

Multivariate Analysis of Wasting and Stunting Among Under-Five Children in Case of Segen Area People and South Omo Zone, SNNPR, Ethiopia

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Abstract: Nutrition is the intake of food, considered in relation to the body's dietary needs. Good nutrition – an adequate, well balanced diet combined with regular physical activity – is a cornerstone of good health. Poor nutrition can lead to reduced immunity, increased susceptibility to disease, impaired physical and mental development, and reduced productivity. The aim of this study was to analyze the determinants of Stunting and Wasting among Under-five Children of Segen Area People and South Omo Zone, Ethiopia. A total of 339 children are selected from 5 woreda using self-administered questionnaire. From these 148 children are females and 191 are males and 35.4% of children are wasted and 54.9% are stunted. Binary logistic regression model was used to analyze the data. Among the various socio-economic, demographic and child health and care practices characteristics considered, residence, Primary mothers education level, sex of the child (female) are significantly associated with wasting. Rural residence, mothers' education level and female child were remained to be significantly associated with stunting. The prevalence rate of malnutrition in the study area was found high and this was coupled with association of many independent variables. Family religion, mothers' occupation, mothers education level, family food source, source of drinking water (public tap), child sex, child order, duration of breast feeding, vaccination status, prenatal and postnatal care, Diarrhea and Fever are associated with wasting and stunting.

Keywords: Under Five Children, Nutrition, Stunting, Wasting

1. Introduction

Nutritional status is the result of complex interactions between food consumption and the overall status of health and health care practices. Numerous socioeconomic and cultural factors influence patterns of feeding children and the nutritional status of women and children. The period from birth to age two is especially important for optimal growth, health, and development. Unfortunately, this period is often marked by micronutrient deficiencies that interfere with optimal growth. Additionally, childhood illnesses such as diarrhea and acute respiratory infections (ARI) are common. For women, improving overall nutritional status throughout the life cycle is crucial to maternal health. Women who become malnourished during pregnancy and children who

fail to grow and develop normally due to malnutrition at any time during their life, including during fetal development, are at increased risk of prenatal problems, increased susceptibility to infections, slowed recovery from illness, and possibly death. Improving maternal nutrition is crucial for improving children's health. The nutritional status of children under age five is an important outcome measure of children's health [1].

Malnutrition, in all its forms, includes under nutrition (wasting, stunting, underweight), inadequate vitamins or minerals, overweight, obesity, and resulting diet-related non communicable diseases. In 2014, approximately 462 million adults worldwide were underweight, while 1.9 billion were either overweight or obese. While in 2016, an estimated 155 million children under the age of five years were suffering

from stunting, while 41 million were overweight or obese. Around 45% of deaths among children under five years old are linked to under nutrition. These mostly occur in low- and middle-income countries. At the same time, in these same countries, rates of childhood overweight and obesity are rising [2].

In Ethiopia, 38% of children under age five are stunted or too short for their age, and 18% severely stunted. Ten percent are wasted or too thin for their height, including 3% who are severely wasted. Twenty four percent of children under five years old are underweight or too thin for their age, with 7% severely underweight. The prevalence of overweight children remained low at 1%. The prevalence of stunting has decreased considerably from 58% in 2000 to 38% in 2016, an average decline of more than 1 percentage point per year. On the other hand, the prevalence of wasting changed little over the same time period, with a wasting rate of 10% at the time of the EDHS 2016, which was the same level as in 2011. The prevalence of underweight has consistently decreased from 41% to 24% over the 16-year period [3].

The prevalence of stunting, wasting and underweight among children under-five years of age worldwide have significantly decreased since 1990. This is good news, but overall progress is insufficient and millions of children remain hungry. Although Ethiopia has shown progress, under nutrition is still public a health problem and remain a concern to its rapid economic development. Ethiopia is making progress towards food and nutrition security. Both stunting and underweight prevalence has decreased by more than 10% between 2000 and 2010. The decrease has been steady, with both falling by 1.34 percentage points per year over the 10 year period. Wasting, which measures the more immediate effect of malnutrition, seems to have fallen slightly from around 12% in 2000 and 2005, to 9% in 2010. However, Under-nutrition is still a public health problem and an overarching development concern, affecting not only food

insecure areas of the country but also food secure areas. Stunting affects 44% of children under five years of age in 2011, which is too high. More than 1 out of 4 women in Ethiopia is affected by under-nutrition and anaemia, a key contributing factor to high maternal and neonatal mortality as well as infant under-nutrition [1].

2. Data and Methodology

2.1. Study Area and Population

The study was conducted in Southern Nations Nationalities and People's Region (SNNPR). The SNNPRS is located in the southern and southwestern part of Ethiopia. It is bordered with Kenya in south, Sudan in southwest, Gambella Regional State in north-west, and surrounded by Oromia Regional State in northwest, north and east. This study will be conducted on Segen Area People and South Omo zones.

2.2. Sampling Technique

Using simple random sampling a sample of five weredas (Burji, Derashe, Debub Ari, BenaTsemay and Jinka Town) are selected among 13 weredas in the study area. A data on a total of 339 children's were collected by door to door survey for a month in the selected weredas. This study was used structured questionnaire and the anthropometric measurements of the children were taken using standard procedures.

2.3. Variables of the Study

Variables considered in this study were selected based on earlier studies at the global and national level. Maternal, demographic and socioeconomic variables will take as determinants of stunting and wasting of under five children.

