Child vaccination coverage and dropout rates in pastoral and semi-pastoral regions in Ethiopia: CORE Group Polio Project implementation areas

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Abstract

Background: Vaccination programs are one of the priority health interventions, and all children in every country should be vaccinated. The World Health Organization (WHO) aims for 90% coverage of the Expanded Program on Immunization (EPI) by the age of 12 months. The CORE Group Polio Project (CGPP) Ethiopia implemented interventions in pastoral and semi-pastoral regions to increase routine immunization coverage and support supplemental immunization campaigns.

Objective: Assess vaccination coverage, estimate dropout rates and identify associated factors.

Methods: A cross-sectional study using the modified WHO EPI cluster survey method was conducted as part of the mid-term evaluation in 2015 in six pastoral and semi-pastoral zones in Ethiopia. A sample of 600 children age 12 to 23 months was selected, and mothers/caregivers were interviewed at home using face-to-face interviews, supported by mobile data collection using the Open Data Kit (ODK) system. Data were exported from the server, cleaned, and analysed using STATA 12.0.Both descriptive analytical methods were used and p-values less than 0.05 were used to declare statistical significance.

Results: Of the estimated sample, 577 (96.6%) children were included in the analysis. The overall rate of full vaccination was estimated to be 44.0% (21.2% in pastoral areas and 71.6% in semi-pastoralareas). With vaccine specific coverage of 53.7% for Bacillus Calmette-Guérin (BCG); 58.8% for oral polio vaccine 3 (OPV 3); 58.8% for pentavalent 3; 56.3% for OCV 3 and 53.6% for measles. Mothers'/caregivers' residence, age and education were found to be significant predictors for children not being fully vaccinated, i.e. children of mothers living in pastoralist communities, young age, and with no education were at a significantly higher risk of being not fully vaccinated. Among those children who had at least one vaccine, 20.5% failed to take at least one of the next higher doses. Specifically, among those who took BCG and pentavalent 1, 10.1% and 14.1%, respectively, failed to take the measles vaccination.

Conclusions and recommendations: The proportion of children who were fully vaccinated in pastoral and semi-pastoral zones was low. Dropout rates for measles, BCG and pentavalent 1 immunization were above the acceptable rate of less than 10%. Therefore, efforts should focus on mobilizing the community to complete all child vaccinations, and community-based approaches with the integration of community volunteers, health extension workers and health center staff should be strengthened so that dropout children can be traced so that they can complete their vaccinations. More information is also required on why mothers/caregivers fail to ensure that their children take all available vaccinations. [*Ethiop.J. Health Dev.* 2019;33(Special issue):00-00]

Key words: Vaccination coverage, vaccination dropout, pastoralist, semi-pastoralist, CGPP, Ethiopia

Introduction

Significant proportions of childhood morbidity and mortality in Ethiopia are due to vaccine-preventable diseases (VPDs). Immunization is a process whereby a person is made immune or resistant to VPDs, typically by the administration of a vaccine. Vaccination is one of the most cost-effective interventions for child survival, preventing illness, disability and death from VPDs, including cervical cancer, diphtheria, hepatitis B, measles, mumps, pertussis (whooping cough), pneumonia, polio, rotavirus diarrhoea, rubella and tetanus.

Currently, immunization averts an estimated 2 to 3 million deaths every year. An additional 1.5 million deaths could be avoided, however, if global vaccination coverage improves. An estimated 19.4 million infants worldwide are still missing out on basic vaccines; most infants who live in the poorest countries, where many factors combine to thwart attempts to raise vaccine coverage rates, are still not benefiting from routine immunization services (1).

Despite all the efforts by government and non-government institutions in Ethiopia to reach more people with more vaccines and to boost immunization coverage, there are still huge variations between and within regions.

Although there is limited information on the regional vaccination coverage and associated risk factors, the 2016 EDHS showed that full vaccination coverage was highest in Addis Ababa (89%) and lowest in Afar (15%) (2). Likewise, the 2012 national EPI coverage survey indicated that divergent immunization coverage ranged from 94.1% in Addis Ababa to 12.6% in Afar and Somali. Coverage in pastoral and semi-pastoral regions (Afar, Somali, Gambella and Benishangul-Gumuz) was lower than the rest of the regions (Addis Ababa, Dire Dawa, Hareri, Amhara, SNNPR, Oromia and Tigray) (3).

According to EDHS 2016 (2), vaccination coverage was 38.5%, which is higher than estimates from different studies (4, 5) and has shown some

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improvement, but is lower compared to studies in other areas (6, 7).

