HUMAN VACCINES & IMMUNOTHERAPEUTICS
2024, VOL. 20, NO. 1, 2338952
https://doi.org/10.1080/21645515.2024.2338952

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

OPEN ACCESS Check for updates

Determinants of immunization defaulters among children aged 12–23 months in Ambo town, Oromia, Ethiopia: A case–control study

Gurmessa Bekele[a], Jiregna Darega[b], Erimiyas Mulu[b], and Menen Tsegaw[b]

[a]Public Health, Ambo Town Health Office, Ambo, Ethiopia; [b]Department of Public Health, College of Medicine and Health Sciences, Ambo University, Ambo, Ethiopia

ABSTRACT

Immunization is a public health intervention to reduce morbidity and mortality among children. However, vaccination becomes more effective if the child can receive the full course of recommended vaccination doses according to the schedule. Many children fail to complete the full course of vaccination. To identify the determinants of immunization defaulters among children aged 12–23 months in Ambo town, Oromia, Ethiopia. A community-based, unmatched, case–control study was done from October 1 to 25, 2021. A simple random sampling was used to select 317 (106 cases and 211 controls). Data were collected by using a pretested and structured questionnaire. Data were coded and entered to Epi-data version 3.1 and then transported to SPSS version 21.0 for statistical analysis. Descriptive analysis like frequency, mean, and percentage was calculated. Binary and multivariable logistic regression analysis was done. Finally, variables with a p value $< .05$ were considered statistically significant. Urban residences (AOR = 0.288, 95% CI, 0.146, 570), government employee (AOR = 0.179, 95% CI, 0.057, 0.565), number of family members more than four (AOR = 2.696, 95% CI, 1.143, 6.358), higher income (AOR = 0.250, 95% CI, 0.099, 0.628), attending ANC (AOR = 0..237, 95% CI, 0.107, 0.525), and good awareness (AOR = 0.070, 95% CI, 0.005, 308) were significant predictors of immunization defaulters. This study has found that urban residences, government employee by occupation, number of family members more than four, higher monthly income, and attending ANC were identified as determinants of childhood immunization defaulters. Social Behavior Change intervention programs should focus on providing health information about the importance of the vaccine and vaccine schedule. Due attention should be given for rural residents and farmers who had limited access to information and are more prone to defaulting. Policy-makers should consider those identified factors while designing intervention programs to enhance vaccination coverage.

ARTICLE HISTORY
Received 22 December 2023
Revised 14 March 2024
Accepted 1 April 2024

KEYWORDS
Childhood immunization; defaulters; determinants; 12–23 month children; vaccination; Ethiopia

Introduction

Immunization is unquestionably one of the most indispensable public health interventions to reduce major illnesses that lead to child mortality and morbidity.[1] The immunization program is a global program for the control of vaccine-preventable diseases (VPDs) among children through high immunization coverage. VPDs account for 17% of global under-five mortality each year.[2,3] Vaccination is one method of preventing common childhood illnesses such as diphtheria, hepatitis B, measles, mumps, pertussis, pneumonia, polio, rotavirus diarrhea, rubella, cervical cancer, and tetanus, which are prevented through high immunization coverage.[4] The Expanded Program on Immunization (EPI) was established in 1974 with the goal of providing universal vaccination with necessary vaccines. Diphtheria, pertussis, tetanus, measles, poliomyelitis, and tuberculosis were among the six VPDs initially targeted, and a significant reduction in the burden of preventable childhood illnesses and deaths was achieved in its early years. Ethiopia was the first country to implement EPI in 1980. The goal of the National Immunization Policy was to reduce childhood mortality and morbidity from EPI target diseases by vaccinating all children under the age of one. The program had been planned to make immunization services available to 10% of the population in 1980 and to increase immunization access by 10% each year.[5]

According to the World Health Organization (WHO) 2017 report, 116.2 million infants (85%) received the third doses of DPT, and worldwide, 123 countries reached the third dose of diphtheria, pertussis, and tetanus (DPT3) coverage to 90%. Despite the increasing uptake of new and underused vaccines, still an estimated 19.9 million children under the age of 1 year have not received DTP3 vaccine.[4,6] In 2019, coverage with three doses of pentavalent vaccine and all basic vaccines among children under 1 year of age reached 61% and 44%, respectively. However, about 19% of children had no vaccination at all. There is also high vaccination dropout rate, with a national dropout of 13% from pentavalent 1 to measles, with high regional variation.[7] Incomplete immunization, according to WHO, refers to children who miss scheduled vaccines owing to health facility issues such as canceled vaccination schedules or vaccine stock-outs.[1,8]