Table 1. Distribution of Categorical Variables.

| Variable Type | Variables | Category |
|-----------------------|----------------------------|---|
| Outcome Variables | Wasting: Weight-for-Height | 0 = Not wasting 1 = Wasting |
| | Stunting: Height-for-age | 0 = Not stunted 1 = Stunted |
| | Woreda | 1 = Burji 2 = Derashe 3 = Debub Ari 4 = Benatsemay 5 = Jinka |
| Explanatory Variables | Residence | 1 = Rural 2 = Urban |
| | Household Sex | 1 = Female 2 = Male |
| | Religion | 1 = Orthodox 2 = Muslim 3 = Catholic 4 = Protestant 5 = Other |
| Explanatory Variables | Mother Occupation | 1 = House Wife 2 = Laborer 3 = Agriculture 4 = Self- Employed |

| Variable Type | Variables | Category |
|-----------------------|----------------------------|-----------------------------------|
| Explanatory Variables | Mother Education Level | 5 = Merchant |
| | | 6 = Employed in Governmental Org. |
| | | 1 = Illiterate |
| | | 2 = Read and Write |
| | | 3 = Primary |
| | Mother Marital Status | 4 = secondary and Above |
| | | 1 = Single |
| | | 2 = Married |
| | | 3 = Divorced |
| | Family Food Source | 4 = Widowed |
| | | 1 = Agriculture |
| | | 2 = Purchase |
| | Source of Drinking Water | 3 = Aid |
| | | 1 = Public tap |
| | Child Sex | 2 = other |
| | | 1 =Female |
| Explanatory Variables | Child Order | 2 = Male |
| | | 1 = First |
| | | 2 = Second |
| | | 3 = Third |
| | | 4 = Fourth |
| | Duration of Breast Feeding | 5 = Fifth and Above |
| | | 1 = < 6 Month |
| | | 2 = 6-12 Month |
| | | 3 = 13-24 Month |
| | Vaccination Status | 4 = >24 Month |
| | | 1 = Not Vaccinated |
| | | 2 = Partially Vaccinated |
| | Prenatal Care | 3 = Fully Vaccinated |
| | | 0 = Yes |
| | Postnatal Care | 1 = No |
| | | 0 = Yes |
| | Diarrhea before Two Week | 1 = No |
| | | 0 = No |
| | Fever before Two Week | 1 = Yes |
| | | 0 = No |

2.4. Method of Data Analysis: The Logistic Regression

Suppose that the study have n binary observations of the form y_i , $i = 1, 2, \dots, n$. Let Y denote a dichotomous outcome variable, which may assume values "1" if wasted and stunted and "0" otherwise. Let the vector $X' = (x_1, x_2, \dots, x_k)$ denote a set of k predictor variables. The general data layout can be represented as follows:

$$X = \begin{pmatrix} 1 & x_{11} & x_{12} & \dots & x_{1k} \\ 1 & x_{21} & x_{22} & \dots & x_{2k} \\ \cdot & \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \cdot & \dots & \cdot \\ 1 & x_{n1} & x_{n2} & \dots & x_{nk} \end{pmatrix}_{n \times (k+1)} \quad \text{and} \quad Y = \begin{pmatrix} y_1 \\ y_2 \\ \cdot \\ \cdot \\ \cdot \\ y_n \end{pmatrix}_{n \times 1}$$

Where, X is called the design or regression matrix. And without the loading column of 1's, this design matrix is said to be predictor data matrix.

Then the logistic model which relates the probability of the event occurring to the predictor variables x is given by:

$\pi(x_i)$ is the probability that i^{th} children is health status used given that k predictor variables. β is a vector of unknown coefficients (i.e $\beta = (\beta_0, \beta_1, \beta_2, \dots, \beta_k)'$) $P(Y=1 / X = xi) = \frac{\exp(\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_k x_{ik})}{1 + \exp(\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_k x_{ik})} = \frac{e^{X' \beta}}{1 + e^{X' \beta}} = \pi(x_i)$

and thus $P(Y=0 / X = xi) = 1 - \pi(x_i)$

After performing the logit transformation on $\pi(x_i)$, the following logistic model was obtained:

$$\log it(\pi(x_i)) = \log \left[\frac{\pi(x_i)}{1-\pi(x_i)} \right] = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_p X_{ip}, i=1, 2, \dots, n$$

where log denotes the natural logarithm. This class of generalized linear models allows $\pi(x_i)$ to be related to the linear component $\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_p X_{ip}$ by the use of a logistic link function.

Where: β_0 is the constant of the equation and, $\beta_1, \beta_2, \dots, \beta_p$ are the coefficients of the predictor variables. The above equation is known as the logistic function.

2.4.1. Assumptions of Logistic Regression

The following assumptions of logistic regression are considered [4].

- Linearity in the logit
- Normally distributed error terms are not assumed.
- Meaningful coding. Logistic coefficients will be difficult to interpret if not coded meaningfully. The convention for binomial logistic regression is to code the dependent class of greatest interest as 1 and the other class as 0.
- Logistic regression requires the dependent variable to be binary or dichotomous.
- The categories (groups) must be mutually exclusive and exhaustive; a case can only be in one group and every case must be a member of one of the groups.
- Logistic regression uses Maximum Likelihood Estimation (MLE) and requires a larger sample size than would be required for OLS regression.

2.4.2. Odds Ratio

The odds ratio is the ratio between two odds. The odds of some event happening is defined as the ratio of the probability of occurrence to the probability of nonoccurrence.

The odds ratio is a value which shows the strength of association between a predictor and the response of interest (log odds of the dependent variable) in the model. It can vary from 0 to infinity. If the odds ratio is one, there is no association. So, the parameter estimates of a logistic regression can be interpreted easily in terms of odds ratios. If more than one explanatory variable are present in a model, the odds ratios for one predictor may be calculated keeping

all other predictors at a fixed level.

Akaike Information Criterion (AIC) and Baye's Information Criterion (BIC) are used for model selection and maximum likelihood method was used for parameter estimation [5]. Cox and Snell and Nagelkerke methods are used to estimate the coefficient of determination. And to test the goodness of fit for logistic regression models Hosmer Lemeshow test are used. The Wald test is one of a number of ways of testing whether the parameters associated with a group of explanatory variables are zero [6]. If β_i for a particular explanatory variable or group of explanatory variables different from zero, the Wald test is significant [7].

