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Original Research Article

Multivariate analysis of correlates of children nutritional status in Harar region, Ethiopia

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ABSTRACT

Background: Malnutrition is defined as deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients. In Ethiopia malnutrition is one of the most serious health and welfare problems among infants and young children. Malnutrition among children under five years of age is a chronic problem in most regions of Ethiopia, including the Harari region. The main objective of this study was to assess risk factors attributed to nutritional status of children in Harari region.
Methods: Data was obtained from Ethiopian Demographic Health Survey, 2016. Different factors were considered as determinants of nutritional status of a child. The study used Multivariate Multiple Linear Regression model to identify significant correlates of children nutritional status.
Results: The descriptive statistics in the study revealed that out of a total of 233 children included in the study 21% are underweighted, 19.3% are stunted and 11.2% are wasted in the study area. From Multivariate multiple linear regression, breast feeding factors, health status of child and child vaccination status significantly affect nutritional status of the under five children.
Conclusions: The factor analyses conducted in this study indicated that only two factors (instead of 5 original observed variables or items) were sufficient to explain 78.605% of the total variation in PCFA of observed items related to child nutritional status. Factors duration of breast feeding, birth order of a child, current age of child is statistically significant in affecting child malnutrition.

Keywords: Malnutrition, Wasting, Stunting, Underweight, Factor analysis, Multivariate multiple linear regression

INTRODUCTION

Malnutrition refers to a medical condition arising from a relative or absolute lack or excess of one or more vital nutrients. It is a state of nutrition where the weight for age, height for age and weight for height indices are below 2 Z-score of the National Center for Health Statistics (NCHS).[1] Nutrition is the sum total of the processes involved in the intake and utilization of food substances by living organisms, including ingestion, digestion, absorption, transport and metabolism of nutrients found in food.[2] Globally, every second a person dies from starvation or complications of malnutrition. In the course of one year, the number of children who die from lack of nutrition is over 3 million.[3]

Kids in the lowest income brackets are malnourished in the richest at twice the rate of their peers (kids are used as a measure of hunger). Kids from rich families are much less affected than those from lower-income households, even in many countries with severe malnutrition. More than 10 million children die every year in sub-Saharan Africa primarily from treatable diseases. Of these, 37% die from malnutrition related causes.[4] In East Africa, 48% of children are stunted while 36% are underweight.[5] Malnutrition is highly associated with under five mortalities. About 54% of death of children whose age is below five years, is mainly caused by in inadequate nutrition. This malnutrition can also interrupt the normal growth and development of children particularly at the early child hood period.[6]

In Ethiopia malnutrition is one of the most serious health and welfare problems among infants and young children. Even though the prevalence of chronic malnutrition in the last eleven years has decreased significantly, children under five years of age still experience one of the highest rates of malnourishment in the world, that is, 38% of the children under age of five were stunted, 24% underweight and 10% children were wasted, and 1% are overweight with a greater regional differences ranging from Amhara region (46.3%), Tigray region (39.3%), Harari region (32.0%), Oromia region (36.5%) above the national prevalence to the lowest level in Addis Ababa city (14.6%) and Gambella region (23.5%).[7] Malnutrition continues to be a major public health problem in developing countries. It is the most important risk factor for the burden of disease causing about 300,000 deaths per year directly and indirectly responsible for more than half of all deaths in children.[8] Malnutrition contributes to more than one-third of all deaths of under-five children.[9] Globally, approximately 155 million children under five suffer from stunting and nearly 52 million children under 5 were wasted and 17 million were severely wasted. More than half (56%) of all stunted children under 5 lived in Asia and more than one third (38%) lived in Africa, more than two thirds (69%) of all Wasted children under 5 lived in Asia and more than one quarter (27%) lived in Africa.[10]

A study conducted on influence of socio-economic factors on nutritional status of children in a rural community of Osun state, Nigeria revealed that the prevalence rates of underweight, wasting and stunting were 23.1%, 9% and 26.7% respectively and also prevalence and determinants of malnutrition among under-five children of farming households in Kwara State, Nigeria results indicate that 23.6%, 22.0% and 14.2% of the sample children were stunted, underweight and wasted, respectively.[11] Study done on malnutrition among under-five children in Bangladesh revealed that, the high prevalence of stunting and underweight, for instance 42% and 40% of under-five children were stunted and under weighted, respectively.[12] Also, study conducted on nutritional status of under- five children in Mongolia also showed that, the prevalence of stunting, wasting and underweight were 15.6%, 1.7% and 4.7%, respectively.[13]

The general objective of this study is to identify the determinants of malnutrition among under five children in Harari Region. Specifically, the study wants to: assess the prevalence of stunting, underweight and wasting of under-age five children in the region and identify the relevant demographic, socioeconomic and environmental factors influencing the nutritional status of the studied children.

