

Factors Associated With Protection of Last Live Birth Against Neonatal Tetanus Among Mother Age 15-49 in Ethiopia: A Multilevel Analysis Using EDHS 2016

Gebrezgiher Kalayu

Mekelle University

Girmatsion Fisseha

Mekelle University College of Health Sciences

Reda Shamie (✉ redashamie@yahoo.com)

Mekelle University College of Health Sciences

Awtachew Berhe

Mekelle University College of Health Sciences

Kebede Embaye

Mekelle University College of Health Sciences

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Abstract

Background: Neonatal tetanus is still the major public health problem in about 25 countries, mainly in Africa. Ethiopia has the highest neonatal tetanus mortality and morbidity rates in the world due to low TT immunization coverage coupled with the high amount of deliveries taking place at home. In Ethiopia, only 49% of the pregnant mothers received TT2+ in 2016.

Objective: The objective of this study is to identify individual and community level factors associated with protections of last live birth against neonatal tetanus among mothers 15-49 years age in Ethiopia, evidence from Ethiopia Demographic and Health Survey 2016.

Methods: The data for this study was obtained from Ethiopia Demographic and Health Survey of 2016. Population based cross-sectional study was conducted. The data were analyzed using Stata version 14. Variables that were significant in the bivariate multilevel logistic regression analysis were entered to the final model. Variables with p-value of less than 0.05 in the final model were considered as statistically significant. Interclass correlation coefficient and proportional change in variance were used to quantify the magnitude of the general contextual effect. Receiver operating characteristics curve was used to assess general accuracy of the model. Relative goodness-of-fit test was conducted using akaike's information criterion.

Results: This study depicted that, a total of 7193 women nested in 643 clusters were included in the analysis. The odds of protection of last live birth against neonatal tetanus were 1.27 and 1.53 times higher in mothers with poorer and richer respectively than mothers with poorest wealth index. Mothers who had antenatal care visit one and above had 12.3 times higher odds of protections of neonatal tetanus than those who had no antenatal care visits. The other significantly associated factors were place of delivery, region and community media exposure.

Conclusion and recommendation: It can be concluded from the current study that protection of last live birth against neonatal tetanus is affected both by the individual and community level factors. Therefore, efforts to increase protection of last live birth against neonatal tetanus need to target both at individual and community level factors.

Introduction

Tetanus is bacterial disease caused by the bacterium *Clostridium tetani* that cannot be eliminated as *C. tetani* spores exist in the environment [1]. Globally, an estimated 3.3 million neonatal deaths occur each year of which neonatal tetanus shares a high number of death in developing countries where home delivery is common [2]. The immunization of pregnant women or women of childbearing age with two or above doses of tetanus toxin (TT) vaccination may reduce the neonatal tetanus mortality by 94% [3]. In about 25 countries neonatal tetanus is still a major public health problem, mainly in Africa. However, the utilization of the intervention, like TT immunization remains low in the Sub-Saharan African countries [2].

Ethiopia has the highest neonatal tetanus mortality and morbidity in the world due to low TT immunization coverage and a high amount of deliveries taking place at home in unsanitary conditions[4]. In Ethiopia, only 49% of the pregnant mothers received two and above tetanus toxin doses in 2016 [5].

There are some studies concerning protections of neonatal tetanus undertaken in Ethiopia in different settings. However, these studies were analyzed using single-level analysis which does not consider the hierarchical structure of the data and are limited in scope and context.[6–11]. Therefore; this study aimed to assess the individual and community level factors associated with protections of last live birth against neonatal tetanus among mothers in Ethiopia using multilevel analysis of the Ethiopia Demographic and Health Survey (EDHS) 2016 data. The EDHS data has a nested structure which makes it best suited for multilevel analysis.

Materials And Methods

The Ethiopian DHS was conducted in all regions of Ethiopia, Ethiopia has nine geographical regions and two administrative cities [12]. The data for this study was extracted from the 2016 EDHS which were collected from January 18, 2016, to June 27, 2016. It is the fourth nationally large scale dataset of DHS that is conducted by the central statistical agency (CSA)[13].The study population was all mothers of the reproductive age group who had given birth in the last 5- years before the EDHS 2016.