3. Statistical Data Analysis

The aim of this study was to analyze the Determinants of Stunting and Wasting among Under-five Children of Segen Area People and South Omo Zone. Burji and Derashe were randomly selected from Segen Area peoples and Debub Ari, BenaTsemay and Jinka are selected from South Omo Zone, Ethiopia. Since total number of children in the selected area was not known, a total of 339 childrens were selected from five woredas in two zones by door to door survey. The data analyses were carried out by ENA (Emergency Nutritional Assessment) and SPSS 20 software.

3.1. Descriptive Statistics

Table 2. Frequency Distribution of Response Variables.

| Variables | Category | Frequency | Percentage |
|-----------|-------------|-----------|------------|
| Wasting | Not wasted | 219 | 64.4% |
| | Wasted | 120 | 35.4% |
| Stunting | Not stunted | 163 | 48.1% |
| | Stunted | 176 | 51.9% |

From table 2 this study shows that from 339 randomly selected children's 120 (35.4%) and 176 (51.9%) of children's are wasted and stunted, respectively. Whereas 219 (64.6%) and 163 (48.1%) children's are not wasted and not stunted, respectively.

Table 3. Frequency Distribution of Categorical Variables.

| Variables | Category | Wasting | | Stunting | |
|--------------------|------------|--------------|--------------|--------------|--------------|
| | | Not wasted | Wasted | Not Stunted | Stunted |
| Woreda | Burji | 47 (13.86%) | 17 (5.01%) | 30 (8.85%) | 34 (10.03%) |
| | Derashe | 72 (21.24%) | 29 (8.55%) | 48 (14.16%) | 53 (15.63%) |
| | Debub Ari | 28 (8.26%) | 22 (6.49%) | 28 (8.26%) | 22 (6.49%) |
| | Benatsemay | 55 (16.22%) | 44 (12.98%) | 42 (12.39%) | 57 (16.81%) |
| | Jinka | 17 (5.01%) | 8 (2.36%) | 15 (4.42%) | 10 (2.95%) |
| Residence | Rural | 147 (43.36%) | 91 (26.84%) | 115 (33.92%) | 123 (36.28%) |
| | Urban | 72 (21.24%) | 29 (8.55%) | 48 (14.16%) | 53 (15.63%) |
| Household head Sex | Female | 41 (12.09%) | 14 (4.13%) | 26 (7.67%) | 29 (8.55%) |
| | Male | 178 (52.51%) | 106 (31.27%) | 137 (40.41%) | 147 (43.36%) |
| Religion | Orthodox | 83 (24.48%) | 40 (11.80%) | 63 (18.58%) | 60 (17.70%) |
| | Muslim | 18 (5.31%) | 3 (0.88%) | 10 (2.95%) | 11 (3.24%) |
| | Catholic | 25 (7.37%) | 9 (2.65%) | 15 (4.42%) | 19 (5.60%) |
| | Protestant | 63 (18.58%) | 37 (10.91%) | 48 (14.16%) | 52 (15.34%) |
| | Other | 10 (2.95%) | 31 (9.14%) | 27 (7.96%) | 34 (10.03%) |

| Variables | Category | Wasting | | Stunting | |
|--|---------------------------------------|--------------|--------------|--------------|--------------|
| | | Not wasted | Wasted | Not Stunted | Stunted |
| Mother Occupation | House Wife | 125 (36.87%) | 52 (15.34%) | 85 (25.07%) | 92 (27.14%) |
| | Laborer | 10 (2.95%) | 12 (3.54%) | 14 (4.13%) | 8 (2.36%) |
| | Agriculture | 66 (19.47%) | 45 (13.27%) | 51 (15.04%) | 60 (17.70%) |
| | Self-Employed | 2 (0.59%) | 2 (0.59%) | 2 (0.59%) | 2 (0.59%) |
| | Merchant | 7 (2.06%) | 5 (1.47%) | 4 (1.18%) | 8 (2.36%) |
| | Employed in Governmental Organization | 9 (2.65%) | 4 (1.18%) | 7 (2.06%) | 6 (1.77%) |
| Mother Education Level | Illiterate | 121 (35.69%) | 72 (21.24%) | 92 (27.14%) | 101 (29.79%) |
| | Read and Write | 63 (18.58%) | 33 (9.73%) | 49 (14.45%) | 47 (13.86%) |
| | Primary | 22 (6.49%) | 8 (2.36%) | 12 (3.54%) | 18 (5.31%) |
| | secondary and Above | 13 (3.83%) | 7 (2.06%) | 10 (2.95%) | 10 (2.95%) |
| Mother Marital Status | Single | 16 (4.72%) | 11 (3.24%) | 15 (4.42%) | 12 (3.54%) |
| | Married | 193 (56.93%) | 105 (30.97%) | 139 (41%) | 159 (46.90%) |
| | Divorced | 3 (0.88%) | 1 (0.29%) | 2 (0.59%) | 2 (0.59%) |
| | Widowed | 7 (2.06%) | 3 (0.88%) | 7 (2.06%) | 3 (0.88%) |
| Family Food Source | Agriculture | 140 (41.30%) | 89 (26.25%) | 108 (31.86%) | 121 (35.69%) |
| | Purchase | 78 (23.01%) | 30 (8.85%) | 54 (15.93%) | 54 (15.93%) |
| | Aid | 1 (0.29%) | 1 (0.29%) | 1 (0.29%) | 1 (0.29%) |
| Source of Drinking Water | Public tap | 169 (49.85%) | 85 (25.07%) | 123 (36.28%) | 131 (38.64%) |
| | Spring | 50 (14.75%) | 35 (10.32%) | 40 (11.80%) | 45 (13.27%) |
| Child Sex | Female | 101 (29.79%) | 47 (13.86%) | 80 (23.60%) | 68 (20.06%) |
| | Male | 118 (34.81%) | 73 (21.53%) | 83 (24.48%) | 108 (31.86%) |
| Child Order | First | 43 (12.68%) | 29 (8.55%) | 29 (8.55%) | 43 (12.68%) |
| | Second | 42 (12.39%) | 27 (7.96%) | 38 (11.21%) | 31 (9.14%) |
| | Third | 48 (14.16%) | 19 (5.60%) | 34 (10.03%) | 33 (9.73%) |
| | Fourth | 32 (9.44%) | 10 (2.95%) | 18 (5.31%) | 24 (7.08%) |
| | Fifth and Above | 54 (15.93%) | 35 (10.32%) | 44 (12.98%) | 45 (13.27%) |
| Duration of Breast Feeding | < 6 Month | 23 (6.79%) | 20 (5.90%) | 24 (7.08%) | 19 (5.60%) |
| | 6-12 Month | 84 (24.78%) | 28 (8.26%) | 46 (13.57%) | 66 (19.47%) |
| | 13-24 Month | 106 (31.27%) | 65 (19.17%) | 86 (25.37%) | 85 (25.07%) |
| | >24 Month | 6 (1.77%) | 7 (2.06%) | 7 (2.06%) | 6 (1.77%) |
| Vaccination Status | Not Vaccinated | 7 (2.06%) | 1 (0.29%) | 3 (0.88%) | 5 (1.47%) |
| | Partially Vaccinated | 39 (11.50%) | 27 (7.96%) | 37 (10.91%) | 29 (8.55%) |
| | Fully Vaccinated | 173 (51.03%) | 92 (27.14%) | 123 (36.28%) | 142 (41.89%) |
| Prenatal Care | Yes | 210 (61.95%) | 114 (33.63%) | 157 (46.31%) | 167 (49.26%) |
| | No | 9 (2.65%) | 6 (1.77%) | 6 (1.77%) | 9 (2.65%) |
| Postnatal Care | Yes | 186 (54.87%) | 107 (31.56%) | 144 (42.48%) | 149 (43.95%) |
| | No | 33 (9.73%) | 13 (3.83%) | 19 (5.60%) | 27 (7.96%) |
| Prevalence of Diarrhea before Two Week | No | 180 (53.10%) | 99 (29.20%) | 138 (40.71%) | 141 (41.59%) |
| | Yes | 39 (11.50%) | 21 (6.19%) | 25 (7.37%) | 35 (10.32%) |
| Prevalence Fever before Two Week | No | 187 (55.16%) | 100 (29.50%) | 137 (40.41%) | 150 (44.25%) |
| | Yes | 32 (9.44%) | 20 (5.90%) | 23 (6.78%) | 26 (7.67%) |

