Full immunization coverage and its determinants among children aged 12-23 months in Wogera district, Northwest Ethiopia

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Abstract

Background: Immunization is considered one of the most affordable health initiatives for children. Though there is good progress in Ethiopia, the amount of fully vaccinated children, is still below the target. Possible challenges include women having home visits and men's' involvement in vaccination uptake. Therefore, this study aimed to determine full immunization coverage and its determinants among children aged 12- 23 months in Wogera districts, Northwest Ethiopia.

Aim: This study aimed to determine the full immunization coverage and its determinants among children aged 12-23 months, and to assess the level of immunization coverage and its determinants in Wogera districts, Northwest Ethiopia.

Methods: A community-based cross-sectional study was conducted in Wogera district from May 28-June 25/2020. Cluster sampling method was used to recruit 598 study participants. Interviewer administered questionnaire was used to collect data. A bivariable and multivariable logistic regression analysis was done to identify factors associated with full immunization. Odds ratios with 95% Confidence intervals were used to determine significant variables.

Results: A total of 584 mothers who had children aged 12-23 months participated in this study. The full immunization coverage was 76.5% (95%CI 73.2-79.8). Mother age >40 years (AOR=7.37, 95% CI: 1.65, 32); mothers who initiate vaccine uptake(woman empowerment) (AOR=1.57, 95% CI: 1.13-2.39); mothers who had 1-3 ANC visit (AOR=2.51, 95% CI:1.14, 5.52), and 4+ ANC follow up (AOR=2.73,95% CI: 1.26, 5.91); r health extension worker's home visit during the first weeks of postpartum period (AOR=1.76,95% CI:1.10, 2.84), and males involved in child immunization (AOR=3.27, 95% CI:1.84, 5.81) was positively associated with being fully vaccinated , however, birth order of 6 and above (AOR=0.35, 95% CI: 0.14, 0.86) was negatively associated with being fully vaccinated.

Conclusion: In this study, the full immunization coverage is found to be suboptimal, and it is far from the expected national target coverage. Maternal health care uptake; women empowerment; home visits by HEW during the first week of the postpartum period and male involvement in child immunization were found to be predictors of being fully vaccinated. [*Ethiop. J. Health Dev.* 2021; 35(SI-3):16-27]

Keywords: Full immunization, Children12-23 months, Northwest Ethiopia, Male involvement

Background

Immunization is one of the affordable public health initiatives of infant's survival strategies which prevent child morbidity and mortality from vaccine-preventable diseases. Annually vaccines avert more than 2.5 million child deaths and for the investment of one USD in immunization, there is 16 USD economical gain over the life span of an immunized child (1).Furthermore, achieving full immunization should be the top priority for every country, however, studies have found that global immunization coverage is low (2). Based on the World Health Organization global immunization profile 2019 report, the worldwide vaccination coverage of BCG, DPT3, PCV3, rotavirus second dose and measles were 88%, 85%, 48%, 39% and 85% respectively(3). In low and middle-income countries only 56%-69% of children had received their full vaccinations(4, 5).Worldwide, in 29% of children between the ages of 1-59 months, child deaths can be prevented through vaccination (6). However, elimination of vaccine-preventable childhood disease through adequate vaccination requires locally tailored and evidence-based strategies that are based on efficient use of the limited resources (7).

In Ethiopia, six vaccines which contain ten antigens have been given for children to prevent vaccine-preventable diseases. World Health Organizations and other partners have continued to support Ethiopia to scale up, expanding on the immunization program. In 2018, Ethiopia introduced two additional antigen vaccines in routine immunization programs, namely the (Human papillomavirus(HPV) and measles-containing vaccine 2 (MCV2)(8). The immunization service has been administered through the health facilities and outreach/campaigns Nationally according to Ethiopian public health institution survey report, 94% of the public health facilities provide immunization services (9).

Ethiopian government with the support from other non-governmental organizations have made a tremendous effort to improve child immunization coverage.

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However, the country has not been able to achieve the national target of 90% by 2020. There is also high variation of complete vaccination coverage in administrative regions of Ethiopia which ranged from 21% in Afar to 73% in Amhara region; these discrepancies remain between the population of agrarian and the pastoralist population (10, 11). In 2015, more than 17000 measles cases have been reported nationally(12).