METHODS

Sources of data

The data used in this study was obtained from the 2016 ethiopian health and demographic survey. The survey is the fourth national demography and health survey conducted by the CSA. In the 2016, EDHS7 information on population and health covering topics on family planning, fertility levels and determinants, fertility preferences, infant child, adult and maternal mortality, maternal and child health, nutrition, knowledge of HIV/AIDS, and women's empowerment were collected from the nine regions and two administrative regions of the country. From those regions we randomly took children whose age is under five years in Harari regional state. Thus, after cleaning for missing data this study analyzes responses from 233 children of age 0-59 months.

Study variables

Dependent variables

The dependent variable of the study was malnutrition status of children which was indicated by stunting, wasting, and underweight. Anthropometric measurements are used in nutritional assessments. It is used for growth assessment and is a single measurement that best measures the health or nutritional status of a child. It represents measure of people's growth indicators such as weight and height with respect to their age and sex. According to this measure, the nutritional status of children is determined by comparing growth indicator with the distribution of same indicators of healthy, the international reference standard that is most commonly used that is the data on the weights and heights of a statistically valid population (US National center for health statistics (NCHS)) of healthy children in the US. These comparisons can be expressed in the form of Z-score (standard deviation score). It is defined as the difference between the value for an individual and the median value of the reference population for the same age, height or weight divided by the standard deviation of the reference population.

Based on this comparison method, there are three most commonly used anthropometric indicators for children nutritional status. These are: wasting (weight-for-height), which measures body mass in relation to body height or length and describes current nutritional status. Children whose Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are considered thin (wasted), or acutely undernourished. Children whose weight-for-height Z-score is below minus three standard deviations (-3 SD) from the median of the reference population are considered severely wasted. It is a measure of acute under nutrition that represents the failure to receive adequate nutrition in the period immediately before the survey. Wasting may result from inadequate food intake or from a recent episode of illness that caused weight loss. The second anthropometric indicator stunting (height-for-age) is a measure of linear growth retardation and cumulative growth deficits. Children whose height-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are considered short for their age (stunted), or chronically undernourished. Children who are below minus three standard deviations (-3 SD) are considered severely stunted. It is sign of chronic under nutrition that reflects failure to receive adequate nutrition over a long period. Other indicator under weights (weight-for-age) is a composite index of height-for-age and weight-for-height that accounts for both acute and chronic under nutrition. Children whose weight-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are classified as underweight. Children whose weight-for-age Z-score is below minus three standard deviations (-3 SD) from the median are considered severely underweight. Thus, weight-for-age, which includes both acute (wasting) and chronic (stunting) under nutrition, is an indicator of overall under nutrition.[14] Thus, there are three dependent variables in the study.

Independent variable

The independent variables expected to affect the nutritional status of under five children in this study are classified as socio-economic, demographic, child health and feeding practice factors, sanitation and environmental characteristics.

Table 1: Description of independent variables in the study.

Variables name	Possible categories
Mother highest educational level	1=no education
	2=primary education
	3=secondary and higher education
Source of drinking water	1=piped
	2=unprotected well
	3=protected well
Type of toilet facility	0=with facility
	1=no facility
Wealth index combined	1=poor
	2=middle
	3=rich
Number of living children	Discrete
Husband/partner's education level	1=no education
	2=primary education
	3=secondary and higher education
Birth order number	Discrete
Number of tetanus injections before birth	Discrete
Duration of breastfeeding	In months
Months of breastfeeding	1=Ever breastfed
	2=never breastfed
	3=still breastfed
Had diarrhea recently	0=no
	1=yes
Vitamin A in last 6 months	0=no
	1=yes
Received measles	0=no
	1=yes
Received polio	0=no
	1=yes
Current age of child in months	0-59

Methods of data analysis

The study used the multivariate methods like principal components analysis, Factor analysis and multivariate multiple linear regression approaches for data analysis since the response variable is greater than one.

