Bayesian Multilevel Analysis of Stunting Status among Children Aged 6-59 Months in Ethiopia

Munira Abdulkedir (munirahusen88@gmail.com)
Madda Walabu University

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Bayesian Multilevel Analysis of Stunting Status among Children Aged 6-59 Months in Ethiopia

Munira Husen

Email address: munirahusen88@gmail.com

Institute: Madda Walabu University, Department of Statistics, Bale Robe Ethiopia

Phone number +25932281480

ABSTRACT

Background: *Stunting is a public health problem that can pose a serious threat to global health because it can lead to less optimal growth and development potential. The aim of this study was to determine the prevalence of stunting and identified the various possible factors associated with stunting status among children aged 6-59 months in Ethiopia by using Bayesian Multilevel Analysis.*

Methods: *The descriptive result revealed that 8640 Children's considered in the analysis, also showed that in Ethiopian Children's who live in Afar and Amhara regions were more than other regions in prevalence of stunting. Bayesian multilevel binary logistic regression of random 3 coefficient models were employed for data analysis based on the selection of smallest value of DIC.*

Result: *From these models, place of residence, educational attainment of women, husband educational level, sex of child, age of child, Size at birth, body mass index of mothers, household wealth index and birth order are significant factors.*

Conclusion: *The Bayesian multilevel random coefficients model was better fit than empty and random intercept. The variance of the random component related to the coefficient model was implying regional variations in stunting status of children among the regions in the country.*

Keywords*: Stunting status, Bayesian Multilevel logistic regression, Ethiopia*

INTRODUCTION

All nutrient deficiencies have an enormous impact on health. With good nutrition, children develop into healthy, bright and engaged members of their communities; and they are stronger and more resilient in the face of crisis. Today, there are still 50 million young lives at risk due to acute malnutrition; and 156 million more children under the age of 5 years are chronically undernourished or stunted, compromising their physical growth and brain development.

Stunting is a public health problem that can pose a serious threat to global health because it can lead to less optimal growth and development potential (Perkins *et al.,* 2017), and closely related to the risk of death in children under five (Acevedo *et al.,* 2017). Stunting has declined by almost 2 percent annually over the last four years, affecting 7.7 million fewer children in 2016 than in 2013.

In Ethiopia, the trend Shows in the reduction of child under-nutrition between 2000 and 2016. 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 (CSA, 2016).

Nutrition-specific approach is still important and should be continued and extended especially to low-income households. Although food supplementation and fortification has an important impact, the aspect of complexity emphasized too. Health-based nutrition services in Ethiopia became a priority (UNICEF *et al.,* 2015). This study would like to mention a few with a board impact like education, climate and gender that should be never excluded.

Data and Methodology

Data Description

This study used the data collected in the Ethiopian Demographic and Health Survey (CSA, 2016). The EDHS sample was selected using a stratified, two-stage cluster design and EAs were the sampling units for the first stage. For the 2016 EDHS, a representative sample of approximately18, 008 households from 645 clusters was selected. In the first stage, 645 clusters, 202 urban and 443 rural, were selected from the list of enumeration areas based on sampling frame. In the second stage, a complete listing of households was carried out in each selected cluster. For this study 8640 children were included in the analysis were the other were missing information.

Statistical Analysis

In different studies the response variable height-for-age (stunting) measurement status was expressed in Standard Deviation (SD) units (Z-score) from the median of the reference population. Variable category 0 if not stunted (≥-2SD) and category 1 if stunted (<-2SD). In view of this, the response variable, the status of stunting of the i^{th} child was measured as a dichotomous variable.

The predictor variables were studied as determinants of stunting status of among children aged and 59 months are grouped into Socio-economic, Demographic, and Health and Environmental factors. These includes age of child, size at birth, birth order, mother education status, father education status, mother working, family size, type of place of residence, wealth index, region, body mass index, source of drinking water, toilet facilities, had diarrhea in the last two weeks, and had fever in the last two weeks.

The multilevel logistic regression analysis considers the variations due to hierarchy structure in the data. In this data structure, level-1 is the Children level and level-2 is the regional level. Within each level-2 unit there are n_j in the j^{th} region.

Bayesian Multilevel Analysis of Empty Models

The logit linear predictor is given as:

$$logit(\pi_{ij}) = \beta_0 + U_{0j} \quad (1)$$

Where $\pi_{ij} = \frac{e^{\beta_0 + U_{0j}}}{1 + e^{\beta_0 + U_{0j}}}$ and the deviation U_{0j} are assumed normal distribution with mean zero and variance σ_0^2.

Likelihood Function: The key ingredients to a Bayesian analysis are the likelihood function, which reflects information about the parameters contained in the data, and the prior distribution, which quantifies what is known about the parameters before observing data.

The likelihood contribution from the ith subject in the jth group is Bernoulli: which is given as follows;

$$L\left(\pi_{ij=Y_{ij}}\right) = \prod_j \pi_{ij}^{Y_{ij}} (1 - \pi_{ij})^{1-Y_{ij}} \quad (2)$$

Prior Distribution: Prior distribution plays an important role and the basis in Bayesian analysis i.e. one of the pre-condition in Bayesian analysis is the choice of a prior distribution.

The prior distribution for the parameter β_0 and σ_0^2 is given as follows:

$P(\beta_O)$~Uniform Distribution

P(σ_0^2)~inverse-gamma (α, θ), *where* α *and* θ are fixed constant parameters.

Posterior Distribution:

After finding the likelihood and prior function, the next step is to find the random parameter of empty model from the posterior distribution of empty model from the posterior distribution $P(\beta_O, \sigma_o^2 / Y_{ij})$. This is given as follows;

The full conditional distribution for parameter β_o is.

$$P\,(\beta_o/\sigma_u\,, y_{ij}) \propto \prod_j \left(\frac{e^{\beta_o+u_{oj}}}{1+e^{\beta_o+u_{oj}}}\right)^{y_{ij}} \left(\frac{1}{1+e^{\beta_o+u_{oj}}}\right)^{1-y_{ij}} \quad (3)$$

For the second parameter of σ_0, the full conditional distribution of posterior for parameter from the given likelihood and prior distribution is Follow the gamma distribution. This implies that, the prior is the conjugate prior and the posterior is given as:

$$P\,({}^{\sigma_o}/_{\beta_o}\,, y_{ij}) \sim \text{inverse- Gamma}\,({}^{n}/_{2} + n(\alpha - 1), n\theta) \quad (4)$$

Where n is the Total number of children's interviewed which the sum of n_j.