Although determinants of fully immunized children vary from context to context, however, determinants which are considered to be significant of fully immunized children identified by different researchers are maternal antenatal care service utilization(13-19), place of delivery(13, 16, 19), postnatal care utilization(20), sex of the child(14, 17, 21), women empowerment(21), distance to immunization site(15, 17), wealth status(13, 15, 21, 22), maternal age and residency(17, 21, 23), maternal educational status(13, 16, 17, 21, 22, 24, 25), and also place of vaccination site (18). Findings from qualitative studies also documented other factors, which include, misinformation of the mother (such as immunization should be taken when the child is being sick), and the belief that a single-dose vaccine is considered being fully vaccinated. Evidence documented from five low-income countries, supplementary immunization activity, such as home to home immunization campaigns negatively affect the routine vaccination rate (26, 27). Mechanisms to increase full immunization coverage, include, increasing the number of children registered for vaccination, and reducing the dropout rate by implementing different evidence-based strategies. The possible intervention strategies to increase immunization uptake include demand creation, modification of the delivery approaches, and strengthening the health system at different levels (28).Gender is a cross-cutting issue hence handling the role of gender in immunization is not restricted to determine the coverage of immunization status by boys and girls(29). Further, women empowerment and male contribution on child immunization need to be assessed as a determinant of being fully vaccinated.

However, the role of male involvement and health extension worker supervision of postpartum women is not investigated by many scholars. There is also the variability of the immunization coverage between government administrative reports and studies. Therefore, this study aimed to determine full immunization coverage and its determinants including male involvement and HEW home visits during the postpartum period among mothers of children aged 12-23 months in Wogera district, Northwest Ethiopia. The findings of this study will help the expanded program on immunization (EPI) programmer to consider additional new specific strategies and approaches that consider male involvement and strengthening home visits by health extension worker during postpartum period.

Methodology

Study Design, Period and Setting

A community based cross sectional study design was conducted in Wogera district, Northwest Ethiopia from May 28-June 25/2020. The study was conducted in Wogera district which is 41 KM away from Gondar city. According to the district report, Wogera has a total population of 243,594 and 55,761 expected number of households in the district. The expected number of reproductive women, pregnant women, under one year, under two years, and under-five children was 57439, 8209, 7576, 12301, and 32982 respectively. In the district, there were 47 public health institutions of which one was a primary hospital, eight health centers, and 38 health posts. All the health posts have regularly provided vaccination service both in static and outreach programs while health centers and hospitals provided the services at the health facilities.

Sample Size Determination

The sample size for the study has been estimated using a single population proportion formula assuming P=58.4% from a study conducted at rural districts of Southern Ethiopia(30), 5% margin of error, and 95% confidence level.

$$n=\frac{Z\alpha/2^2*p(1-p)}{d^2}=\frac{1.96^2*0.58*0.42}{0.05^2}=374$$

After considering the design effect of 1.5 for cluster sampling and 10% non-response rate, hence, the final sample size for this study was 598.

Study Population

All women who had children aged 12-23 months in Wogera district, northwest Ethiopia during the data collection period.

Inclusion and Exclusion Criteria

All women who had children aged 12-23 months during the data collection period were eligible for this study. Women who had not resided in the area, for at least for six months before her child completed 12 months of age, in the study area were excluded from this study.

Sampling Technique

Initially, Kebeles were stratified in to urban and rural. Seven Kebeles (one urban and six rural Kebeles) were randomly selected using the lottery method. Since there was no major difference in population size in the selected Kebeles, equal allocation of the sample was employed to each kebele. Then the data collectors had gone house to house consecutively to get eligible participants until the allocated sample size was obtained.

Data Collection Techniques

By reviewing the literature, a structured questionnaire was prepared. The tools were developed by the research team in English and were translated to the local language (Amharic) and back to English. Before the actual data collection, training was given to data collectors and the tool which was particularly used for the quantitative data was pre-tested to see its clarity, order, and to assure its cultural appropriateness.

Seven data collectors who had a bachelor's degree and above in health were involved in the data collection. After obtaining consent from eligible mothers/caregivers, the data was collected using an

interviewer-administered questionnaire. The socio-demographic, reproductive, health facility-related characteristics and other potential independent variables were collected through face-to-face interviews. The immunization status of the child was verified by observation of child vaccination cards, and if the card was not available, through the mothers recall of the child's immunization status.

Operational definitions

Full immunization: A child who received the following vaccinations was fully immunized; 1 dose of Bacillus Calmette-Guerin (BCG), three doses of Oral Polio Vaccine (OPV), 3 doses of Pentavalent (diphtheria, pertussis, tetanus, Hemophilus influenza type b and Hepatitis B), 3 doses of Pneumococcal Vaccine (PCV), 2 doses of Rota and 1 dose of Measles. A child is expected to take 13 doses by age of two years(13, 18).

Male involvement in immunization: Males who did at least one of the following: order the mother to take the child for immunization or the male provided money for transportation for the child to access immunization services or accompanied the mother when the child accessed the immunization service. Male partner or the father of the child who did at least one of the above three mentioned activities was coded as 1 and those male partners who did not perform at least one of the three activities was coded as 0.