Measurements

Protection of last live birth against Neonatal Tetanus was the dependent variable and was dichotomized in to “protected” or “not protected”. Protected at birth was measured when mothers during pregnancy had received ≥ 2 TT dose (protected at birth) or had received < 2 TT doses (not protected at birth). The independent variables includes individual factors (socio-demography variables of mother and husband, parity, ANC visit, place of birth, mode of birth), community factors (place of residence, region, community media exposure, community poverty). All region in Ethiopia includes Tigray, Afar, Amhara, Oromiya, Somali, Benishangul-Gumuz, Southern Nations, Nationalities and People’s Region (SNNPR), Gambela, Harari, Addis Ababa, and Dire Dawa. Community media exposure was categorized as exposed if the proportion of women in the community exposed to media was $\geq 19.35\%$ and categorized as not exposed if the proportion was 0-19.35%. Community poverty status was defined as the proportion of poor or poorest mothers within the cluster and aggregated to show overall poverty status within the cluster. This was classified as high if the proportion of women protecting last live birth against neonatal tetanus in a community was $\geq 25\%$ and as low if the proportion was 0-25%. Community-women education was defined as the proportion of mothers who attended primary/secondary/higher education within the cluster. It was categorized as higher or lower according to the national median value. It was classified as high if the proportion of women in a community attending at least primary-school and above was $\geq 33.3\%$ and as low if the proportion was 0-33.3%.

Media exposure: Based on their exposure status to radio or television, two categories were created: no exposure to either media and exposed to either media. **Community poverty status:** It is defined as the

proportion of poor or poorest mothers within the cluster. Within the cluster proportion of poor or poorest were aggregated and show over all poverty status within the cluster. There were two categories for this variable with reference to the national median value; higher proportion of poor/poorest mothers and lower proportion of poor or poorest mothers within the cluster. This was classified as high if the proportion of women protecting last live birth against neonatal tetanus in a community was $\geq 25\%$ and as low if the proportion was 0-25%.

Statistical Analysis

The analysis was done using STATA version 14. Frequencies and percentages were used to describe the categorical variables. Cross-tabulation was also performed between all explanatory variables and the outcome variable. To assess the factors associated with the dependent and independent variables a multilevel binary logistic modeling was used by account the hierarchical nature of the EDHS data. The multilevel model involves two levels (individuals nested in communities). The explanatory variables with a p-value of < 0.25 in this binary model were entered into the multivariable regression for adjustment [14]. Those variables with a p-value of < 0.05 in the multivariable multilevel regression model were declared statistically significant. The measures of association of the individual and community level factors with the protection of last live birth against neonatal tetanus were reported using the odds ratio with their respective 95% confidence interval (CI).

Four models (model I-IV) were fitted. Model I (null model) was run to test the inter-group (community) variability on neonatal tetanus and to decide whether the data is fit for multilevel modeling or not. Intra-class Correlation Coefficient (ICC) was calculated– the percentage of variability explained by the upper level (community). Model II includes individual-level factors only. Model III includes community-level factors only. Model IV includes the mixed model with both individual and community level factors. The model has a fixed or deterministic part and the random part. Proportional Change in Variance (PCV) and ICC were calculated [15] and compared between each models.

Parameter estimation

The Maximum Likelihood estimation method was used to estimate the parameters. Whereas the random-effects (measures of variation) were reported as an ICC which is the proportion of community-level variance as compared to the total variance and PCV express the change in variance between the null model (Model I) and the consecutive models. Those Akaike Information Criteria (AIC) was used to compare and select the model that best fits the data [16].

Results

Characteristics of the study subjects

This study extracted a total weighted sample of 7193 mothers age 15-49 (individuals) nested within 643 EAs (communities) from the EDHS 2016. The median ages of women's nested per community were 28. Out of 4359 not educated women's, 1445(34.9%) of them were protected their last live birth against neonatal tetanus. Most, 1797(63.2%) poorest women were not protected their last live birth against neonatal tetanus. Out of 4712 mothers, 2753 (56.9%) of them were visits health facility and protected their last live birth against neonatal tetanus (**Table 1**).

Characteristics of the community

This study included 643 clusters in which all the mothers among the age group of 15-49 years had lived. Out of 5,679 rural resident women, 3587(61.3%) of them were not protected their last live birth against neonatal tetanus. Above six out of ten 3650(64.2%) of the clusters were from communities with a low proportion of media exposure and not protected their last live birth against neonatal tetanus. About half 1508(49.3%) of the clusters were from communities with a high proportion of women education. About 1808(56.3%) were from communities with high proportion of community poverty.

