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Mothers' health service utilization and attitude were the main predictors of incomplete childhood vaccination in east-central Ethiopia: a case-control study

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Abstract

Background: Vaccination is an effective public health intervention for reducing childhood morbidity and mortality. It becomes more effective if the child receives the full course of the recommended doses. In Ethiopia, many children fail to complete the full course, and there is a consensus on the low coverage of complete vaccination; however, factors relating to the problem have not been largely explored by community based studies. The problem still persists posing a challenge to the health care delivery system. Therefore, this study assessed the predictors of incomplete childhood vaccination among children aged 12–23 months. The result is expected to improve health promotion efforts to boost childhood vaccination uptake and serve as a tool for increasing the utilization of the existing Expanded Program on Immunization efforts.

Methods: A community-based unmatched case-control study was conducted in six kebeles of Amanuel district in east-central Ethiopia from March to April 2014. Census was carried out to identify cases and controls. A total of 308 mother-child pairs (154 cases and 154 controls) were selected by the stratified multistage sampling technique. Cases were children in the 12–23 months age group who missed at least one dose of the recommended vaccination. Child vaccination cards and mothers' oral responses were used to verify the vaccination status of each child. Data were collected using interviews through a pretested structured questionnaire and analyzed using SPSS version 20. A *p*-value of less than 0.05 was considered for declaring statistical significance.

Results: The study revealed that the odds of defaulters from childhood vaccinations noted among mothers who delivered at home were high [AOR = 4.11, (95% CI: 2.26, 7.47)]. Other irregularities detected were lack of antenatal care visits during pregnancy [AOR = 2.54, (95% CI: 1.31, 4.95)], misperception about vaccines [AOR: 2.83, 95% CI: (1.56, 5.15)], and lack of postnatal care visits [AOR = 2.51, 95% CI: (1.18, 5.33)].

Conclusion: Home deliveries, a misconception on vaccine, lack of prenatal and postnatal care services were found to be the predictors of incomplete childhood vaccinations. Therefore, increasing mothers' awareness on childhood vaccination, strengthening maternal health service utilization, and supervision and monitoring are highly recommended to reduce incomplete vaccination in the study setting.

Keywords: Predictors, Incomplete vaccination, 12–23 months children, Case-control study: East-central Ethiopia

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Background

Immunization remains one of the most cost-effective public health interventions to reduce childhood morbidity and mortality [1, 2]. Since it is accessible to the most hard-to-reach and vulnerable population, it is considered as a globally proven strategy for childhood intervention. Each year, immunization averts more than 2 million vaccine-preventable deaths globally [3–6]. Vaccination becomes more effective when it is administered with the most potent vaccine at the appropriate age [7, 8]. In connection to this, the World Health Organization (WHO) recommends that it should be made sure that all children receive all necessary doses of all vaccines before their first birthday. Thus, children are considered as fully vaccinated when they have received vaccinations against tuberculosis (BCG), three doses of pentavalent vaccine DPT-Hep-Hib, polio vaccines, two dose of Rota, pneumonia and a measles [9, 10].

Although vaccination offers greater benefits of health, well-being, and survival of children than any other interventions, vaccine-preventable diseases are still responsible for about 25% of deaths of under-five children [3, 11]. Most of the deaths are from diarrheal diseases, acute respiratory infections, and measles. Globally, about 22.6 million children under the age of 1 year are partially protected, and more than a quarter of these are reported in low and middle-income countries [3, 12, 13].

In spite of the accepted benefits of vaccination for childhood survival and health, full childhood vaccination practice has been diverse and affected by various factors, such as wealth status [11, 14–16], mothers' age [11, 14, 15, 17–19], mothers' education [11, 14, 15, 19–23], history of prenatal care [14, 17, 24], child sex and age [11], birth place [17, 21, 24, 25], residence [11, 26], mothers' knowledge about immunization [14, 16, 23, 24, 27, 28], health workers' home visits [17], missing opportunities [29], distance to health institutions [14, 21, 26] and perception about the benefits of immunization [11, 19, 26, 27].

