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The reality associated with diarrhea in children under-five in Ethiopia: Multilevel analysis of Ethiopian demographic and health survey data (2016).

Teferi Gebru Gebremeskel*

Department of Reproductive Health, Aksum University, Aksum, Ethiopia

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Abstract

Introduction: Diarrhea is a major cause of morbidity and mortality in children under-five in sub-Saharan Africa including Ethiopia. In Ethiopia, several studies were done to assess factors associated with diarrhea. However, they were specified to a certain area, focused only on the influence of single-level factors and the multilevel study conducted also lacked evidence on the effects of latrine and hand washing facility.

Objective: This study aimed to identify factors associated with diarrhea at the individual and community level among children under-five in Ethiopia.

Methods: The source of data for this study was the Ethiopian demographic and health survey 2016, which was a cross-sectional study, employed a multistage stratified cluster sampling technique to select study participants. In this study, a total of 10,006 children under-five living in 643 clusters were included. The multilevel binary logistic regression model was used to identify significant factors of diarrheal illness.

Results: Twelve percent of children under-five were suffered from diarrhea. At individual level; Low birth weight (AOR=1.51, 95% CI=1.26, 1.80), underweight (AOR=1.34, 95% CI=1.12, 1.60) and mother employment (AOR=1.30, 95% CI=1.10, 1.54), bottle feeding (AOR=1.32, 95% CI=1.08-1.62) and child age 6-11 months (AOR=4.60, 95% CI=3.22, 6.57), 12-23 months (AOR=4.18, 95% CI=3.05, 5.72), 24-35 months (AOR=2.80, 95% CI=2.10, 3.74) were significantly associated with diarrheal illness. The region SNNPR (AOR=1.81, 95% CI=1.01, 3.25) and Gambela (AOR=1.89, 95% CI=1.02, 3.47) was a significant factor of diarrhea illness at the community level.

Conclusion: The prevalence of diarrhea was almost 12%. Children aged less than 47 months, underweight, children with smaller than average birth size, children from employed mothers, children with bottle feeding practice and children living in SNNPR and Gambela were found with increased risk of diarrheal illness. Hence, efforts like provision of health education, strengthen community based nutritional programs, avoid bottle feeding and developing an intervention strategy that considers age of children are needed to prevent and reduce diarrhea among children under-five.

Keywords: Diarrhea, Ethiopian demographic, Health survey, Multilevel analysis.

Abbreviation: AIC: Akaike Information Criteria; AOR: Adjusted Odds Ratio; ARI: Acute Respiratory Infection; CSA: Central Statistical Agency; DHS: Demographic and Health survey; EDHS: Ethiopian Demographic and Health Survey; FMOH: Federal Ministry of Health; ICC: Interclass Correlation Coefficient; IQR: Inter Quartile Range; PCV: Proportional Change in Variance; ROC: Receiver Operating Characteristic; UNICEF: United Nations Children's Fund; VIF: Variance Inflation Factor; WHO: World Health Organization

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Introduction

WHO defined diarrhea as the passage of three or more loose or liquid stools per day. Diarrheal infection is the second prominent cause of childhood illness and death, which is caused by ingesting bacteria, virus and parasitic organisms. Diarrhea mostly results from contaminated water and food sources. In children with diarrheal disease, death is due to severe dehydration, reduced absorption of nutrients and infectious complications. In developing countries children less than five years old experience three episodes of diarrhea on average every year. Every year around 1.7 billion cases of childhood diarrheal illness occurred; with nearly 525,000 children dying from the illness. More than 90% of these global child deaths concentrated in low and middle-income countries. About 88%of deaths from diarrhea among children under five can be avoided by executing existing effective preventions, management and scaling up of accessible costs effective interventions such as access to safe drinking water, good personal and environmental hygiene, vaccination and adequate nutrient intake [1].

According to Ethiopia demographic and health survey 2011, 12% of children under-five had diarrheal illness in the two weeks preceding the survey which is almost the same from the prevalence of diarrhea found in EDHS 2016. Additionally, factors associated with diarrheal illness are quite complex ranging from individual to community level.