In this study there are different explanatory variables that may affect under five age child nutritional status. In this study from table 3 there are 238 (70.2%) of child who are live in rural area and 101 (29.8%) of child in urban area. Among the selected households for investigation, 55 (16.2%) head of household are females and 284 (83.8%) are males. Mother education level from table 3 shows 193 (56.9%) are illiterate, 96 (28.3%) of mothers can be read and write, 30 (8.8%) of mothers education level are Primary and 20 (5.9%) of mothers education level are secondary and above. Among 339 mothers under study 177 (52.2%) of mothers occupation are housewife.

Table 3 shows a total of 298 (87.9%) mothers are married, 229 (67.6%) of family food source from the observed family are agriculture, 254 (74.9%) of drinking water source are public tap and 171 (50.4%) of duration of breast feedings are between 13-24 months. The above table shows that 60 (17.7%) are Diarrhea Prevalence case before two week of sample taken and 52 (15.3%) are fever prevalence in under five children.

From table 3, 26.84% and 36.28% under five children who are

live in rural area are wasted and stunted, respectively. From children who are live in urban area 8.55% are wasted and 15.63% are stunted. This shows that children who live in rural are more exposed to be wasted and stunted than urban area.

Table 3 shows 21.24% illiterate mothers child are wasted and 29.78% are stunted. These percentages are lower in mothers' education level increases. For instance, the mothers' education level is secondary and above, 2.06% and 2.95% of under five children are wasted and stunted, respectively. This descriptive statistics shows mothers' educational level is highly affect children malnutrition status.

From under five children who have Diarrhea before two week of the sample taken, 6.19%, 10.32% were wasted and stunted, respectively. And 5.9% and 7.67% of under five children who have fever before two week of the sample taken are wasted and stunted, respectively.

But in case of family food source, source of drinking water, duration of breast feeding and vaccination status this descriptive measures result shows a contradict of the reality. Example, children who are fully vaccinated is highly

malnourished and vice versa.

The association between explanatory variables and outcome variable should be tested using chi-square test of

association. If P-value less than the level of significance (α), the null hypothesis will be rejected and the conclusion drawn is based on alternative hypothesis.

Table 4. Pearson χ^2 Association of socio-demographic factors and wasting and stunting.

| Variable | Wasting | | | Stunting | | |
|----------------------------|---------|------------|---------|----------|------------|---------|
| | df | Chi-square | Sig. | df | Chi-square | Sig. |
| Woreda | 4 | 9.446 | 0.05** | 4 | 3.998 | 0.016* |
| Residence | 1 | 2.812 | 0.004* | 1 | 0.018 | 0.000* |
| Household Sex | 1 | 2.839 | 0.002* | 1 | 0.017 | 0.077** |
| Religion | 4 | 12.180 | 0.016* | 4 | 1.058 | 0.001* |
| Mother Occupation | 5 | 8.316 | 0.014* | 5 | 3.56 | 0.001* |
| Mother Education Level | 3 | 1.353 | 0.000* | 3 | 1.165 | 0.000* |
| Mother Marital Status | 3 | 0.657 | 0.833 | 3 | 2.781 | 0.001* |
| Family Food Source | 2 | 4.132 | 0.007* | 2 | 0.24 | 0.887 |
| Drinking Water Source | 1 | 1.656 | 0.000* | 1 | 0.048 | 0.005* |
| Child Sex | 1 | 1.523 | 0.000* | 1 | 3.752 | 0.005* |
| Child Order | 4 | 5.689 | 0.007* | 4 | 3.823 | 0.031* |
| Duration of Breast Feeding | 3 | 10.063 | 0.010* | 3 | 3.743 | 0.001* |
| Vaccination Status | 2 | 2.765 | 0.000* | 2 | 2.337 | 0.011* |
| Prenatal Care | 1 | 0.145 | 0.003* | 1 | 0.411 | 0.522 |
| Postnatal Care | 1 | 1.186 | 0.000* | 1 | 0.980 | 0.011* |
| Diarrhea Before Two Week | 1 | 0.567 | 0.030* | 1 | 1.202 | 0.000* |
| Fever Before Two Week | 1 | 0.252 | 0.060** | 1 | 0.9 | 0.000* |