Hypothesis:

H_0: There is no regional variation on Stunting Status in Ethiopia.

H_1: There is regional variation on Stunting Status in Ethiopia.

Bayesian Multilevel Analysis of Random Intercept Models

The logit of π_{ij} is a sum of linear function of explanatory variables and given as

$$\text{Logit}(\pi_{ij}) = \log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_{oj} + \beta_{oj}X_{1ij} + \cdots + \beta_k X_{kij} = \beta_{oj} + \sum_{h=1}^{k} \beta_h\, x_{hij} \quad (5)$$

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 $\beta_{0j} = \beta_0 + U_{0j}$ as a result.

$$logit(\pi_{ij}) = \beta_0 + \sum_{h=1}^{k} \beta_{hj} x_{hij} + U_{0j} \quad (6)$$

where $\beta_0 + \sum_{h=1}^{k} \beta_{hj} x_{hij}$ is the fixed part of the model and U_{0j} is the random part.

The π_{ij} is given as:

$$\pi_{ij} = \frac{e^{\beta_0 + \sum_{h=1}^{k} \beta_{hj} x_{hij} + U_{0j}}}{1 + e^{\beta_{0j} + \sum_{h=1}^{k} \beta_{hj} x_{hij} + U_{0j}}} \quad (7)$$

For the prior and posterior distribution it is the same as in equation (3) and (4) above except the number of parameter are larger in Bayesian Multilevel Random Intercept model.

Bayesian Multilevel Analysis of Random Coefficient Models

Consider a model with group specific regression of logit of the success probability logit (π_{ij}), on a single level -one explanatory variables x.

$$logit(\pi_{ij}) = \log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_0 + \sum_{h=1}^{k}\beta_h x_{hij} + U_{0j} + \sum_{h=1}^{k}U_{hj}x_{hij} \quad (8)$$

The term $\sum_{h=1}^{k}U_{hj}x_{hij}$ can be regarded as a random interaction between group and the explanatory variables. The deviation U_{hj} are assumed normal distribution with mean zero and variance covariance matrix Ω. This model implies that the groups are characterized by two random effects: their intercepts and their slopes. It assumes that, for different groups the pairs of random effects (U_0, U_{hj}, h= 1,2,...,k) are independent and identically distributed. The random intercept variance, $Var(U_{0j}) = \sigma_0^2$, the random slope variance, $Var(U_{1j}) = \sigma_1^2$ and the covariance between the random effects, $Cov(U_{0j}, U_{1j}) = \sigma_{01}^2$ are called variance components (Snijders and Bosker, 1999).

Likelihood Function

$$(y_{ij}/\pi_{ij}) \propto Bernoulli(\pi_{ij}) \quad (9)$$

Let us denote the likelihood function like $L(y_{ij}, \pi_{ij})$ and written as follows;

$L(\pi_{ij/Y_{ij}}) = \prod_{ij}(y_{ij}/\pi_{ij})$ and the linear predictor or the logit function is,

$$logit(\pi_{ij}) = \log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_{0j} + \sum_{h=1}^{k}\beta_{hj}x_{hij} + U_{0j} + \sum_{h=1}^{k}U_{hj}x_{hij}, \quad (10)$$

$$Where, \pi_{ij} = \frac{e^{\beta_{0j}+\sum_{h=1}^{k}\beta_{hj}x_{hij}+U_{0j}+\sum_{h=1}^{k}U_{hj}x_{hij}}}{1+e^{\beta_{0j}+\sum_{h=1}^{k}\beta_{hj}x_{hij}+U_{0j}+\sum_{h=1}^{k}U_{hj}x_{hij}}} \quad (11)$$

Prior Distribution

Let us denote the parameters $\beta_0, \beta_1, \dots\dots\dots\dots\beta_k$ and Ω_u as prior distribution as follows.

P(β_0)$\propto 1$, P(β_1), ...P(β_k)$\propto 1$ and p(Ω_u)~inverse-Wishart$_k$(s_u,h) distribution. Where Ω_u is the variance covariance matrices, s_u is an estimate for the true value of Ω_u, k is dimension of Ω_u, is the parameter that denotes the degree of freedom, so this prior is essentially as uninformative prior. In statistics, Wishart distribution is a generalization to multiple dimensions of the chi-squared distribution, or, in the case of non-integer degrees of freedom, of the gamma distribution (Steven W. Nydick, 2012). The Wishart distribution is the sampling distribution of the matrix of sums of squares and products of normal distributional assumption.

Then Ω_u is positive definite with probability density function is given by:-

$$f(\Omega_u)=\frac{|s|^{\frac{h}{2}}}{|\Omega|^{\frac{h+p+2}{2}}2^{\frac{hk}{2}}gamma(k)^{\frac{h}{2}}}exp\left\{-\frac{1}{2}tr(s^{-1}\Omega)\right\} \quad (12)$$

Posterior Distribution

Using the above prior and likelihood function above the the full conditional distribution of posterior parameter $\beta_0, \beta_1,$, is given by:

$$P\left({}^{B_h}/_{\Omega_u}, U_{oj}, Y_{ij}\right) \propto \prod_{ij}((\pi_{ij}^{y_{ij}}(1-\pi_{ij})^{1-y_{ij}}) \quad (13)$$

Where h= 1,2,…….,k and

$$P\left({}^{\Omega_u}/_{B_h}, U_{oj}, y_{ij}\right) \propto P\left({}^{y_{ij}}/_{\Omega_u}, B_h, U_{oj}\right)P\left({}^{U_{oj}}/_{\Omega_u}\right)P(\Omega_u) \quad (14)$$

RESULTS AND DISCUSSION

Descriptive Results

The association between stunting status of children aged 6–59 months and predictors shown from Table 1 indicates that stunting was strongly associated with region, family size, wealth index, sex of child, age of child, place of residence, body mass index of mother, size at birth,

birth order, mother's educational level, father's educational level, mother's employment status, had diarrhea in the last two weeks and had fever in the last two weeks.