In Ethiopia, a routine immunization program was launched by providing six traditional antigens in 1980. The Program was revised subsequently and was capable of providing 10 vaccines to under 1 year of age at the moment [30, 31]. In addition to the traditional vaccines that are given without any charge, new vaccines are continuously introduced into the Immunization Program. Recently, the program has successfully introduced additional antigens which have resulted in the protection of millions of children from vaccine-preventable diseases. Haemophilus influenza type B and Hepatitis B vaccines were introduced in the form of a pentavalent combination vaccine in 2007, while Pneumococcal Conjugate (PCV-10) and Rotavirus vaccines were introduced in 2011 and 2013, respectively [6, 32, 33]. Currently, vaccination in Ethiopia is being given on routine and outreach bases. Thus the national routine vaccination schedule recommends that childhood vaccination should start from birth and be completed before the first birthday with one dose of bacillus Calmette–Guerin (BCG), oral polio vaccine doze (OPV 0), three doses of OPV, Pentavalent, two doses of Rota, pneumonia vaccines, and finally measles vaccine at the age of 9 months. Moreover, Inactivated Polio Virus (IPV), measles-rubella, meningitis, and yellow fever vaccines for less than one-year-old children are planned under the implementation [32, 33] (Table 1).

Currently, immunization services are given to 3 million children under the age of 1 year in most health facilities. Despite various government initiatives, incomplete vaccination has still been a problem in the country. In Ethiopia, vaccination coverage among children aged 12–23 months is the highest (81%) for the first dose of polio vaccine, followed by 73% of first dose of DPT-HepB-Hib vaccine. The 2016 Ethiopian Demographic and Health Survey (EDHS) indicated that more than half (53%) of children in Ethiopia received three doses of the DPT-HepB-Hib vaccine and 54% measles vaccination [9]. Nationally, the dropout rate from the first to the third dose of (DPT-HepB-Hib and polio vaccine) was 20% and 25%, respectively [9]. According to the national report of EDHS in 2016, there was a steady progress in full immunization coverage, and the percentage of children aged 12–23 months who received all basic vaccinations increased from 14% in 2000 to 20% in 2005 [34], from 24% in 2011 [35] to 39% in 2016 [9]. However, the national full vaccination coverage in 2016 increased by 25% from the level reported in the 2000 EDHS. This remained far below the goal of 66% coverage set in HSDP IV and the 90% target in 2020 [36]. Particularly, the Amhara Region had a low level of full immunization of 26.3% in 2011 and 46% in 2016, and the district in question is known for frequent outbreaks of vaccine-preventable diseases, especially measles. Full vaccination coverage in Ethiopia varied by region, and the lowest full vaccination coverage of 15% was

Table 1 Routine immunization schedule in Ethiopia, 2014

Vaccines	Number of dose	Disease prevent	Age at which vaccine delivered
BCG	One dose	Tuberculosis	At birth
Pentavalent	3 (Penta 1,2 & 3)	Diphtheria, Pertussis, Tetanus, H. influenza type b, Hepatitis B	6,10,14 weeks
OPV	3 doses	Polio	At birth, 6, 10, 14 weeks
Pneumonia-conjugate vaccine (PCV)	3 doses	Pneumonia	6,10,14 weeks
Rota	2 dose	Rota Virus	6, 10 weeks
Measles	one dose	Measles	9 months

[OPV]Oral polio vaccine, [BCG] Baccille Calmette-Guerin

reported in Afar Region. Although there has been progress in full vaccination coverage, many children in the country do not get the full benefits of the program [10], and full immunization coverage is less than the herd immunity level desired to prevent the spread of vaccine-preventable diseases.

Most of the studies conducted earlier on immunization were part of the coverage evaluation surveys (cross-sectional), so there were chances of recall bias. Therefore, this study can minimize this research gap and draw attention to the largely unexplored factors that may be associated with incomplete childhood immunization. The study thus assessed factors associated with incomplete vaccinations among children 12–23 months of age at Amanuel district to generate data that could be used for better planning and strengthening routine immunization services.