Women empowerment: as an independent variable was measured in terms of a women's ability to make major decisions in the household (purchase or sell), the women's ability to make decisions to visit her family/relative, the women's decision making to get health care on her own (when there is illness), her ability to make decisions for the child's care when the child is sick, decision making power for child immunization, decision making power for antenatal care, and decision-making power for service delivery.

Women who had responded yes for each empowerment questions were coded as 1 and women who responded no was coded as 0. Finally, the total score was computed, and the mean score was calculated. When women scored above the mean value (4.6) of the empowerment questionnaires, they were considered as empowered women and coded as 1 and when they scored less than 4, they were coded as 0.

Data Quality Assurance

Data collectors were given training for three days during which they did a pre-test to see the clarity of each question, the order/flow of questions and skip patterns, and to see respondents' reaction (to see culturally sensitive issues) to each question. Few amendments on questions were done. The overall data collection procedure was supervised by the investigators.

Data Management and Analysis

The data was entered into a computer using EPI info version 7 and then transferred to SPSS version 20 for future data cleaning, coding, and analyses. The data was cleaned, and each categorical variable was coded. The outcome variable, full immunization status, was coded 0 if the child not vaccinated with any of the intended vaccines and 1 if the child had taken all the intended vaccines. The descriptive analysis was done and reported using number, frequency, and percentage. Median and inter-quartile range measures of the summary was used. A binary logistic regression model specifically bivariable and multivariable logistic regression was fitted. All the variables with p-value<0.2 from bivariable logistic regression model were entered into a multivariable logistic regression to control potential confounders. Backward Stepwise logistic regression analysis was done and the goodness of fit test of the final model was checked using Hosmer-Lemeshow goodness-of–fit test, finally the results were found to be 0.74. Adjusted odds ratios with 95% confidence interval were used to determine the presence and the strength of association between full immunization status and independent variables. Multi-collinearity between the independent variables was checked using variance inflation factors. Finally, the results of the study were reported using text, tables, and graphs.

Ethical consideration

The ethical approval was obtained from University of Gondar Institutional Review Board (IRB). Study participants were given adequate information about the study including the purpose of the study, benefits, risks, the nature of confidentiality of the study, and their right not to participate or withdraw at any time from the study. Since it is a cross-sectional study, participating in this study will not have major risks. So, informed verbal consent was obtained from each eligible woman before data collection. Privacy during data collection time and confidentiality of the data was strictly maintained. The data were collected anonymously and there were no individual identifiers included.

Results

Socio-demographic characteristic of mothers and children

A total of 584 mothers of children aged 12-23 months were interviewed giving the response rate of 97.6%. The median age of the mothers of the children was 30 years (inter-quartile range (IQR) 25 - 35 years). Slightly more than fifty percent 309 (52.9%) of the mothers were in the age category of 21-30 years. One-fifth of the mothers were urban dwellers. Regarding the educational and occupational status of mothers, 56.9% and 87.8% had no formal education and were housewife respectively. Regarding the husband(partners), 55.3% had no formal education and 81.3% were farmers by occupation. Regarding the sex of the children, 51.7 % were male. Considering the family size 58.6% of the mother had five and less family member, and 33.4% was from a poor category based on the wealth status (Table 1).

Table1: **Socio-demographic characteristics of mother and children aged 12- 23 months in Wogera district, Northwest Ethiopia 2020**

Variables	Category	Frequency (n=584)	Percentage
Age of the mother	≤20	38	6.5
	21-30	309	52.9
	31-40	207	35.5
	≥41	30	5.1
Residency	Urban	115	19.7
	Rural	469	80.3
Religion	Orthodox Christian	552	94.5
	Muslim	32	5.5
Educational status of mother	Have no formal education	329	56.4
	Elementary school (1-8)	173	29.6
	Secondary and preparatory school (9-12)	48	8.2
	College/university	34	5.8
Mother occupation	Housewife	513	87.8
	Employed	27	4.6
	Merchant	19	3.3
	Others (student, daily labor)	25	4.4
Husband educational status	No formal education	323	55.3
	Elementary school(1-8)	176	30.1
	Secondary school (9-12)	54	9.2
	College/university	31	5.3
Husband occupational status	Farmer	476	81.5
	Merchant	30	5.1
	Employed	41	7.0
	Others(student, daily labor)	37	6.3
Sex of index child	Male	302	51.7
	Female	284	48.3
Family size	≤ 5	341	58.4
	>5	243	41.6
Wealth status	Poor	195	33.4
	Medium	194	33.2
	Rich	195	33.4

Reproductive characteristics and maternal health service utilization of the mother

The median age of the women, at first marriage was 16 years (IQR 15-18years). More than one third 235(40.2%) of mothers at the time of their first marriage, their age was 15 years or younger. Nearly all (95.2%) of mothers first marriage was arranged by the family members. Approximately one fifth (19%) of the mothers were from para one and index child first birth order. About the index pregnancy, 499(85.5%) were wanted. Regarding maternal health service utilization, 58.9% had four and above antenatal care, 60.3% delivered at health facilities including health posts, and nearly two-thirds (64.9%) had at least one postnatal care visit. Only 31.8% of mothers were visited by health extension workers at home during the first week of the postpartum period (Table 2).