Also from Table 1 result the association of response variable for each predictor, a test of association was carried out using the chi-square at 5% level of significance. The hypothesis testing is: H_0: There is no association between the response variable and each predictor Vs H_1: There is an association between response variable and each predictor. Accordingly, the chi-square association between Stunting Status of among aged 6 and 59 months and each predictors.

In the multilevel analysis, a two-level structure is used with regions as the second-level units and Children as the first level units. This is basically with the expectation that there would be a difference in Stunting Status among regions. The nesting structure is Children within regions with a total of 8640 respectively.

Bayesian Multilevel Logistic Regression of Empty model

From the results presented in the from Table 2 above show that overall mean of Stunting Status is estimated at β_o=3.722 respectively and significant.

Here the null hypothesis tested is $\sigma_{0j} = 0$. i.e., there is no regional variation in Stunting Status in Ethiopia. Based on the from Table 2 result the values are significant at 5% significance level and the null hypothesis has to be rejected, indicating strong evidence that the between region variance is non zero. The variance of the random factor is significant which indicates that there are regional differences in Stunting Status and thus, multilevel analysis can be considered as an appropriate approach for further analysis.

Bayesian Multilevel Logistic Regression Random Intercept Model

From the result of Bayesian Multilevel Random intercept model from Table 3 understood that the random part is the intercept only having many covariates. The result shows that, the variance of the random factor is significant which indicates that there are regional differences in Stunting Status in the data set. The covariate, Women education level, husband education level, Body mass index, Sex of child, Size of child at birth, Birth order, mother working status, age of Children, wealth index, place of residence was significant, but Had Dirrhea in the last two weeks and Had fever in the last two weeks was not significant.

Bayesian Multilevel Logistic Regression of Random Coefficient Model

From the output of the random coefficient Bayesian multilevel model presented from Table 4 below, we interpret the results as follows. Some of the independent variables were found to be significant on the stunting status among 6 and 59 month in Ethiopia these are;-Women educational level, father educational level, Body mass index, sex of child, size of child at birth, birth order, employment status of mother, age of children, wealth index and place of residence.

Accordingly, the test statistics explored that family size, had diarrhea in the last two weeks, and had fever in the last two weeks is the only explanatory variables that are found to be insignificant ($p > 0.05$) factors of the dependent variables among the considered explanatory variables. The interpretation of the odds ratio for multilevel logistic regression model has no difference from the interpretation in logistic regression model. But the difference between them is the multilevel logistic regression model is additional information than single level regression model, which are they include additional term which is called the random part.

The stunting status among children aged between 6 and 59 months whose mothers have secondary educational level was 72.3% less likely than children whose mothers have no educatio nal level exp(-1.282)=0.277. Likewise, the odds of stunting status among children aged between 6 and 59 months father who had primary educational level was exp(-3.644) = 0.026 this means 97.4% less likely than Children whose fathers had no educational level. Meaning that children from father who had educational levels were primary, secondary and higher level was less likely to be stunted than children from fathers who had no education.

In addition, body mass index of mother is a significant factor on stunting of child at 5% level of significance. The odds of body mass index of mother categories of normal body mass index were exp(-1.539)=0.215. This means that 78.5% less likely stunting status of child than children from mother who had thin body mass index.

Another finding of this study from Table 4 below indicate that birth order is significant factor on stunting of children among aged 6 and 59 month at 5% level of significance. The odds of birth order of children who are sixth birth order were exp(4.689)=108.74 times more likely Stunting Status among aged 6 and 59 month than first order and the odds Ratio of children between 2-3 birth order and 4-5 birth order were exp(2.745)=15.565 and exp(3.456)=31.689 times more likely stunting status of child than children that first order, respectively. This indicates that children born there after are more likely to be stunted when compared with first order.

On the other hand, Children aged between 6 and 59 months whose mother have employed were exp(3.982)=53.624times more likely to be stunted when compared to children whose mothers have Unemployed. Similarly, for the categorical variable sex of child, the odds of female children is exp(-0.424)= 0.654, which means that the stunted status of female children aged between 6 and 59 month is 34.6% less likely than male child.

As it indicated in Table 4, The odds of stunting status children with age between 12-23 months was exp(2.423) =11.28 times more likely than the risk of stunting status of children aged between 6-11 months and the odds ratio of stunting status aged between 6 and 59 month children with aged between 24-35 months was exp(-2.423)=0.089 this means that 91.1% less likely to be stunted status of children than aged between 6-11 months and the odds of stunting status for children 48- 59 months were exp(-3.125)=0.044. This indicate that 95.6 less likely than the stunting status from the reference (6-11 months).

The odds of stunting status among children aged between 6 and 59 months, those from middle and rich families was exp(-1.136)=0.321 and exp(-0.976)=0.377 respectively, means that 67.9% and 62.3%, less likely stunted status of child compared to those from poor families. likewise, a variable of place of residence the odds of stunting status of child who living in the rural areas being that children aged between 6 and 59 month was exp(1.097)=2.995 times more likely than stunting status of child who living in Urban area.

In Table 4 shown, the value of var(u_{0j}) and var(u_{11j})are the estimated variance of intercept, slope of Size at birth a region wise intercepts and the slopes vary significantly, that is, there is a significant variation in the effects of these explanatory variables across the regions. Since the estimated regional variance$\sigma^2_{u0j}$was estimated as 93.737. Here the null hypothesis tested was σ^2_{u0j} =0.i.e. there was no regional variation in stunting status of among age 6 to 59 month in Ethiopia versus the alternative hypothesis there was regional variation in stunting status of among age 6 and 59 month in Ethiopia**.**

In view of the fact that their p-value is less than 0.05, the null hypothesis has to be rejected, indicating that the variance of the random factor is significant which means that there were regional variations in stunting status among of children among aged 6 and 59 month. Also estimated variance of slope of size at birth was σ^2_{u11j} =60.574, Here the null hypothesis tested was σ^2_{11j} =0. (There no is significant variation in the effects of these explanatory variables across the regions). Versus the alternative there was a significant variation in the effects of these explanatory variables across the regions. Since their p-value is less than 0.05, the null hypothesis has to be rejected, indicating that the variance of the random factor is significant which means that there was a significant variation in the effects of these explanatory variables across the regions.