The principal component analysis

Principal components analysis (PCA) is frequently used in public health research. It aims to reduce numerous measures to a small set of the most important summary scores. It explains the variance-covariance structure through a few linear combinations of the original variables. The original sets of p correlated variables are transformed into a new set of uncorrelated variables in order to examine the relationships among them. Usually the maximum number of new variables that can be formed is equal to the number of original variables, and the new variables are uncorrelated among themselves. The new sets of uncorrelated variables are called principal components. PCA is formed either using the covariance matrix Σ, or correlation matrix ρ of original variables.

The orthogonal factor model

The observable random vector $X' = (X_1, X_2, \ldots, X_p)$ with P components has mean μ and covariance matrix Σ. The factor model postulates that X is linearly dependent upon a few *m* unobservable random variables f_1, f_2, f_m called common factors, (m <*p*) and *p* additional source of variation ε_1, ε_2, ε_3, ε_p are called errors (specific factors).

The factor analysis model is given by:

$$X_1 = \mu_1 + l_{11}f_1 + l_{12}f_2 + \cdots + l_{1m}f_m + \varepsilon_1$$

$$X_2 = \mu_2 + l_{21}f_1 + l_{22}f_2 + \cdots + l_{2m}f_m + \varepsilon_2$$

…

$$X_p = \mu_p + l_{p1}f_1 + l_{p2}f_2 + \cdots + l_{pm}f_m + \varepsilon_p$$

The principal component method

Let Σ has Eigen value – Eigen vector pairs $(\lambda_1, e_1), (\lambda_2, e_2), \ldots, (\lambda_p, e_p)$ with $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p > 0$.

The spectral decomposition of covariance Σ is given as:$\Sigma = \lambda_1 e_1 e_1' + \lambda_2 e_2 e_2' + \cdots + \lambda_p e_p e_p' \Sigma = LL' + 0$, here we have m = p common factors and $\Psi_i = 0\ \forall i$

From the above equation, we can obtain the loading, $L = \left(\sqrt{\lambda_1 e}_1, \sqrt{\lambda_2 e_2}, \ldots, \sqrt{\lambda_p e_p}\right)$

Apart from the scale factor$\sqrt{\lambda_i}$, the factor loadings on the i^th^ factor are the coefficients of i^th^ principal component. Even though the above FA representation is exact it is not useful since it employs as many common factors as variables, $m = p$ and it does not allow any variation in the specific factors Σ.

One approach to prefer just a few common factors is to ignore the contributions of $\lambda_{m+1}, \lambda_{m+2}, \ldots, \lambda_p$ (when the last $(p - m)$ Eigen values are small).

Then we have $\Psi = \Sigma - \mathrm{LL}'$.

In applying the principal component to perform factor analysis, we have use, the sample covariance matrix S will be use.

In general, the proportion of total variance due to the i^th^ factor is:

$$\frac{\hat{\lambda}_i}{\hat{\lambda}_1 + \hat{\lambda}_2 + \cdots + \hat{\lambda}_p}$$

for a FA of sample covariance S

$$\frac{\hat{\lambda}_i}{\rho}$$

for a FA of sample correlation R

Common practices to choose "m" are: m=number of Eigen values greater than one (for a FA of the sample correlation matrix R). Choose m so that say 75%, or 70% – 80% of the variance is explained.

Multivariate multiple linear regression model

Sometimes the model or the relationship among variables may be more complicated. In such cases, more than one response variable can be affected by one predictor or by the same set of predictors. In multivariate multiple linear regression model, we consider the relationship between more than one dependent variable and more than one independent variable. The multivariate extension of multiple linear regression used to model the relationship between *m* responses variables denoted by $Y_1, Y_2, \ldots, Y_m$and a same set of k predictor variables$x_1, x_2, \ldots, x_k$.