Table 2: **Reproductive characteristics and maternal health service utilization of mother in Wogera district, Northwest Ethiopia 2020**

Variables	Category	Frequency(n=584)	Percentage
Age at first marriage	≤ 15 years	235	40.2
	16-20 years	304	52.1
	>20 years	45	7.7
First marriage arrangement	Family	556	95.2
	Self(between two couple)	28	4.8
Age at first birth	≤ 15 years	14	2.4
	16-20 years	385	65.9
	>20 years	185	31.7
Parity	Para 1	111	19
	Para 2-4	312	53.4
	Para ≥5	161	27.6
Index childbirth order	1st	111	19
	2nd-3rd	225	38.5
	4th-5th	161	27.6
	>5th	87	14.9
Number of current alive children	1	111	19
	2-4	327	56
	≥5	146	25
Was the index child pregnancy wanted?		499	85.5
		65	11.1
	Do not want at all	20	3.4
ANC follow up	No ANC	36	6.2
	First visit	11	1.9
	Second visit	33	5.7
	Third visit	160	27.4
	Fourth visit and above	344	58.9
Taken TT vaccine during the index pregnancy	Yes	501	85.8
	No	83	14.2
Place of delivery	Home	232	39.7
	Health facility	352	60.3
PNC follow up	Yes	379	64.9
	No	205	35.1
	At six hours	269	46.1
Timing of PNC follow up	Third day	54	9.2
	Seven day	77	13.2
	Six weeks	138	23.6
Home visit during the first week of the postpartum period by HEW	Yes	186	31.8
	No	398	62.2

Health facility characteristics, women empowerment, and male involvement in immunization

The median time to reach the nearest health facility by walk was 24 minutes (IQR 10-40 minute) and 70.4% responded the taken-on foot to the nearest health facility was 30 minutes or less. Two-third (68.3%) of the nearest available health facilities was a health post, and one third (34.4%) of the children were immunized at the outreach site. Considering the time taken to the immunization site by foot, 515 (88.2%) of mothers reached within 30 minutes. Of the mothers, 357(61.1%) were empowered women (Table 3).

Table 3: **Health facility-related characteristics, women empowerment, and male involvement in child immunization in Wogera district, Northwest Ethiopia 2020**

Variables	Category	Frequency(n=584)	Percentage
Types of health facility available near to home	Health post	399	68.3
	Health center/Hospital	185	32.7
Distance to the nearest Health facility by foot walk	≤ 30 minutes	441	70.4
	31-60 minutes	127	21.7
	>60 minutes	46	7.9
Where child get regular immunization	Outreach site	201	34.4
	Health post	240	41.1
	Health center	130	22.3
	Hospital	13	2.2
Distance to the nearest Immunization site	≤ 30 minutes	515	88.2
	31-60 minutes	65	11.1
	>60 minutes	4	0.7
Women empowerment	Yes	357	61.1
	No	227	28.9
	No contribution totally	66	11.3
Husband/child father contribution for child immunization	Order the mother to take the child for immunization	463	79.3
	Gave money to women for transportation in order child get immunization service	6	1
	Accompany the women when the child getting the immunization service	49	8.4
Male involvement in immunization	Yes	518	11.3
	No	66	88.7

Child full immunization coverage in Wogera district, northwest Ethiopia

The full immunization coverage of children vaccinated was 447, 76.5% (95%CI 73.2-79.8). However, the full immunization coverage documented by card only was 206, 35.3% (95%CI 31-39) (figure 1). Of the total children, 6(1%) of them have not taken any vaccine at all and 124(22.4%) had taken some vaccine doses. Vaccine coverage by dose of each vaccine taken is reported in Figure 2. Nearly 80% 466(79.8%) of children had taken vitamin A supplementation. However, by card documentation only 137(23.5%) had taken vitamin A supplementation.

