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Factors Associated with Stunting of Under-Five Children in Ethiopia

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Abstract

The objective of this study was to identify socio-economic, demographic and other proximate factors associated with stunting of under-five children in Ethiopia. The study included 8,487 children under-five years of age. Descriptive, single and multilevel logistic regression analyses were used to determine the prevalence and determinants of stunting among under-five children in Ethiopia. Age of child, mother's level of education, wealth index, place of residence, whether a child had fever in the two weeks before the survey, educational level of partner and geographical region were associated with stunting of under-five children. Moreover, there were regional disparities with regard to the prevalence of stunted children. Children younger than 6 months, born to uneducated mothers, born to mothers having uneducated partner, from households of low socioeconomic status, living in rural area and who had fever in the two weeks before the survey were at a higher risk of being stunted.

Key words: Ethiopia; logistic regression; risk factors for stunting; stunting; under-five children

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1. Introduction

Stunting is a well-established child health indicator of chronic malnutrition related to environmental and socio-economic circumstances (WHO 1995; WHO 1996). Obviously, adequate nutrition is needed to ensure optimum growth and development of children. Normal growth is dependent on adequate nutrition and human body can use carbohydrate, protein and fat as a source of energy. Inadequate intake of energy may lead to malnutrition in the long run (Mamoun et al. 2005). Malnutrition could be a consequence of unfavorable condition and is associated with poor development and disturbances in mental and intellectual capacity (Scrimshaw 1998).

Stunting affects the physical and mental outcome of children adversely. A stunted child is a child below his or her appropriate height for age (Rice et al. 2000).

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The lack of parent's thorough knowledge about complementary feeding, educational deficiencies, and socio-economic deprivation, impel babies to be a vulnerable group. Other factors represented by the disequilibrium in body composition are depletion of nutrient stores which is lost in the absolute body size and tissue composition (Rolfes et al. 2004). A multivariate logistic regression analysis of the age-wise prevalence rate of under-nutrition in children in India revealed that the prevalence rate of malnutrition varied substantially according to age of children (Vir et al, 2015).

Out of the roughly 10 million deaths annually among children below 5 years of age, the share of stunting was estimated to be 15% (Michaelsen et al. 2008).

Freedman et al. (2004) used a multivariate model to assess the relationship between demographic and clinical variables and height-for-age Z-score. The results illustrated that age, severe anemia (hemoglobin < 7 mg/dl), history of diarrhea in the past 2 weeks, recent treatment of malaria conventional medication, high-density parasites in blood (parasitemia), combined level of education for the head of household (primary custodian), and socioeconomic status are amongst risk factors related directly to stunting.

Both in the Near East and North Africa as well as in sub-Saharan Africa, the number of undernourished people has risen during the 11-year period following the Rome World Food Summit (WFS) baseline (FAO 2006). Stunting, or chronic malnutrition, defined on the basis of the height to age ratio, shows malnutrition resulting from cumulative inadequacies in the child's nutritional status (Shaikh et al. 2003).

A study by Ahmed, et al (2012) used multinomial logistic regression and their results showed that the odds of female children to become moderately and severely stunted were 30% and 21% less than that for their male counterparts, respectively. A multilevel logistic regression study concerned with individual and contextual factors associated with childhood stunting in Nigeria revealed that low income, low maternal educational level, short maternal stature, and mother's over evaluation of her child's height are independent risk factors for a child to be stunted/overweight (Uthman 2009).

A study by Semba et al. (2008) showed 3-5 % reduced risk of stunting with each year of extra parental education. In 2009, a multivariate multinomial logistic regression study done in rural Bangladesh revealed mother's education level, poor socioeconomic conditions, father's education and occupation as important factors. Intake of vitamin A too had positive effect on better nutritional status of children aged 12-59 months (Rahman et al. 2009).

A multivariate multilevel logistic regression study by Hien and Kam (2008) dealing with nutritional status and the characteristics related to malnutrition in children less than five years of age in Vietnam indicated that region of residence, the mother's level of education and occupation, household size, number of children in the family, weight at birth and duration of exclusive breastfeeding are significant risk factors for stunting.