Methods

Study design and setting

A community-based unmatched case-control study was conducted from March to April 2014 in Amanuel, one of the 18 districts in East Gojam Zone, Amhara Regional State, east-central Ethiopia. The district is known for frequent outbreaks of vaccine-preventable diseases, especially measles. It has 26 kebeles (one urban and 25 rural), and an estimated total population of 133,188. Initially, the kebeles (the smallest administrative units in Ethiopia) in the district were stratified into urban and rural settlements.

Sample size and sampling procedure

Mothers who had children aged 12–23 months were the population under study. Sample size was calculated using Epi-info version 3.5.3 by considering the following assumptions, proportion of illiterate mothers or caretakers among controls 52%, among cases 76% [37], 95% level of confidence, 5% margin of error, a design effect of 2, case: control ratio of 1:1, and 15% non -response rate. Finally, the minimum sample size of 308 (154 cases and 154 controls) was obtained. Initially, the district was stratified into urban and rural kebeles. Out of the total 25 rural kebeles, 6 were selected randomly, and the only urban kebele was included. Mother-child pairs were recruited from six rural and one urban kebeles. A community survey was conducted a week before the actual data collection to identify cases and controls (Tables 2 and 3). The final sample size of cases and controls from each kebele was allocated based on the probability proportional size to the number of children aged 12–23 months. As a result, participants were mothers who had children aged 12–23 months in the kebels selected by the stratified multistage random sampling method and were assigned based on proportion to size to each kebele (Fig. 1).

Table 2 Number of case and control identified during survey stratified by study kebeles in Amanuel District, east-central Ethiopia, 2014

	Study populations from survey	
Study Kebele	Cases	Controls
Yewulla	29	65
Delma	24	78
Degasegnen	33	56
Amanuel 01	41	110
Zuria	38	49
Yedefas	26	42
Kerer	19	53
Total	210	453

Data collection tools and procedures

A structured interviewer-administered questionnaire was used to collect the data. In addition to WHO EPI data collection forms, instruments were constructed by reviewing a variety of literature. The instrument consisted of socio-demographic and economic variables, mother health service related characteristics, and knowledge and attitude on immunization. Moreover, health care access and satisfaction with health care service were assessed in the questionnaire. To maintain consistency, the questionnaire was first translated from English to Amharic (the native language of the study area) and was retranslated to English by professional translators and public health experts. Five clinical nurses and two health officers were recruited as data collectors and supervisors, respectively. A two-day intensive training regarding the objective of the study, confidentiality of information, and techniques of conducting interviews was given to both groups. The tool was also piloted on 5% of the total sample out of the study area, and the acceptability and applicability of the procedures and tools were evaluated by the pretest.

Table 3 Proportional allocation of case and control in each kebeles in Amanuel district, east-central Ethiopia, 2014

	Sample populations	
Kebele	Cases	Controls
Yewulla	21	22
Delma	18	27
Degasegnen	24	19
Amanuel 01	30	37
Zuria	28	17
Yedefas	19	14
Kerer	14	18
Total	154	154

