor and analyze country progress going forward in relation to United Nations targeted goal of improving child nutrition.

Child undernutrition increases the risk of neonatal and child mortality and future maternal reproductive outcomes [4]. Child growth failure (CGF) is the specific subset of child under-nutrition, excluding micronutrient deficiencies, that is characterized by the relationship between insufficient height and weight at a given age and this subset is most universally described in terms of univariate 'growth standards', for which age-specific heights and weights are compared to healthy reference populations.

By the Millennium Development Goal (MDG) era, Ethiopia achieved a slight reduction in under-5 and neonatal mortality [10]. Yet, the pace of progress toward these goals substantially varied at the sub-national level, demonstrating an essential need for tracking even more local trends in child mortality in Ethiopia. Our study here has provided not only estimates for national prevalence of undernutrition but also a comprehensive assessment of risk factors associated with stunting, underweight and wasting to inform policy makers. The importance of addressing risks factors in context and informs the need for more efforts to reduce child undernutrition in the country.

Despite expected disparities over time, geographic inequalities persisted among countries with the lowest and highest child mortality rates [1]; the underlying causes of child malnutrition are similar across all countries in SSA and globally as outlined in the UNICEF conceptual framework for child nutrition [12]. Malnutrition is a multi-sectoral, multi-level problem that results from the complex interplay

between household and individual decision-making, agri-food, health and environmental systems that determine access to services and resources and related policy processes [21]. Food intake or infection or a combination of the two and other factors including poverty, low parental education, poor feeding practices, economic status, residence, family size, living in developing countries, number of under five children in one family, as well as urban and rural differences [3].

East Africa has the potential and capacity to produce enough food for its local consumption and a large surplus for export to the world market [22]. However, the region is grossly affected by natural and manmade factors such as population growth, food shortages, unfavorable climatic and drought conditions as well as limited access to land for agricultural purposes [9]. These factors seriously undermine progress toward improving agricultural productivity, food and nutrition security to promote child nutrition in the region.

Leveraging Agriculture for Nutrition in East Africa (LANEA) mapped evidence across agriculture—nutrition pathways in East Africa and reported that effective food systems had positive impact on child nutrition [21]. However, most households in SSA do not have adequate nutrition knowledge for decision making that accounts for the full cost-benefit analysis of a balanced diet. Feeding practices in typical African households are mostly geared to abetting hunger as a singularity [23] and so nutrition is rarely considered or factored into food security strategies. As a result, they miss opportunities to diversify their diet beyond cereal based foods around other nutrient-rich food stuffs such as pulses, seeds and animal source foods. All these factors affect the nutritional status of an individual child and may eventually lead to chronic under-nutrition especially, among low income urban and most rural households.

In the present study, children who resided in the rural area and outside the capital (Addis Ababa) of Ethiopia had a significantly higher risk of being stunned, underweight and wasted. Children living outside capital, especially, Amhara, Benishangul-Gumuz, Afar and Dire Dawa regions had significantly higher odds of being stunted and underweight. Whereas, children residing in Somali, Afar and Benishangul-Gumuz region had significantly higher odds of being wasted compared with those in capital. This could be due to big variations in diversities between geopolitical regions in terms of resources, agricultural production and food security [24] and other factors such as feeding practices, access to education and household wealth [10]. Regions outside capital such as Amhara, Tigray, Oromia, SNNPR, Somali, Benishangul Gumuz and Gambella one way or the other partly characterized by sub-optimal agricultural production and even some are acutely food insecure due to recurrent El Niño contributing to the worst drought in more than 50 years in Ethiopia [24].

Moreover, the proportions of children who are stunted and underweight decline with increasing mother's education and increasing household wealth. National study (EDHS 2016) also confirms that children born to mothers with higher education and household wealth were more likely to receive breastfeeding including pre-lacteal feeding, compared with children of mothers with lower education level and household wealth [10]. Although, there is a significant regional variation exists in the proportion of children who receive the minimum acceptable diet; children in urban areas (19%) are more likely to fed according to the minimum acceptable dietary standards than those in rural areas (6%); with the highest level of 27% in Addis Ababa and the lowest levels (2-3%) in Affar, Somali and Amhara [10]. However, the likelihood that a child is receiving the minimum acceptable diet generally improves with the mother's education level and household wealth, demonstrating the importance of working on educating mothers and improving household wealth in the course of alleviating child undernutrition.

In addition, sex of a child, mother's perception of the birth size of their child and place of delivery were significantly associated with the three indicators of child growth outcome in the study setting. Children who were delivered at home/other places and children who were perceived to be small by their mothers at birth were more likely to be stunned, underweight and wasted than those delivered at a health facility and perceived to have been average/large. This is consistent with results of previous studies in Nigeria [11] that reported birth size as a valid indicator of nutritional status demonstrating the importance of women's health and prenatal care for giving their offspring a better chance in life.

The present finding highlights the importance of adequate nutrition during the first 1000 days, beginning at conception and extending through to the second birthday of a child, is a critical window for preventing undernutrition and its long-term consequences [23,25,26]. Poor feeding practices during this vulnerable period can increase the risk of undernutrition, and this can impair the physical and cognitive development, weaken the ability of the child to fight against deadly infectious diseases [27] and eventually leading to reduced school performance, lower economic productivity, shorter adult stature and decreased offspring birth weight in long-terms.