According to the report by the central statistical agency (CSA) of Ethiopia and ICF International (2012) on the 2011 Ethiopian Demographic and Health Survey (EDHS), nationally, 44 percent of children under age five are stunted, and 21 percent are severely stunted. Even though the problem of child malnutrition in Ethiopia is known, the reasons behind it are still poorly understood. Moreover, there is inconsistency across studies regarding the determining factors of childhood stunting. Furthermore, to our knowledge, there have been no studies done on identification of the factors that may explain the variation in childhood stunting between regions of Ethiopia. Therefore, this study attempts to investigate and identify the major socio-economic, demographic, health and environmental determinants of stunting in Ethiopia. Moreover, the study will attempt to identify the factors that may explain the variation in childhood stunting between regions of Ethiopia and examine the extent of the variation in stunting within and between regions of Ethiopia. Stunting is defined as height-for-age z-score (HAZ) of equal to or less than minus two standard deviation (-2 SD) below the mean of a reference standard (WHO 1995).

2. Methods

2.1. Data Source

The source of data for this study is the 2011 Ethiopian Demographic and Health Survey (EDHS) obtained from the Central Statistical Agency of Ethiopia and. The survey is the third major survey designed to provide estimates for the health and demographic variables of interest for the following domains: Ethiopia as a whole, urban and rural areas of Ethiopia (each as a separate domain), and all geographic areas (nine regions namely: Tigray, Affar, Amhara, Oromiya, Somali, Benishangul-Gumuz, Southern Nations, Nationalities and Peoples (SNNP), Gambela and Harari regional states and two city administrations: Addis Ababa and Dire Dawa). In the 2011 EDHS a representative sample of approximately 17,018 households from 624 clusters was selected. The sample was selected in two stages. In the first stage, 624 clusters (187 urban and 437 rural) were selected from the list of Enumeration Areas (EA). From 10,282 under-five children only 8,487 were measured for anthropometric measurements height and weight. Thus, the analysis presented in this study on the status of stunting is based on the 8,487 under-five children with complete anthropometric measurements.

2.2. Methodology

Ordinary logistic regression analysis and multilevel logistic regression analysis were used to identify and analyze factors associated with childhood stunting. In the multilevel analysis, three multilevel models were constructed. The first model, an empty model, was without any explanatory variable i.e. simple component of variance analysis. The second model controlled for the individual-level variables, the third model controlled for community-level variables.

Ordinary Logistic Regression

In this study, the measurement height-for-age was calculated using the Child Growth Standards released by the World Health Organization in April 2006. The binary response variable, y_i representing the status of stunting of the i^{th} child, was coded 0 if the i^{th} child is not stunted (height-for-age z-score $\geq$-2) and coded 1 if the i^{th} child is stunted (height-for-age z-score < -2.0). Consequently, the response variable, the status of stunting, y_i of the i^{th} child was measured as a dichotomous variable: accordingly

$$y_i = \begin{cases} 0 \ \ if \ \ not \ \ stunted \ (height - for - age \ z \ score \geq -2 \ from \ the \ median \ of \ reference) \\ 1 \ \ if \ \ stunted \ \left(height - for - age \ z \ score < -2 \ from \ the \ median \ of \ reference\right) \end{cases}$$

The predictor variables considered as potential determinants of childhood stunting are grouped into socio-economic factors (mother's education, employment status of the mother, employment status of partner, education of husband/partner, household income, household size, place of residence and geographical region), demographic factors (age of the child, sex of the child, birth interval and birth order of the child), and health and environmental factors (Diarrhea, fever, water supplies and toilet facilities).

Consider a collection of k independent variables which will be denoted by the vector (Hosmer and Lemeshow, 2000) $\mathbf{x}' = (x_1, x_2, \ldots, x_k)$. Let the conditional probability that the outcome is present be denoted by $P(Y=1|\mathbf{x}) = p(\mathbf{x})$.