According to EDHS 2019 data on vaccination coverage among children age 12–23 months who received specific vaccines at any time before the survey (according to a vaccination card or the mother's recall), only 4 out of 10 children (43%)

CONTACT Menen Tsegaw menentsegaw@gmail.com Public Health, Ambo Town Health Office, Ambo, Ethiopia.

have received all basic vaccinations. Fifty-seven percent of children living in urban areas have received all basic vaccinations, compared with only 37% of children in rural areas.[9] Different studies revealed that educational status, marital status, residence, income, family size, place of delivery, and age of the mother were significantly associated with incomplete vaccination.[10–14]

According to the Ambo town health office eHMIS report, the vaccination drop-out rate of $Penta_1$ to $Penta_3$ in 2018/2019 and 2019/2020 was 13.8% and 12.2%, respectively, which is high when compared to WHO and national standard (>10%).[15] The reports of the two past years show Ambo town has high vaccination defaulters when compared to national standards. Therefore, this study included all town urban and rural kebeles to identify determinants of immunization defaulters among children aged 12–23 months in Ambo town, Oromia, Ethiopia.

Methods

Study area and period

Ambo town is one of the 19 administrative towns in the Oromia regional state, located at a distance of 114 km from Addis Ababa central of Ethiopia on the main road that leads to Wollega. The town was established in 1889 and covers 8,587 hectares of land. The town and its surroundings have a mean annual precipitation of 912 mm, and the mean annual temperature of the town is about 17.6°C. The town has three urban and three rural administrative kebeles. There are two public hospitals in the town, namely, one general hospital and one referral hospital, two health centers, three health posts, and six special clinics; 26 medium-sized and 10 primary private clinics; nine pharmacies; and 31 drug stores (public and private). The town's health administrative office and public health centers have 79 health professionals of different professions.

Study design and period

A community-based, unmatched, case–control study was conducted from October 1 to 25, 2021.

Population

Source population

All mothers/caretakers with children aged between 12 and 23 months living in Ambo town.

Study population

The study population for this study was mothers/caretakers with children aged between 12 and 23 months (as per the reported dates of birth), within the eligible area of Ambo town.

Inclusion and exclusion criteria

Inclusion criteria. Mothers or caretakers who lived in Ambo town for at least a year with at least one living child aged between 12 and 23 months were eligible for the study.

For cases, all mothers/caretakers of children aged 12–23 months who had missed at least one dose of the recommended by WHO for under-one-year-old children.

For controls, all mothers/caretakers who had children aged 12–23 months received the total recommended by WHO for under-one-year-old children.

Exclusion criteria. Mothers/caretakers of the children aged 12–23 months who had not begun vaccination at all, were excluded.

Sample size determination and sampling technique

Sample size determination

To estimate the sample size, 95% confidence level, 80% power, and 10% of non-response rate assumptions were used. The ratio of cases to controls (r) was set at 1:2, with an OR of 2.35. The sample size was determined by using Epi-info version 7.2.2.6. Moreover, to estimate the sample size, all significantly associated factors in a previous study conducted in North Gondar, Ethiopia, where the percentage of controls was 49.1% and the percentage of cases was 64.8 (with TT vaccine received being used as the major variable and odds ratio (OR) = 2.35), were considered.[16] Accordingly, the total sample size using Fleiss w/cc method was 317 (106 cases and 211 controls) (Table 1).

Sampling procedure

All six kebeles, three urban and three rural, in Ambo town were included in the study. The baseline survey was conducted one week prior to data collection to identify the list of children who completed their immunizations according to the schedule within 12 months (controls) and those who did not complete their immunizations or defaulted (cases) by a trained data collector. All eligible cases and controls were listed with their full addresses from the registration book of nearby health facility, separately for each selected kebeles before actual data collection. During the baseline survey, households that had completed immunization or defaulted on children between the ages of 12 and 23 months were identified and recorded according to the definition of cases and controls. The house numbers given previously by urban health extension professionals (UHEPs) were registered on the survey checklist. The total sample size was proportionally allocated to each *kebele* based on population size. Using the sampling frame of

Table 1. Variables for sample size determination for determinants of immunization defaulters among children aged 12–23 months in Ambo town, Oromia region, Ethiopia.