The correlation matrix contains the estimated correlation between random intercepts and the random slopes. Positive correlation between intercepts and slopes implies that regions with higher intercepts tend to have on average higher slopes. The negative sign for the correlation bet ween intercepts and slopes implies that regions with higher intercepts tend to have on average lower slopes on the corresponding predictors.

Model Comparison and Model Fit

From Table 5 Shown that, the deviance information criteria are the sum of Dbar and pD. So, to compare the models using DIC when we see the DIC (deviance information criteria) diagnostics of Bayesian multilevel logistic regression for random intercept model with the fixed explanatory variables is reduced by 333.85 from that of Bayesian multilevel logistic regression for the null model. So, this Bayesian multilevel logistic regression of random intercept model with the fixed

explanatory variables is a highly significant improvement suggesting that this model is better than Bayesian multilevel for the null model and the DIC diagnostics of Bayesian multilevel logistic regression of random coefficient model is reduced by 343.57 and 9.72 from Bayesian multilevel logistic regression for random intercept model with the fixed explanatory variables and null model respectively.

Therefore, this smallest values of Bayesian deviance information criteria indicates that Bayesian multilevel logistic regression for random coefficient model is better fits the data to predict stunting status among children aged between 6 and 59 months in Ethiopia. It is also an indication of focusing the Bayesian multilevel logistic regression for random coefficient model.

Assessment of Model Convergence

From Figure below show the convergence of the fifth parameter (coefficient for mother education and Birth Order) in the surveys. From both figures, 1 and 5 the time series plot looks like horizontal band at 30,000 Iteration. It confirms that the chains are converged. The kernel graphs in both figure 4 and 8 also shows that the coefficient has no bimodal density and it also shows convergence in the surveys. The high mixing within the chain in both figures 2 and 6 also show that high convergence to posterior distribution on ACF. As the number of iteration increased the MSE was decreased as we have seen from both figures 3 and 7 it also shows convergence.

Discussion

This study attempted to determine the socio-economic, demographic, and health related factors stunting status among age 6 and 59 month in Ethiopia using 2016 EDHS data. Accordingly, descriptive method and Bayesian Multilevel logistic regression were used in analyses. The Bayesian multilevel logistic regression empty model, the Bayesian multilevel logistic regression random intercept model and Bayesian multilevel logistic regression random coefficient model were used in this study. From the result of model adequacy or goodness of fit of the model using deviance information criteria, Bayesian multilevel logistic regression random coefficient model was identified and this study confirms with the findings in (Tizazu Bayko, *2014*)

At first the study included fourteen predictor variables that were categorized under socioeconomi c, demographic and environmental proximate variables. In this analysis Children are considered as nested within the various regions in Ethiopia. In order to explain regional differences in stunting of child, we employed three multilevel linear regression models for response variable.

The results of Bayesian multilevel logistic regression for random coefficient model, educational attainment of mother, educational attainment of father, body mass index, ,sex of child, size at birth, birth order, employment status of mother, wealth index, age of child, place of residence, were significant factor on stunting status of children among age 6 and 59 month.

Place of residence was significant association with stunting status of child. This shows that Children who are living in rural areas were more likely to be stunted than living in urban areas. This difference might be due to the fact that the resulting in insufficient food production and lack of education about children health, therefore stunting of child in urban area is less than in rural areas. This finding is related with the finding by (TesfahunYonas*at el.,* 2016).

Another determinant factor was educational attainment of mother. These variables were significant contributions on stunting status of child among aged 6 and 59 month at 5% level of significance. Children whose mother have primary education level, secondary education levels and higher education level less stunting status of child among age 6 and59 month than children whose mother have non education. This indicate that the nutritional status of children is dependent on maternal education and occupation and socioeconomic status, since education

gives women a sense of empowerment and confidence to make decisions regarding their health and that of children(Eugenie W. and H. Maiga). This result was in line with the result by (Osamor& Grady, 2016), (NNP $ Sebastian Vollmer, 2016), (Nkurunziza et al., 2017) and (Belete Adelo, 2014 and Gautam SK, 2018).

Another determinant factor were sex of child, this variables were significant contributions on stunting of child among aged 6 and 59 month at 5% level of significance. Male child have more likely stunting status than female child. This could be due to genetic differences between male and female children and, due to girls' greater access to food through their gender-ascribed role in contributing to food preparation (Gautam SK, 2018). This Finding agrees with other studied by (Akombi, B. J, 2017) and (MandefroAsfaw, 2015).

The study showed that, Size of child at birth has significant contributions on stunting of child at 5% level of significance. Smaller than average Size of child at birth more likely stunting than average at birth and larger than average at birth. This result is also similar reported from other study (Indria GA *et al.,* 2016) this study conducted that stunting was positively affected by low birth weight and similarly agree with study by (Ahmed, 2017) as well as reported from (who,2017).

Maternal employment is another determinant of Stunting of child between aged 6 and 59 month and found significantly associated with maternal employment. This means children whose mothers have job are more stunted than children who are non-employed mothers. In other way it have negative effects on the nutritional status of children as it decrease mothers' time spent for their children's caring, feeding and breastfeeding and increases care(Hiwot Eshete*et al.,* 2017). This result was in line with the finding by (Airin*et al.,* 2019)and (Tehsil TakhtBhai, 2017) conducted that Children whose mothers are house wife, the prevalence of Stunting is very low as compare to the children whose mothers are working.

The study showed that Age of child is important determinant factor on stunting of child and positive effect. This indicate that age of a child whose age is 12-23 month is more likely stunted than aged 11-23, 24-35, and 48-59. This might be due to in many such settings, prevalence starts to rise at the age of about three months; the process of stunting slows down at around three years of age, after which mean heights run parallel(F. Habyarimana, 2016). In other ways for children

under age 5 sharply increases between age 6 and 23 months, and peaks at age 24- 35 months; this represents the impact of under-nutrition in the first 1,000 days of life (EDHS, 2016). This finding is similar from the finding studied by, (Domisiano K. Mwabu*et al.,* 2017).

Conclusions

The purpose of this study was to identify the determinant of stunting status and to assess regional variation of stunting status among children aged 6-59 months in Ethiopia by using Bayesian Multilevel logistic regression Analysis. This study shown, from the three Bayesian multilevel models, the Bayesian multilevel analysis of random coefficient is preferable since it had smaller Bayesian deviance information criteria than that of empty and random intercept model. The variance of the random component related to the constant term and slope of Size of child at birth were found to be statistically significant, which implies that there is variation in stunting status of children among the regions.

