Original article

Factors influencing TT immunization coverage and protection at birth coverage in Tselemti District, Ethiopia

Teklay Kidane

Abstract

Background: Tetanus toxoid (TT) immunization coverage is low in Tigray as in many other parts of Ethiopia. Protection at birth (PAB) coverage has never been assessed in Tigray.

Objective: To identify factors influencing TT immunization and PAB coverage.

Methods: A community based cross-sectional immunization coverage survey was conducted in Tselemti district, Ethiopia in July 2001. Two hundred-twenty households with 0-23 months old children in 7 rural villages and 4 urban centres were selected using a stratified multistage cluster sampling technique. Trained nurses assessed the immunization status of 140 rural and 80 urban mothers by reviewing of vaccination cards and mother's history.

Results: TT_{3+} coverage (mothers vaccinated with three or more doses of TT) was 75.5% by card plus history, 82.1% for rural and 63.8% for urban areas (p=0.002). Percent of children PAB from tetanus was 61.8% by card plus history, 71.4% for rural and 45.0% for urban areas (p<0.001), 58.6% for illiterate and 79.4% for literate mothers (p=0.022). Multi-variate logistic regression analysis demonstrated maternal immunization awareness score (MIAS), and residence to be predictors of TT_{3+} immunization status, and MIAS, residence and maternal education to be the predictors of PAB.

Conclusion: Community mobilization and raising mothers' awareness along with the expansion of antenatal care services might be important strategies to increase TT immunization coverage and protect newborns in urban as well as in rural areas. [*Ethiop.J.Health Dev.* 2004;18(3):153-158]

Introduction

Globally it is estimated that neonatal tetanus is responsible for 14% of all neonatal deaths, accounting for up to 25% in some African countries, while maternal tetanus is responsible for at least 5% of maternal deaths annually worldwide (1). Ethiopia's Expanded Program on Immunization (EPI) started in 1980 and remains the singl most important component of primary health care (PHC) supported by the Ministry of Health (2,3). The TT vaccination schedule in Ethiopia for childbearing women follows the schedule recommended by WHO for developing countries (4). Studies in some developing countries have shown higher TT immunization coverage in rural than in urban areas (5,6) with highest coverage in women with no education and lowest in those with higher education (6). Antenatal care (ANC) attendance during pregnancy has also been reported to be associated with being protected at delivery from tetanus (7).

Tetanus toxoid coverage is routinely monitored in Ethiopia and other developing countries by the "TT_{2+}" method, in which the reported number of protective doses of TT (TT_2, TT_3, TT_4 and TT_5) given to pregnant women during a calendar year is divided by the estimated live births during the same year (8). In Ethiopia, the Demographic and Health Survey (DHS) 2000 reported that only 17.2% of mothers who had a live birth in the five years preceding the survey had received two or more doses of TT during pregnancy. Mothers living in urban areas were nearly three times more likely to be protected against tetanus than mothers in rural areas, and women with secondary and higher levels of education were three times more likely to have been immunised against tetanus than women with no education (9).

The people in Tigray Region are well organized at the grass roots level (10). Community mobilization to solve public problems has been a long tradition in the rural areas (11), and community based organisations function well and are strong pillars for community based health promotion activities (12). Community health workers (CHWs) and representatives from social organisations (women, youth and farmers' associations) are involved in EPI advocacy, community mobilisation for immunization and monitoring of immunization programs through regular assessment sessions.

The DHS Ethiopia 2000 reported that TT_{2+} coverage for Tigray for pregnant women was only 14.3% for the 1995-2000 period, while annual regional TT_{2+} coverage figures for the same five-year period compiled from routine monthly immunization reports ranged from 42-57% in non-pregnant to 16-28% in pregnant women (13). In the western zone of Tigray, EPI services started in 1992 soon after the end of the civil war. In 2000, Tselemti District had the best EPI performance of the nine western zonal districts. Reported 2000 TT_{2+} immunization coverage for Tselemti district, compiled

Tigray Region Health Bureau, P.O. Box 7, Mekelle, Tigray, Ethiopia, Tel. 251 04 403111
Fax: 251 04 402811, E-mail: teklay8desta@yahoo.com

from routine monthly immunization reports, was 65.1% for non-pregnant women but only 26.7% for pregnant women, and coverage was higher for rural than urban areas (14). We felt the reported coverage in pregnancy might have under estimated actual coverage, and we were interested in documenting protected at birth (PAB) coverage, which had never also been assessed. We therefore, conducted a community based TT immunization coverage survey to verify the reported coverage and to assess how reliable the nationally used "TT_{2+} method" is for estimating protection at birth. The objectives were to determine TT immunization coverage, to determine the proportion of children protected at birth, and to describe factors associated with any urban and rural immunization coverage differences. The study is important to improve TT immunization coverage.