Suppose that the number of response variables is m, so we have n observations for each Y_i, i = 1, 2…, m. The general formula for the multivariate regression model is given by:

$Y_i = \beta_{0i} + \beta_{1i}X_1 + \beta_{2i}X_2 + \cdots + \beta_{ki}X_k + \varepsilon_i$ for all *i*= 1,2, 3..., *m*. Thus:

$$Y_1 = \beta_{01} + \beta_{11}X1 + \cdots + \beta_{k1}X_k + \varepsilon_1$$

$$Y_2 = \beta_{02} + \beta_{12}X_1 + \cdots + \beta_{k2}X_k + \varepsilon_2 \ldots$$

$$Y_m = \beta_{0m} + \beta_{1m}X1 + \cdots + \beta_{Km}X_K + \varepsilon_m$$

$\varepsilon = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_m)'$has expectation 0 and variance matrix Σ. The errors associated with different responses on the same sample unit may have different variances and may be correlated. The strategy in the least squares is the same as in the simple and multiple linear regression models.

Checking the goodness of fit of the model

After fitting the multivariate multiple models, we have to show how the model is good fit. In this study we used likelihood ratio tests. Computations to obtain the maximum likelihood estimator (MLE) of the regression coefficients in the multivariate multiple regression model are no more difficult than for the univariate multiple regression model, since the $\hat{\beta}_{(i)}$ are obtained one at a time.

Goodness of fit of the model and model diagnostics are usually carried out for one regression model at a time. As in the case of the univariate model, we can construct a likelihood ratio test to decide whether a set of $k-q$ predictors is associated $X_{q+1}, X_{q+2,} \ldots, X_k$with the m responses.

The appropriate hypothesis is H_0: $\beta_{(2)} = 0$,

where $\beta = \begin{bmatrix} \beta_{(1),\ (q+1)xm} \\ \beta_{(2),(k-q)\times m} \end{bmatrix}$

If we set $[X = X_{(1),(q+1)xn} X_{(2),(k-q)xn}]$, then $E(Y) = X_{(1)}\beta_{(1)} + X_{(2)}\beta_{(2)}$

Under H_0, $Y = X_{(1)}\beta_{(1)} + \varepsilon$.

The likelihood ratio test consists in rejecting H_0 if Λ is small

$$\text{where } \Lambda = \frac{max\beta_{(1)},\Sigma L\beta_{(1)}\Sigma}{max\beta_{,}\Sigma L(\beta,\Sigma)} = \frac{L\left(\hat{\beta}_{(1),}\hat{\Sigma}\right)}{L\left(\hat{\beta},\hat{\Sigma}\right)} = \left(\frac{\left|\hat{\Sigma}\right|}{\left|\hat{\Sigma}_1\right|}\right)^{\frac{n}{2}}.$$

Sometimes we don't need the distribution of Λ, since;$\Lambda^{\frac{2}{n}} = \left[1 + \frac{T^2}{n-1}\right]^{-1}$, where $T^2$is the Hotelling's T^2.

Under H_0 T^2 has an F distribution with numerator and denominator degrees of freedom p and $(n-p)$ respectively. Thus, we reject the null hypothesis if $T^2$is large, $T^2 > \frac{(n-1)p}{n-p} F_\alpha(p,\ n-p)$, where p is the number of parameters in the model.

RESULTS

Descriptive statistics

The statistical analysis for the descriptive results is shown in the following tables. Out of a total of 233 children included in the study the result indicates that the overall prevalence of underweight, stunting and wasting were 21%, 19.3% and 11.2% respectively. According to the results shown on Table 2, of total children underweighted 4.7% are severely underweighted while 16.3% are moderately underweighted. Concerning the anthropometric height for age Z-score (stunting) 19.3% are malnourished from which about 6.0% are severely stunted and 13.3% of the children in the study are moderately malnourished (stunted). Wasting (Z score weight for height) is indicator child malnutrition; regarding this 11.2% are malnourished (1.3% severe and 9.9% moderate) malnutrition respectively.

Factor analysis

In factor analysis principal component analysis (PCA), which is one of the most popular multivariate analysis methods, the research was conducted using only five quantitative variables to show higher correlation between variables.

Table 2: Summary statistics for nutritional status of children.

Nutritional status		N	Percentage (%)	Cumulative percentage (%)
Underweight	Severe	11	4.7	4.7
	Moderate	38	16.3	21
	Nourished	184	79	100
Stunting	Severe	14	6.0	6.0
	Moderate	31	13.3	19.3
	Nourished	188	80.7	100
Wasting	Severe	3	1.3	1.3
	Moderate	23	9.9	11.2
	Nourished	207	88.8	100
	Total	233	100.0	

Table 3: Major demographic and socio-economic variables considered in the study.