The study Identify some socio-economic and demographic determinant of stunting of child among aged 6 to 59 month. Educational level of mother, educational level of fathers, Sex of child, Size at Birth, body mass index of mothers, birth order, and employment status of mothers, Age of child, Wealth index and place of residence were the significant factor of stunting status of child among aged 6 and 59 month in Ethiopia.

Educational level of women and their husbands are one of the determinant factors of the stunting status of children among aged 6 and 59 month. As education level of mothers and fathers increase the opportunity children are affects by stunting is decreasing. Male children are most likely stunting of child than male children. Again the stunting of child high in smaller than average at birth than average at birth and larger than average at birth.

The amount of stunting high those children whose mother have thin body mass index than normal body mass index and overweight body mass index. In case of birth order there is high stunting in the sixth birth order than 1st, 2-4 and 4-5 birth order. The amount of stunting is high in child whose mothers have employment than unemployment. Again the stunting of children among aged 6 and 59 month high in age group of 12-23.

The economic status of the household was significantly associated with the Stunting of child rich household were less likely stunting status of child than middle wealthindex household and poor wealth index household. yet again stunting status of children among aged 6 and 59 month high in rural area than urban area.

Declarations

Ethics approval and consent to participate Not applicable in manuscript

The Data taken from Ethiopian Demographic Health Survey.

Consent for publication Not applicable in manuscript

Availability of data and material Not applicable in manuscript

Competing interests

The authors declare that they have no any competing interests

Authors' contributions

MH developed the strategy for the review, screened titles and abstracts, conducted the quality assessment, supported data extraction, contributed to the writing of the manuscript, undertook data extraction, conducted the quality assessment, performed the meta-analysis and contributed to the writing of the manuscript. All things can be done by these authors.

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Author details

I am Munira Husen, lecturer at Madda Walabu university school of natural and computational science department of statistics in Ethiopia

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Variable	Category	Count	%	Height for age status of the child		Df	chi-square	p-value
				Not stunted%	Stunted%			
Region	Tigray	855	9.9	443(51.8%)	412(48.2%)	10	308.79	0.000
	Afar	898	10.4	539(59.0%)	359(41.0%)			
	Amhara	807	9.3	335(41.5%)	472(58.5%)			
	Oromiya	1341	15.5	766(57.1%)	575(42.9%)			
	Somlia	1110	12.8	469(42.3%)	641(57.7%)			
	Benshangul	736	8.5	329(44.7%)	407(55.3%)			
	SNNPR	970	11.2	545(56.2%)	425(43.8%)			
	Gambela	570	6.6	350(61.4%)	220(38.6%)			
	Harari	541	6.3	281(51.9%)	260(48.1%)			
	AdissAbeba	348	4.0	294(84.5%)	54(15.5%)			
	Dire Dawa	464	5.4	273(58.8%)	191(41.2%)			
Family Size	1-4	2482	28.7	1433(57.7%)	1049(42.3%)	2	43.613	0.000
	5-9	5447	63.1	2868(52.7%)	2579(47.3%)			
	10 and above	711	8.2	315(44.3%)	396(55.7%)			
Age of Child	6-11 month	1024	11.9	419(40.9%)	605(59.1%)	4	989.29	0.000
	12-23 month	1909	22.1	698(36.6%)	1211(63.4%)			
	24-35 month	1870	21.6	901(48.2%)	969(51.8%)			
	36-47 month	1844	21.3	951(51.6%)	893(48.4%)			
	48-59 month	1993	23.1	1647(82.6%)	346(17.4%)			
Sex of child	Male	4602	53.3	1957(42.5%)	2645(57.5%)	1	64.880	0.000
	Female	4038	46.7	2067(51.2%)	1971(48.8%)			
Mother's Education attainment	No Education	5414	62.7	2227(41.1)	3187(58.9%)	3	907.52	0.000
	Primary	2393	27.7	1725(72.1%)	668(27.9%)			
	Secondary	746	8.6	579(77.6%)	167(22.4%)			
	Higher	87	1.0	85(97.7%)	2(2.3%)			
Father's Education attainment	No education	4168	48.2	1557(37.4%)	2611(62.6%)	3	917.17	0.000
	Primary	3097	35.8	2064(66.6%)	1033(33.4%)			
	Secondary	1103	12.8	737(66.8%)	366(33.2%)			

	Higher	272	3.1	258(94.9%)	14(5.1%)			
Place of residence	Urban	1483	17.2	1092(73.9%)	391(26.1%)	1	7.762	0.006
	Rural	7157	82.8	3524(49.2%)	3633(50.8%)			
Mother's working status	Not working	6174	71.5	3685(59.7%)	2489(40.3%)	1	340.65	0.000
	Working	2466	28.5	931(37.8%)	1535(62.2%)			
Size at Birth	larger than average	2233	34.8	1265(56.7%)	968(43.3%)	2	22.016	0.000
	Average	3401	39.4	1840(54.1%)	1561(45.9%)			
	smaller than average	3006	25.8	1511(50.3%)	1495(49.7%)			
BMI	<18.5(thin)	2532	29.3.	940(37.1%)	1592(62.9%)	2	386.93	0.000
	18.5-24.9(Normal)	4357	50.4	2585(59.3%)	1772(40.7%)			
	>=24.9(Overweight)	1751	20.3	1091(62.3%)	660(37.7%)			
Wealth Index	Poor	4723	54.7	2221(47.0%)	2502(53.0%)	2	989.29	0.039
	Middle	2258	26.1	1182(52.3%)	1076(47.7%)			
	Rich	1659	19.2	932(56.2%)	727(43.8%)			
Birth order	1	1706	19.7	1584(92.8%)	122(7.2%)	3	1971.8	0.000
	2-3	2643	30.6	913(34.5%)	1730(65.5%)			
	4-5	2114	24.5	1409(66.7%)	705(33.3%)			
	6+	2177	25.2	710(32.6%)	1467(67.4%)			
Had diarrhea in the last two month	No	7157	82.8	3975(55.5%)	3182(44.5%)	1	74.895	0.000
	Yes	1483	17.2	641(43.2%)	842(56.8%)			
Had Fever in the last two month	No	7015	84.2	3535(69.9%)	3480(49.6%)	1	218.50	0.000
	Yes	1625	18.8	490(30.1)	1135(50.4%)			