Methods

The study area has 13 localities and a population of 67,964. The study was a descriptive community based cross-sectional survey. Sample size was determined from a concomitant immunization coverage survey of 0-23 months old children and was 220 (15). Choice of sites followed the WHO EPI multistage cluster sampling method. In order to enrol a sample large enough for urban/rural comparison, it was decided for convenience to choose 4 urban and 7 rural clusters. The clusters were randomly selected from the urban and rural localities respectively. The "spin the pen" method was then used to select twenty households with mothers of 0-23 months old children in each cluster. All eligible mothers of children born from July 6, 1999 to July 6, 2001 in the randomly selected households were surveyed using a revised WHO EPI immunization coverage questionnaire. A medical doctor supervised and trained eight nurses for two days including field exercises about data collection.

Data were entered in SPSS Version 9.0. Immunization differences were reported as statistically significant when chi square p-value was less than 0.05. Independent T-test for two samples was used to compare two means. Stepwise multiple logistic regression with backward elimination was performed to analyse which factors predicted mothers compliance with TT immunization. A significant level of $p \leq 0.2$ was used to include independent variables in the model, $p \geq 0.4$ for dropping variables from the model at each step, and $p < 0.05$ for keeping variables in the final model.

TT and PAB are reported throughout from information collected form card plus history. All TT doses were assumed to meet minimum interval requirements between valid doses. When defining PAB, TT_2, TT_3, TT_4, and TT_5 immunization were assumed to confer three years, five years, ten years, and lifelong protection (8). The following operational definitions were used.

TT card dose: Dose of TT mother received as recorded on immunization card.

TT history dose: Dose of TT mother received as reported by the mother.

Coverage by card plus history: Coverage numerator based on card and history.

Maternal immunization awareness score (MIAS): Sum of mother's correct answers to the nine questions on EPI vaccines.

Literate: Mother with formal education or able to read and write.

Protected at birth (PAB):

1. Mother received two or more TT card or history doses during pregnancy with child being assessed, or
2. Mother received one TT card or history dose during pregnancy with child being assessed and one TT card or history dose any time previously, or
3. Mother received no TT card or history dose during pregnancy with child being assessed, but 2 or 3 TT card or history doses before pregnancy with child being assessed, could state month and year of last TT dose, and birth of child occurred during the expected period of protection conferred by the last TT dose, or
4. Mother received four or more TT card or history doses before pregnancy with child being assessed.

Results

Two hundred and twenty mothers were surveyed, 80 urban and 140 rural. Eighty five percent of mothers were illiterate (72.5% urban versus 91.4% rural, $p<0.001$), and 88.6% were married (78.8% urban versus 94.3% rural, $p<0.001$) (Table 1). The proportion of married women in the urban-illiterate group when compared to the rest of the group was lower (77.6% versus 92.6%, $p=0.002$).

Table 1: **Education, marital status and occupation of mothers.**

Characteristics n=220	Urban No. (%)	Rural No. (%)	Total No. (%)
Education			
Illiterate	58 (72.5)	128 (91.4)	186 (84.5)
Read and write	5 (6.5)	0 (0)	5 (2.3)
Primary school	11 (13.8)	11 (7.9)	22 (10.0)
Secondary school and above	6 (7.6)	1 (0.7)	7 (3.2)
Marital status			
Married	63 (78.8)	132 (94.3)	195 (88.6)
Single	1 (1.3)	1 (0.7)	2 (0.9)
Divorced	6 (7.5)	5 (3.6)	11 (5.0)
Separated	10 (12.5)	2 (1.4)	12 (5.5)
Occupation			
House-wife	60 (75.0)	132 (94.3)	192 (87.3)
Daily labourer	8 (10.0)	0 (0)	8 (3.6)
Merchant	5 (6.3)	0 (0)	5 (2.3)
Government employee	2 (2.5)	0 (0)	2 (0.9)
Self employed	5 (6.3)	8 (5.7)	13 (5.9)