Then, the logit of the multiple logistic regression is given by the equation

$$\log it\left[\frac{p(x)}{1-p(x)}\right] = \log\left[e^{g(x)}\right] = \beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k \tag{1}$$

where, $g(x) = \beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k$

in which case we have the logistic regression model given by

$$p(x) = \frac{e^{g(x)}}{1+e^{g(x)}} = \frac{e^{\beta_0+\beta_1 x_1+\ldots+\beta_k x_k}}{1+e^{\beta_0+\beta_1 x_1+\ldots+\beta_k x_k}} \tag{2}$$

In this study, the maximum likelihood estimation technique was applied to estimate parameters of the model.

Consider the logistic model, $p_i = \dfrac{e^{x_i'\beta}}{1+e^{x_i'\beta}}$ (3)

Where, $x_i = (x_{1i}, x_{2i}, \ldots, x_{ki})'$ $\boldsymbol{\beta} = (\beta_0, \beta_1, \beta_2 \ldots \beta_k)'$ are the model parameters.

Since observed values of Y say, $y_i's$ (i= 1, 2... n) are independently distributed as Bernoulli with parameter p_i, $y_i \sim$ Bernoulli $(1, p_i)$, the likelihood function of Y is given by:

$$l(\beta, y) = \prod_{i=1}^{n} p_i^{y_i}(1-p_i)^{1-y_i} = \prod_{i=1}^{n}\left[\frac{e^{x_i'\beta}}{1+e^{x_i'\beta}}\right]^{y_i}\left[\frac{1}{1+e^{x_i'\beta}}\right]^{1-y_i} \tag{4}$$

Two-Level Logistic Regression Model

The 2011 EDHS dataset used for this study is based on multistage stratified cluster sampling. The structure of data in the population is hierarchical, and a sample from such a population can be viewed as a multistage sample. For multistage clustered samples, the dependence among observations often comes from several levels of the hierarchy. The response variable in this study, the status of childhood stunting, is binary. The clustering of the data points within geographical regions offers a natural 2-level hierarchical structure of the data, i.e. children are nested within regions. We used y_{ij} to denote the binary outcome variable, coded ‘0’ or ‘1’ associated with level-one unit i nested within level two unit j.

Also let p_{ij} be the probability that the response variable equals 1; $p_{ij} = P(y_{ij} = 1)$. Here, y_{ij} follows a Bernoulli distribution. Like the ordinary logistic regression, p_{ij} is modeled using the link function, logit. The two-level logistic regression model can be written as,

$$\log\left[\frac{p_{ij}}{1-p_{ij}}\right] = \beta_0 + \beta_1 x_{ij} + u_{0j} \tag{5}$$

Where u_{0j} is the random effect at level 2.

Therefore, conditional on u_{0j}, the y_{ij}’s can be assumed to be independently distributed. Here, u_{0j} is a random quantity and follows $N(0, \sigma_u^2)$. The basic data structure of two-level logistic regression is a collection of N groups (units at level-two (regions)) and within group j (j=1, 2,…, N) a random sample of n_j level-one units. The outcome variable is dichotomous and denoted by y_{ij} ($i = 1,2,\ldots,n_j$, $j = 1,2,\ldots,N$) for level-one unit i in group j. If we let the success probability in group j be denoted by p_j, the dichotomous outcome variable for the individual i in group j, y_{ij}; which is either 0 or 1 can be expressed as the sum of the probability in group j, p_j (the average proportion of j levels in group j, E (y_{ij}) $= p_j$) and some individual-dependent residual ε_{ij} , that is, $y_{ij} = p_j + \varepsilon_{ij}$. The residual term is assumed to have mean zero but has a peculiar property that it can assume only the values $-p_j$ and $1-p_j$. The variance of the residual is, $Var(\varepsilon_{ij}) = p_j(1-p_j)$.

The Empty Logistic Regression Model

This is the simplest case of a hierarchical two level model for a dichotomous outcome variables in which there are no explanatory variables at all. This model only contains random groups and random variation within groups.