*and **shows statistically significant at 5% and 10% level of significance, respectively

Table 4 shows the Pearson χ^2 test of association of those explanatory variables with explanatory variables. The P-values of mother marital status is 0.833. This value is greater than the level of significant ($\alpha = 5\%$ and 10%) which means mothers marital status is not statistically significant. Whereas, the other explanatory variables are statistically significant at 5% and 10% level of significant.

Table 4 shows that the p-value for the two explanatory variables, (family food source and prenatal care) are greater than 5% and 10% level of significant. This indicates that they have no association with stunting at 5% and 10% level of

significant. The rest explanatory variables are statistically significant at 5% and 10% level of significant and they have an association with response variables (stunting).

3.2. Multiple Binary Logistic Regression Analysis

Here this study considered two models for wasting and stunting (one with all covariates (Model I) and the other without insignificant explanatory variables (Model II)). The results of goodness of fit tests for each model are shown in Table 5. This can be done by Omnibus and Hosmer and Lemeshow test.

Table 5. Hosmer and Lemeshow test.

| Model | Test | Wasting | | | Stunting | | |
|----------|---------------------|------------|----|-------|------------|----|-------|
| | | Chi-square | df | Sig. | Chi-square | df | Sig. |
| Model I | Hosmer and lemeshow | 5.767 | 8 | 0.673 | 4.086 | 8 | 0.849 |
| Model II | Hosmer and lemeshow | 3.076 | 8 | 0.929 | 4.740 | 8 | 0.785 |

An insignificant chi-square indicates a good fit to the data and, therefore, good overall model fit. Table 5 shows the p-value for wasting is 0.673 (>0.05) for model I and 0.929 (>0.05) for model II. P-value for stunting is 0.849 for Model I and 0.785 for Model II. All are greater than α (5%) level of

significant. Therefore, all logistic regression models (Model I and II) are good fit.

But to choose the best fit model among these two, Akaike information criterion (AIC) and Bayesian information criteria (BIC) formula will be used.

Table 6. Akaike information and Bayesian information criterion for Model Selection.

| Omnibus Test | | | Model Selection Criterion | | | |
|--------------|-----------------|----------|---------------------------|---------|----------|---------|
| Model | -2Loglikelihood | | Response Variables | | | |
| | Wasting | Stunting | Wasting | | Stunting | |
| | | | AIC | BIC | AIC | BIC |
| Model I | 387.316 | 437.534 | 505.316 | 536.598 | 555.534 | 586.815 |
| Model II | 387.935 | 438.998 | 497.935 | 527.095 | 546.998 | 575.628 |

Table 6 shows AIC and BIC values of wasting and stunting for Model I and II. From these table both AIC and BIC are smaller in Model II than model I. Since Model II has smaller values of both AIC and BIC, conclude that Model II is a better fit to the data for all outcome variables. The result of multiple binary logistic regression for Model II are shown in Table 7 and 8 below.

Table 7. Binary logistic regression model for wasting.