Common factors that were identified for huge numbers of unvaccinated children beyond the reach of routine immunization were: weak health service delivery; difficult geographical terrain; loss of public confidence in vaccination due to real or spurious links to adverse events; failure to mobilize populations and establish a well-informed demand for vaccines; lack of funding; and armed conflict (8). On the other hand, a study conducted in a district in central Ethiopia showed that antenatal care follow-up, being born in the health facility, mothers' knowledge about the age at which vaccination begins and knowledge about the age at which vaccination completes were significantly associated with full immunization, whereas area of residence and mother's socio-demographic characteristics were not significantly associated with full immunization of children (4). Another study in rural districts of Ethiopia indicated that residence and mother's education were significant predictors of the immunization status of children, while children from rural areas and whose mothers were literate had higher immunization coverage (7). Similarly, a study in Dili, Timor-Leste, showed caregivers' knowledge, attitudes and perceptions, barriers at immunization service sites, access to services and information, health workers' attitudes and practices, caregivers' fears of side effects, conflicting priorities, large family size, lack of support from husbands and paternal grandmothers, and seasonal migration as a main reasons for low vaccination rates (9). The 2012 national EPI coverage survey in Ethiopia demonstrates that vaccination coverage for all antigens tends to be higher in children of caregivers with higher educational attainment, higher wealth level, children of first parity, and those residing in urban areas (3).

A study conducted in Jagdalpur city, India identified a consistent decline in coverage rates from the first to the third doses of doses of diphtheria, pertussis and tetanus (DPT) and oral polio vaccine (OPV). The dropout rate for both DPT and OPV from the first to the third doses was 4.9% and 8.9%, respectively (10). In addition, a study in North Kenya identified the dropout rates between pentavalent 1 to pentavalent 3, and pentavalent 1 to measles vaccination, as 5.5% and 9.3%, respectively (11). A study in Nigeria showed that there was increasing dropout rate between consecutive vaccines: 7.2% between BCG and DPT 1, and 19.3% between DPT1 and DPT3 and 11.7% between DPT 3 and measles vaccination (12). Similarly, the dropout rate in Ethiopia for pentavalent 1 to pentavalent 3 is higher than the recommended level (25% as opposed to less than 10%) (3).

In order to support the EPI implementation with sound evidence and bespoke interventions, data on vaccine coverage and dropout are vital. Therefore, the aim of this study was to determine immunization coverage, dropout rates, and associated factors among children aged 12 to 23 months in six pastoral and semi-pastoral CORE Group Polio Project implementation areas in Ethiopia.

Methods

Study design and setting: A cross-sectional, community-based survey was conducted in 2015 in five CORE Group Polio Project (CGPP) implementation areas (pastoral and semi-pastoral) in Ethiopia, including in Benishangul-Gumuz, Gambella, Oromia, Somali, and Southern Nations, Nationalities and Peoples' regions.

Study population and sample: All children aged 12 to 23 months and their mothers/caregivers residing in 80 CGPP-implementing woredas were targeted. A sample of 600 children was selected using the WHO 30 by 10 cluster sampling method, with a design effect of 2.

Variables: The main outcomes of interest were fully immunized children and children who had dropped out, based on the availability of vaccination cards. 'Fully immunized' is defined as a child who has received all recommended vaccines by 12 months of age, i.e. one dose of Bacillus Calmett-Guérin (BCG), three doses each of OPV, pentavalent (diphtheria, pertussis, tetanus, haemophilus influenzae type B and hepatitis B) and pneumococcal vaccine (PCV), and one dose of measles vaccine. OPV 0 was not included, neither was rotavirus vaccine as it was not fully started in all the regions at the time of the survey that may underestimate the coverage. A child is defined as 'dropped out' of the vaccination schedule if they took a given dose but failed to take the second or subsequent dose for multi-dose vaccines, or took BCG but not measles vaccination, or pentavalent 1 but not measles vaccination.

The main exposure variable of interest was residential area, classified as pastoral or semi-pastoral. In addition, we included in the analysis: mothers'/caregivers' age (< 30/30 and above), education (no formal education/at least primary education), occupation (housewife/not housewife), religion (Islam/Christianity/other) and sex of child (male/female).