The proportion of last live birth protection against neonatal tetanus was 43.8% in Ethiopia of which Afar and Gambela were the least protected (**Fig 1**).

Contextual factors associated with the protection of last live birth against neonatal tetanus

In this final fixed-effect model where both individual and community-level factors are adjusted, ANC visits of mothers, wealth status and place of delivery of mothers from individual-level factors whereas region and community media exposure from community-level factors were associated factors with protected last live birth against neonatal tetanus (**Table 2**).

Random effect results

The random effects were explained in terms of the ICC and PCV. The community variation in the odds of protection of last live birth against neonatal tetanus has continued to be statistically significant ($V_0 = 0.28, p < 0.001$). The ICC found from this mixed model showed that 7.89% of the total variance in the odds of neonatal tetanus could be attributed to community characteristics. A PCV of 74.33% implies that 74.33% of the variation in the log-likelihood of protection of last live birth against neonatal tetanus between communities was explained by both individual and community level variables included in the model.

Discussion

This study aimed to identify both the individual and community level factors of protection of last live birth against neonatal tetanus based on the data from EDHS 2016. ANC visit, wealth status and place of delivery were individual-level factors that associated with protection of last live birth against neonatal

tetanus in Ethiopia. The community-level variables that could explain the variation in the protection of neonatal tetanus among communities were regional variation and community media exposure.

The current study revealed that women's who utilized ANC had higher odds protection of last live birth against neonatal tetanus than those women who had not utilized ANC visits. This is similar with studies conducted in SNNP of Ethiopia, Northern Ethiopia and Eastern Ethiopia [8–10]. This might be due to health professionals provide women who come to health facilities for ANC visits with health education including the advantages and schedule of mother's vaccination.

The odds of neonatal tetanus were higher among mothers having wealth of richer than women's having poorest wealth status. This is in line with studies conducted in north India, Pakistan [17, 18] and Ethiopia [12, 13]. This could be due to the reason that having good income uses to get health access and more informed to the health facility to get tetanus vaccination.

This study shows that women who gave birth at home were less likely to protect their last birth as compared to those mothers who have given birth at the health facility. This is similar to the Indonesian, Pakistan, and Ethiopia study's [9, 18, 19]. The possible reason might be because of the opportunity for health education and advice and the provision of the mother with at least the first dose of TT just immediately after delivery procedures.

Region of residence was revealed to be a significant predictor of neonatal tetanus in the current study. Mothers from Oromia, Hariri, and Diredawa regions had higher odds of protections of neonatal tetanus as compared to those from the Addis Ababa region. Tigray region had lower odds of protection of last live birth against neonatal tetanus. The reason could be due to geographical difference and access of health service as of studies in Africa [20, 21]. Another reason might be due to a lack of uniform performance commitment to implement Tetanus Toxoid vaccination services in all regions of the country.

The odds of protections of last live birth against neonatal tetanus were higher in those who were from a community with a high proportion of media exposure. This finding is similar to the study conducted in Sub-Saharan African countries [8, 9, 22]. This might be due to media programs play a great role in delivering information for the large population.

Conclusions

This study found that both the individual and community level factors determine the protections of last live birth against neonatal tetanus in Ethiopia. At an individual level, ANC utilization, place of delivery and wealth status of the household was significantly associated with neonatal tetanus. At community-level, regional variation was significantly associated with neonatal tetanus. Therefore, addressing both the individual and community level factors, improving access, quality of antenatal and delivery service is important. A specific region like the Afar region needs also a special support from the Ministry of Health to improve coverage of TT vaccination.

Strength and limitation of the study

This study has used the data from the EDHS 2016 which is large scale and nationally representative survey from the nine regions and two administrative cities of Ethiopia. Since this survey is conducted in 2016 it provides us with recent estimates of the protection of last live birth against neonatal tetanus in Ethiopia. The hierarchical nature of the EDHS data, a two-level mixed effects logistic regression was used to handle both the fixed effects of individual and community factors and random effects to explain the between-cluster variations simultaneously. As the result, this study endeavored to generate variables that can characterize communities by aggregating individual data into cluster values. EDHS data has a hierarchical nature (individuals nested within communities), multilevel modeling is appropriate to identify the individual and community level factors simultaneously. Besides, weights were applied in describing background characteristics of respondents and during cross tabulation to adjust estimation for the representativeness of the EDHS data.