| Variables | B | S.E. | Wald | df | Sig. | Exp (B) | 95% C.I. for EXP (B) | |
|----------------------------|--------|-------|-------|----|------|---------|----------------------|--------|
| | | | | | | | Lower | Upper |
| Woreda | | | 1.546 | 4 | .000 | | | |
| Burji (1) | -.388 | .644 | .364 | 1 | .010 | .678 | .192 | 2.396 |
| Derashe (2) | -.253 | .693 | .134 | 1 | .003 | .776 | .200 | 3.017 |
| Debab Ari (3) | -.411 | .786 | .274 | 1 | .220 | .663 | .142 | 3.091 |
| BenaTsemay (4) | .456 | .743 | .377 | 1 | .005 | 1.578 | .368 | 6.766 |
| Residence (1) | 0.532 | 0.621 | 1.271 | 1 | .000 | 1.702 | 0.324 | 2.627 |
| Household Sex (1) | -.500 | .413 | 1.466 | 1 | .001 | .607 | .270 | 1.362 |
| Religion | | | 4.968 | 4 | .000 | | | |
| Orthodox (1) | -.612 | .816 | .562 | 1 | .021 | .542 | .110 | 2.685 |
| Muslim (2) | -2.025 | 1.088 | 3.464 | 1 | .008 | .132 | .016 | 1.113 |
| Catholic (3) | -1.017 | .758 | 1.803 | 1 | .385 | .362 | .082 | 1.596 |
| Protestant (4) | -.598 | .767 | .608 | 1 | .251 | .550 | .122 | 2.472 |
| Mother Occupation | | | 6.565 | 5 | .000 | | | |
| House Wife (1) | .070 | .880 | .006 | 1 | .044 | 1.073 | .191 | 6.021 |
| Laborer (2) | .187 | .999 | 1.412 | 1 | .003 | 1.205 | .462 | 23.238 |
| Agriculture (3) | -.174 | .949 | .034 | 1 | .009 | .840 | .131 | 5.399 |
| Self-employed (4) | .588 | 1.534 | .147 | 1 | .650 | 1.800 | .089 | 36.373 |
| Merchant (5) | .625 | .961 | .652 | 1 | .430 | 1.8682 | .330 | 14.279 |
| Mother Education Level | | | 1.055 | 3 | .000 | | | |
| Illiterate (1) | -.539 | .754 | .510 | 1 | .002 | .583 | .133 | 2.560 |
| Read and Write (2) | -.232 | .732 | .100 | 1 | .000 | .793 | .189 | 3.332 |
| Primary (3) | -.524 | .798 | .431 | 1 | .000 | .592 | .124 | 2.831 |
| Family Food source | | | .661 | 2 | .000 | | | |
| Agriculture (1) | -.117 | 1.967 | .004 | 1 | .000 | .890 | .019 | 41.985 |
| Purchasing (2) | -.502 | 1.960 | .066 | 1 | .513 | .605 | .013 | 28.200 |
| Public tab (1) | -.583 | .497 | 1.376 | 1 | .179 | .558 | .211 | 1.478 |
| Female (1) | -.179 | .264 | .459 | 1 | .000 | .836 | .498 | 1.404 |
| Child order | | | 8.304 | 4 | .001 | | | |
| First (1) | .260 | .413 | .395 | 1 | .000 | 1.296 | .577 | 2.911 |
| Second (2) | -.210 | .399 | .277 | 1 | .004 | .811 | .371 | 1.773 |
| Third (3) | -.589 | .413 | 2.038 | 1 | .005 | .555 | .247 | 1.246 |
| Fourth (4) | -.944 | .475 | 3.942 | 1 | .029 | .389 | .153 | .988 |
| Duration of Breast Feeding | | | 9.085 | 3 | .000 | | | |
| <6 month (1) | -.269 | .830 | .105 | 1 | .002 | .764 | .150 | 3.884 |
| 6-12 month (2) | -1.298 | .706 | 3.379 | 1 | .011 | .273 | .068 | 1.090 |
| 13-24 month (3) | -.533 | .675 | .623 | 1 | .000 | .587 | .156 | 2.204 |
| Vaccination Status | | | 3.491 | 2 | .000 | | | |
| Not vaccinated (1) | -2.402 | 1.286 | 3.491 | 1 | .062 | .091 | .007 | 1.125 |
| Partially Vaccinated (2) | -.240 | .452 | .282 | 1 | .000 | .787 | .325 | 1.907 |
| Prenatal care (1) | .383 | .666 | .329 | 1 | .000 | 1.466 | .397 | 5.413 |
| Postnatal care (1) | .667 | .450 | 2.196 | 1 | .110 | 1.949 | .806 | 4.712 |
| Diharrea (1) | .091 | .431 | .045 | 1 | .000 | 1.095 | .471 | 2.547 |
| Fever (1) | -.359 | .451 | .634 | 1 | .005 | .698 | .288 | 1.691 |
| Constant | 1.488 | 2.642 | .317 | 1 | .001 | 4.429 | | |

Table 8. Binary logistic Regression model for Stunting.

| Variables | B | S.E. | Wald | df | Sig. | Exp (B) | 95% C.I. for EXP (B) | |
|-------------------|-------|-------|-------|----|------|---------|----------------------|-------|
| | | | | | | | Lower | Upper |
| Woreda | | | 2.543 | 4 | .010 | | | |
| Burji (1) | .254 | .579 | .192 | 1 | .000 | 1.289 | .414 | 4.011 |
| Derashe (2) | .298 | .595 | .250 | 1 | .000 | 1.347 | .419 | 4.325 |
| Debab Ari (3) | -.258 | .709 | .132 | 1 | .350 | .773 | .192 | 3.102 |
| BenaTsemay (4) | .570 | .678 | 1.291 | 1 | .005 | 1.768 | .572 | 8.151 |
| Residence (1) | .444 | 0.531 | 1.883 | 1 | .001 | 1.559 | 0.265 | 7.562 |
| Household Sex (1) | .018 | .411 | .002 | 1 | .000 | 1.018 | .454 | 2.280 |
| Religion | | | .321 | 4 | .000 | | | |
| Orthodox (1) | -.115 | .713 | .026 | 1 | .000 | .891 | .220 | 3.606 |
| Muslim (2) | .022 | .868 | .001 | 1 | .020 | 1.022 | .186 | 5.606 |
| Catholic (3) | -.293 | .673 | .189 | 1 | .000 | .746 | .200 | 2.792 |
| Protestant (4) | -.060 | .665 | .008 | 1 | .311 | .942 | .256 | 3.466 |
| Mother Occupation | | | 1.883 | 5 | .000 | | | |
| House Wife (1) | -.121 | .808 | .022 | 1 | .000 | .886 | .182 | 4.319 |
| Laborer (2) | -.664 | .941 | .498 | 1 | .011 | .515 | .081 | 3.257 |
| Agriculture (3) | -.228 | .874 | .068 | 1 | .011 | .796 | .143 | 4.418 |

