

# Spatial Distribution of Underweight among Adolescent Girls Aged 15-19 Years in Ethiopia, 2016: Spatial and Multilevel Analysis

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#### ABSTRACT

**Background:** Adolescence is the period of development that occurs between childhood and adulthood. Nutrient needs are extremely high during this period, so nutritional inadequacy is common, particularly in low-income areas. As a result, 3 the purpose of this study was to assess underweight and the community and individual level factors that contribute to it in adolescent girls aged 15-19 years in Ethiopia.

**Methods:** Data from the Ethiopian demography and health survey 2016 were used. In Ethiopia, a multilevel logistic regression model was used to identify individual and community level factors associated with underweight in adolescent girls aged 15 to 19 years. Finally, the adjusted odds ratio was reported, along with a 95% confidence interval.

**Results:** The magnitude of underweight among adolescent girls was 32.48% (31.60-64.02). In the multivariable multilevel logistic regression analysis; individual level variables such as being at the age of 16 years (Adjusted Odds Ratio (AOR)=1.74; 95% CI: 1.23-2.47), 17 years (AOR=2.84; 95% CI: 1.98-4.05), 18 years (AOR=3.10; 95% CI: 2.14-4.49), 19 years (AOR=4.33; 95% CI: 2.76-6.79) and being secondary education (AOR=0.18; 95% CI: 0.07-0.44), has menstruated in last six weeks (AOR=1.99; 95% CI: 1.45-2.73) and family size greater than five (AOR=1.73; 95% CI: 1.22-2.45) were significantly associated with underweight among adolescent girls, among community level variables; living in city regions (AOR=1.72; 95% CI: 1.13-2.64), living in Agrarian regions (AOR=2.01; 95% CI: 1.44-2.80) and use of improved toilet facility (AOR=1.15; 95% CI: 0.64-2.05) were significantly associated with underweight among adolescent girls.

**Conclusion:** In this study the magnitude of underweight adolescent girls was high. Family size, menstruated in last six weeks, region and type of toilet facility were the most essential factors associated with underweight. Therefore, interventions targeting community organization of acute malnutrition in adolescents might be appropriate to manage the problem of underweight and also efforts should also be made to reduce underweight by focusing on the identified associated factors.

Keywords: Underweight; Adolescent girls; Multilevel model; Spatial analysis; Ethiopia

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Abbreviations: CSA: Central Statistics Agency; DHS: Demography Health Survey; EDHS: Ethiopia Demography Health Survey; EA: Enumeration Area; GLMM: Generalized Logistic Mixed Effect Regression Model; ICC: Intra Class Correlation Coefficient; OR: Median Odds Ratio; PCV: Proportional Change in Variance; WHO: World Health Organization

### INTRODUCTION

Adolescence is a transition period between 10 and 19 years of age which again classified as younger (10-14 years) and older (15-19 years). Adolescence is a transition period between from childhood to adulthood. It is identified for rapid growth: Up 20% of final adult height and 50% of adult weight is achieved, bone mass increases by 45% and also affected bone growth occur. During the period of adolescence nutrient needs are the highest nutrition habit influences on growth and development throughout infancy, childhood and adolescence [1].

In developing countries, underweight residues are one of the leading causes of morbidity and mortality in children under the age of five. Adolescent underweight is more prevalent in Asia and Africa, with magnitudes ranging from 32%-65% to 4%-30%, respectively. Adolescent under nutrition is 15%-58% in sub-Saharan Africa, which is higher than in other African countries.

Underweight adolescent girls are a major public health issue all over the world. 50% of adolescents in developing countries do not reach their full growth potential. Adolescent nutrition can be influenced by a lack of dietary diversity and insufficiency, recurring illness, a lack of health care access and increased nutritional requirements.

Adolescence is a critical stage in breaking the cycle of malnutrition, poverty and food insecurity. Progress in this population group will ensure long-term sustainable results in reducing poverty, food insecurity and malnutrition. However, in developing countries such as Ethiopia, this group has received the least attention. As a result, adolescent underweight is a common problem in low-income developing countries such as Ethiopia. As a result, the purpose of this study was to assess individual and community-level determinants, as well as the spatial distribution of underweight among adolescent girls aged 15-19 years in Ethiopia in 2016: Analysis of spatial and multilevel data [2].