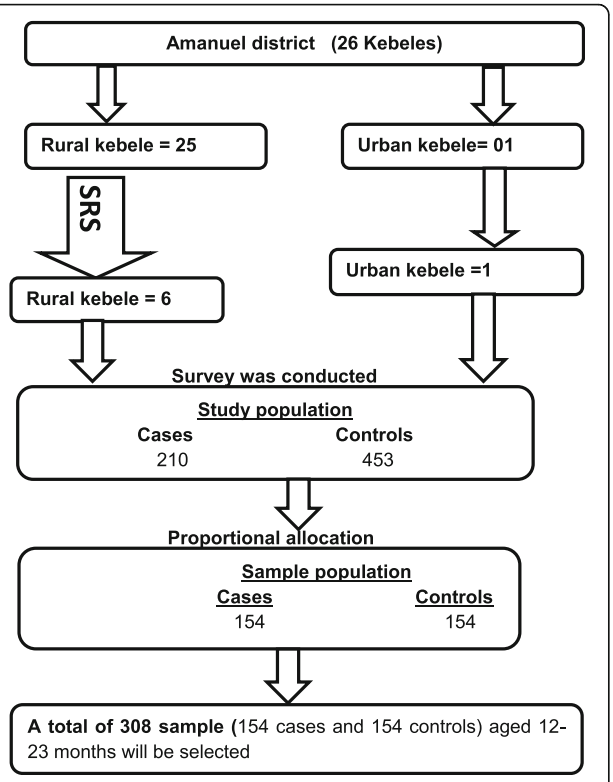

Fig. 1 Sampling procedure of study kebeles in Amanuel district beast-central Ethiopia, 2014

Operational definitions and study variables

- **Complete vaccination:** A child aged 12–23 months and took all the recommended vaccines, that is, a dose of Baccille Calmette-Guerin (BCG), three doses of Pentavalent and PCV, three doses of OPV, and a measles vaccine before their first birthday (by the age of 12 months). The child vaccination card and mother's oral response were used to verify vaccination status of the child.
- **Incomplete vaccination:** Children in the age group of 12–23 months who missed at least one of the recommended vaccines before their first birthday (by the age of 12 months).
- **Cases and controls:** A case was defined as a child between 12 and 23 months old who missed at least one dose of the nine vaccines before their 1st birthday, while controls were defined as children who took all the recommended vaccines.
- **Knowledge of schedules of immunization:** Mothers' knowledge of the schedules of vaccination was assessed using nine questions. Mothers were asked about the age at which the children began immunization, at what age measles vaccine was administered, about the number of vaccinations needed for a child to be fully immunized, and the age at which children completed the immunizations. The composite knowledge index was analyzed using the Principal Component Analysis and converted into tercile as "poor", "medium", and "good".
- **Household wealth index:** The household wealth index was computed using a composite indicator for urban and rural residents by considering household asset properties and size of agricultural land. Principal Component Analysis was performed to categorize the household wealth index into "lowest", "middle", and "highest".
- **Health care access:** Mothers' health care access was determined by asking them how many hours it took them to reach health care facilities. If it took less than two hours, it was considered as "good" health care access and was coded as "1"; otherwise, "0" if it took two hours or more.
- **Missed opportunit**y: It was assessed if a child came to a health facility or an outreach site and did not receive the vaccination for which they were eligible.
- **Misconceptions about vaccine contraindication:** This was measured by asking misconception related questions using a five-option likert scale ranging from "*strongly agree*" to "*strongly disagree*". After computing the mean score, the status was dichotomized into "*positive*" and "*negative*" misconception about vaccine contraindication.

Data processing and analysis

Data were entered into Epi-info version 3.5.3 and exported to the Statistical Package for Social Sciences (SPSS) version 20 for further analysis. Data cleaning was performed by running frequencies. Descriptive statistics, including frequencies and proportions were computed to summarize the variables by using the binary logistic regression model. Both bivariate and multivariate logistic regression analyses were entered into the multivariate analysis. Variables with a p-value of ≤ 0.2 in the bivariate analysis were entered into the multivariate analysis. Both Crude Odds Ratio (COR) and the Adjusted Odds Ratio (AOR) with a 95% confidence interval were estimated to show the strength of associations. A p-value of ≤ 0.05 was used to identify variables that showed statistical significance in the multivariate analysis.