We focus on the model that specifies the transformed probabilities $f(p_j)$ to have a normal distribution. This is expressed, for a general link function f(p) , by the formula

$$f(p_j) = \beta_0 + u_{0j} \qquad (6)$$

Where β_0 is the population average of the transformed probabilities and u_{0j} the random deviation from this average for group j. If f(p) is the logit function, then $f(p_j)$ is just the log-odds for group j. Thus, for the logit link function, the log-odds have a normal distribution in the population of groups, which is expressed by

$$\operatorname{logit}(p_j) = \beta_0 + u_{0j} \qquad (7)$$

For the deviations u_{0j} it is assumed that they are independent random variables with a normal distribution with mean zero and variance σ_0^2.

This model does not include a separate parameter for the level-one variance. This is because the level-one residual variance of the dichotomous outcome variable follows directly from the success probability, as indicated by the following equation.

$$Var(\varepsilon_{ij}) = p_j(1-p_j)$$

The probability corresponding to the average value β_0, denoted by π_0, is defined by

$$f(\pi_0) = \beta_0$$

For the logit function, the so-called logistic transformation of β_0, is defined by

$$\pi_0 = \operatorname{logit}(\beta_0) = \frac{\exp(\beta_0)}{1+\exp(\beta_0)} \qquad (8)$$

Note that due to the non-linear nature of the logit link function, there is no simple relation between the variance of the deviations u_{oj}. However, there is an approximate formula which is valid when the variances are small and is given by

$$Var(p_j) = (\pi_0(1-\pi_0))^2\sigma_0^2 \qquad (9)$$

The Random Intercept Logistic Regression Model

In the random intercept logistic regression model the intercept is the only random effect meaning that the groups differ with respect to the average value of the response variable. But the relation between explanatory variables and the response can differ between groups in more ways.

The random intercept model expresses the log-odds, i.e. the logit of p_{ij} , as a sum of a linear function of the explanatory variables. That is, since

$$p_{ij} = \frac{e^{\beta_0+\sum_{h=1}^{k}\beta_h x_{hij}+u_{0j}}}{1+e^{\sum\beta_h x_{hij}+u_{0j}}} \tag{10}$$

$$\log it(p_{ij}) = \log\left[\frac{p_{ij}}{1-p_{ij}}\right] = \beta_{oj} + \beta_1 x_{1ij} + \beta_2 x_{2ij} + ... + \beta_k x_{kij} = \beta_{0j} + \sum_{h=1}^{k}\beta_h x_{hij} \tag{11}$$

where the intercept term β_{0j} is assumed to vary randomly and is given by the sum of an average intercept β_0 and group-dependent deviations,u_{0j} that is $\beta_{0j} = \beta_0 + u_{0j}$

The Random Coefficient Logistic Regression Model

This is used to assess whether the slope of any of the explanatory variables has a significant variance component between the groups. Now consider a model with group-specific regressions of logit of the success probability, logit(p_{ij}), on a single level-one explanatory variable X,

$$\log it(p_{ij}) = \log\left[\frac{p_{ij}}{1-p_{ij}}\right] = \beta_{oj} + \beta_{1j} x_{1ij} \tag{12}$$

The intercepts β_{0j} as well as the regression coefficients, or slopes, β_{1j} are group-dependent. These group-dependent coefficients can be split into an average coefficient and the group-dependent deviation

$$\beta_{0j} = \beta_0 + u_{0j} \qquad \beta_{1j} = \beta_1 + u_{1j} \tag{13}$$

Substituting (13) into (12) leads to the model

$$\log it(p_{ij}) = \log\left[\frac{p_{ij}}{1-p_{ij}}\right] = (\beta_o + u_{0j}) + (\beta_1 + u_{1j})x_{1ij} = \beta_0 + \beta_1 x_{1ij} + u_{0j} + u_{1j}x_{1ij} \tag{14}$$

There are two random group effects, the random intercept u_{0j} and the random slope u_{1j}. It is assumed that the level-two residuals u_{0j} and u_{1j} have means zero given the value of the explanatory variable X. Thus β_1 is the average regression coefficient like β_0 is the average intercept. $\beta_0 + \beta_1 x_{1ij}$ is called the fixed part of the model and the second part, $u_{0j} + u_{1j} x_{1ij}$ is called the random part.