Although the study has got important strengths, it has limitations too. The problem of missing observations in some variables which were supposed to affect protection of last live birth against neonatal tetanus was one of the limitations. Even some variables were totally with missing observations. The variables perception of drugs availability, beliefs and cultural tradition was totally missing observations.

Abbreviations

AIC: Akaike Information Criterion; AOR: Adjusted Odds Ratio; AUC: Area under the ROC curve; ANC: Antenatal Care; BIC: Bayesian information criteria; COR: Crude Odds Ratio; CSA: Central Statistical Agency; EA: Enumeration Area; EDHS: Ethiopian Demographic and Health Survey; HEW: Health Extension Worker; ICC: Intra –Class- Correlation -Coefficient; NT: Neonatal Tetanus; PCV: Proportional Change in Variance; ROC: Receiver Operating Characteristics and TT: Tetanus Toxin.

Declarations

Ethics approval and consent to participate

For DHS data, ethical approval has obtained from the individual national institution's review board and by ICF international institutional review board for women. We obtain permission to use the data from the DHS program and the data set used for this study is available from www.dhsprogram.com.

Consent for publication

Not applicable.

Availability of the data and materials

The data set used for the current study available from <https://www.dhsprogram.com>.

Competing interests

The authors declare that they have no competing interests.

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No funding was obtained for this study.

Author's contributions

GK, GF, AB, KA and RS had made substantial contributions to the conception and design of the study. GK has designed the study, participated in analysis, interpretation, and write-up, drafted the manuscript and critically revised it. GF and AB has participated in study design, analysis, interpretation, and critically revised the manuscript. KA and RS participated in the reanalysis of the study findings, interpretation, and critically revised the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1: Distribution of protection of last live birth against neonatal tetanus by individual-level characteristics of mothers age 15-49 in Ethiopia, EDHS 2016 (n=7193)

Individual variable	Protection of neonatal tetanus (%)		Total, n(%)
	Protected, n(%)	Not protected, n(%)	
Maternal age			
15-19	156(42.3)	202(57.7)	358(100)
20-29	1553(43.4)	1956(56.6)	3509(100)
30-39	1071(40.4)	1603(59.6)	2674(100)
40-49	210(31.6)	442(68.4)	652(100)
Maternal education			
No education	1445(34.9)	2914(65.1)	4359(100)
Primary	1010(49.1)	932(50.9)	1942(100)
Secondary	333(59.5)	244(40.5)	577(100)
Higher	202(61.6)	113(38.4)	315(100)
Maternal employment status			
Not employed	534(36.8)	900(63.2)	1434(100)
Nonagricultural	836(47.8)	846(52.2)	1682(100)
Agricultural	1620(40.0)	2457(60.0)	4077(100)
Wealth index			
Poorest	631(30.6)	1797(69.4)	2428(100)
Poorer	479(37.3)	700(62.7)	1179(100)
Middle	431(38.7)	597(61.3)	0281(100)
Richer	459(47.2)	485(52.8)	944(100)
richest	990(55.7)	651(44.3)	1641(100)
Place of delivery			
Home	1363(34.2)	3032(65.8)	4395(100)
Health facility	1627(54.9)	1171(45.1)	2798(100)
Marital status			
Living together	2783(41.1)	3937(58.9)	6720(100)
Not living together	207(39.8)	266(60.2)	473(100)
ANC visit			
None	237(14.3)	2244(85.7)	2481(100)

At least one visits	2753(56.9)	1959(43.1)	4712(100)
Mode of delivery			
No	2819(40.6)	4118(59.4)	6937(100)
Yes	146(61.4)	115(38.6)	261(100)
Parity			
<=2 children	1407(45.7)	1539(54.3)	2946(100)
3-4 children	814(39.7)	1202(60.3)	2016(100)
>4 children	769(36.8)	1462(63.2)	2231(100)

Table 2: Individual and community-level factors associated with protections of last live birth against neonatal tetanus among mothers age 15-49 in Ethiopia, EDHS 2016 (n=7193)