Data collection and management: Data were collected from mothers/caregivers via face-to-face interviews. The recording of child immunization cards at home or at health facilities was carried out by trained data collectors using a mobile data collection system with Open Data Kit (ODK) tools. Data collection tools were translated into three local languages – Amharic, Oromifa and Somali – and pre-tested. The collected data were sent to a central server after being checked by supervisors on a daily basis. Data checking on completeness and consistency was checked by the data manager immediately, and communicated to the field coordinators for correction and check-up in cases of data problems. The data were extracted from the server and exported to STATA version 12.0 for analysis. Tables and figures were used to organize and present the findings, and indicators of coverage and dropout were calculated accordingly. Binary logistic regression was used to identify associated factors for children who were not fully immunized and any dropout among vaccinated children. Odds ratios and 95% confidence intervals (CIs) interval were determined to measure the effect of each covariate on the outcome variables.

Ethical issues: Data collectors, supervisors and coordinators were trained on research ethics; interviewers obtained both written and verbal informed consent from all respondents; and participation was voluntary.

Operational definitions

Vaccination coverage: The proportion of children who received a specific vaccine dose or combination of doses among eligible children aged 12 to 23 months included in the study.

Dropout rate (DOR): The proportion of children who failed to receive a higher dose per 100 of those who received the lower dose. For example, the dropout rate for pentavalent 1 to pentavalent 3, with assigning number of children received Penta 1 and Penta 3 as # Penta 1 and # Penta 3, is calculated as:

$$Penta\ 1\ to\ 3\ DOR = \frac{\#\ Penta\ 1\text{-}\#\ Penta\ 3}{\#\ Penta\ 1} \times 100$$

Results

Of the planned sample of 600 children aged 12to 23 months, we managed to get a complete response for 577 (96.2%). Two (0.3%) refused and 21 (0.8%) were excluded due to incomplete data. The remaining 16 (2.7%) were not at home during the survey period.

Vaccination coverage: Mothers/caregivers reported that 567 (98.3%) of the children were vaccinated, of whom 408 (72.0%) claimed to have vaccination cards, but only 375 (91.9%) cards were recovered: 287 (76.5%) at home and 88 (23.5%) from the health centers or health posts (Table 1).

Table 1: **Reported vaccination status and vaccination card availability and source**

Vaccination and card	Number	Percentage
Child reported to be vaccinated		
Yes	567	98.3
No	10	1.7
Vaccination card reported available		
Yes	408	72.0
No	159	28.0
Vaccination card shown		
Yes	291	71.3
No	117	28.7
Source of vaccination card for analysis		
Home	287	76.5
Health center or health post	88	23.5

Vaccination status was assessed for each antigen and it was found that 310 (53.7%) children were vaccinated for BCG;338 (58.6%), 339 (58.8%) and325 (56.3%) children for the third dose of oral polio, pentavalent and pneumococcal vaccines, respectively; and 309 (53.6%) children for measles vaccine. Not all children who received the first dose of multi-dose vaccines received subsequent vaccines(Figure 1).
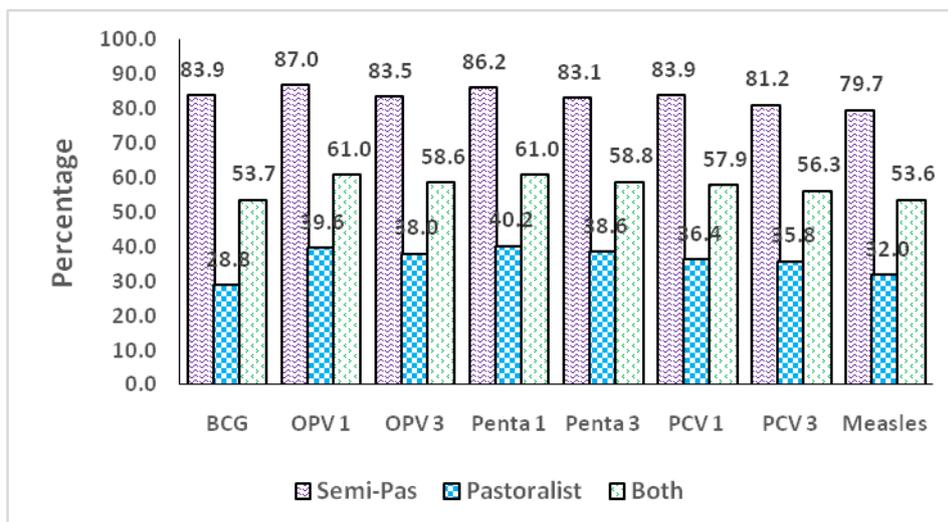