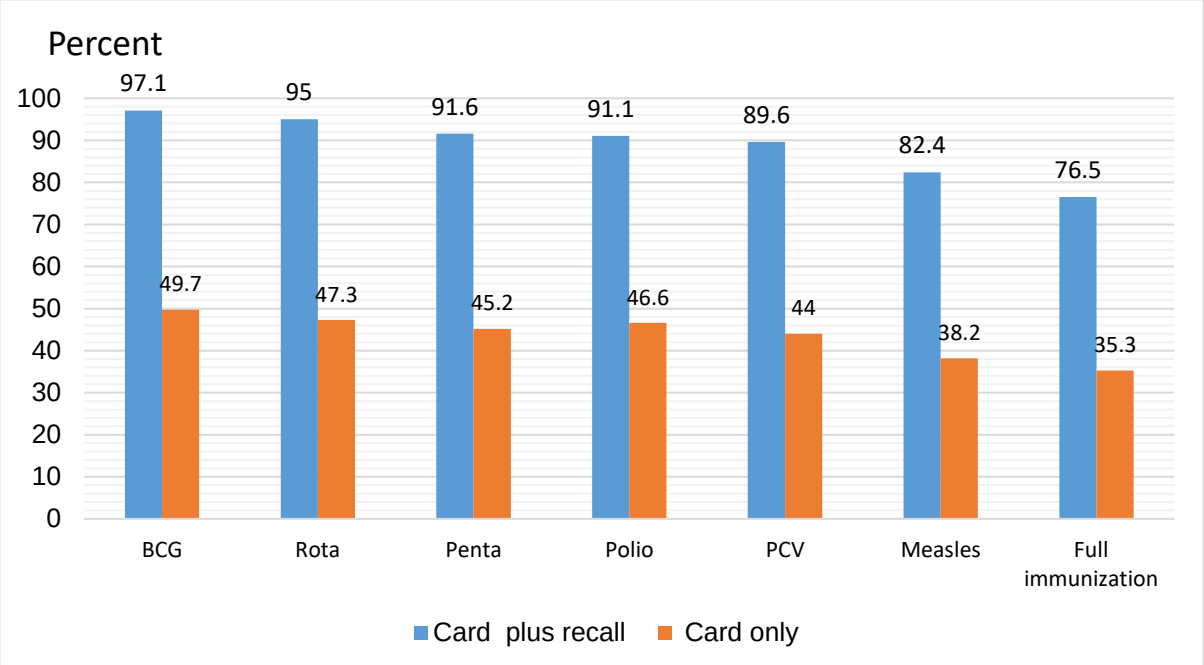

Fig 1: **Child vaccination status by specific vaccine and full vaccination based on the card plus mother recall and card only among 12-23 months children in Wogera district, Northwest Ethiopia 2020**

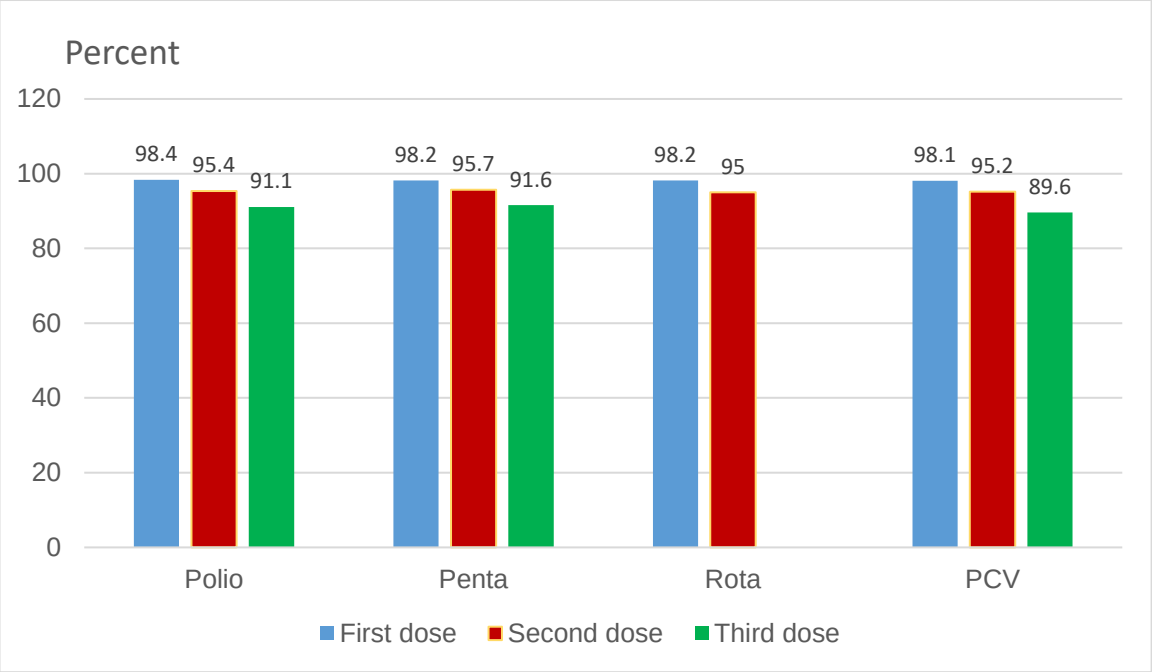

Fig 2: **Children aged 12-23 months vaccination status by a dose of the specific vaccine have in Wogera District, Northwest Ethiopia,2020**