Covariates	Categories	Stunted			Underweight			Wasted		
		Nourished (%)	Moderate (%)	Severe (%)	Nourished (%)	Moderate (%)	Severe (%)	Nourished (%)	Moderate (%)	Severe (%)
Mother Highest educational level	No education	123 (52.8)	25 (10.7)	14 (6.0)	127 (54.5)	26 (11.2)	9 (3.9)	146 (62.7)	13 (5.6)	3 (1.3)
	Primary education	30 (12.9)	6 (2.6)	0 (0.0)	26 (11.2)	8 (3.4)	2 (0.9)	29 (12.4)	7 (3.0)	0 (0.0)
	Secondary and higher education	35 (15)	0 (0.0)	0 (0.0)	31 (13.3)	4 (1.7)	0 (0.0)	32 (13.7)	3 (1.3)	0 (0.0)
Source of drinking water	Piped	40 (17.2)	7 (3.0)	7 (3.0)	41 (17.6)	9 (3.9)	4 (1.7)	48 (20.6)	6 (2.6)	0 (0.0)
	Unprotected well	101 (43.3)	15 (6.4)	4 (1.7)	99 (42.5)	19 (8.2)	2 (0.9)	109 (46.8)	8 (3.4)	3 (1.3)
	Protected well	47 (20.2)	9 (3.9)	3 (1.3)	44 (18.9)	10 (4.3)	5 (2.1)	50 (21.5)	9 (3.9)	0 (0.0)
Type of toilet facility	With facility	50 (21.5)	5 (2.1)	4 (1.7)	46 (19.7)	10 (4.3)	3 (1.3)	50 (21.5)	9 (3.9)	0 (0.0)
	No facility	138 (59.2)	26 (11.2)	10 (4.3)	138 (59.2)	28 (12.)	8 (3.4)	157 (67.4)	14 (6.0)	3 (1.3)
Wealth index combined	Poor	122 (52.4)	22 (9.4)	9 (3.9)	122 (52.4)	25 (10.7)	6 (2.6)	134 (57.5)	16 (6.9)	3 (1.3)
	Middle	28 (12. 0)	3 (1.3)	3 (1. 3)	22 (9.4)	7 (3.0)	5 (2.1)	28 (12.0)	6 (2.6)	0 (0.0)
	Rich	38 (16.3)	6 (2.6)	2 (0.9)	40 (17.2)	6 (2.6)	0 (0.0)	45 (19.3)	1 (0.4)	0 (0.0)
Husband/partner's education level	No education	83 (35.6)	12 (5.2)	3 (1.3)	85 (36.5)	11 (4.7)	2 (0.9)	92 (39.5)	4 (1.7)	2 (0.9)
	Primary education	42 (18.0)	9 (3.9)	6 (2.6)	41 (17.6)	12 (5.2)	4 (1.7)	46 (19.7)	10 (4.3)	1 (0.4)
	Secondary and higher education	63 (27.0)	10 (4.3)	5 (2.1)	58 (24.9)	15 (6.4)	5 (2.1)	69 (29.6)	9 (3.9)	0 (0.0)
Months of breastfeeding	Ever breastfed	50 (21.5)	8 (3.4)	5 (2.1)	48 (20.6)	13 (5.6)	2 (0.9)	56 (24.0)	6 (2.6)	1 (0.4)
	Never breastfed	54 (23.2)	8 (3.4)	3 (1.3)	49 (21.0)	9 (3.9)	7 (3.0)	54 (23.2)	9 (3.9)	2 (0.9)
	Still breastfed	84 (36.1)	15 (6.4)	6 (2.6)	87 (37.3)	16 (6.9)	2 (0.9)	97 (41.6)	8 (3.4)	0 (0.0)
Had diarrhea recently	No	98 (42.1)	26 (11.2)	7 (3.0)	103 (44.2)	20 (8.6)	8 (3.4)	121 (51.9)	10 (4.3)	0 (0.0)
	Yes	90 (38.6)	5 (2.1)	7 (3.0)	81 (34.8)	18 (7.7)	3 (1.3)	86 (36.9)	13 (5.6)	3 (1.3)
Vitamin A in last 6 months	No	155 (66.5)	30 (12.9)	13 (5.6)	152 (65.2)	35 (15.0)	11 (4.7)	174 (74.7)	21 (9.0)	3 (1.3)
	Yes	33 (14.2)	1 (0.4)	1 (0.4)	32 (13.7)	3 (1.3)	0 (0.0)	33 (14.2)	2 (0.9)	0 (0.0)
Received measles	No	154 (66.1)	23 (9.9)	12 (5.2)	148 (63.5)	30 (12.9)	11 (4.7)	166 (71.2)	20 (8.6)	3 (1.3)
	Yes	34 (14.6)	8 (3.4)	2 (0.9)	36 (15. 5)	8 (3.4)	0 (0.0)	41 (17.6)	3 (1.3)	0 (0.0)
Received polio	No	126 (54.1)	14 (6.0)	9 (3.9)	130 (55.8)	15 (6.4)	4 (1.7)	137 (58.8)	11 (4.7)	1 (0.4)
	Yes	62 (26.6)	17 (7.3)	5 (2.1)	54 (23.2)	23 (9.9)	7 (3.0)	70 (30.0)	12 (5.2)	2 (0.9)