| Variables | B | S.E. | Wald | df | Sig. | Exp (B) | 95% C.I. for EXP (B) | |
|----------------------------|-------|-------|-------|----|------|---------|----------------------|--------|
| | | | | | | | Lower | Upper |
| Self-employed (4) | -.252 | 1.397 | .033 | 1 | .551 | .777 | .050 | 12.010 |
| Merchant (5) | .492 | .940 | .274 | 1 | .350 | 1.636 | .259 | 10.325 |
| Mother Education Level | | | .315 | 3 | .000 | | | |
| Illiterate (1) | .074 | .695 | .011 | 1 | .005 | 1.077 | .276 | 4.208 |
| Read and Write (2) | -.066 | .691 | .009 | 1 | .000 | .937 | .241 | 3.632 |
| Primary (3) | -.181 | .746 | .059 | 1 | .001 | 0.834 | .278 | 5.168 |
| Mother Marital Status | | | 3.090 | 3 | .002 | | | |
| Single (1) | .474 | .956 | .656 | 1 | .712 | 1.606 | .333 | 14.120 |
| Married (2) | .272 | .877 | 2.104 | 1 | .000 | 1.313 | .640 | 19.919 |
| Divorced (3) | .143 | 1.356 | .711 | 1 | .021 | 1.154 | .220 | 44.705 |
| Public tab (1) | -.483 | .453 | 1.135 | 1 | .380 | .617 | .254 | 1.499 |
| Female (1) | -.334 | .243 | 1.899 | 1 | .011 | .716 | .445 | 1.152 |
| Child order | | | 3.359 | 4 | .000 | | | |
| First (1) | .254 | .391 | .423 | 1 | .000 | 1.289 | .600 | 2.773 |
| Second (2) | -.372 | .375 | .984 | 1 | .005 | .689 | .330 | 1.438 |
| Third (3) | -.124 | .374 | .111 | 1 | .459 | .883 | .424 | 1.838 |
| Fourth (4) | .231 | .422 | .301 | 1 | .397 | 1.260 | .552 | 2.880 |
| Duration of Breast Feeding | | | 3.284 | 3 | .000 | | | |
| <6 month (1) | .104 | .763 | .019 | 1 | .011 | 1.110 | .249 | 4.950 |
| 6-12 month (2) | .312 | .644 | 1.221 | 1 | .022 | 1.366 | .577 | 7.201 |
| 13-24 month (3) | .365 | .630 | .336 | 1 | .000 | 1.441 | .419 | 4.952 |
| Vaccination Status | | | 3.966 | 2 | .000 | | | |
| Not vaccinated (1) | .529 | .891 | .669 | 1 | .497 | 1.697 | .361 | 11.888 |
| Partially Vaccinated (2) | -.588 | .398 | 2.183 | 1 | .000 | .556 | .255 | 1.212 |
| Postnatal care (1) | .237 | .392 | .367 | 1 | .002 | 1.267 | .366 | 10.700 |
| Diharrea (1) | -.776 | .407 | 3.640 | 1 | .000 | .460 | .207 | 1.021 |
| Fever (1) | -.652 | .417 | 2.441 | 1 | .008 | .521 | .447 | 4.347 |
| Constant | -.741 | 1.681 | .194 | 1 | .000 | .477 | | |

3.2.1. Evaluation of the Final Model: Pseudo R Square

Table 9. Model Summary for Wasting and Stunting.

| Model | Pseudo R squares | |
|----------|----------------------|---------------------|
| | Cox & Snell R Square | Nagelkerke R Square |
| Wasting | 0.192 | 0.264 |
| Stunting | 0.118 | 0.158 |

Both the Cox and Snell and Nagelkerke R squared values can be interpreted in a similar manner to how you would the R square value in regression – the percentage of variability in data that is accounted for by the model. This table shows that all models are good enough.

3.2.2. Diagnostic Checking

The standardized and deviance residuals reveal that all have values of less than absolute value of 3 indicating the absence of outliers in the model. In addition, there are no large values of Cook's distance ($Di < 1$) which means that there are no influential cases having an effect on the model (Cook's). And there are no high values of DFBETAS (all values less than $2/\sqrt{n} = 0.1086$) which means that there are no influential observations for the individual regression coefficients for all models (Wasting and stunting). Therefore, the models are adequate.

3.2.3. Discussion and Interpretation of Results

From 339 randomly selected under five children in South Omo zone and Segen Area Peoples from five woredas 120 (35.4%) and 176 (51.9%) of children's are wasted and stunted, respectively. The statistic shows there are high nutritional problems in the selected places.

Using Jinka woreda as reference category the odds ratio will be interpret that obtained in table 7. The odds of under five children being wasted has decreased by a factor of 0.678 for Burji as compared to Jinka controlling for the other variables in the model. Likewise, the odds ratio for Derashe and Debub Ari are 0.776 and 0.663, respectively, which indicates that the odds of under five children being wasted has decreased by a factor of 0.776 for Derashe as compared to Jinka controlling for the other variables in the model. But the odds of under five children being wasted has increased by a factor of 0.368 for Bena Tsemay as compared to Jinka controlling for the other variables in the model.

For the variable child place of residence, the reference category is urban; the odds of children living in rural area are wasted increased by a factor of 1.702 compared to urban area. Children living in rural area are 70.2% more likely to be wasted as compared to urban area children.

Household sex is one predictor variable in this study, male is reference variable, the odds of child being wasted has decreased by a factor of 0.607 for females as compared to male.

In table 7 religion is on explanatory variable. By referring other religion category, the odds of being wasted has decreased by a factor of 0.542, 0.132, 0.362 and 0.55 for Orthodox, Muslim, Catholic and Protestant, respectively controlling other variables in the model.

Mothers' education level was one of the explanatory variables in this study. By using secondary and above education level as a reference variable, the odds of children being wasted has decreased by 0.583, 0.793 and 0.592 for illiterate mother, read and write and primary educated mother,

respectively controlling for the other variables in the model. Severe acute malnutrition is associated with maternal education [9, 10].

Taking aid as a reference variable in family food source, the odds of child being wasted are decreased by a factor of 0.890 for agriculture controlling for the other variables in the model.

Child sex is very important variable in this study. By taking male as a reference category, the odds of female children being wasted is decreased by 0.836 as compared to male controlling for the other variables in the model.

For the variable child order, taking fifth and above as a reference category, the odds of children being wasted has increased by 29.6% for first order children controlling for the other variables in the model. Whereas, the odds of being wasted have decreased by 0.811, 0.555 and 0.389 for second, third and fourth order children, respectively.

Breast feeding plays a great role for children development. Duration of breast feeding is one variable in this study, taking 25 month and above as a reference category, the odds of children being wasted has decreased by 0.764, 0.273 and 0.587 for less than 6 month, 6-12 month and 13-24 month breast feeding, respectively controlling for the other variables in the model.