Results

Socio-demographic and economic characteristics

A total of 302 mother-infant pairs (152 controls and 150 cases) were included in the study. The mean (±SD) age of the mothers and the children was 29.53 (± 5.10) years and 16.92(± 3.17) months, respectively. In this study, more than three-fourths of cases and controls (79.9% and 76.3%, respectively) were rural dwellers. Two-thirds (64%) of cases and more than one-third (39.1%) of controls were male. Most of the caretakers for the controls

and the cases (99.3% and 93.3%, respectively) were mothers. About two-thirds of the cases and the controls (70% and 63.8%) were uneducated. More than half of the cases and the controls of the mothers (68.5% and 58.3%, respectively) gave birth in less than 2 years of interval. The mean (±SD) next childbirth interval for cases and controls was 18 (± 9.1) and 21(± 11.4) months, respectively. Three-fourths of the cases (74.5%) and nearly half of the controls (47%) gave birth more than three times. About two-thirds of the cases (63.3%) were born in the second order of birth, while 63.8% of the controls were born in the third order. More than three-fourths (75.3%) of cases and less than half of (48.7%) the controls' mothers had more than five family members (higher than the national average) (Table 4).

Mothers' health service related characteristics

It was revealed that most (95.3% and 98.7%, respectively) of the cases and the controls had heard about immunization. About 61.2% of the cases did not get health worker home visits in the last 1 month, while more than two-thirds of the controls (69.7%) were visited by community health workers. One-third of cases (34.7%) and more than two-thirds of controls (73%) attended their prenatal care visits during their pregnancy. The report indicated that only one-third (35.3%) of cases preferred to deliver at health institutions. About one-third of the controls and the cases (31.3% and 36.2%, respectively) had poor access to health care (more than 2 h) (Table 5).

More than half (56.7%) of the cases did not maintain their vaccination cards, while about 57.6% of the controls' vaccination cards were maintained by the mothers or caretakers. Level of satisfaction with the health care provision indicated that two-thirds of the cases (67.3%) and one-third of the controls (39.5%) were not satisfied. A significant portion of the cases (66.7%) had a misconception on vaccine, while a similar proportion of the controls (67.8%) had favorable attitude towards vaccination. A similar proportion of the cases and controls (65.3% and 64.5%, respectively), had a positive perception of the benefits of vaccines (Table 5).

Predictors of incomplete childhood vaccination

Both bivariate and multivariate analyses were done to identify the predictors of incomplete childhood vaccination. The result of the bivariate analysis showed that the age of mothers and children, health worker home visits, lack of prenatal and postnatal care, home delivery, the level of mother's satisfaction, knowledge of vaccination, misconception about vaccines, and missed opportunity were common predictors of incomplete vaccination with a *p*-value of 0.2.

Consequently, these variables were subjected to multivariate analysis, and it was noted that higher odds of

Table 4 Socio-demographic and economic characteristics of respondents in Amanuel district, east-central Ethiopia, 2014

Variables	Incomplete childhood vaccination	
	Yes *N* (%)	No *N* (%)
Residency		
Urban	30 (20.1%)	36 (23.7%)
Rural	119 (79.9%)	116 (76.3%)
Child's caretaker		
Mother	140 (93.3%)	151 (99.3%)
Grandparent	10 (6.7%)	1 (.7%)
Marital status		
Married	137 (91.3%)	151 (99.3%)
Divorced/separated	9 (6.0%)	1(0.7%)
Widowed	2 (1.3%)	0 (.0%)
Caretakers' age (years)		
< 26	29 (19.7%)	48 (31.6%)
27–34	88 (59.9%)	98 (64.5%)
> 35	30 (20.4%)	6 (3.9%)
Educational status		
No education	105 (70.0%)	97 (63.8%)
Primary [1–8]	20 (13.3%)	32 (21.1%)
Secondary [9–12]	10 (6.7%)	6 (3.9%)
College and above	15 (10.0%)	17 (11.2%)
Child sex		
Male	96 (64.0%)	59 (39.1%)
Female	54(36.0%)	92 (60.9%)
Child age (months)		
12–18	78 (52.0%)	105 (69.1%)
19–23	72 (48.0%)	47 (30.9%)
Parity		
One	10 (6.7%)	27 (17.9%)
Two	28 (18.8%)	53 (35.1%)
More than three	111 (74.5%)	71 (47.0%)
Birth order		
1	19 (12.7%)	36 (23.7%)
2–3	95 (63.3%)	97 (63.8%)
≥ 4	36 (24.0%)	19 (12.5%)
Birth interval (in month)		
4–36	39 (26.2%)	58 (38.4%)
≥ 37	8 (5.4%)	5 (3.3%)
Family size		
≤ 3	37 (24.7%)	78 (51.3%)
≥ 4	113 (75.3%)	74 (48.7%)
Wealth index		
Poor	51 (34.0%)	51 (33.6%)
Medium	36 (24.0%)	33 (21.7%)
Rich	63 (42.0%)	68 (44.7%)