However, the majority of the studies conducted on diarrhea were limited only on the effect of single-level factors which ignores the hierarchical nature of factors affecting diarrhea and limited in scope since they were not nationally representative. The multilevel study conducted using the EDHS 2011 was also unable to show clearly the effect of hand washing facility, latrine facility, community education and community poverty. So the main aim of this study is to address these limitations and for further investigation of an individual and community level factors associated with diarrheal illness simultaneously with the application of multilevel modeling.

Materials and Methods

The source of data for this study was the EDHS 2016, especially the child recode. EDHS 2016 was the fourth nationally representative demographic health survey conducted by the Central Statistical Agency (CSA from January 18, 2016, to June 27, 2016, with a nationally representative sample from 9 regions and two administrative cities.

The EDHS 2016 sample areas were selected in two stages. First, each region was stratified into urban and rural areas yielding 21 sampling strata. The sample of enumeration areas was selected independently in each stratum in two stages. In the first stage, a sample of 645 enumeration areas (202 in urban areas and 443 in rural areas were selected with probability proportion. In the second stage, a complete household listing was conducted in each selected cluster and a representative sample of 28 households per cluster was selected with an equal probability systemic selection. The survey collected information from all sampled women 15-49 and men 15-59. All the data related with all children under-five and their parents who are included in EDHS 2016 was taken from child recode, women recode and household recode particularly the child recode. A total of 10,006 children under-five living in 643 clusters were included in this study.

The dependent variable in this study was diarrhea which was constructed as binary variable equal to one if a child had diarrhea two weeks preceding the survey and zero otherwise. But in the EDHS dataset diarrhea was coded in to yes, no diarrhea and do not know. As stated in the above in this study do not know category was merged in to no diarrhea because of the respondents of this category were very small (0.08%) and I thought that it could not have a significant effect for the result as they were very small [2].

Individual and community level variables available in the DHS dataset, which were known, from previous studies, to have association with the dependent variables, were chosen as the independent variables. The individual level variables includes age of child, gender of child, birth order, age of mother, number of children under five, household size, wealth index, mother's education, mother's occupation, father's education, child measles vaccination, child nutritional status (duration of breastfeeding, size of child at birth, wasting, underweight and bottle feeding), handwashing facility and toilet facility. Children whose weight-for-age Z-score was below minus two standard deviations (-2 SD) from the median of the reference population were classified as children having underweight. Toilet facility was coded in to improved and unimproved (Flush/pour flush not to sewer/septic tank/pit latrine pit latrine without slab/open pit, shared toilet and open defecation).

The community level variables composed of direct community variables (Residence, region, time to get water, source of drinking water and treatment) and aggregate community variables (community education and community poverty). Time to get water was amount of time taken to fetch water from the source whereas water treatment is making water safe from microorganisms by adding chemicals and other methods. Aggregate community variables were formed by aggregating individual level variables at community level. The aggregate were computed using the proportion of a given variable on each cluster. The aggregate value for all generated variable was not normally distributed. So categorization of the aggregate variables was done as high and low based on national median values. Community education was the proportion of mothers with primary education and above where as community poverty was the proportion of mothers in the poor and poorest wealth index in the community.

Stata version 13 was used for the whole data analysis. In this study, the two-level mixed model was used in which individuals (level 1) were nested within the community (level 2) to assess the effect of individual and community-level factors on diarrhea. Bivariate logistic regression analysis was performed between the individual and community level characteristics with diarrhea (Table 1). These explanatory variables whose bivariate analysis has a p-value of 0.25 or less were candidates for the multivariable analysis to increase candidate variables [3].