Figure 1: **Vaccination coverage by antigen and residential area**

Using dates of vaccination from vaccination cards, child vaccination status was also assessed in three categories: not vaccinated, partially vaccinated and fully vaccinated, based on BCG, OPV excluding OPV 0, pentavalent, PCV and measles vaccines, Accordingly, 202 children (35.0%) had no vaccination; 121(21.0%) were partially vaccinated; and 254 (44.0%) were fully vaccinated. Rates of full vaccination varied significantly between semi-pastoral and pastoral areas, mothers'/caregivers' educational status, religion and age group. Higher rates of full vaccination were observed in semi-pastoral (71.6%) areas than in pastoral areas (21.2%); among mothers/caregivers with at least primary level of education (58.4%) compared to those with no education (37.2%); in followers of Christianity (61.6%) compared to Islam (29.4%) and

other religions (46.2%); and among relatively young (45.5%) and older (41.1%) mothers/caregivers (Table 2).

Table 2: **Child vaccination status by mothers'/caregivers' characteristics, and sex of child**

Mothers'/caregivers' characteristics, and sex of child	Child vaccination status							
	Not vaccinated		Partially		Fully		Total	
	n	%	N	%	n	%	n	P-value
Residence area								< 0.001
Semi-pastoral	31	11.9	43	16.5	187	71.6	261	
Pastoral	171	54.1	78	24.7	67	21.2	316	
Educational status								< 0.001
At least primary	36	19.5	41	22.2	108	58.4	185	
No education	166	42.3	80	20.4	146	37.2	392	
Religion								< 0.001
Islam	146	49.3	63	21.3	87	29.4	296	
Christianity	42	17.4	51	21.1	149	61.6	242	
Others	14	35.9	7	17.9	18	46.2	39	
Age group								0.014
30 and above	82	42.7	31	16.1	79	41.1	192	
< 30	120	31.2	90	23.4	175	45.5	385	
Occupation								0.235
Housewife	137	36.5	71	18.9	167	44.5	375	
Not housewife	65	32.2	50	24.8	87	43.1	202	
Sex of child								0.512
Male	105	37.4	57	20.3	119	42.3	281	
Female	97	32.8	64	21.6	135	45.6	296	
Total	**202**	**35.0**	**121**	**21.0**	**254**	**44.0**	**577**	

Factors associated with children who were not fully immunized: Children who failed to receive all 11 vaccines, except OPV 0 and rotavirus vaccines, were considered to be not fully immunized in our analysis. In this regard, among mothers'/caregivers' and children's characteristics considered as factors for non-fully immunized children, only residential area, educational status and age were found to be statistically and significantly associated with being not fully immunized. Accordingly, mothers/caregivers who live in pastoral areas were 10.3 times (95% CI: 6.0-17.6) more likely to have children who were not fully immunized. Similarly, mothers with no education and aged< 30 years were 1.8 (95% CI: 1.1-2.8) and 1.6 (95% CI: 1.0-2.4) times, respectively, more likely not to have fully immunized children (Table 3).

Table 3: **Factors associated with being not fully immunized, CORE Group Polio Project Ethiopia implementation areas**

Background characteristics	Adj. OR	95% CI for OR	
Residential area (Semi-pastoral)			
Pastoral	10.3	6.0	17.6
Educational status (At least primary)			
No education	1.8	1.1	2.8
Age of mother/caregiver (30 years and above)			
< 30 years	1.6	1.0	2.4
Religion (Islam)			
Christianity	1.1	0.6	1.9
Others	0.5	0.2	1.1
Occupation (Housewife)			
Non-housewife	1.4	0.9	2.2
Sex of child (Male)			
Female	0.9	0.6	1.4
Constant	0.2	0.1	0.4