Table 5 Mother health service related characteristics of respondents in Amanuel district, east-central Ethiopia, 2014

Variables	Incomplete childhood vaccination	
	Yes *N* (%)	No *N* (%)
Hear about vaccination		
Yes	143 (95.3%)	148 (98.7%)
No	7 (4.7%)	2 (1.3%)
Health workers' home visit		
Yes	57 (38.8%)	106 (69.7%)
No	90 (61.2%)	46 (30.3%)
Antenatal care visit (ANC)		
No	98 (65.3%)	41 (27.0%)
≤ 2	34 (64.0%)	36 (33.0%)
≥ 3	18 (36.0%)	75 (67.0%)
Post natal care visit (PNC)		
Yes	20 (13.3%)	51 (33.6%)
No	130 (86.7%)	101 (66.4%)
TT Vaccination		
Yes	47 (31.3%)	76 (50.0%)
No	103 (68.7%)	76 (50.0%)
Health care access		
Within 2 h	100 (66.7%)	97 (63.8%)
> 2 h	47 (31.3%)	55 (36.2%)
Place of delivery		
Home	97 (64.7%)	32 (21.2%)
Health Institution	53 (35.3%)	119 (78.8%)
Vaccination card available		
Yes	65 (43.3%)	87 (57.6%)
No	85 (56.7%)	64 (42.4%)
Level of satisfaction		
Satisfied	101 (67.3%)	60 (39.5%)
Not satisfied	46 (30.7%)	37 (24.3%)
Missed opportunity		
Yes	90 (61.6%)	56(37.1%)
No	56 (38.4%)	95 (62.9%)
Knowledge on the schedule of vaccination		
Poor	46 (30.7%)	37 (24.3%)
Medium	39 (26%)	55 (36.2%)
Good	65 (43.3%)	60 (39.5%)
Misconception on vaccine contraindication		
Yes	100 (66.7%)	49 (32.2%)
No	50 (33.3%)	103 (67.8%)
Perception on benefit of vaccine		
Positive	98 (65.3%)	98 (64.5%)
Negative	52 (34.7%)	54 (35.5%)

defaulting from childhood vaccinations were noted among children delivered at home [AOR = 4.11, 95% CI: 2.26, 7.47], mothers who had no prenatal [AOR = 2.54, 95% CI: 1.31, 4.95], and postnatal care [AOR = 2.51, 95% CI: 1.18, 5.33], mothers of higher parity (≥ 3) [AOR = 3.55, 95% CI: 1.32, 9.58], and mothers who had misconception about vaccination [AOR = 2.83, 95% CI: 1.56, 5.15] (Table 6).

Discussion

The study assessed the predictors of incomplete vaccination among children aged 12–23 months in Amanuel district, East Gojjam zone. Socio-demographic and mothers' health service utilization characteristics were assessed, and the adjusted logistic regression analysis indicated that antenatal and post-natal care services, place of delivery, parity, and misconceptions on vaccine were the predictors of incomplete childhood vaccination.

Immunization is one of the most powerful and cost-effective health interventions globally. It prevents debilitating illnesses and disability and saves millions of lives every year. Vaccines have the power not only of saving but also of transforming lives, giving children the chance to grow up healthy, go to school, and improve their life prospects [38]. Considering this acknowledged benefits of immunization, Ethiopia has adapted these established facts and set a target to improve full vaccination to reach 90% by 2020 [36].