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy in Table 4 tests whether the partial correlations among variables are small. A p-value of more than 5% indicates that the partial correlations among variables are statistically significant. Bartlett's test of sphericity tests whether the correlation matrix is an identity matrix, which would indicate that the factor model is inappropriate. Rejection of the null hypothesis (correlation matrix is an identity matrix) implies that the factor model is appropriate. The KMO measures of sampling adequacy tests were 0. 517greater than 0.5 indicating that the sampling was adequate for factor analysis and there were significant relationships among the perceived factors of nutritional measures. The data were also checked for Bartlett 's test of Sphericity to see that the correlation matrix is an identity matrix, the test shows that the factor model is appropriate (p value <0.0001).

Table 4: KMOs and Bartlett's tests for factor analyses.

Kaiser-Meyer-Olkin measure of sampling adequacy		0.517
Bartlett's test of sphericity	Approx. chi-square	921.736
	Df	10
	Sig.	0.000

The criteria that the required amount of explained variation accounted for being large, logical interpretability of factors and Scree plot tests were considered with Kaiser criteria. Kaiser criteria is accurate when communalities after extraction being greater than 0.6.

Table 5: Principal component analysis: total variance explained.

Component	Initial Eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative (%)	Total	% of variance	Cumulative (%)	Total	% of variance	Cumulative (%)
1	2.149	42.990	42.990	2.149	42.990	42.990	2.089	41.784	41.784
2	1.781	35.616	78.605	1.781	35.616	78.605	1.841	36.822	78.605
3	0.877	17.531	96.136						
4	0.160	3.190	99.327						
5	0.034	0.673	100.000						

Extraction method: principal component analysis.

The output matrixes contained the loading of each variable onto each factor. The results of factor analysis (with factor loadings greater than 0.4 in absolute) are presented in Table 5 and shown in Figure 1. The scree plot reveals the first two components have Eigen values above 1, explaining at least as much of the variation as the original variables.

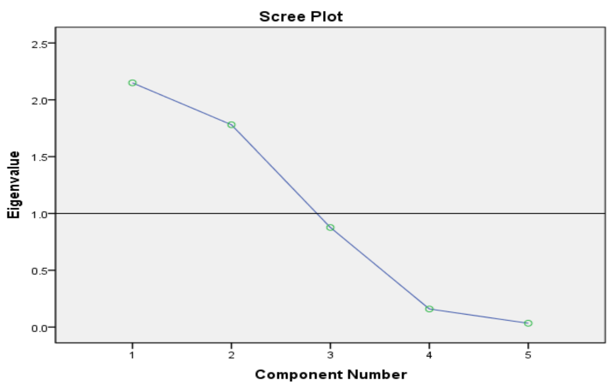

Figure 1: Scree plot of eigen values after PCA.

Principal component factor analysis was done considering the demographic characteristics of a child and health status of child. The component loadings represent the correlation between the components and original variables. In this study we concentrate on loadings above 0.4 or below -0.4 and components/factors are named based on the highest loadings. Factor scores of each component factor for each of the 233 individual children were computed and these scores were used as data for further analysis. The common factors obtained from the PCFAs which were used as covariates are: current age of child breast feeding (duration of breast-feeding months of breast feeding and current age of child) and family size of medical treatments (number of living children, birth order, and number of tetanus injections before birth)

Results of multivariate multiple linear regression analysis

The results in Table 6 show the multivariate multiple linear regression analysis determinant factors for nutritional status of under five children based on the three anthropometric indicators: Z score weight for height, Z score weight for age and Z score height for age. The factors maternal educational level, source of drinking water, type of toilet facility, wealth index combined, husband partner's education level, months of breast feeding, vitamin A in last 6 months, received measles and received polio of child was found to be jointly statistically significant for Z score weight for height (wasting).