Individual-level variables	Protection of neonatal tetanus frequency (%)		
	Protected	Not protected	Multivariable-Model 4 (AOR [95%CI])
Wealth index			
Poorest	631(30.6)	1797(69.4)	1
Poorer	479(37.3)	700(62.7)	1.27 [1.04, 1.54]*
Middle	431(38.7)	597(61.3)	1.22 [0.99, 1.52]
Richer	459(47.2)	485(52.8)	1.53 [1.21, 1.93]***
Richest	990(55.7)	651(44.3)	1.22 [0.94, 1.58]
Place of delivery			
Health facility	1627(54.9)	1171(45.1)	1
Home	1363(34.2)	3032(65.8)	0.83 [0.72, 0.96]**
ANC visit			
No ANC visit	237(14.3)	2244(85.7)	1
At least one ANC visit	2753(56.9)	1959(43.1)	12.35[10.42, 14.62]***
Community variables			
Region			
Addis -Ababa	229(61.7)	146(38.3)	1
Tigray	298(41.2)	474 (58.8)	0.55 [0.38, 0.79]**
Afar	151(28.1)	496(71.9)	0.78[0.51, 1.18]
Amhara	265(35.7)	499(64.3)	0.83 [0.56, 1.21]
Oromo	417(41.4)	614(58.6)	1.54 [1.06, 2.23]*
Somali	254(32.2)	552(67.8)	1.38 [0.93, 2.05]
Benishangul-Gumuz	250(44.4)	326(55.6)	1.23 [0.82, 1.84]
SNNPR	395(44.3)	498(55.7)	1.15 [0.79, 1.66]
Gambela	228(49.2)	306(50.8)	1.39 [0.94, 2.08]
Harari	267(63.9)	114(36.1)	2.54 [1.69, 2.42]***
Diredawa	384(63.3)	148(36.7)	1.62 [1.09, 2.42]*

Community media exposure			
High	862(51.0)	553(49.0)	1
Low	2128(35.8)	3650(64.2)	0.79 [0.65, 0.96]*

NB: * = p<0.05; ** = p<0.01; *** = p<0.001; ANC = Antenatal Care; AOR = Adjusted Odds Ratio; CI = Confidence Interval; SNNPR = Southern Nations Nationalities and Peoples Region; 1= Reference.

Figures

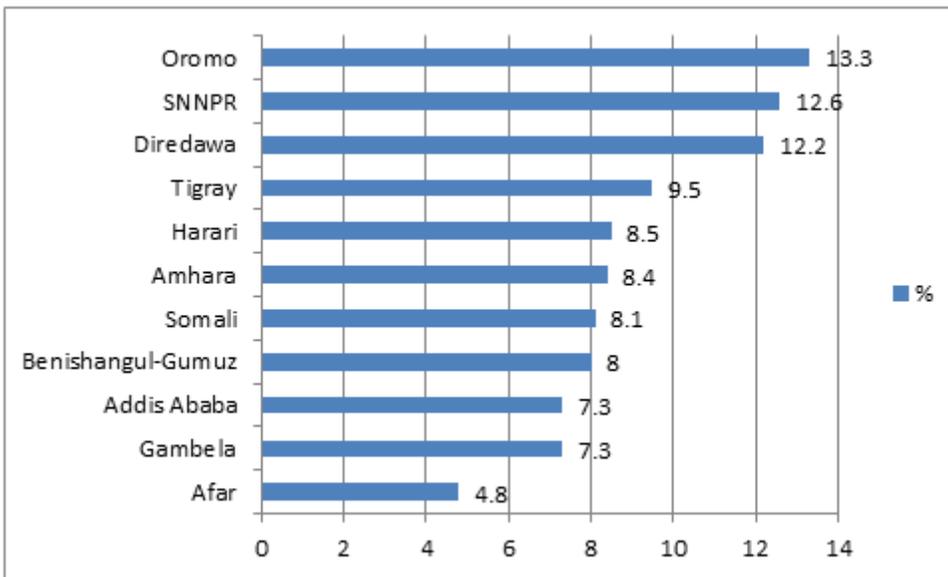


Figure 1

Proportion of last live birth protection against neonatal tetanus among regions of Ethiopia, EDHS 2016 (n=7193)