### MATERIALS AND METHODS

#### Data source and population

The data for this study were derived from the nationally representative 2016 Ethiopian Demographic and Health Survey (EDHS), which was conducted between January 18, 2016 and June 27, 2016. The survey used the 2007 Ethiopian Population and Housing Census (PHC) as a sampling frame. In 2007; PHC created 84,915 Enumeration Areas (EAs). The survey sample was stratified and chosen in two stages. The second stage involved selecting 28 households per cluster using an equal probability systematic selection. Comprehensive data on reproductive

health issues was gathered (girls' ages, menstrual cycles for the previous 6 weeks and number of antenatal care visits). In general, the EDHS 2016 report contains additional information about the survey. Our analysis was based on the EDHS 2016 women's data (IR data) set, which was obtained from the measure demographic and health survey. In the five years preceding the survey, a total weighted sample of 3,381, adolescent girls aged 15-19 years old in Ethiopia were used [3].

#### Study variables

Underweight (Yes/No): For this study, the independent variables were both individual level and community level variables. The individual level variables were women age, women educational status, women occupation, marital status, religion, wealth index. In this study, the community level variables were residence and region. The other variable was region, with Afar, Benishangul, Somalia and Gambela classified as "Pastoralist regions," Amhara, Tigray, Oromia and Southern Nations Nationalities and Peoples Region (SNNPR) classified as "Agrarian regions" and Addis Ababa, Harari and Dire Dawa classified as "Cities" based on their geopolitical location [4].

#### Data management and analysis

To reduce the effect of sampling bias, data were extracted, coded and analysed using Stata software version 14 and weighted by sample weight factor (v005) within the Ethiopia demography health survey dataset. A multilevel logistic regression analysis was used to explain the hierarchical nature of the demography health survey data and a bivariable multilevel logistic regression analysis was performed to estimate the crude odds ratios at 95% confidence intervals and variables with p-values less than 0.20 were measured for multivariable analysis. In the multivariable multilevel logistic analysis, variables with p-values of 0.05 or higher were found to be significantly associated with adolescent girls aged 15 to 19 years women's health. After selecting variables for multivariable analysis, four models containing variables of concern were fitted: Model 1 without explanatory variables, model 2 examined the effects of individual level characteristics, model 3 examined the effects of community-level variables and model 4 examined the effects of both individual and community-level characteristics simultaneously. The random effect results were estimated using three methods: Intra-Class Correlation (ICC), Median Odds Ratio (MOR) and Proportional Change in Variance (PCV). Deviance was used to assess model fitness because these models were nested [5].

# RESULTS

# Regional prevalence of underweight in Ethiopia, 2016

The overall prevalence of underweight in Ethiopia was 32.48% (31.60, 64.02) which was significantly varied across regions ranging from 52.29% in the Somali region to 23.47 in Addis Ababa (Figure 1) [6].



Table 1: Background characteristics of respondents in Ethiopia, 2016.

#### Background characteristics of respondents

A total of 3,381 adolescent women aged 15-19 years old with their most recent birth in the five years preceding the 2016 EDHS survey were included in this study. The proportion of underweight women was 32 percent (32%). One-fourth of the 913.28 (27.01%) participants were under the age of 18. In terms of the respondents' household wealth index, 991 (29.33%) were the richest and the majority (2,147.71 (63.53%)) attended primary school. The majority of respondents (2,576.31 (76.20%)) were from rural areas and the majority of women (2,294.74 (67.87%)) were Christians (Table 1) [7].