Table 6: Parameter estimates of multivariate multiple linear regression model.

Dependent variable	Parameter	Estimate	Std. error	T value	Pr(>|t|)
Stunted	(Intercept)	1.976000	0.438000	4.514	0.000000***
	Mother primary education	1.299774	0.228507	5.688	4.17e-08***
	Mother secondary and higher education	1.267125	0.226720	5.589	6.88e-08***
	Water un protected well	1.146805	0.202910	5.652	5.01e-08***
	Current age of child breastfeeding	-0.091375	0.008831	-10.347	2e-16***
	Partners primary education	-0.682084	0.198265	-3.440	0.000698***
	Partners secondary and higher education	-1.102798	0.190139	-5.800	2.35e-08***
	Family size of medical treatments	-0.163695	0.035926	-4.556	8.72e-06***
	Months of never breastfed	0.679302	0.211598	3.210	0.001529**
	Months of still breastfed	-0.700313	0.193437	-3.620	0.000367***
	Had diarrhea recently yes	1.006103	0.155046	6.489	5.86e-10***
	Vitamin a in last 6 months yes	0.955012	0.220838	4.324	2.34e-05***
	Received polio yes	-0.671882	0.164813	-4.077	6.43e-05***
Under weight	(Intercept)	1.897000	0.359000	5.281	0.000000***
	Water protected well	-0.455967	0.180465	-2.527	0.012236*
	Without toilet facility	0.802397	0.152685	5.255	3.55e-07***
	Rich wealth index	0.711370	0.169559	4.195	3.98e-05***
	Current age of child breastfeeding	-0.074398	0.007246	-10.268	2e-16***
	Partners primary education	-0.997045	0.162679	-6.129	4.17e-09***
	Partners secondary and higher education	-0.910540	0.156010	-5.836	1.95e-08***
	Family size of medical treatments	-0.104497	0.029478	-3.545	0.000482***
	Months of never breastfed	0.543955	0.173618	3.133	0.001971**
	Had diarrhea recently yes	0.510578	0.127216	4.013	8.26e-05***
	Vitamin a in last 6 months yes	1.152262	0.181200	6.359	1.20e-09***
	Received measles yes	0.686975	0.165817	4.143	4.93e-05***
	Received polio yes	-0.885666	0.135230	-6.549	4.19e-10***
Wasted	(Intercept)	-0.647364	0.292984	-2.210	0.028191*
	Mother primary education	-0.570391	0.203055	-2.809	0.005427**
	Mother secondary and higher education	-0.476835	0.201468	-2.367	0.018830*
	Water un protected well	-0.647122	0.180310	-3.589	0.000411***
	Water protected well	-0.670365	0.195445	-3.430	0.000724***
	Without toilet facility	1.146873	0.165359	6.936	4.67e-11***
	Rich wealth index	0.877051	0.183634	4.776	3.31e-06***
	Partners primary education	-0.567994	0.176182	-3.224	0.001461**
	Months of still breastfed	0.350548	0.171892	2.039	0.042638*
	Vitamin A in last 6 months yes	0.649144	0.196241	3.308	0.001102**
	Received measles yes	0.367043	0.179581	2.044	0.042184*
	Received polio yes	-0.465015	0.146456	-3.175	0.001717**

Significant codes: 0 '***' 0.001 '**'0.01 '*'0.05 '.'0.1 ' ' 1.

DISCUSSIONS

This section discusses the main findings of the study. Results of the study were discussed as follow where some of the results are discussed by relating with the results of the previous studies.