Table 2:

Model	Coefficient	S.E	Z-value	P-value
Fixed Intercept (β_0)	3.722	0.941	4.00	0.0043
Random Intercept Var(u_{0j})	212.516	38.381	5.54	0.0010

Table 3:

Covarities	Categories	Coef	Std. Err.	Z	P>Z	Odds ratio
	Constant	-5.77	1.203	-4.79	0.000	0.0032
Mother education level	No education(ref)					
	Primary	-7.69	1.39	-5.54	0.000	0.00045
	Secondary	-5.52	1.49	-3.70	0.000	0.004
	Higher	-4.17	2.27	-1.84	0.066	0.015
Father education	No education(Ref)					
	Primary	-4.050	1.318	-3.073	0.000	0.017
	Secondary	1.405	3.986	0.352	0.267	4.075
	Higher	*-0.692*	*4.329*	*-0.159*	*0.402*	*0.50*
Family size	*1-4(ref)*					
	5-9	*-0.069*	*0.338*	*-0.204*	*0.405*	*0.933*
	10 and above	*-0.409*	*0.362*	*-1.129*	*0.135*	*0.664*
BMI	<18.5(ref)					
	18.5-24.9	-1.108	0.69	-1.605	0.050	0.33
	>=25	1.007	0.71	1.418	0.071	2.734
Sex of Child	Male(ref)					
	Female	-1.387	0.175	-7.93	0.000	0.249
Size of Child at Birth	Larger than Average(ref)					
	Average	0.881	0.601	1.466	0.100	2.413
	Smaller than Average	3.17	2.78	7.032	0.000	23.801
Birth order	1(ref)					
	2-3	4.799	0.433	11.083	0.000	121.38
	4-5	2.785	0.414	6.727	0.000	16.199
	6+	3.423	0.452	7.573	0.000	30.661

Mother Working status	Not Working(ref)					
	Working	4.038	0.669	6.035	0.000	56.712
Age of children	6-11(ref)					
	12-23	-3.038	1.336	-2.273	0.000	0.048
	24-36	-4.858	1.176	-4.130	0.000	0.0077
	37-46	-2.116	1.100	-2.00	0.001	0.121
	47-59	-4.580	1.195	3.833	0.000	0.010
Wealth index	Poorest(ref)					
	Middle	-1.168	0.232	-5.034	0.000	0.311
	Rich	-0.943	0.267	-3.532	0.001	0.389
Type of Place of Residenc e	Urban(ref)					
	Rural	6.409	1.891	3.389	0.000	607.29
Had Diarrhea in the last two weeks	No(ref)					
	Yes	0.693	0.601	1.153	0.121	1.99
Had Fever in the last two weeks	No(ref)					
	Yes	-0.297	3.940	-0.075	0.390	0.743
Random effect		Estimate	S.E	Z-val	P-va	
Var_{-oij}		149.20	35.96	4.15	0.002	

Table 4:

Covariates	Categories	Coef	Std. Err.	Z	P>Z	Odds ratio
Mother education level	Constant	-1.585	1.324	-1.197	0.121	0.205
	No education(ref)					

	Primary	-0.894	2.238	-0.399	0.138	0.409
	Secondary	-1.282	0.198	-6.475	0.000	0.2775
	Higher	-3.421	3.011	-1.136	0.116	0.033
Father education	No education(Ref)					
	Primary	-3.644	1.502	-2.426	0.010	0.026
	Secondary	-4.232	2.712	-1.560	0.060	0.015
	Higher	6.397	3.913	1.634	0.246	600
Family size	1-4(ref)					
	5-9	-0.090	0.304	-0.296	0.382	0.914
	10 and above	-0.399	0.334	-1.194	0.114	0.671
BMI	Thin(<18.5)(ref)					
	Normal(18.5-24.9)	-1.539	0.679	-'2.665	0.007	0.215
	Overweight(>=25)	0.589	0.680	0.866	0.203	1.802
Sex of Child	Male(ref)					
	Female	-0.424	0.177	-2.395	0.012	0.654
Had diarrhea in the last two weeks	No(ref)					
	Yes	0.632	0.714	0.885	0.188	1.881
Size of Child at Birth	Larger than Average (ref)					
	Average	1.624	0.775	-2.095	0.023	5.073
	Smaller than average	0.584	0.049	11.92	0.000	1.793
Birth order	1(ref)					
	2-3	4.689	0.380	12.34	0.000	108.74
	4-5	2.745	0.414	6.631	0.000	15.565
	6+	3.456	0.385	8.977	0.000	31.689
Mother Working status	Not working(ref)					
	Working	3.982	0.694	5.738	0.000	53.624
Age of children	6-11(ref)					
	12-23	2.423	1.070	-2.264	0.015	11.279
	24-35	-3.485	1.175	-2.966	0.012	0.031
	36-47	-0.793	1.244	-0.637	0.286	0.452
	48-59	-3.125	1.310	2.385	0.000	0.044
Wealth index	Poorest(ref)					
	Middle	-1.136	0.254	-4.472	0.000	0.321

	Rich	-0.976	0.275	-3.549	0.000	0.377
Had fever in the last two weeks	No(ref)					
	Yes	0.538	1.761	0.305	0.108	1.713
Type of Place of Residence	Urban(ref)					
	Rural	1.093	0.508	2.152	0.005	2.983
Random effect		Estimate	S.E	Z-val	P-va	
$Var(u_{0j})=\sigma^2_{u0j}$		93.732	16.28	5.757	0.000	
$Var(u_{11j})=\sigma^2_{u11j}$		60.574	12.624	4.798	0.000	
$Cov(u_{0j},u_{11j})=\sigma^2_{u0j}\sigma^2_{u11j}$		49.976	18.299	2.731	0.004	

Table 5:

Model	Dbar	D(thetabar)	PD	DIC
Empty model	1611.92	1464.19	147.73	1759.65
Random Intercept model	1259.91	1094.0	165.90	1425.81
Random Coefficient model	1246.88	1077.67	169.21	1416.09