Of the 220 mothers, 43.2% knew that TT vaccination protects the mother and the newborn from tetanus, and 90.3% knew that it does not have side effects. More than 90% of mothers reported positive attitude of husbands towards TT vaccination. The mean MIAS for literate mothers was significantly higher than for illiterate mothers (7.4±1.1 versus 6.0±1.8, t=4.3, p<0.001).

As shown in Table 2, 95.5% of mothers had received at least one dose of TT, while 4.5% had received none. Overall, 29.1% were vaccinated with TT_5 (30.1% with 0-11 months children and 27.3% with 12-23 month children). TT_5 coverage for literate mothers was 13.6% in urban areas and 66.7% in rural areas (p=0.002). TT_{3+} coverage was 75.5%: 63.8% in urban areas versus 81.2% in rural areas (p=0.002), and 73.7% for illiterate mothers versus 85.3% for literate mothers (p=0.147).

Mothers who received TT_{3+} had significantly higher mean MIAS than mothers receiving fewer doses or none (6.3±1.7 versus 5.4±1.9, t= 3.76, p<0.001). Mean MIAS for illiterate mothers from rural areas vaccinated with TT_{3+} was 6.3±1.8 versus 5.5±1.9 for illiterate mothers from urban areas not vaccinated with TT_{3+} (t=1.9, p=0.053). There was no statistically significant difference in the TT_{3+} status of mothers of 0-23 months old children by their marital status, occupation or family size. On multiple logistic regression, residence and MIAS were found to be significant predictors of TT_{3+} vaccination status in mothers with children of 0-23 months old (Table 3).

Table 2: **TT immunization status of mothers by area of residence and literacy**

TT dose received	Residence				Literacy				Total	
	Urban		Rural		Illiterate		Literate			
	n=80	%	n=140	%	n=186	%	n=34	%	n=220	%
None	5	6.3	5	3.6	10	5.4	0	0	10	4.5
TT_{1+}	75	93.8	135	96.4	176	94.6	34	100	210	95.5
TT_{2+}	69	86.3	132	94.3	168	90.3	33	97.1	201	91.4
TT_{3+}	51	63.8	115	82.1	137	73.7	29	85.3	166	75.5
TT_{4+}	16	20.0	88	62.9	89	47.8	15	44.1	104	47.3
TT_5	13	16.3	51	36.4	53	28.5	11	32.4	64	29.1

TT_{1+}, TT_{2+}, TT_{3+}, TT_{4+} and, TT_5 stand for one or more, two or more, three or more, four or more and five doses of TT respectively.

Table 3: **Factors influencing TT_{3+} coverage**

Included in multiple logistic regression analysis	Univariate analysis			Multivariate analysis	
	Vaccinated / not vaccinated for TT_3	Odds Ratio (95%CI)	p-value	**Odds ratio** (95%CI)	p-value
Education					
Illiterate	137 / 49	1			
Literate	29 / 5	2.07 (0.76,5.66)	0.147	**NA***	
Residence					
Urban	51 / 29	1			
Rural	115 / 25	2.62 (1.39,4.90)	0.002	3.22 (1.64,6.32)	0.001
MIAS	-	1.38 (1.17,1.64)	<0.001	1.45 (1.21,1.72)	<0.001
Marital status					
All other	15 / 10	1			
Married	151 / 44	2.28 (0.96,5.45)	0.056	**NA**	
Family size	-	1.17 (0.97,1.42)	0.096	NA	
Reference child age group					
0–11 months	78 / 32	1			
12-23 months	88 / 22	1.64 (0.88,3.06)	0.117	NA	
Not included multiple logistic regression analysis					
Occupation					
All other	19 / 9	1			
Housewife	147 / 45	1.55 (0.65,3.66)	0.317	NA	

*NA=Not applicable

Criterion for entry into model p≤0.2 on univariate analysis, p≥0.4 for dropping from the model at each step and p<0.05 to remain in the final model.