Table 3 presents the descriptive statistics of the major covariates considered in this study with stunting (H/A Z scores), underweight (W/A z-score) and wasting (W/H Z score). Children born to mothers with no education has the highest proportion of malnutrition; 16.7% stunted (6.0% severe malnutrition and 10.7% moderately stunted), 15.1% underweight (3.9% severe and 11.2% moderately underweight) and 6.9% wasted (1.3% severe and 5.6% moderately) malnourished. The result of this study revealed that, the prevalence of stunting and wasting were less as compared with study conducted on prevalence of malnutrition and associated factors among children aged 6-59 months at Hidabu Abote district, 47.6 % stunted and 16.7% were wasted.[15] Even though the prevalence of underweight very high in this district but lower than study conducted on food Surplus region of Ethiopia in case of West Gojam zone with 49.2% of children under five were affected by underweight. However, present study showed that prevalence of stunting and wasting were higher as compared with study of west Gojam zone.[16] Prevalence of stunting higher but prevalence of underweight was low as compared to study done in Bangladesh, 42% and 40% of children were stunted and underweight, respectively.[12]

The result of the multivariate multiple linear regression analysis (Table 5) indicated that factors duration of breast feeding and months of breast feeding, socioeconomic status of households composed of education level of mothers and partner, source of drinking water, availability of toilet facility, economic level of households, health status of child encompassing had diarrhea recently, tetanus injections before birth, child vaccination which encompassed of vitamin A last six months, measles and polio have significant impacts on nutritional status of the children aged under five years in the study area.

Source of drinking water (unprotected) have direct relationship with malnutrition. This finding similar to study conducted western Kenya showed that, more children who drank water that was not consistently treated in households were wasted.[17] Households are not use an appropriate treatment method to ensure that water is safe for drinking.[18] Consequently, diarrhea and waterborne diseases caused by unsafe drinking water at the level of households may directly or indirectly increase the prevalence of malnutrition.

Current age of child in month and months of breast feeding had a significant negative impact on child malnutrition in terms of wasting (low weight-for-height), underweight (low weight-for-age) and stunting (low height-for-age).

This result consistent with other studies conducted in Ethiopia and other developing countries, which showed the prevalence of stunting positively associated with child age.[16] This may be due to the longer time that a mother feed breast to her child at least for six months the more the child is health and gets balanced nutrients. Similarly, factors family size of medical treatments, birth order and number of tetanus injections before birth of child also had significant negative impact on child malnutrition in terms of low weight-for-age.

Theoretically the risk of malnutrition/health problem is, on average, significantly higher for children whose mothers have no education in terms of long and short-run measures (i.e., underweight). This may mean that awareness strengthens mothers' ability to implement basic health information and promotes their ability to manipulate their environment like health care facilities, communicate more efficiently with health care professionals, comply with treatment recommendations, and preserve clean environment. Furthermore, educated women have greater control over health choices for their children. Better off households have better access to food and higher cash income than poor households, allowing them to consume a healthier diet, have greater access to medical care, and spend more money on important non-food items such as education, clothes and hygiene products.[19]

The findings of this study also show that child health status incorporating recently had diarrhea has inversely related to child malnutrition. From various literatures and theories children who have diarrhea or fever and cough are significantly vulnerable to malnutrition and health problem. This is because diarrhea accelerates the onset of malnutrition by reducing the intake of food and increasing the organism's metabolic reactions. Diarrhea also affects both dietary intake and use, which can adversely affect the improved nutritional status of children. Family size of Medical treatments is also an important factor that affects the nutrition/health status of children in terms of long short height and for age (i.e. stunting).

CONCLUSION

This study was intended to identify factors contributing to malnutrition among under five children in the study area. Accordingly, factor analysis, and multivariate multiple linear regression techniques on the three anthropometric measures were employed. The factor analyses conducted in this study indicated that only two factors (instead of 5 original observed variables or items) were sufficient to explain 78.605% of the total variation in PCFA of observed items related to child nutritional status.

The factors current age of child breast feeding, family size of medical treatment, mother educational level, source of drinking water, type of toilet facility, wealth index combined, husband partners education level, months of breast feeding, vitamin A in last 6months, received measles and received polio were the common factors explaining most of the variability of nutritional status in terms of each wasting Z score weight for height, Z score weight for age and Z score height for age, these two common factors were enough to explain about 78.605% of the variation using 5 originally observed variables in the PCFA. The study revealed that the factors duration of breast feeding, living children, birth order of a child, current age of child in months, sanitation services like drinking water and availability of toilet, mother educational level and father education level, economic level of household, receiving measles, polio and vitamin A in the last six months and child health status indicators like having diarrhea recently had a statistically significant on child malnutrition in Harar region.

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