These two group effects u_{0j} and u_{1j} will not be independent; they are rather correlated. Further, it is assumed that, for different groups, the pairs of random effects (u_{0j}, u_{1j}) are independent and identically distributed. Thus, the variances and covariance of the level-two random effects (u_{0j}, u_{1j}) are denoted as follows:

$$Var(u_{0j}) = \sigma_{00} = \sigma_0^2 \qquad Var(u_{1j}) = \sigma_{11} = \sigma_1^2 \qquad Cov(u_{0j}, u_{1j}) = \sigma_{01}$$

The model for a single explanatory variable discussed above can be extended by including more variables that have random effects. Suppose that there are k level-one explanatory variables x_1, x_2,…,x_k, and considering the model where all x-variables have varying slopes and random intercept, we have

$$\log it(p_{ij}) = \log\left[\frac{p_{ij}}{1-p_{ij}}\right] = \beta_{oj} + \beta_{1j} x_{1ij} + \beta_{2j} x_{2ij} + ... + \beta_{kj} x_{kij}$$

3. Results

3.1. Descriptive Analysis

The major socioeconomic, demographic, health and environmental background characteristics of the respondents and the number of stunted children are presented in Table 1. The total number of children measured for anthropometric measurements of height for age was 8,487. As can be seen in Table 1, 85.6% of the stunted children resided in rural areas at the time of the survey. The prevalence of stunting of children ranged from 2.2% in Addis Ababa to 17.1% in Tigray region. About 70% of children born to mothers with no education and 5.1% of the children born to mothers with at least secondary education were stunted. In addition, 52.2% of children born to mothers having husbands/partners with no education and 11.4% of children born to mothers having husbands/partners with at least secondary education were stunted.

Table 1 also shows that 49.7% of the children from poor households and 33.3% of the children from rich household were stunted. With regards to child age, 42.2% of the children under 6 months and only 2% of the children aged 48-59 months were stunted.

Table 1. Number and percentage of stunted children for the different factor categories

Variables	Categories	Number of stunted children	Percent	Total number of children
Sex of child	Female	1031	47.4	4169
	Male	1146	52.6	4318
Last Birth interval in Month	0-24months	1258	57.8	5632
	25-47 months	664	30.5	2361
	48-59 months	255	11.7	494
Age of child	<6 months	919	42.2	1721
	6-11 months	604	27.7	1844
	12-23 months	308	14.1	1656
	24-35 months	179	8.2	1550
	36-47 months	101	4.6	1050
	48-59 months	66	2	666
Birth order of the child	1	407	18. 7	1455
	2-3	704	32.3	2674
	4-5	486	22.3	2041
	6+	580	26.6	2317
Mother's Education	No education	1514	69.5	6156
	Primary education	553	25.4	2069
	Secondary and above	110	5.1	262
Employment status of mother	Unemployed	1512	69.5	6012
	Employed	665	30.5	2472
Wealth index	Poor	1082	49.7	4559
	Medium	370	17	1495
	Rich	725	33.3	2433
Education of husband/ partner	No education	1137	52.2	4621
	Primary education	791	36.3	3173
	Secondary and above	249	11.4	693

Variables	**Categories**	**Number of stunted children**	**Percent**	**Total number of children**
Number of household members	1-4	463	21.3	2008
	5-9	1536	70.6	5854
	10 and above	178	8.2	625
Place of Residence	Rural	1864	85.6	7583
	Urban	313	14.4	904
Region	Tigray	373	17.1	1416
	Afar	185	8.5	833
	Amhara	232	10.7	640
	Oromia	190	8.7	977
	Somali	209	9.6	585
	Benishangul-Gumuz	327	15	1302
	SNNP	213	9.8	978
	Gambela	145	6.7	784
	Harari	133	6.1	403
	Addis Ababa	47	2.2	139
	Dire Dawa	123	5.6	430
Source of drinking water	Not improved	1097	50.4	4501
	improved	1080	49.6	3986
Had Diarrhea in the two weeks before the survey	No	1938	89	7137
	Yes	239	11	1350
Had fever in the two weeks before the survey	No	1834	84.2	6785
	Yes	343	15.8	1702
Type of toilet facility	No facilities	2042	93.8	8098
	Have facilities	132	6.2	389