Among the 220 reference of the surveyed mothers, 136 (61.8%) were protected at birth (PAB), 55 (25.0%) were not protected, but protection status was not possible to determine for 29 (13.2%). Considering children with indeterminate status as unprotected, more children of rural than urban mothers were PAB (71.4% versus 45.0%, p<0.001), and children of literate mothers had higher PAB coverage than children of illiterate mothers (79.4% versus 58.6%, p=0.022). The percentage of children PAB was 34.5% for urban illiterate mothers, 69.5% for rural illiterate mothers, 72.7% for unban literate mothers and 91.7% for rural literate mothers (Figure 1). Among children of TT_2 vaccinated mothers, 3/31 (9.7%) children of illiterate mothers versus 4/4 (100%) children of literate mothers were PAB respectively (p<0. 0.01). Compared to the rest, children of urban-illiterate mothers were at higher risk of not being protected at birth (65.5% vs 28.4%, Odds Ratio 4.79 (95% CI 2.53,9.08)). Among the factors analysed, multiple logistic regression demonstrated maternal education, residence, and MIAS to be significant predictors of PAB status (Table 4).

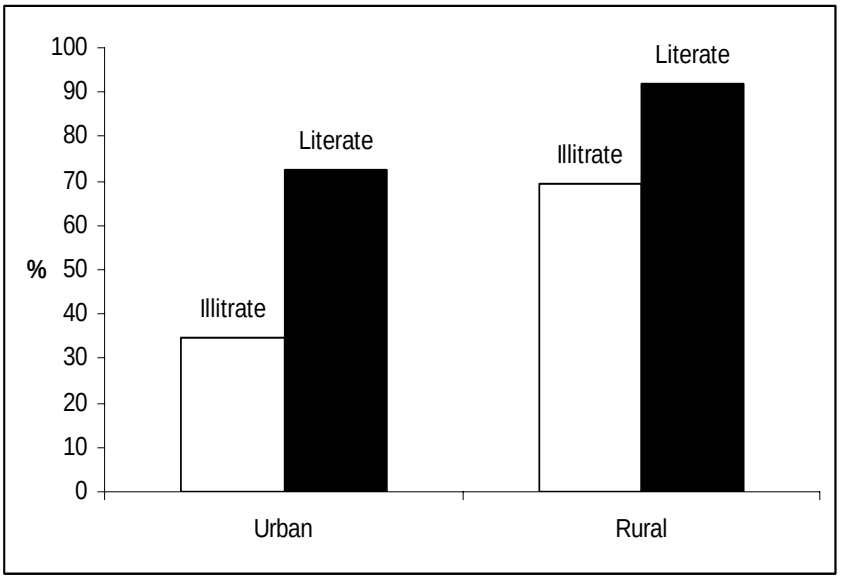

Figure 1: **Proportion of 0-23 month old children protected from tetanus at birth by maternal residence and education (n=220)**

Table 4: **Maternal factors influencing protection at birth (PAB) coverage of 0-23 months old children**

Included in multiple logistic regression analysis	PAB / Not PAB	Univariate analysis Odds Ratio (95%CI)	p-value	Multivariate analysis Odds Ratio (95%CI)	p-value
Education					
Illiterate	109/ 77	1		1	
Literate	27/ 7	2.73 (1.13,6.58)	0.026	3.73 (1.38,10.06)	0.009
Residence					
Urban	36/44	1		1	
Rural	100/ 40	3.06 (1.72,5.42)	<0.001	4.64 (2.42,8.92)	<0.001
MIAS	-	1.28 (1.09,1.49)	0.002	1.28 (1.08,1.51)	0.005
Marital status					
All other	11/14	1			
Married	125/ 70	2.27 (0.98,5.28)	0.056	*NA*	
Family size	-	1.11 (0.95,1.31)	0.187	NA	
Occupation					
All other	14 / 14	1			
Housewife	122/ 70	1.74 (0.79,3.87)	0.172	**NA**	
Not included multiple logistic regression analysis					
Reference child age group					
0–11 months	68/ 42	1			
12-23 months	68/42	1.00(0.58,1.72)	1.00	NA*	

*NA=Not applicable

Criterion for entry into model p≤0.2 on univariate analysis, p≥0.4 for dropping from the model at each step and p<0.05 to remain in the final model.