Determinants of fully immunized children

From the bivariate logistic regression analysis mothers age, mothers' occupation, husbands' occupation, wealth status, age at first birth, ANC utilization, place of delivery, PNC utilization, types of index pregnancy, birth order, HEW home visit during the first week of the postpartum period, and male involvement in child immunization were significant at p value<0.2.

In the multivariable logistic regression analysis, mothers age, women empowerment, ANC utilization, birth order, health extension worker home visit during the first week of the postpartum period, and male involvement in child immunization variable remained statistically associated with children being fully immunized at a p-value of 0.05.

Mothers age >40 years was 7.37 times (AOR=7.37,95% CI:1.65-32) more likely to have their children fully immunized compared with mother age <20 years. An empowered mother was 1.57 times (AOR=1.57, 95%CI: 1.13-2.39) more likely to have their child fully immunized than an unempowered women. Mothers who had 1-3 visit ANC follow up were 2.51times likely (AOR =2.51, 95%CI: 1.14, 5.52), and four and above ANC follow up were 2.73 times (AOR=2.73,95%CI;1.26-5.91) more likely to have their child fully immunized than whose mother had no ANC follow up. Childbirth order six and above reduced full immunization by 65% (AOR=0.35, 95%CI: 0.14, 0.86) compared with first birth order. Child of mother visited by health extension worker at home during the first weeks of postpartum period was 1.76 times (AOR=1.76, 95%CI:1.10, 2.84) more likely to be fully immunized compared with those children whose mother was never visited by health extension workers during the first week of the postpartum period. Male involved in child immunization was 3.27 times (AOR=3.27, 95%CI: 1.84, 5.81) more likely to have their child fully immunized compared with a child whose father was never involved in the immunization (Table 4).

Table 4: **Bivariate and multivariable logistic regression analysis on factors associated with child full immunization in Wogera districts, Northwest Ethiopia.**

Variables	Full immunization			
	Yes	No	COR, 95% CI	AOR,95% CI
Age				
≤20	25(65.9)	13(34.2)	1	1
21-30	236(76.4)	73(23.6)	1.68(0.81-3.45)	1.67(0.70-3.90)
31-40	160(77.3)	47(22.7)	1.77(0.84-3.72)	2.45(0.91-6.60)
≥41	26(86.7)	4(13.3)	3.38(0.97-11.77)	7.37(1.65-32)*
Mother occupation				
Housewife	397(77.4)	166(22.6)	1	
Employed	22(81.5)	5(18.5)	1.28(0.47-3.47)	
Merchant	12(63.2)	7(36.8)	0.50(0.19-1.30)	
Others (student, daily labor)	16(64)	9(36)	0.51(0.22-1.20)	
Husband occupation				
Farmer	367(77.1)	109(22.9)	1	
Merchant	24(80)	6(20)	1.18(0.47-2.98)	
Employed	32(78)	9(22)	1.05(0.48-2.28)	
Others (student, daily labor)	241(64.9)	13(35.1)	0.54(0.27-1.11)	
Wealth status				
Poor	139(71.3)	56(28.7)	1	
Medium	155(79.9)	39(20.1)	1.60(1.00-2.55)	
Rich	153(78.5)	42(21.5)	1.46(0.92-2.32)	
Women empowerment				
No	166(70.9)	66(39.1)	1	1
Yes	286(80.1)	71(19.9)	1.65(1.12-2.41)	1.57(1.13-2.39)*
Age at first birth				
≤ 15 years	8(57.1)	6(32.9)	1	
16-20 years	297(77.1)	88(32.9)	2.53(0.85-7.49)	
>20 years	142(76.8)	43(23.2	2.47(0.81-7.53)	
Types of the index pregnancy				
Wanted	386(77.4)	113(22.6)	2.27(0.90-5.70)	
Wanted later	49(75.4)	16(24.5)	2.04(0.70-5.88)	
Do not want at all	12(60)	8(40)	1	
ANC during the index pregnancy				
No ANC follow up	19(52.8)	17(47.2)	1	1
1-3 visit ANC follow up	156(76.5)	48(23.5)	2.90(1.40-6.03)	2.51(1.14-5.52
Four and above ANC follow up	272(79.1)	72(20.9)	3.30(1.67-6.83)	2.73(1.26-5.91*
Birth order				
1st	86(76.1)	27(23.9)	1	1
2nd-3rd	166(74.4)	57(25.6)	0.91(0.54-1.54)	0.66(0.35-1.25)
4-5th	135(83.9)	26(26.1)	1.63(0.89-2.97)	1.07(0.49-2.29)
6+	60(69)	27(31)	0.69(0.37-1.30)	0.35(0.14-0.86)*
Place of delivery				
Home	165(71.1)	67(28.9)	1	
Health facility	282(80.1)	70(19.9)	1.63(1.11-2.40)	
TT for the mother				
No	55(66.3)	28(33.7)	1	
Yes	392(78.2)	109(21.8)	1.83(1.10-3.02)	
PNC follow up				
No	141(68.8)	64(3.2)	1	
Yes	306(80.7)	73(19.3)	1.90(1.28-2.81)	
Home visit by HEW during first weeks of postpartum period				
No	290(72.9)	108(27.1)	1(Ref)	1(Ref)
Yes	157(84.4)	29(15.6)	2.01(1.28-3.17)	1.76(1.10-2.84)*
Male involvement				
No	35(53)	31(47)	1(Ref)	1(Ref)
Yes	412(76.5)	106(23.5)	3.44(2.03-5.84)	3.27(1.84-5.81)*