Vaccination dropout rate: The dropout rate between antigens was calculated for pastoral and semi-pastoral areas. In general, of the 11 antigens, except for OPV 0 and rotavirus vaccines, among those children who had received at least one vaccine, 77 (20.5%) failed to take at least one of the next higher doses. Specifically, the dropout rate was higher between pentavalent 1 and measles vaccinations (14.1%), followed by BCG and measles (10.1%) – in both cases, higher proportions than the recommended minimum of less than 10%. With respect to residential areas, statistically significant higher rates were observed among pastoralists compared to semi-pastoralists in four of the combinations (Figure 2).
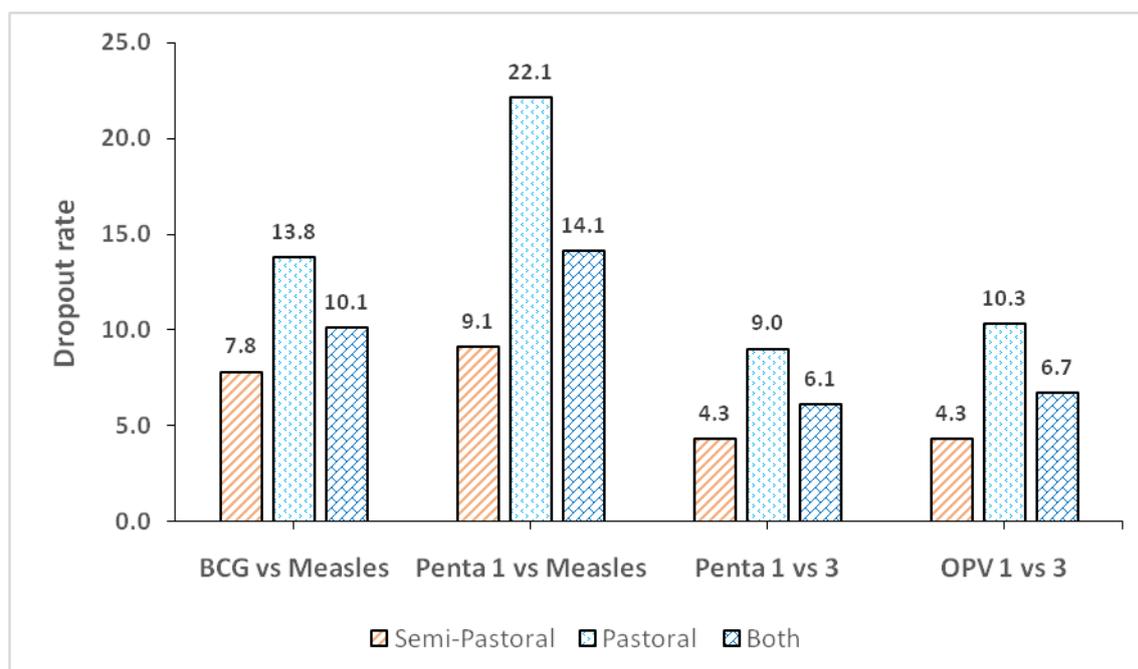
Figure 2: **Dropout rates by antigen and pastoralist and semi-pastoralist area**

Mothers'/caregivers' and children's background characteristics were considered as factors for dropout. Accordingly, there was a statistically significant difference in the dropout rates of pastoralists and semi-pastoralists, but no difference was observed in the other characteristics that were considered. On the other hand, in the multivariate binary regression model, none of the factors considered were found to be statistically significant (Table 4).

Table 4: **Incidence of dropout by background characteristics of mothers/caregivers, and sex of child, CORE Group Polio Project Ethiopia implementation areas**

Characteristics	Total	Dropped out		Unadjusted p-value	Adj. OR	95% CI for OR	
		n	%				
Residential area				< 0.001			
Semi-pastoral	230	32	13.9		1		
Pastoral	145	45	31.0		1.29	0.67	2.48
Educational status				0.144			
At least primary	149	25	16.8		1		
No education	226	52	23.0		1.07	0.61	1.86
Religion				0.05			
Islam	150	40	26.7		1		
Christianity	200	32	16.0		1.01	0.51	1.99
Others	25	5	20.0		0.78	0.27	2.28
Age group				0.468			
30 and above	110	20	18.2		1		
< 30	265	57	21.5		1.55	0.88	2.73
Occupation				0.446			
Housewife	238	46	19.3		1		
Not housewife	137	31	22.6		1.3	0.76	2.22
Sex of the child				0.634			
Male	176	38	21.6		1		
Female	199	39	19.6		0.97	0.6	1.58
Total	**375**	**77**	**20.5**	**Constant**	**0.09**	**0.04**	**0.21**