Figures

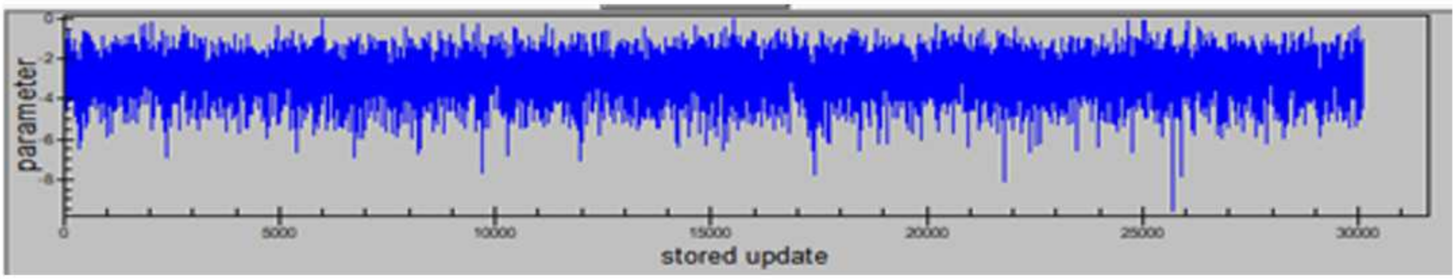

Figure 1

time series plot looks like horizontal band at 30,000 Iteration

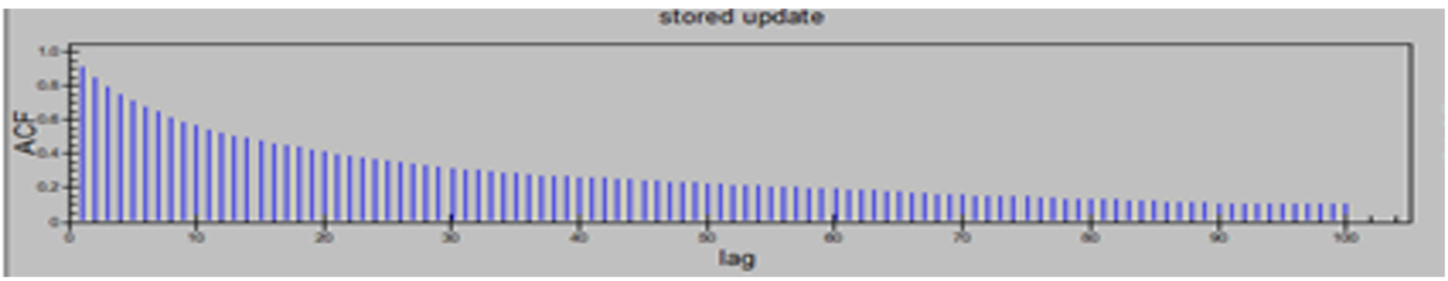

Figure 2

high convergence to posterior distribution on ACF

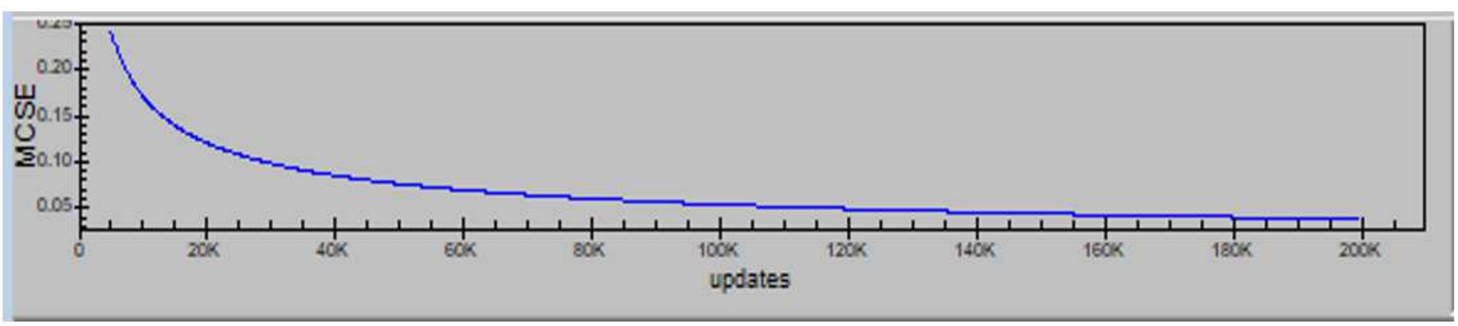

Figure 3

convergence

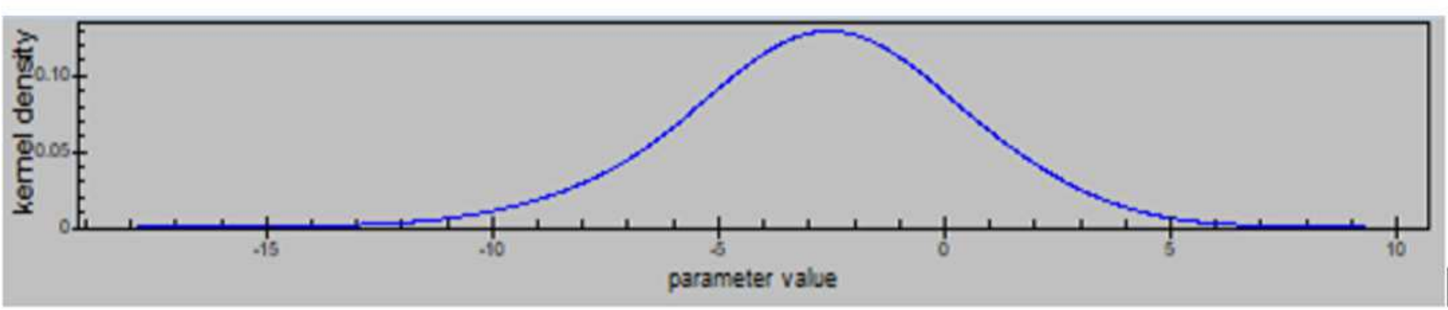

Figure 4

the coefficient has no bimodal density and it also shows convergence in the surveys