3.2. Multiple Logistic Regression Analysis

Single level multiple logistic regression was used to identify the determinants of stunting of under-five children. As can be seen in Tables 2, the single level logistic regression analysis identified, age of child, mother's level of education, wealth index, place of residence, whether a child had fever in the two weeks before the survey, level of education of husband/partner and geographical region as significant determinants of stunting status of under-five children. A level of p <0.05 was considered statistically significant. SAS 9.2 has been used to fit the logistic regression model and estimate the odds ratios. The results are given in Tables 2 and Table 3.

Table 2. A binary logit model fit results and test of Significance of Independent Variables

Covariate and Category	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	1.0655	0.0651	267.8289	<.0001*
Region				190.8589	<.0001*
Tigray	1	0.4708	0.0855	30.2888	<.0001*
Affar	1	0.1980	0.0913	4.7073	0.0300*
Amhara	1	0.3054	0.0839	13.2631	0.0003*
Oromiya	1	-0.0145	0.0695	0.0433	0.8351
Somali	1	-0.6046	0.0939	41.4791	<.0001*
Benishangul-Gumuz	1	0.4643	0.0956	23.5983	<.0001*
SNNP	1	0.1055	0.0735	2.0637	0.1508
Gambela	1	-0.5746	0.0938	37.5497	<.0001*
Harari	1	-0.3531	0.1125	9.8590	0.0017*
Dire Dawa	1	0.0237	0.1985	0.0143	0.9049
Place of residence				13.1874	0.0003*
Rural	1	-0.1241	0.0533	5.4082	0.0200*
Fever				6.7166	0.0096*
No	1	-0.0947	0.0367	6.6615	0.0099*
Education level of mother's				54.5113	<.0001*
No education	1	0.2591	0.0671	14.9084	0.0001*
Secondary and above	1	0.1663	0.0632	6.9196	0.0085*
Wealth index				7.7897	0.0203*
Poor	1	0.1156	0.0413	7.8453	0.0051*
Medium	1	-0.0568	0.0501	1.2857	0.2568
Education level of partner				6.3682	0.0414*
No education	1	0.1107	0.0465	5.6622	0.0173*
secondary and above	1	0.0579	0.0510	1.2887	0.2563
Age of child				1176.4731	<.0001*
<6 month	1	0.8785	0.0934	88.4032	<.0001*
6-11 month	1	0.7997	0.1131	49.9608	<.0001*
12-23 month	1	0.6350	0.0747	72.2209	<.0001*
24- 35 month	1	0.0741	0.0632	1.3727	0.2414
36-47 month	1	0.7553	0.0547	190.7367	<.0001*

The results in Table 3 show that the likelihood of being stunted was highly significant for under-five children. Children in the age groups less than 6 months, 6-11 months, 12-23 months, 24-35 months and 36-47 months were more likely to be stunted than children in the age group 48-59 months (OR=2.40, 2.22, 9.65, 5.507 and 2.403 respectively) controlling for other variables in the model.

The analysis also showed that children whose parents resided in rural areas were 12% less likely to be stunted when compared to those children whose parents resided in urban areas. The fitted model also indicated that children whose parents resided in Tigray, Benshangul-Gumuz, Amhara and Affar regions were 60.1%, 59.1%, 35.7% and 21.9% more likely to be stunted respectively when compared with children whose parents resided in Addis Ababa controlling for other variables in the model.