Discussion

This study looked at the levels of immunization coverage and dropout rates in children aged 12 to 23 months in pastoral and semi-pastoral regions in CORE Group Polio Project implementation areas of Ethiopia. Rates of fully immunized children were estimated at 44.0% (95% CI: 39.9-48.25), 71.6% (95% CI: 65.8-77.0) for semi-pastoral areas, and 21.2% (16.8-26.1) for pastoral areas. In total, 35.0% (95% CI: 31.1-39.1) of children were not immunized, as there was no evidence presented by mothers/caregivers, although the number of children who were claimed to be unimmunized was very low (1.7%). A significantly higher proportion of unimmunized children was observed in pastoral (54.1%, 95% CI: 48.4-59.7) compared to semi-pastoral (11.9%, 95% CI: 8.2-16.4)

areas. Individual antigen coverage ranged from 7.1% for OPV 0 to 61.0% for OPV 1 and pentavalent 1, with variations between pastoral (2.2% for OPV 0 and 40.2% for pentavalent 1) and semi-pastoral (13.0% for OPV 0 and 87.0% for OPV 1) areas. Although not adjusted, the univariate analysis showed child immunization status was significantly associated with residence, age, educational status and the religion of mothers/caregivers ($p < 0.05$).

The rate of fully immunized children (44.0%) in this study was higher compared with a study in Jigjiga, Somali Region in 2011 (36.6%) (13) and the EDHS 2011 (24%) (5), based on both cards and maternal report, but lower that the 50% reported in the 2012 national immunization coverage survey. In our survey, the estimated coverage for BCG and measles were 53.7% and 53.6%, respectively, which are similar to the 2012 national EPI coverage survey report (3). In the six regions where the project operates, it was reported that coverage of BCG varied between 49.9% and 88.2%, and measles between 46.7% and 79.1% in Somali and SNNP regions. With respect to vaccination status, the proportion of children who were fully vaccinated was relatively higher than the 2011 EDHS report (24%) (5), but lower than the 2012 national EPI coverage survey (49.9%) (3), where proportion of fully vaccinated children ranged from 12.6% in Somali and 58.7% in SNNP regions. On the other hand, studies conducted in two informal settlements of Nairobi (11), Aden, Yemen (14) and urban slums of Jagdalpur City, India (10) found a higher rate of fully immunized children, that could be attributed due to differences in the study areas, whereas our study was conducted in pastoral and semi-pastoral hard-to-reach areas, and the latter study also used mothers report.

Among the factors considered, mothers'/caregivers' residential area, education and age were found to be statistically and significantly associated with full vaccination. This is consistent with EDHS 2011, in so far as maternal education and region of residence were found to be significantly associated with full vaccination (5). Similarly, a study conducted in rural Mozambique showed maternal education and accessibility to vaccination sites and home delivery were important predictors for incomplete vaccination (15), while a study in Aden, Yemen showed that children from older mothers were more likely to complete vaccination (14).

Except for OPV 0 and rotavirus vaccines, the dropout rate between antigens was calculated for pastoral and semi-pastoral areas. Among those who had at least one vaccine, dropout rate for at least one higher dose was estimated to be 20.5%. With the specific vaccines, a higher rate was observed between pentavalent 1 to measles (14.1%) vaccinations, followed by BCG to measles (10.1%) vaccinations. Specifically, the dropout rate was higher between pentavalent 1 to measles (14.1%) that were higher than the minimum recommended (less than 10%). Differences in dropout rates between pastoral and semi-pastoral areas were significant in the univariate analysis, but when adjusted for other factors, the differences lacked significance.

The 2006 immunization coverage survey reported overall DPT1 to measles immunization dropout rates of 35.6%; in all regions, the proportion was above 10% (16). A study in rural Ahmadabad reported a DPT1 to measles immunization dropout rate of 16%, with the main reasons cited for partial immunization as living far away from vaccination sites, not aware about vaccination and sick child (17).

Conclusions and recommendations
The study highlights the status of vaccination coverage and dropout rates in hard-to-reach pastoral and semi-pastoral areas in Ethiopia. The rate of fully vaccinated children in the areas was low and dropout rates between pentavalent 1 and measles immunization, and between BCG and measles immunization, were high. The rate of full vaccination significantly varied between pastoral and semi-pastoral areas, mothers'/caregivers' education, and age.

Based on the findings of the study, we make the following recommendations:
1. There must be a concerted effort to increase vaccination coverage in the study areas by involving all stakeholders, including the community and the health services, from community to at least *woreda* levels.
2. Community-based efforts should be strengthened to trace defaulting children so that missed vaccines can be given to children to get the highest level of protection.
3. More emphasis should be given to pastoralist communities, which have a lower coverage and higher dropout rates compared to semi-pastoralist communities.
4. More information is required on why mothers/caregivers fail to bring their children for vaccination, as well as why they are unable to complete the full schedule of vaccinations.

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