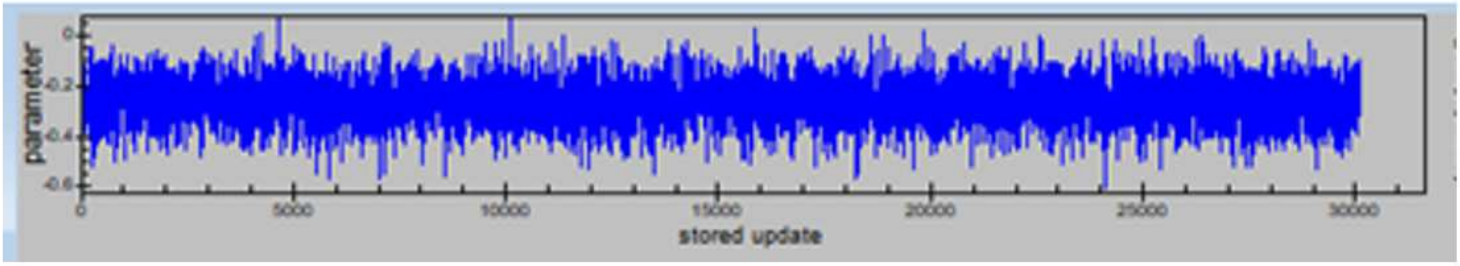

Figure 5

time series plot looks like horizontal band at 30,000 Iteration

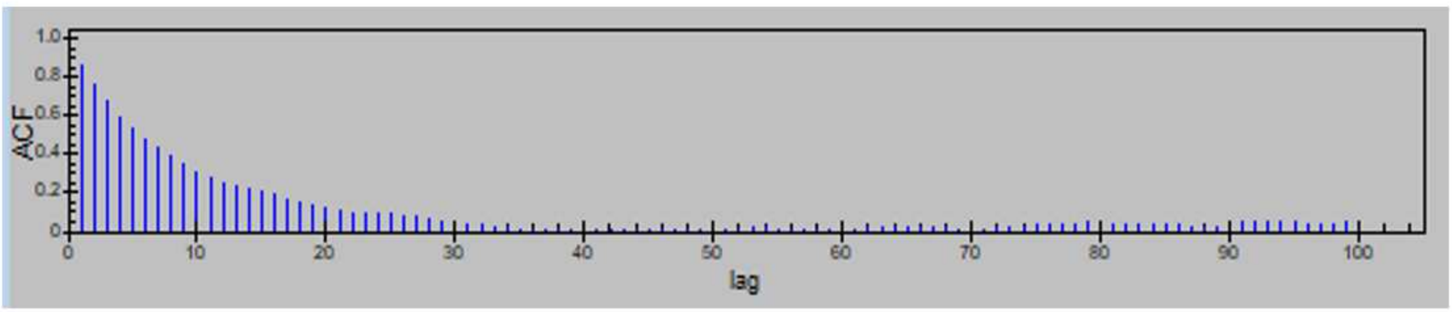

Figure 6

high convergence to posterior distribution on ACF

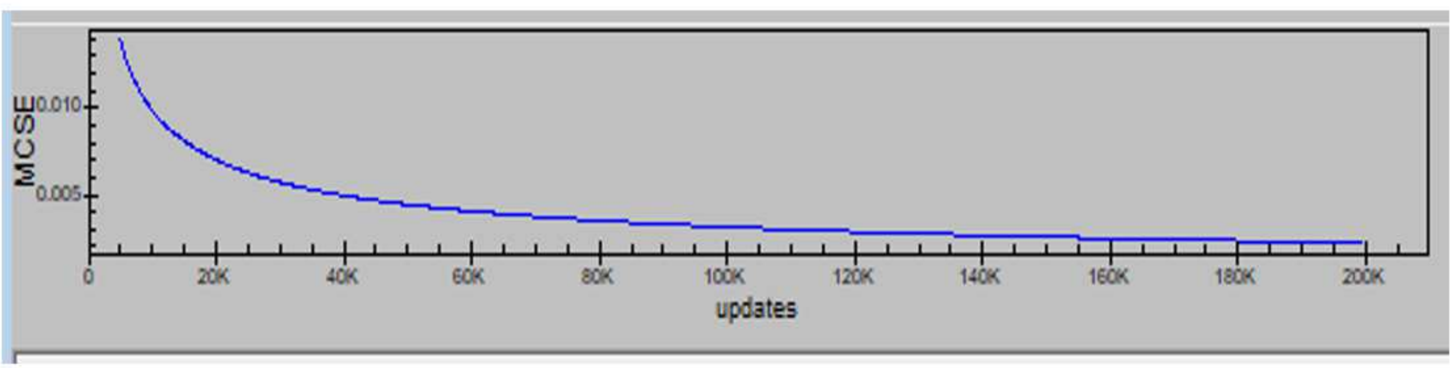

Figure 7

convergence

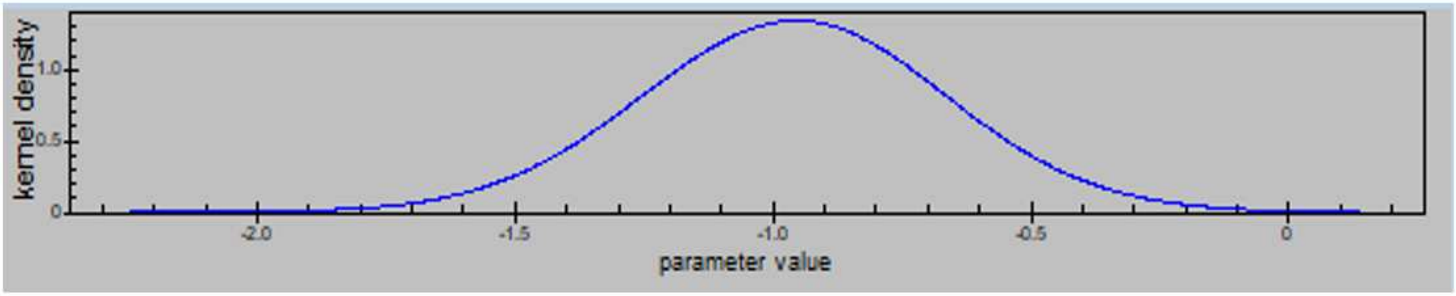

Figure 8

the coefficient has no bimodal density and it also shows convergence in the surveys