Main variables	% Among controls	% Among cases	AOR	Power	Non-response rate	Sample Size for		
						Cases	Control	Total
PNC attend	38%	20.4%	3.05	80%	10%	69	139	208
Counseling on vaccination	38	20.04	7.17	80%	10%	34	67	101
Fear of vaccine side effects	30.7	63	3.56	80%	10%	57	115	172
TT vaccine received	**49.1**	**64.8**	**2.35**	**80%**	**10%**	**106**	**211**	**317**

cases and controls from the baseline survey, 106 cases and 211 controls were selected by systematic random sampling technique from cases and controls separately. Households that had two or more children ages 12–23 months should have been interviewed for only one child. As part of the interview, information on the immunization status of eligible children was obtained from the caregivers and subsequently verified from childhood immunization cards maintained by the parents/guardians. The child's vaccination card and the mother's oral response were used to verify the vaccination status of the child.

Study variables

Dependent variables

Childhood immunization defaulters.

Independent variables

Socio-demographic characteristics. Residence, sex of the child, age of mother/caretaker, age of the child, religion, marital status, education, occupation, birth order, birth interval, family income, and family size.

Health-service-related characteristics. Estimate time to reach health institution, antenatal care visit, postnatal care, receive TT vaccination, and place of child delivery.

Mothers/caretakers knowledge and attitude. Age when the child starts immunizations, age at which a child should complete immunizations, a growing child does not require immunization, immunizations provide lifelong protection, immunizations are harmful for your child, immunization prevents life-threatening diseases, and multiple immunizations on the same visit are unsafe.

Operational and term definition

Fully vaccinated/complete immunization

A child between the ages of 12 and 23 months who received one dose of BCG, at least three doses of pentavalent, three doses of OPV/IPV, two doses of rotavirus vaccine, and one dose of measles vaccine by card, as well as a mother history, before reaching one year of age.

Incomplete immunized/defaulters

A child who missed at least one dose among the recommended vaccines (a dose of BCG, three doses of pentavalent, polio, and PCV, two doses of rotavirus vaccine, and a dose of measles vaccine) before reaching one year of age.

Primary caretaker

Mother or caregiver who was directly involved in vaccinating the child in the previous two years of life and who was in charge of childbirth in the previous two years of life.

Non-vaccinated

A child 12–23 years old who had not received any vaccines before the age of one year.

Data collection tool and techniques

Data collection tool

A structured questionnaire was used to collect data, which was adapted from past research.[16,17,] A questionnaire developed in English and translated into the local language of the region was used to gather data (Afan Oromo) and then re-translated into English by language experts (experienced high school language teachers) and researchers to ensure coherence with the original version.

Data collection technique

The data collectors had to wait until the mother or caretaker had finished their duties and given permission to proceed with the questionnaire, respecting their privacy. Six data collectors who have completed grade 12 and are fluent in the Afan Oromo language and three health professional supervisors who hold BSc degrees in nursing were recruited to collect data using a questionnaire based on face-to-face interviews and child immunization card reviews. They received appropriate COVID-19 transmission prevention measures such as hand sanitizer, mask use, and physical distance. After that, data were collected by trained data collectors using a structured Afan Oromo version of the questionnaire.

Data quality control and management

Training was given for both data collectors and supervisors for one day. The questionnaires were pretested on 5% (for both case and control) of data collectors in a similar population (among mothers and caregivers) in Toke Kutaye, Guder town, which is located 12 km away from the study area, after which necessary modifications were made. Data were checked for consistency, completeness, editing, and suspicious irregularities throughout the data collection and analysis using a standardized tool.

Data processing and analysis

Data were first checked manually for completeness, then coded and entered into Epi data version 3.1 and exported to SPSS version 21 for further analysis. Descriptive analysis was performed to calculate mean, frequencies, and percentages. Variance inflation factor (VIF) was used to assess multicollinearity between the independent variables. Each candidate independent variable with a value of VIF < 5 indicates the assumption of no multicollinearity between the independent variables. Bivariable logistic regression analysis was conducted to see the association of each independent variable with the outcome variable. Variables with p-values < .25 were candidate variables for the multivariable logistic regression model to reduce the effects of confounders and to identify the independent effects of each variable on the outcome variable. Hosmer and Lemeshow goodness-of-fit model was used to check model fitness, and the result indicated a good fit. Adjusted odd ratio with 95% confidence interval and p-value <.05 were reported to declare significant determinants for immunization defaulters. Finally, the result was presented with texts and tables.