Children whose mothers had primary level education or no formal education were 80.7% and 98.3% more likely to be stunted respectively than children whose mothers had at least secondary level of education. Similarly, children whose father/mother's partner had primary level education or no formal education as compared to those whose father/mother's had at least secondary level education were more likely to be stunted.

Household wealth index also showed a statistically significant association with stunting. The likelihood of being stunted was 12% higher for children from poor families than those from the rich families. Moreover, the fitted model revealed that the odds of being stunted for children who had no fever in the two weeks before the survey date were 0.909 times the odds of being stunted for children who had fever in the two weeks before the survey.

After adjustment for other factors, the variables, namely, sex of child, birth interval of the child, birth order of the child, household size, sources of drinking water, employment of mother, had diarrhea in the two weeks before the survey and type of toilet facility appeared to have no significant effect on determining the status of stunting of under-five children in Ethiopia.

Table 3. Odds ratio Estimates

Covariate	Category	Point Estimate	Pr > ChiSq
Region	Tigray vs Addis Ababa	1.601	<.0001*
	Affar vs Addis Ababa	1.219	0.0300*
	Amhara vs Addis Ababa	1.357	0.0003*
	Oromiya vs Addis Ababa	0.986	0.8351
	Somali vs Addis Ababa	0.546	<.0001*
	Benishangul-Gumuz vs Addis Ababa	1.591	<.0001*
	SNNP vs Addis Ababa	1.111	0.1508
	Gambela vs Addis Ababa	0.562	<.0001*
	Harari vs Addis Ababa	0.703	0.0017*
	Dire Dawa vs Addis Ababa	1.024	0.9049
Place of Residence	Rural vs Urban	0.883	0.0200*
Fever	No vs Yes	0.909	0.0099*
Educational level of mother's	No educational vs secondary and above educational level	1.296	0.0001*
	Primary educational level vs secondary and above educational level	1.181	0.0085*
Wealth index	poor vs rich	1.122	0.0051*
	medium vs rich	0.945	0.2568
Educational level of partner's	No education vs secondary and above	1.117	0.0173*
	Primary education vs secondary and above education level	1.060	0.2563
Age of child	<6 month vs 48-59 month	2.407	<.0001*
	6-11 month vs 48-59 month	2.224	<.0001*
	12-23month vs 48-59 month	1.887	<.0001*
	24- 35month vs 48-59 month	1.077	0.2414
	36-47 month vs 48-59 month	0.470	<.0001*

* Significant (p<0.05)

3.3. Multi Level Logistic Regression Analyses

In the multilevel analyses, a two-level structure was used with regions as the second-level unit and children as the first-level unit. The nesting structure is children within regions that resulted in a set of 11 regions with a total of 8487 children. The data was tested to determine whether there is heterogeneity between regions. The result obtained was χ^2 = 8,220.061 with $p < 0.01$ providing evidence of heterogeneity among regions with respect to the status of stunting of under-five children.

In Table 4 below, the significant deviance-based chi-square value for the empty model implies that an empty model for stunting with random effect is better than an empty model for stunting without random effect. Similarly, the deviance based chi-square test for significance of random effects indicates that the random intercept model with the fixed slope is a better fit as compared to the empty model. Also the significant deviance-based chi-square value for the random coefficient model implies that the random coefficient model for stunting with random effect is a better fit as compared to the empty model and random intercept model.

Table 4. Deviance based chi-square and -2 Log likelihood values for the multilevel regression models

	Empty model	**Random intercept model**	**Random coefficient model**
-2 Log Likelihood	9664.57	8367.47	8367.47
Deviance-based chi-square value	99.46	107.73	108.08
Pr > ChiSq	<.0001	<.0001	<.0001

4. Discussion and Conclusions

This study is an attempt to identify the determinants of stunting of under-five children in Ethiopia based on the Ethiopian Demographic and Health Survey (EDHS 2011) data. Descriptive, ordinary multiple logistic regression and multilevel logistic regression analyses were employed.