Variables	Frequency	rcentage		
Respondents age in years				
15 years	707.5	20.93%		
16 years	701.37	20.75%		
17 years	641.41	18.97%		
18 years	913.28	27.01%		
19 years	417.32	12.34%		
Household wealth index				
Poorest	477.71	14.13%		
Poorer	557.93	16.50%		
Middle	637.66	18.86%		
Richer	716.03	21.18%		
Richest	991.55	29.33%		
Place of residence				
Urban	804.58	23.80%		
Rural	2,576.31	76.20%		
Women educational status				
No education	468.54	13.86%		

Primary education	2,147.71	63.53%
Secondary education	677.83	20.05%
Higher education	86.8	2.57%
Religion		
Christian	2,294.74	67.87%
Muslim	1,064.01	31.47%
Other <sup>*</sup>	22.14	0.66%
Maternal working status		
Not working	2,623	74.99%
Working	875	25.01%
Current marital status		
Unmarried	2,641.64	78.13%
Married	587.76	17.38%
Divorced/Separated	151.49	4.48%
Type of toilet facility		
Improved	3,198.18	94.60%
Unimproved	182.71	5.40%
Source of drinking water		
Improved	2,193.02	64.87%
Unimproved	1,187.87	35.13%
Note: Other <sup>*</sup> =Traditional and other		

#### Random effect and model comparison parameters

Table 2 showed the random effect model, in the null model; about 9% of the total variation on underweight was occurred at the community level and is attributable to the community-level factors. The highest MOR value (2.23) in the null model shows that was a variation of underweight between clusters. Furthermore, the highest (82.63%) PCV in the final model (model 4) indicates that 82.63% of the variation in underweight

across communities was explained by both individual and community level factors. The model fitness was checked by using the log-likelihood ratio and the model with the lowest loglikelihood ratio (model 4) was the best-fitted model.

Table 2: Random effect (community-level clustering) and model comparison for factors associated with underweight Ethiopia, 2016 [8].

Parameters	Model l	Model 2	Model 3	Model 4
ICC	9%	5%	6%	5%
Variance	0.51	1.03	1.48	0.97
MOR	2.23	2.27	2.11	2.21

PCV	Reference	81.57%	73.52%	82.63%
LLR	-1980.97	-1858.32	-1966.38	-1851.38

# Effect of individual and community level characteristics on the underweight

Table 3 showed the fixed effects model. In the bi-variable multilevel modeling, all of the associated factors (both individual level and community level variables), except distance to health facility, had shown statistically significant association at a p-value of <0.20, in the multivariable multilevel logistic regression analysis, women who are age 16 years old 1.74 times (AOR (95% CI)=1.74 (1.232.47)), 17 years old 2.84 times (AOR (95% CI)=2.84 (1.98-4.05)), 18 years old 3.10 times (AOR (95% CI)=3.10 (2.14-4.49)), 19 years old 4.33 times (AOR (95% CI)=4.33 (2.76-6.79)) were more likely being underweight as compared to 15 years old girls. Women who had higher education 82% (AOR (95% CI)=0.18 (0.07-0.44)), were less likely

to being underweight as compared to no education. Women who had work 1.35 times (AOR (95% CI)=1.39 (1.04-1.87)) were more likely to being underweight as compared to not working. Respondents with a household size of five and above had 1.39 times (AOR (95% CI)=1.39 (1.04-1.87)) were more likely to being underweight as compared with household size less than five members. A girl who lives in city and agrarian regions had 1.72 times (AOR (95% CI)=1.72 (1.13-2.64)) and 2.01 times (AOR (95% CI)=2.01 (1.44-2.80)) higher odds of being underweight respectively as compared to a woman from pastoralist regions [9].

Table 3: Multilevel logistic regression analysis of individual and community-level factors associated with underweight in Ethiopia, 2016.

Respondent characteristics Mode	el 1 (AOR 95% CI)	Model 2 (AOR 95% CI)	Model 3 (AOR 95% CI)	Model 4 (AOR 95% CI)
Individual-level factors				
Respondent age				
15 years <sup>®</sup>		1		1
16 years		1.73 (1.22-2.45)		1.74 (1.23-2.47)
17 years	,	2.86 (2.00-4.10)		2.84 (1.98-4.05)***
18 years		3.12 (2.16-4.51)		3.10 (2.14-4.49)
19 years	4	4.38 (2.79-6.86)		4.33 (2.76-6.79)
Respondent education				
No education <sup>®</sup>		1		1
Primary	(	0.85 (0.61-1.19)		0.82 (0.58-1.14)
Secondary	(	0.95 (0.60-1.48)		0.89 (0.57-1.40)
Higher	(	0.20 (0.08-0.47)		0.18 (0.07-0.44)
Wealth index				
Poorest <sup>®</sup>	:	1		1
Poorer	:	1.62 (1.01-2.59)		1.46 (0.90-2.36)
Middle		1.01 (0.65-1.55 )		0.90 (0.59-1.39)
Richer		1.28 (0.83-1.99 )		1.15 (0.74-1.79)
Richest		1.63 (1.06-2.49)		1.16 (0.65-2.06)