ANC- Antenatal care, HEW- health extension worker, PNC- Post Natal Care, TT- Tetanus Toxoid, *Significant at P-value <0.05

Discussion

In this study full immunization coverage is found to be 76.5%. Still, this is a significant lag in the target of the national EPI coverage to have a reach of 90% in 2016-2020(31). In this present study, we have observed the difference in vaccination coverage between specific vaccine type and full vaccination. The immunization coverage of children aged 12-23 months by vaccine type; BCG, polio, Pentavalant3, PCV3, Rota 2 and measles vaccine was 97.1%, 89.6%, 91.1%, 82.4% respectively.

Our findings of children being fully vaccinated/immunized is in line with study findings in Sekota zuria district Wag Himra zone, Amhara regional state Ethiopia 77.4%, Southeast Ethiopia 76.8%, and findings from studies in Ethiopia 74%, Atakumosa districts in Nigeria 74.4% Senegal 70.9% (15, 32-34). However, the current finding is lower than findings of full immunization coverage in Techiman Municipality, Ghana 89.5% (35). The possible difference in the previous study, might be due to the rotavirus vaccine and pneumococcal conjugate vaccines, which were not considered, which might lower the full immunization coverage to some extent. This implies that, adding one vaccine, from the full immunization coverage measurement in this study could lower the coverage. In Ghana inequalities in childhood immunization coverage has been reduced over time (36) and the other possible discrepancy might be explained by factors like performance difference between two countries in the EPI program.

The result of full immunization coverage in this study is higher than findings in Wonago district Southern Ethiopia 52%, systematic and meta-analysis study finding in Ethiopia 60%, Gondar city administration 64.3%, and Atakumosa districts in Nigeria 58% (10, 14, 16, 33). The plausible reason for the difference might be in some studies the vaccination status was verified through the use of the vaccination card and for those children without a vaccination card, health facility record was used to verify their vaccination status, also in few studies the vaccination card was considered the only form of verification for full vaccination status(33). The study period difference could also be a possible reason for the discrepancy because the EPI program is the top priority initiative for child health survival strategies that the government has been working on and putting in tremendous efforts.

There is also a significant discrepancy of full immunization coverage (76.5% versus 35.3%) by card and maternal recall and card only methods respectively. Such types of discrepancy between the two methods are also observed from other previous studies in Senegal and Nigeria (16, 33).This has an implication for the gap in women keeping the child vaccination card properly. Possibility of recall and social desirability bias may under or overestimate the full immunizations status of the child when we use card plus mother/caregiver recall of child immunization status.

In the multivariable logistic regression analysis, it was found that child immunization status improved with increasing maternal age. The odds of full immunization of children from mother age >40 years were 7.37times higher compared with mother age <20 years. This finding is supported by evidence from different settings, where the mother whose age was 40 years and above was more likely to have their child fully immunized compared with a younger mother (age less than 20 years), increasing maternal age improved child full immunization(14, 25, 35). Children from maternal age above 35 years were also more likely to vaccinate for the BCG vaccine(38). This could be due to older women might be more aware of the benefits involved with immunizations and the dangers of not taking children to be immunized. However, our finding is contradicting with a study by Zeleke Et al. in Ethiopia. Mother/caregiver age of 35 years, was negatively associated with child complete immunization (17) and child measles-containing vaccine (39), however this can be attributed to contextual factors.