Moreover, children delivered at home tend to have poorer nutritional status than children delivered at a health facility in the study population. This finding is consistent with similar studies in other African countries [11]. Usually, home delivery is practiced by women of lower educational status [11,28]; and such women are tending to lack the necessary knowledge needed to make informed decisions concerning the health of their child. And also, women who deliver at home miss out the opportunity for the valuable post-natal counseling provided at the health facilities, which

may help in improving the nutritional status of both mother and child.

Although, the basic biological reason for it is not clear; our finding shows male children sustains a significantly higher risk of being undernourished compared with their female counterparts. This finding is consistent with a meta-analysis of 16 demographic and health surveys in SSA that reported boys to be more stunted than girls [29]. In SSA, male children under five years of age are more likely to become stunted than females, which might suggest that boys are more vulnerable to health inequalities than their female counterparts in the same age groups. In several of the surveys, sex differences in stunting were more pronounced in the lowest socioeconomic status (SES) groups.

Study shows that changes in maternal BMI correlates with long term changes in childhood malnutrition [30]. Our present study also shows that children whose mothers had a BMI less than 18.5 kg/m^2 were significantly more likely to be underweight and wasted than those whose mothers had a higher BMI than 18.5 kg/m^2. A similar cross-sectional study conducted in Nigeria also reported same findings [11], demonstrating the need to work on improving in maternal BMI as one of the strategy to reduce childhood malnutrition. In this regards, encouraging experience has been reported from Bangladesh [30], which indicated that without significant nutritional transition among under 5 years' children; improvement in maternal BMI over the past 15 years was accompanied by a reduction in malnutrition in under 5 years.

Several literatures including PATH communication message [31] and *Lancet Series* [32] indicated that good nutrition is essential for child growth, development, and immune system function to boost children's defenses against infectious diseases like diarrhea. However, the children most vulnerable to diarrheal disease are often malnourished. The relentless cycle of malnutrition and diarrhea places a great burden on developing countries and on children, in particular. In consistent with the message, our study also shows that children who suffered a contraction of diarrhea in the two weeks preceding the survey tend to be more nutritionally deprived than children who did not. This suggests that, addressing malnutrition within an integrated approach against diarrheal disease is key in helping children reach their full potential.

Reports from Brown [33] also confirmed the deleterious effect of diarrhea on children's nutritional status. Thus, promotion of breastfeeding to prevent diarrhea and reduce its nutritional complications, continued feeding during illness and supplementation with selected micronutrients, both to prevent enteric infections and to reduce their severity, are all important nutritional aspects in the control of diarrheal diseases and their associated nutritional complications.

At last, our study presents the significance of household's exposure to information in improving child nutrition. Children from households who were exposed to information, particularly television are less prone to child undernutrition. This finding is also similar to that of a cross-sectional study conducted in Nigeria [11], which reported a positive association between frequent exposure to television and improved child malnutrition.

The strength of this study lies in the fact that prevalence estimates for child undernutrition are relatively robust, allowing the possibility to track national changes over time. The national estimates presented here are based on data from national household surveys. The analysis based data population-based with a large sample size covering most part of the country and used most updated national data available (2016 DHS dataset) to estimate the prevalence of stunting, underweight and wasting. However, due to the cross-sectional nature of the study design, the association between observed risk factors and the dependent variables might not be necessarily causal relationship.

Moreover, national household surveys data are collected infrequently and measure malnutrition at one point in time (e.g. during several months of field work), making it difficult to capture the rapid fluctuations in wasting that can occur over the course of a given year, as incidence data (i.e., the number of new cases that occur during the calendar year) would allow for better tracking of changes over time, do not exist.

CONCLUSION

In conclusion, our study highlights the need for multi-sectoral intervention approach in addressing the multiple level causes of child under-nutrition, demanding to adopt a multi-strategy community-based approach that targets the immediate, underlying and basic determinants. At the individual level, interventions should focus on educating mothers on the basics of proper nutrition and the need to make necessary preparation such as adequate maternal nutrition for optimal BMI before and during pregnancy and lactation. Broad approaches targeting women's socio-economic status and nutrition of the mother is importantly needed from before conception as well as throughout pregnancy and breastfeeding.

At the community level, healthcare systems that facilitate public health interventions such as maternal-and-child health programs need to be made accessible to women in rural areas. There is also a need for interventions to promote health care seeking and the treatment of childhood infections including diarrhea, as well as maternal health and nutrition (before) during pregnancy to reduce low birth weight in children. Then after; optimal breastfeeding in the first two years of life, nutritious and safe foods in early childhood and a healthy environment including access to basic services are key ingredients to prevent child under-nutrition.

ACKNOWLEDGMENT

We acknowledge archives and data managers of the Demographic and Health Surveys (DHS) Program, ICF (USA) for authorizing to download Survey data from the Demographic and Health Surveys (DHS) Program.

FINANCIAL SUPPORT

This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

CONFLICT OF INTEREST

N/A

AUTHORSHIP

Mr. Berra conceived and designed the study, implementation, data interpretation, wrote the manuscript and provided critical revisions of the manuscript.

ETHICS

As this study was based on an analysis of existing survey datasets in the public domain that are freely available online with all identifier information removed, no ethics approvals were required. The first author obtained authorization to access the EDHS survey dataset from the Demographic and Health Surveys (DHS) Program (Gaither Road, Suite 500, Rockville, MD 20850 USA).

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