In this study, the result of the adjusted analysis indicated that the odds of defaulters from child vaccination were higher among mothers who had no prenatal care service during pregnancy than mothers who had prenatal care visits. The finding was supported by reports elsewhere [14, 17, 24]. Similarly, mothers who had no postnatal care visits had high odds of defaulting from childhood vaccination compared to mothers who had postnatal care visits. This may be due to the fact that mothers who had no prenatal and postnatal care visits missed the chance of communicating with health care providers to hear about the benefits of vaccination and the relevance of completing it. The impact of prenatal and postnatal care information mainly operates through the role of clinicians in the process of providing the right and up-to-date information to mothers. In fact, birth preparedness and immunization counseling are important components of prenatal care, and repeated visits help to bring the intended maternal behavioral change toward full childhood vaccination.

Similarly, in this study, higher odds of defaulters from childhood vaccination were reported among mothers who delivered at home. The finding of the study was in line those with other studies conducted in Ethiopia [24, 39, 40], Mozambique [21], Kenya [25], and Tokyo [17]. This could be so due to the fact that home delivery was considered as a proxy determinant of poor access to health care service utilization. In addition, mothers who give birth at health

Table 6 Multivariable logistic regressions analysis for predictors of incomplete childhood vaccination in Amanuel District, east-central Ethiopia, 2014

Variables	Incomplete childhood vaccination		Crude OR	Adjusted OR
	Yes (%)	No (%)	(95% CI)	(95% CI)
Mothers' age (in years)				
≤ 26	29 (19.7%)	48 (31.6%)	0.67 (0.39,1.16)	0.77 (0.38,1.57)
27–34	88 (59.9%)	98 (64.5%)	1.00	1.00
≥ 35	30 (20.4%)	6 (3.9%)	5.57 (2.21,14.01)	2.62 (0.87,7.94)
Health worker home visit				
Yes	57 (38.8%)	106 (69.7%)	1.00	1.00
No	90 (61.2%)	46 (30.3%)	3.64 (2.25,5.87)	1.09 (0.53,2.27)
ANC				
Yes	52 (34.7%)	111 (73.0%)	1.00	1.00
No	98 (65.3%)	41 (27.0%)	5.10 (3.12, 8.34)	2.54 (1.31, 4.95) *
PNC				
Yes	20 (13.3%)	51 (33.6%)	1.00	1.00
No	130 (86.7%)	101 (66.4%)	4.60 (2.60, 8.14)	2.51 (1.18, 5.33) *
TT vaccination				
Yes	47 (31.3%)	76 (50.0%)	1.00	1.00
No	103 (68.7%)	76 (50.0%)	2.19 (1.37,3.50)	1.55 (0.27,1.11)
Place of delivery				
Home	97 (64.7%)	32 (21.2%)	6.81 (4.07, 11.38)	4.11 (2.26,7.47) *
Health institution	53 (35.3%)	119 (78.8%)	1.00	1.00
Parity				
One	10 (6.7%)	27 (17.9%)	1.00	1.00
Two	28 (18.8%)	53 (35.1%)	1.42 (0.61, 3.36)	1.48 (0.49, 4.41)
Above three	111 (74.5%)	71 (47.0%)	4.22 (1.93, 9.23)	3.55 (1.32, 9.58) *
Child age (in months)				
12–18	78 (52.0%)	105 (69.1%)	0.48 (0.30, 0.77)	0.52 (0.28, 1.95)
19–23				
Birth order				
First	19 (12.7%)	36 (23.7%)	0.27 (0.13,0.61)	0.78 (0.33,1.81)
Second & third	95 (63.3%)	97 (63.8%)	0.52 (0.28,0.97)	1.42 (0.41,4.87)
Above four	36 (24.0%)	19 (12.5%)	1.00	1.00
Knowledge on vaccine schedule				
Poor	46 (30.7%)	37 (24.3%)	1.72 (1.23,4.37)	1.24 (0.57,5.63)
Medium	39 (26%)	55 (36.2%)	1.63(1.027,2.580)	1.17 (0.64,2.18)
Good	65 (43.3%)	60 (39.5%)	1.00	1.00
Level of satisfaction				
Satisfied	49 (32.7%)	92 (60.5%)	1.00	1.00
Dissatisfied	101 (67.3%)	60 (39.5%)	3.16 (1.97,5.06)	2.94 (0.45,1.93)
Misconception on vaccine				
Yes	100 (66.7%)	49 (32.2%)	4.20 (2.600,6.798)	2.83 (1.56,5.15) *
No	50 (33.3%)	103 (67.8%)	1.00	1.00
Missed opportunity				
Yes	90 (61.6%)	56 (37.1%)	2.73 (1.705,4.360)	1.23 (.637,2.386)
No	56 (38.4%)	95 (62.9%)	1.00	1.00