Discussion

In this study, we calculated TT coverage based on information obtained from the card plus history. A study in rural Bangladesh comparing the sensitivity, specificity, and predictive value of maternal recall for tetanus immunization revealed good recall for the second dose of TT, but a considerably reduced recall for more than two doses of TT (16). Serological surveys in the Central African Republic and Burundi have also shown higher levels of protection among pregnant women than expected from reported vaccination coverage (1,7) with sensitivity and specificity of reported vaccination status as predictor of seropositivity of 80.7% and 70.0% respectively (7). Therefore, we felt that the card plus history would give acceptable estimates of TT coverage in situations in which TT cards were not retained.

This study revealed that rural-literate mothers had the highest tetanus toxoid immunization coverage while urban-illiterate mothers had the lowest coverage. Consequently, children from urban-illiterate mothers were at high risk of being unprotected from neonatal tetanus. Though some studies have shown higher TT coverage in rural than urban areas (5,6), others, including the 2000 Demographic and Health Survey for Ethiopia, have shown the opposite (7,9). The possible explanation for the high rural coverage in this study might be attributed to the long tradition of community mobilisation experience in the rural areas (11). Higher immunization awareness could result from effective community mobilisation in rural areas. The presence of a strong community structure all the way down to the level of twenty households in rural areas in Tigray is essential for community mobilisation for promotive and preventive health services at the household level. Using this organizational structure, mothers in rural areas are called to outreach immunization sites on special days, which become big events in the villages and a time for all mothers to gather. In contrast, urban mothers most of the time get TT immunization in health institutions, which means they must go as individuals, and independently from community mobilised events. This difference could explain urban rural immunization coverage differences.

The proportion of literate mothers who received five doses of TT (TT_5) was also lower in urban than rural areas (13.6% vs 66.7%). Since information was not collected on mothers' ages and parity it is not possible to definitively explain the lower urban literate TT_5 coverage. It could be that urban literate mothers were younger and had lower parity and thus were not yet eligible for higher doses of TT. The higher TT_{2+} coverage in mothers with children aged 12-23 months than with children aged 0-11 months (96.4% versus 86.4%, p=0.008) could similarly be explained by a longer exposure time for mothers with 12-23 months old children to get vaccinated with more doses of TT.

The routinely reported 2000 TT_{2+} coverage for pregnant women for Tselemti was 26.7%, more than 3 times lower than the 96.4% TT_{2+} coverage for mothers of 12-23 months old children found in this study. TT_{2+} coverage for mothers of children this age corresponds to the TT_{2+} coverage for pregnant women for the year 2000. A possible reason for this large discrepancy is that the considerable proportion of the women who had completed TT_5 (27.3%) would not have been included in the numerator of standard "TT_{2+}" coverage calculations. In this study, "Protected-at-birth (PAB) method" was a better indicator for TT coverage than the "TT_{2+}" method. The new PAB method could be appropriate for countries with high coverage for first dose of diphtheria-pertussis-tetanus vaccine (DPT_1). When children receive DPT_1, the TT immunization history of the child's mother at the time of child's birth could be used to determine if the child was PAB. Children's PAB starts could be calculated using the number of children receiving DPT_1 as denominator (1). In our case, as the DPT_1 coverage in the study area was very high (97.3%), as reported from a community based immunization survey (15), PAB might have been a more appropriate method for TT coverage monitoring in the study area.

The fact that maternal education was a predictor for the child being PAB, but not for TT_{3+} vaccination suggests better timing of TT vaccination in literate mothers: literate mothers may have received protective doses before delivery, while illiterate mothers received protective doses after delivery of the reference child. This is supported by the higher PAB coverage in children of literate mothers vaccinated with TT_2. On the other hand the MIAS, which might reflect knowledge acquired after delivery of reference child as well, was a significant predictor of TT_{3+} vaccination in the study area.