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Religion			
Christian®	1		1
Muslim	1.01 (0. 78- 1.31)		1.13 (0.87-1.48)
Other	0.49 (0.15-1.56)		0.48 (0.14-1.61)
Marital status			
Unmarried ®	1		1
Married	0.86 (0.55-1.36)		0.88 (0.56-1.39)
Divorced	1.28 (0.53-3.05)		1.26 (0.53-3.02)
Menstruated in last six weeks			
No®	1		1
Yes	1.99 (1.45-2.72)		1.99 (1.45-2.73)
Family size			
≤ 5 <sup>®</sup>	1		1
>5	1.41 (1.05-1.89)		1.73 (1.22-2.45)
Sex of household head			
Male®	1		1
Female	0.97 (0.74-1.29)		0.97 (0.73-1.29)
Community-level factors			
Regions			
Pastoralist <sup>®</sup>		1	1
City		1.88 (1.48-2.41)	1.72 (1.13-2.64)
Agrarian		1.80 (1.27-2.57)	2.01 (1.44-2.80)**
Residence			
Rural®		1	1
Urban		1.78 (1.26-2.51)	1.59 (0.92-2.75)
Source of drinking water			
Unimproved®		1	1
Improved		0.95 (0.71-1.27)	1.01 (0.74-1.37)
Type of toilet facility			
Unimproved®		1	1
Improved		0.87 (0.48-1.58)	1.15 (0.64-2.05)

Note: <sup>®</sup>: Reference; AOR: Adjusted Odds Ratio; CI: Confidence Interval, <sup>\*</sup>=P<0.05, <sup>\*\*</sup>=P<0.01 and <sup>\*\*\*</sup>=P ≤ 0.001

#### Spatial analysis

**Spatial autocorrelation analysis:** The global spatial autocorrelation analysis showed that the spatial distribution of underweight was significantly varied across the country with Global Moran's Index value of 0.01 (p<0.05) (Figure 2) [10].



#### Spatial distribution analysis

In this study, areas with a low magnitude of underweight were identified in Addis Ababa, Dire-Dawa and Hareri. In contrast, areas with a high prevalence of underweight were showing in Tigray, Afar and Amhara regions (Figure 3) [11].



#### Spatial interpolation

In the Kriging interpolation analysis, the highest prevalence of underweight was detected in South east Tigray, Afar, West and South Amhara regions. In contrast, the predicted low prevalence of underweight was identified in Addis Ababa, Central Oromia and North Somali regions (Figure 4) [12].



#### Figure 4: Kriging interpolation of underweight in Ethiopia, 2016.

# DISCUSSION

This examine aimed to evaluate the superiority and associated factors of underweight amongst adolescent women in Ethiopia using EDHS 2016 records. In line with the findings of this look at, the anticipated occurrence of underweight in Ethiopia changed into 32.48% (31.60-64.02). That's steady with exclusive studies performed in Ethiopia [13].

This significance of underweight in our examine is higher than studies achieved Tigray Ethiopia, Bule Hora Ethiopia, Indian and Tanzania. This is probably because of the time hole distinction wherein presently stepped forward cognizance approximately nutrition in adolescent parents and the present day nutritional intervention. The alternative cause is may be due to the distinction in cultural and dietary practices. But our result is lower than studies carried out in Afar, Somali Ethiopia; and demography health survey of Nigeria. This look at constant with within the Gahanna. This is probably due to the low socioeconomic popularity in this examine location and because of the study period and socio cultural traits one-of-a-kind [14]. In multivariable multilevel logistic regression analysis, women academic status, family length, place and kind of bathroom facility have been considerably related to underweight amongst adolescent women in Ethiopia. Constant with exclusive studies conducted in Nigeria, Botswana, Ghana and Kenya. This modification due to the difference in cultural and nutritional practices. Regarding elements related to underweight, this study has discovered that youngsters elderly 15-19 years finding is steady with some research findings [15].