Community variables	Diarrhea	
	Yes n (%)	No n (%)
Residence		
Urban	121 (10.84)	996 (89.16)

Rural	1,058 (11.90)	7,831 (88.10)
Region		
Tigray	86 (12.99)	573 (87.01)
Afar	11 (11.47)	89 (88.53)
Amhara	259 (13.73)	1,630 (86.27)
Oromiya	468 (10.66)	3,923 (89.34)
Somali	27 (6.04)	430 (93.96)
Benshangul	10 (9.02)	99 (90.98)
SNNPR	289 (13.87)	1,794 (86.13)
Gambela	3 (14.50)	21 (85.50)
Harari	2 (10.83)	21 (89.17)
Addis Ababa	17 (7.44)	210 (92.56)
Diredawa	5 (12.14)	37 (87.86)
Source of drinking water		
Improved	662 (11.94)	4,884 (88.06)
Unimproved	516 (11.58)	3,944 (88.42)
Time to get a water source		
<30 minute	563 (11.81)	4,203 (88.19)
≥ 30 minute	616 (11.75)	4,624 (88.25)
Water treatment		
Yes	116 (13.19)	766 (86.81)
No	1,062 (11.65)	8,062 (88.35)
Community education		
High	627 (12.64)	4,333 (87.36)
Low	552 (10.94)	4,494 (89.06)
Community poverty		
High	406 (10.52)	3,457 (89.48)
Low	772 (12.57)	5,371 (87.43)
Type of toilet facility		
Improved	98 (9.77)	909 (90.23)
Unimproved	631 (12.16)	4,556 (87.84)
No toilet	450 (11.80)	3,362 (88.200

Table 1. Description of factors associated with diarrhea at the community level among children under-five in Ethiopia, EDHS 2016 n=10,006.

The result was presented using p-value. Multivariable multilevel regression analysis was done with all the candidate predictors found in the bivariate analysis and was reported using the Adjusted Odds Ratio (AOR) with 95% confidence interval. P-value of <0.05 was used to identify factors significantly associated with diarrhea. Random intercept only model was used. Four models containing variable of interest were built:

Model I: This model was run without a predictor variable to check variability among communities on diarrhea. It is used to estimate the Intraclass Correlation Coefficient (ICC) and to decide whether the data has justifiable evidence to use multilevel modeling or not.

Model II: This model was used to examine the effect of individual-level factors on diarrhea.

Model III: This model was used to examine the effect of community-level factors on diarrhea.

Model IV: This model was constructed by mixing both individual and community level factors simultaneously.

The fixed effects (measures of association) estimate the association between the likelihood of diarrhea and the individual and community level factors and were expressed as AOR with a 95% confidence interval. The random effects are the measure of variation in diarrhea across communities expressed as ICC and Proportional Change in Variance (PCV). The ICC was calculated to evaluate whether the variation in diarrhea is within or between communities whereas the PCV measures the amount of variation in diarrhea across the community explained by the different explanatory variables compared to the null model.

Ethical clearance was obtained from the Institutional Review Committee (IRC), college of medicine and health sciences, Mekelle university. Authorization letter was received from DHS responsible organization.

Results

The overall prevalence of diarrhea among children under-five was 11.78% (95% CI: 11.16%, 12.43%). Diarrhea proportion was highest 231 (22.46%) in children aged 6-11 months and declined significantly 101 (4.79%) in children aged 48-59 months. Children of mothers with primary 355 (13.17%) and secondary education 69 (14.68%) were found with a higher proportion of diarrhea. Children with smaller birth size than average had a higher proportion of diarrhea 408 (15.32%). The proportion of diarrhea was higher 334 (15.58%) among children with underweight.

A higher 1,058 (11.90%) proportion of diarrheal illness was observed in rural resident children. Children from communities with high maternal education had a high 627 (12.64%) proportion of diarrheal illness. By regional distribution, the proportion of diarrhea in Ethiopia was higher in Gambela (14.50%) and lowest in Somalia (6.04%) (Table 2) [4].