In this study empowered women were 1.57 times more likely to have their child full vaccinated as compared to unempowered women. This finding is supported by a systematic review study in India and Ethiopia(21, 40). This might be due to women empowerment as a cross-cutting issue for all maternal and child health service uptake. Study findings, in Senegal, women with a decision-making ability were associated with improved child full immunization (19).

A child born from a mother who had ANC during the index pregnancy, was more likely to adopt full immunization than a child born from women had no ANC follow up during the index childbirth pregnancy (13-19, 34, 37). In our finding children born from women who had 1-3 ANC visits were 2.5 times more likely and those who had four and above ANC visits were 2.7 times more likely to fully immunize their children than their counterparts. This might be because those women knew more about the health care system and the benefits of child vaccination. If women know the health care system, they are more likely to know the vaccination schedule and those women know the schedule in the catchment area, are more likely to fully vaccinate their children (18).

The odds of full immunization for birth order six and above was reduced by 65% compared to the child first birth order. There are study findings in agreement with these results(41, 42) and evidence also documented that birth order had no association with child full immunization (43). The possible reason for high birth order children less likely to obtain full immunization might be due to less attention being given for higher birth order children by parents.

Children of mothers who were visited by health extension workers at home during the first weeks of postpartum period, were 1.76 times more likely to have full immunization compared with those children whose mothers were never visited by health extension workers

during the first week of the postpartum period. A Mother being visited at home by a health extension worker during the first weeks of a postpartum period is more likely to have their child fully immunized (15). Lack of health work home visit was also cited as factors for defaulting from child immunization (20, 44). This requires health extension workers and other trusted individuals to keep mothers/caregivers informed about when, where, and how many times they need to bring children for immunization(6). This might be true that during the home visit the health extension worker provides information about child immunization including the schedule. Even those who require the vaccine may opt to be vaccinated following a visit from the health extension worker during the home visit.

In this study, male involvement was found to be a predictor of child full immunization status. The odds of full immunization of children who had a male involved in child immunization was 3.27 times higher compared with a child whose father was never involved in child immunization. The role of male involvement and approval as predictors of child full immunization has been stated in a study from Nigeria(45). Our results are supported by a qualitative study in Hadya zone, Ethiopia in which a lack of male support in child immunization contributed in children defaulting from immunization(44). Research has found, that the presence of a male partner with a positive outlook in terms of health belief and their attitude towards vaccination contributed towards immunization coverage(46). The role of childcare including visiting the immunization sites has been undertaken by the women in most situations. If the child develops any side effects related to immunization; the husband would reprimand the women for having vaccinated the child. However, if the husband is involved in child immunization, he would be more understanding and accepting of the side effects and the importance of vaccination. We are living in a country, where men influence the general activities and wellbeing of their families and loved ones. In most cases women require male approval to seek child immunization, hence, if men adopted active roles in health seeking behaviors, especially with regards to vaccine uptake, children stand a stronger chance of being fully immunized against many vaccines' preventable diseases, thus decreasing the burden of disease on health institutions.

Limitation of the study

The study has admitted some limitations: firstly, we did not address health system-related factors, secondly, full immunization status verified by child immunization card, if the card is not available, the mother/caregiver would recall if the child had been vaccinated, this may lead to recall and social desirability bias.

Conclusions

In this study, the child full immunization coverage is found to be suboptimal, and it is far from the expected national target coverage of 90%. Maternal late reproductive age, women empowerment, ANC follow up, birth order, a home visit by HEW during the first week of the postpartum period and male involvement in child immunization were found to be predictors of child full immunization.

Ensuring male involvement, particularly with regards to accompanying women for child immunization, providing money to the women for transportation, discussing with women or ordering women to take the child for immunization could be one strategy to increase child full immunization coverage; hence male involvement needs to be prioritized in order to improve child full immunization coverage. Attention needs to be given for children of high birth order and women who have no antenatal care follow up. Improving maternal health services would be strategies to scale up child full immunization. Health extension worker home to the home visits within the first week of postpartum period regardless of the place of delivery is a key strategy to improve child full immunization coverage.

Abbreviations

ANC: Antenatal Care; **BCG:** Bacillus of Calmette–Guerin; **DTP:** Diphtheria, Tetanus, Pertussis; **EPI:** Expanded Program on Immunization; **HEW:** Health Extension Worker; **PCV:** Pneumococcal Conjugate Vaccine; **PNC:** Post Natal Care

Declarations

Ethical approval and consent to participate

This was approved by the Institutional Review Board of the University of Gondar and received ethical clearance. Besides, study permission was obtained at each level of the health system. Finally, written informed consent was obtained from each study participant.

Availability of data and materials

Data will be available upon reasonable request from the corresponding author

Conflict of interest

All authors declared that they have no conflict of interest.

Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current Journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

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