On this examine, adolescent women better instructional fame become associated with underweight. This result is in line with findings of research carried out in Adwa Northern a part of Ethiopia, Wollega zone Ethiopia. Higher academic fame of can relate with a good earnings, appropriate information, availability and get right of entry to a balanced eating regimen [16].

Regarding to household length, the high wide variety of adolescent women in households become more likely to be associated with underweight. Numerous literature studies indicated that large adolescent girls in households had been significantly undoubtedly associated with underweight. This will be because the huge family size is widely regarded as a danger component for underweight mainly for 15-19 years vintage adolescent ladies due to food insecurity [17].

Regarding to age 15-19 adolescent girls have been extensively related to underweight primarily based on this take a look at, the age of adolescent became determined appreciably associated with the nutritional popularity of adolescent ladies. As the age of the women extended by using three hundred and sixty five days her risk of under nutrition is increased and it is consistent with a examine conducted in EDHS, 2016, Gondar city and Bangladesh this is due to the fact younger moms, apart from inadequate development in their reproductive gadget and their want of vitamins for their developing frame [18].

Furthermore, place was a critical community level variable and adolescent ladies from town and Agrarian areas had higher odds of under nutrition. This regional version indicated in this take a look at is in step with studies carried out in Ethiopia, China and Indian. Ladies in city and Agrarian regions is probably because of the low socioeconomic status on this study area and due to the examine duration and one-of-a-kind in socio cultural traits. And on the whole there are much more likely to be underweight [19].

This have a look at had electricity which primarily based on nationally consultant records with big pattern size. The other power turned into we used the precise statistical technique of multilevel version to house the hierarchical nature of the facts. Moreover, given that it is primarily based on the country wide survey facts the observe has the capability to offer insight for policy makers and program planners to design appropriate intervention techniques both at country wide and regional ranges.

However, this take a look at had a few boundaries in that the EDHS survey is basically based totally on respondents 'self-document and can have the possibility of bear in mind bias. Once more, this examine only suggests the associations among

underweight and some essential character level and communitydegree elements this is it did not set up causality [20].

# CONCLUSION

This take a look at proven that the importance of underweight became high, in this look at each the man or woman and community degree characteristics were observed to have a widespread impact on under nutrition. In multivariate multilevel logistic regression evaluation were respondent age (15-19), ladies training, menstruated in final six weeks, own family size, regions and type of lavatory facility had been variables that had finished statistically considerable affiliation to underweight among adolescent girls (15-19 years vintage). Therefore nutrition education by health extension works should take delivery of to enhance the notice of own family on nutritional pattern of young people, particularly nutritional range and frequency of food eaten by using teens in keeping with food pyramid of nutrition. Age and gender particular vitamins schooling application must be evolved within the look at location for better behavioral adjustments amongst young people and their families on adolescent vitamins.

# ETHICS APPROVAL AND CONSENT TO PARTICIPATE

For this study ethical approval was not required since this is a secondary analysis of the 2016 EDHS data. But we registered and requested access to EDHS datasets from DHS online archive and received approval to access and download the data files.

### CONSENT FOR PUBLICATION

Not applicable.

# AVAILABILITY OF DATA AND MATERIALS

All result-based data are available within the manuscript and anyone can access the data set online from www.measuredhs.com.

# **COMPETING INTERESTS**

The authors declare that they have no competing interests.

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No, any funding was received from any organization.

# AUTHORS' CONTRIBUTIONS

DS: Conceived the topic and drafted of the study, wrote up of the research proposal, analyzed the data, presented the results and wrote up the draft manuscript and involved in data analysis; TM and DS: Supervised the protocol development and revisited the manuscript critically for important intellectual content. The three authors are involved in the analysis and design of the study and also the three authors read and approved the final manuscript. DS, TM were agreed to be accountable for all aspects of the work.

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