Multivariable multilevel logistic regression analysis

In a model without the explanatory variable, the ICC was 10.08% in diarrheal illness. This indicates that 10.08% of the total variation in diarrheal illness was attributed to the difference between communities respectively. The presence of ICC value different from zero in the null model also shows that we can do better using multilevel modeling than the ordinary logistic regression. The PCV indicates that the addition of explanatory variables to the null model better explained the odds of diarrhea across communities as compared to the null model. Among the four consecutive models model, four were found with the lowest value of AIC, which shows that the fourth model is the best. The area under the ROC curve for this study was above 50%, it showed that the final model is acceptable in predicting ability (Table 2).

Random effect	Null model	Model II	Model III	Model IV
Community variance (σ2μ)	0.369	0.342	0.286	0.296
ICC	0.1008	0.0943	0.08	0.0827
PCV	Ref.	0.0731	0.2249	0.1978
Model fitness				
AIC	6821	5688	6797	5683
AUC				0.68

Table 2. Random effect and model fitness result of factors associated with diarrhea individual and community level among children under five in Ethiopia, EDHS 2016.

Null model: Empty model (without explanatory variable.

Model II: Includes only individual-level factors.

Model III: Includes only community-level factors.

Model IV: Combined model (includes both individual and community level factors).

Individual and community-level factors associated with diarrhea. Among the individual-level factors ages of a child, birth weight of the child, underweight, bottle feeding and mother employment were significantly associated with diarrheal illness. Regarding community-level variables region was a significant predictor of diarrheal illnesses.Diarrhea than children aged 48-59 months respectively, by holding other predictors constant.

Children who were bottle feeders had 32% (AOR=1.32, 95% CI=1.08, 1.62) higher likelihood of developing the diarrheal illness as compared to children who did not have bottle feeding practice. The odds of having diarrhea in children with smaller birth size than average was 51% (AOR=1.51, 95% CI=1.26, 1.80) higher compared to children with average birth size. Being underweight increases the probability of occurrence of diarrhea by 34% (AOR=1.34, 95% CI=1.12, 1.60) compared to well-nourished children. Children whose mothers were employed had 30% (AOR=1.30, 95% CI=1.10, 1.54) increased odds of diarrheal illness than children of non-employed mothers. Children living in SNNPR 1.8 (AOR=1.81 95% CI=1.01, 3.25) and Gambela 2 (AOR=1.89 95% CI=1.12, 3.53) times more likely affected by diarrheal illness than children from Addis Ababa respectively.

Discussion

The purpose of this study was to assess factors associated with diarrhea at individual and community level among children under-five in Ethiopia using EDHS 2016. As a result, underweight, low birth weight, bottle feeding practice, children from employed mothers, young age child and regional variation were the factors that increased the odds of diarrheal illness.

This study revealed that the likelihood of diarrheal illness was greatest in children aged 6-11 months (4.6 times) and 12-23 months (4.2 times) compared to children above 47 months. This result is similar to findings of a national study conducted in Ghana using multilevel modeling that shows high odds of diarrhea in children aged 6-11 months (3.5 times) and 12-23 months (4.57 times). This was also the case in a national study conducted in Ethiopia using EDHS 2011. This might be due to after 6 months children start crawling on the ground which increases the risk of getting diarrheal illness and initiation of complementary feeding could increase exposure to diarrheal illness if the food is not prepared and handled in hygienic condition. Additionally, the innate immunity may reduce through time and the acquired immunity is not well developed to resist infection.

The nutritional status of the child was significantly associated with diarrheal illness. Children under-five who were underweight had more likely (30%) to experience diarrheal illness than children who were not underweighted. The finding of this study is lower (54.8%) compared to a national study done in Ethiopia using EDHS 2011 with the multilevel binary logistic model. This might be due to different intervention programs that have been made to prevent malnutrition and its complications among children under-five. Children who were bottle feeders had a high risk of diarrheal illness as compared to children who were not bottle feeders. This might be due to the possibility of contamination of the feeding bottle as a result of poor handling by the caregivers. Children under-five who had smaller than average birth size were also more suffered (51%) from diarrheal illness than children who had average birth size. This finding was higher compared to a multilevel study conducted in sub-Saharan and developing countries (14%) using DHS data. This difference could be due to socio-demographic, socio-economic and sample size differences.