Taking fully vaccinated as a reference category in vaccination status variable, the odds of being wasted has decreased by a factor of 0.091 and 0.787 for not vaccinated and partially vaccinated children, respectively. This shows that not vaccinated children are more likely to be wasted than vaccinated one.

Clinical follow up was very important for mothers' health and child development. Hence prenatal and postnatal cares were used for this study. Taking prenatal and postnatal care as a reference category, mothers' who are not taking prenatal and postnatal care for their children are being wasted were increased by 46.6% and 94.9%, respectively. Children whose mothers attended ANC (AOR: 0.18, 95% CI: (0.18 (0.07–0.45) were associated with wasting. This shows clinical follow up was very essential to reduce children nutritional problem [11].

Prevalence of Diarrhea and Fever before two week of children investigation was used in this study. By taking prevalence of Diarrhea as reference category, the odds of children being wasted was increased by 9.5% for those no Diarrhea. The presence of diarrhea (AOR: 39.5, 95% CI: (13.68–114.30) is associated with wasting. But taking prevalence of Fever as reference category, the odds of being wasted was decreased by a factor of 0.698 for no Fever children controlling for the other variables in the model [11].

The odds of children being stunted for Burji, Derashe and Bena tsema were increased by 28.9%, 34.7% and 76.8%, respectively controlling for the other variables in the model by taking Jinka woreda as reference category in table 8.

For the variable child place of residence, taking urban as a reference category; the odds of children living in rural area being stunted increased by a factor of 1.559 compared to urban area. This means children living in rural area are 55.9%

more likely to be stunted as compared to urban area children controlling for the other variables in the model.

Household head sex is one predictor variable in this study, male is reference variable, the odds of child being stunted has increased by a factor of 1.018 for females household as compared to male household controlling for the other variables in the model. Looking results in wasting, children are more likely to expose to be stunted for male household.

Table 8 also shows taking other religion category as a reference, the odds of being stunted has decreased by a factor of 0.891, 0.746 and 0.942 for Orthodox, Catholic and Protestant, respectively controlling other variables in the model. But 2.2% Muslim families are more likely to be stunted.

Taking mothers employed in governmental organization as a reference category, the odds of being stunted has decreased by a factor of 0.886, 0.515 and 0.796 for housewife, labourer and agriculture, respectively. But the odds of merchant mothers being stunted has increased by 63.6% controlling for the other variables in the model.

By taking secondary and above education level of mother as a reference category, the odds of children being stunted has increased by a factor of 1.077 for illiterate mothers. But for mothers who can read and write and mothers have primary education level, the odds of being stunted has decreased by a factor of 0.937 and 0.834, respectively controlling for the other variables in the model. Severe acute malnutrition is associated with maternal education [9].

This model shows that all category of mother marital status have an increasing effect on stunting. Taking widowed as a referencing category, the odds of being stunted for single, married and divorced are increased by 60.6%, 31.3% and 15.4%, respectively controlling for the other variables in the model. Further investigation is needed because all effects are an increasing effect.

Taking male as a reference category, the odds of female children being stunted is decreased by 0.716 as compared to male controlling for the other variables in the model. Sex of child (AOR: 0.75; 95% CI: 0.57-1.0) is highly significant association with stunting [12].

For the variable child order, taking fifth and above as a reference category, the odds of children being stunted has increased by 28.9% and 26% for first order and fourth order children, respectively controlling for the other variables in the model. But the odds of being stunted have decreased by a factor of 0.689 and 0.883 for second and third children order, respectively. At 5% level of significant third order children are not significant because P-value is 0.459.

Duration of breast feeding was one variable in this study. By taking 25 and above month as a reference category, the odds of children being stunted has increased by 11%, 36.6% and 44.1% for less than 6 month, 6-12 month and 13-24 month breast feeding, respectively controlling for the other variables in the model. This shows it needs to be further investigation why this happen. Breast feed the child still now (AOR: 0.40; 95%CI: 0.20-0.78) is a significant effect with stunting [12].

Taking fully vaccinated as a reference category in vaccination status variable, even if the P-value was not significant the odds of being stunted has increased by 69.7% for not vaccinated children. Whereas the odds of being stunted has decreased by a factor of 0.556 partially vaccinated children controlling for the other variables in the model.

Postnatal cares were used as a one variable for stunting. The odds of not taking postnatal care being stunted have increased by 26.7% as compared to taking postnatal care. This shows clinical follow up was very essential to reduce children nutritional problem.

Taking children occurrence of Diharrea and fever before two week as reference category, the odds of children being stunted was decreased by a factor of 0.46 and 0.521 for no Diharrea and Fever, respectively controlling for the other variables in the model. This implies children who have Diharrea and Fever are more exposed to be stunted.

4. Conclusions

The aim of this study was to analyze the determinants of Stunting and Wasting among Under-five Children of Segen Area People and South Omo Zone, Ethiopia by using multivariate logistic regression model. 339 children are selected from 5 woreda using self-administered questionnaire. Among these 148 children are females and 191 are males. From 339 children under study, 35.4% of children are wasted and 54.9% are stunted. These shows there are a malnutrition problem in Segen Area People and South Omo Zone, Ethiopia.

Based on the finding of this study family religion, mothers' occupation except agriculture, mothers education level, family food source, source of drinking water (public tap), female children, child order except first order, duration of breast feeding and vaccination status are decreasing effect on wasting. Children whose mother does not attended ANC were increasing effect with wasting. Children who have fever before two week are more likely to expose to wasting than no fever.

Religion is highly important explanatory variable to reduce stunting. Likewise, mothers occupation except merchant, mothers education level except illiterate (illiterate mothers child are more exposed to be stunted than the other), female children, child order (second and third), vaccination status

(partially and fully vaccinated), Diharrea and Fever are decreasing effect on stunting. But marital status and duration of breast feeding are an increasing effect on stunting.

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