At the beginning, the study included the most important predictor variables that were categorized under socio-economic, demographic and health and environmental characteristics. The results indicated that there are regional disparities with regard to the prevalence of stunted children. Children in Tigray, Benishangul-Gumuz, Amhara and Affar regions were at a higher risk of being stunted than children who resided in Addis Ababa. The observed higher risk of malnutrition and hence stunting in Tigray, Amhara and Benishangul-Gumuz regions may be attributed to differences in cultural and dietary practices (Woldemariam and Timotiwos 2002).

The result of the present study also indicated that age of a child is associated with stunting of under-five children in Ethiopia. The prevalence of stunting was higher in children aged less than 6 months than the other age groups. This finding is different from the findings of two previous studies conducted by Kabubo-Mariara et al. (2009) and Shrimpton et al. (2001), which revealed a rapid fall in children's height from birth to 59 months; although stunting continues after 24 months. This could be as a result of weaning and lower breast milk intakes, which make them prone to childhood stunting.

The risk of being stunted was significantly higher for children whose mothers had primary level education or no education than children whose mothers had at least secondary level education consistent to the finding by Mishra et al, (2015). They found out that children whose mothers were illiterate were twice more likely to be stunted as compared to children having mothers education of 12 years or more. This finding also seemed to be consistent with other studies (Oyekale and Oyekale 2005; Smith and Haddad 2000). They indicated that education improves the ability of mothers to implement simple health knowledge and facilitates their capacity to manipulate their environment. Furthermore, educated women have greater control over health choices for their children. The result of the current study is also in agreement with a study done in Bangladesh. The analysis of that study indicated that the educational level of caregiver was positively related to the better nutritional status of children. This is likely to be attributed to better education because educated mothers are more conscious about their children's health; they tend to look after their children in a better way (Rayhan and Hayat 2006).

Rahman et al. (2009) made a study based on the experience of 63 developing countries over 25-years period to identify the determinants of child malnutrition for each developing region. Six factors were explored; one of the important factors was women's education. They depicted that improvements in female secondary school enrollment rates were estimated to be responsible for 43% of the total 15.5% reduction in the child malnutrition rate of developing countries during the period 1970-95. In addition, the percentage of having stunted children amongst fathers with low level of education was the highest. Fathers who are illiterate had much higher percentage of stunted children than those with higher education.

In addition, our study revealed that under-five children from poor households are at a higher risk of being stunted than children from rich households. This finding is consistent with the finding of Mishra et al (2015) which indicated that children belonging to poorest families had twice risk of being stunted than those belonging to richest families. It is also consistent with the findings in other studies (Smith et al. 2005; Woldemariam and Timotewos 2002).They indicated that better off households have better access to food and higher cash incomes than poor households, allowing them a quality diet, better access to medical care and more money to spend on essential non-food items such as schooling, clothing and hygiene products. Our findings also show that children who had no fever in the two weeks before the date of the survey were significantly vulnerable to being stunted than those who had no fever. This finding is consistent with other studies (Sommerfelt et al. 1994).

This study examined whether individual and community-level (regional) factors are significant determinants of stunting in under-five children in Ethiopia. It confirms the importance of region-wise variations with respect to childhood stunting.

Using multilevel logistic regression analysis, this study examined variations in childhood stunting among geographical regions. The model suggested that the status of stunting of children differs among regions, although the variations among different communities/regions with respect to the odds of having childhood stunting were found to originate mainly from variations in individual-level factors. These findings are consistent with most studies that have tried to differentiate contextual effects from compositional effects (Frohlich et al. 2002; Subramanian et al. 2003) and support a major role for community-level phenomenon as a strong influence on childhood stunting.

The study identified the following socio-economic, demographic and health and environmental variables as important determinants of stunting status of under-five children in Ethiopia: Age of child, mother's level of education, wealth index, place of residence, whether a child had fever in the two weeks before the survey, educational level of partner and geographical region. The study also revealed that there are regional disparities with regard to the prevalence of stunted children. Interventions towards improving the economic and educational status of mothers and their partners with the objective of improving the nutritional status of children are recommended.

Conflict of Interest

We declare that we have no conflict of interest

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