Illiterate rural mothers had higher TT immunization coverage and knowledge than their urban counterparts. The difference could be due to a better and more timely dissemination of information to rural areas as discussed above. The high risk of not being PAB in urban illiterate mothers might be explained by the higher proportion of non-married mothers. Such women might face lack of social and family support and greater instability.

This study has several limitations. The interpretation of the TT status of women would have been more conclusive if data regarding age and parity of the mother, place of delivery of the child and antenatal care attendance were available.

Timely and frequent health education is important to raise the awareness of mothers on TT immunization and improve the low TT immunization coverage in urban areas as well as rural areas. Identifying mothers not complying with TT immunization, providing education

at the individual level and mobilisation of mothers by CHWs and local administrators are other important strategies that could be used to improve TT immunization and protect mothers and their newborns from tetanus. We recommend use of the PAB method for monitoring TT immunization coverage in DPT_1 high coverage areas like Tselemti district.

Acknowledgement

I would like to acknowledge the Western Zone Health Department for the financial and logistical support it provided for the study. I am also highly indebted to Dr. Karen Witten for reviewing the draft paper and forwarding her useful comments. I thank Dr. Peter Byass, Dr. Shabbir Ismail and Dr. Mengiste Mesfin for their useful comments. I also acknowledge the community health workers who participated in the survey by guiding interviewers and thank the mothers who participated in the study for their co-operation.

References

1. World Health Organisation. Maternal and Neonatal Tetanus Elimination African Region. WHO/ UNICEF Five-year Regional Plan of Action 2001-2005. January 2001.
2. Berhane Y, Masresha F, Zerfu M, Kebede S, Shashikant S. Status of expanded program on immunization in a rural town, south Ethiopia. Ethiop Med J. 1995;33(2):83-93.
3. Tekie M, Kidane T. Immunization coverage survey in western Tigray zone, Ethiopia, 2000. Ethiopian Public Health Association XIIth Annual Public Health Conference. 7-9 November 2001, Addis Ababa. Ethiopia. Ethiopian Public Health Association.
4. World Health Organisation. Immunization Policy. Geneva. WHO/GPV/GEN/95.03, REV.1, 1996.
5. South African Ministry of Health. South Africa Demographic and Health Survey 1998. Full Report, Chapter 7; Maternal and child health care. Pretoria, South Africa.
6. Maral I, Baykan Z, Aksakal FN, Kayikcioglu F, Bumin MA. Tetanus immunization in pregnant women: Evaluation of maternal tetanus vaccination status and factors affecting rate of vaccination coverage. Public Health. 2001;115(5):359-364.
7. Deming MS, Roungou JB, Kristiansen M, et al. Tetanus toxoid coverage as indicator of serological protection against neonatal tetanus. Bulletin of the World Health Organisation. 2002;80(9):696-703.
8. World Health Organisation. Immunological Basis for immunization. Geneva. WHO/EPI/GEN/93.15, 1993.
9. Central Statistical Authority. ORC Macro. Ethiopia Demographic and Health Survey 2000. Addis Ababa, Ethiopia and Calverton, Maryland. May 2001.
10. Tigray Development Association. 1989-1999. TDA's 10th Anniversary magazine. Mekelle, Tigray.
11. Hammond J. Fire from the ashes. A chronicle of the revolution from 1975–1991 in Tigray, Ethiopia. First printing. The Red Sea Press, Inc. Trenton, New Jersey. 1999.
12. Ghebreyesus TA, Witten KH, Getachew A, Yohannes AM, Tesfay W, Minass M, Bosman A, Teklehaimanot A. The community based malaria control programme in Tigray, northern Ethiopia. A review of programme setup, activities, and impact. Parrasitologia. 2000;44:255-290.
13. Tigray Health Bureau. Tigray Region Health Sector Development Plan 1995-1997 EC. June 2002. Mekelle, Ethiopia.
14. Western Zone Health Department Annual Report to the Tigray Regional Health Bureau. July, 2000.
15. Kidane T, Tekie M. Factors influencing child immunization coverage in a rural district of Ethiopia, 2000. Ethiopian Journal of Health Development. 2003;17(2):105-110.
16. Francisco A, Chakrabortry J. Maternal recall of tetanus toxoid vaccination. Ann Trop Paediatr. 1996; 16(1):49-54.