Regarding mother employment, this study identified children from employed mothers were more likely to have a diarrheal illness (30%) than children of non-employed mothers. This result is higher (12.7%) than finding reported from a national study done in Ethiopia using EDHS 2011 with a multilevel binary logistic model. This difference might be due to mother employment becomes increasing from time to time which can affect the duration of breastfeeding and care provided by others could harm the health of the child.

Out of the community-level variables only region was found to be a significant factor of diarrheal illness. Other nationwide studies conducted Vietnam, Bangladesh, Uganda and Ethiopia using multilevel logistic regression modeling also point out that, the significant regional variations in diarrheal illness. The possible explanation for this variation could be the difference in basic environmental and behavioral characteristics of caregivers, the difference in the socio-demographic, environmental and behavioral characteristics of households [5].

Based on findings from different studies hand washing facility, source of drinking water and toilet facility have significant effect on getting diarrheal illness but they were found to be insignificant in this study [6]. This difference might be due to governmental and non-governmental efforts are done through implementation of health extension packages to expand coverage and accessibility of hygiene and sanitation facilities to improve child health [7].

In this study age of child, underweight, birth weight, mother employment, bottle feeding and region were found the significant factors of diarrheal illness. Similarly, according to results obtained from study conducted using EDHS 2011 age of child, maternal working status, underweight and region were found to have significant effect on diarrheal illness [8]. However, stunting, wasting and duration of breastfeeding were found as contributing factors in EDHS 2011. The difference is due to efforts are done to improve child nutritional status through giving health education on how to feed children and by applying community based nutritional programs in the previous years. In this study also bottle feeding was found as significant factor for diarrheal illness because of bottle feeding practice currently increases from time to time [9].

It might recall bias because mothers could have forgotten the illness that occurred during the interview. Under and over-reporting the illness as people from different backgrounds are likely to have different perception of diarrheal illness, the mother's report of child ill health might be not the same across different groups. In the DHS question also frequency and type of stool are not included. As a result mothers may confuse with dysentery [10].

Conclusion

The prevalence of diarrhea in this study was 11.78% (95% CI: 11.16%, 12.43%). This finding is similar with EDHS 2011. Finding of this study was lower compared to study done in Ghana and higher as compared to study conducted in Egypt. Ages of child less than 47 months, low birth weight of the child, underweight, bottle feeding practice and children from employed mothers were found with a high risk of diarrheal illness at the individual level. At the community level; a region where child lives was a significant factor of diarrheal illness. Compared to EDHS 2011 age of child, maternal working status, underweight and region remains significant in both studies. Based on the findings of this study; the following recommendations might be needed to prevent and reduce diarrheal illness among children under-five, for the federal ministry of health in collaboration with the regional health bureau.

- Better to develop an intervention strategy that considers the age of children

- Efforts are required to avoid regional differences in the promotion of favourable health outcomes in the population through cooperation with different governmental and non-governmental organizations.
- Better to develop a policy for mothers to have adequate time after giving birth.
- Additional efforts are needed to promote provision of improved drinking water supply and improved sanitation and hygiene facilities through cooperation with governmental and non-governmental organizations as environmental factors are the basic determinants of diarrheal illness even these factors were not significant in this study.
- For health care providers and health extension workers.
- Strengthen community-based nutritional programs including monthly growth monitoring and screening of children under-five for early detection and management of underweight.
- Promote the provision of health education to mothers to increase knowledge on the importance of adequate nutrient intake during pregnancy to their child and enhance nutritional screening of mothers during pregnancy for early detection and management of maternal malnutrition to prevent small birth size.
- Strengthen the provision of health education to mothers on the disadvantage of bottle feeding practice.
- Better to conduct additional studies to identify the potential reasons why diarrheal illness is higher in SNNPR and Gambela.

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Competing Interest

The authors declare that they have no competing interests.

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*Correspondence to:

Teferi Gebru Gebremeskel

Department of Reproductive Health,

Aksum University,

Aksum, Ethiopia

E-mail: teferigebru12@gmail.com