*Significant at a *p*-value of < 0.05

facilities are closer to health services, and most of the time the first doses of vaccination are given just after birth in health institutions. The other probable justification can be explained by the fact that home delivery can be an indicator for the absence of health extension worker home visit (the case of Ethiopia) which subsequently affects health care service utilization.

In the study, it was noted that mothers who had more than three parities had higher odds of defaulting from childhood vaccination compared to those who had only one. The finding is consistent with reports from Kenya and Bangladesh [14, 25]. This can be due to the fact that having more children may have a negative effect on health care utilization owing to competing for care responsibilities and because more children place competing demands on mothers, while time and resources available for the care of each child become less available.

The study also noted that mothers' misconception about vaccines is a predictor for incomplete childhood vaccination. This finding is similar to that of a study conducted elsewhere [11, 19, 26, 28, 41]. This is due to the fact that if mothers have a negative perception on the use of vaccination and its possible side effects, they will be less likely to take their children for vaccination according to schedule.

Though the study did its best to indicate the predictors of incomplete childhood vaccination, it is not free from limitations. Firstly, the measurement of vaccination status was based on vaccination cards and mothers' recall. Secondly recall bias in the reporting of vaccination status was not ruled out. Finally, variables that needed further qualitative investigations were not included.

Conclusion

In this study, incomplete vaccinations were noted among older children and mothers who lacked prenatal and postnatal care services, delivered at home, had multiple parity and misconceptions about vaccine contraindications. Therefore, the District Health Office needs to focus on strategies that could increase mothers' awareness of vaccination; health care providers should motivate and counsel mothers to attend antenatal and postnatal care health services. In addition, strategies such as health worker home visits could be used to identify defaulters in the district and work to help pregnant women to attend ANC, to deliver at health institution, and access PNC services. In addition, supervision and monitoring should be strengthened to increase full immunization coverage. Reminding and tracing mechanism is required for parents who default from childhood vaccination. Moreover, professional work on arousing health-seeking behavior, providing health education and communication are essential for curbing the poor and incomplete childhood immunization practice in the study community.

Abbreviations

ANC: Antenatal care; AOR: Adjusted odds ratio; BCG: Baccille calmette guerin; CI: Confidence interval; COR: Crude Odds ratio; DPT: Diphtheria Pertussis and Tetanus; OPV: Oral polio vaccine; PCA: Principal component analysis; SPSS: Statistical Package For Social Sciences and; WHO: World Health Organization

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Availability of data and materials

Data will be available upon request from the correspondence authors.

Authors' contributions

MKY conceived of the study, design of the study and tool development coordinated data collection, performed statistical analysis, and drafted the manuscript. YAG and AMS performed statistical analysis and drafted the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Ethical clearance was obtained from the Ethical Review Board of Jimma University, and a letter of permission from the Zonal Health Department prior to data collection. After the objective of the study was explained, verbal consent was secured from mothers. The right of participants to withdraw from the study at any time without any precondition was communicated unequivocally. Moreover, the confidentiality of information gathered was guaranteed by all data collectors and investigators by using code numbers rather than personal identifiers and by keeping the questionnaire locked.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

Publisher's Note

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