Results

Socio-demographic characteristics of participants

Of the total 317 children, 316 children (106 cases and 210 controls) were included in the study, with a response rate of 99.68%. Most caretakers, 89 (84%) for cases and 194 (92.4%) for controls, were mothers. Additionally, 75 (70.79%) of case and 184 (87.7%) of controls had their child's vaccination cards as evidence of immunization status (Table 2).

Health care service-related characteristics of mothers/caretakers of cases and controls

The utilization of antenatal care by mothers showed that 21 (20.0%) of caretakers of cases and 17 (8%) of caretakers of controls did not attend antenatal care service before delivery. Additionally, 33 (31.13%) of caretakers of cases and 53 (25.24%) of caretakers of controls did not attend postnatal care service after delivery. Place of child delivery indicated that 15 (14.2%) of mothers of cases and 21 (10%) of mothers of controls delivered their child at home (Table 2).

Awareness of mothers/caretakers on determinants of immunization defaulters

Regarding the awareness of mothers/caretakers on the age at which the child begins immunization, only 29 (14.06%) cases and 64 (30.48%) controls stated "just after birth," while 65 (61.32%) cases and 141 (67.14%) controls mentioned "after six weeks", and 9 (8.49%) cases and 6 (2.86%) controls mentioned that they do not know the age at which the child should begin immunization. Perception about immunizations provide lifelong protection and multiple immunizations on the same visit are unsafe was almost similar between cases and controls (Table 2).

Determinants of immunization defaulters

First, a bivariable analysis was conducted to screen the possible determinants of childhood immunization defaulters, and variables with p-values < .25 were included in the multivariable model. Accordingly, residence, child caretaker, educational status, occupation, marital status, number of family members in the households, average monthly income, ANC, received TT during pregnancy, place of delivery, knowing at what age at the child should complete immunization were candidate variables for multiple logistic regression analysis. Thus, multiple logistic regressions were conducted in order to identify determinants of immunization defaulters. After adjustments for possible effects of confounding variables, six variables were identified to be the determinants of immunization defaulters. Finally, multiple logistic regression analysis revealed that rural residence, occupation as a farmer, household family size greater than four members, lower average monthly income, not attending ANC, not receiving TT during pregnancy, and lack of understanding about when the child's immunizations should be completed were significantly and independently associated with incomplete vaccination.

Children whose mothers/caretakers live in urban areas were 82% (AOR = 0.179, 95% CI: 0.057, 0.565) less likely to default from childhood immunization than children whose mothers/caretakers live in rural areas. In addition, mothers/caretakers who had more than four family members in their households were 2.7 times (AOR = 2.696, 95% CI: 1.143,6.358) more likely to default on their childhood immunization than those who had fewer than three family members in their household.

Mothers/caretakers who are government employee were 73% less likely to have their child default from completing immunization (AOR = 0.288, 95% CI: 0.146, 0.570) compared to mothers residing in urban areas, and mothers who had an average monthly income greater than 3000 were 66% less likely to have their child default from completion of vaccination (AOR = 0.345, 95% CI: 0.147, 0.812). Mothers who had an average monthly income of 1000–2000ETB were 68% less likely to have their child default from completion of vaccination (AOR = 0.223, 95% CI: 0.086, 0.576), and mothers who had an average monthly income 2000–3000ETB were 75% less likely to have their child default from completion of immunization (AOR = 0.250, 95% CI: 0.099, 0.628) compared to mothers having an average monthly income less than 1000ETB (Table 2).

Discussion

This study aimed to assess the determinants of immunization defaulters in order to contribute to tackling the burden of incomplete childhood immunization and its consequences. Thus, this study revealed that rural residences, government employee, family members greater than four, income greater than 3000ETB, attending ANC follow-up during pregnancy, and poor awareness about the age a child should complete immunization were determinant factors for immunization defaulters.

This study shows that rural dwellers default to more comprehensive immunizations for their children according to the schedule than urban dwellers. When compared to urban child, the child of a mother who lives in an urban area was 82% less likely to default from childhood immunization than children whose mothers/caretakers live in rural areas. This finding is consistent with the studies conducted in Bangladesh, and Shoa Robit town, Amahra Region in Ethiopia.[15,18] This might be due to urban resident mothers who might have better information and recognize the importance of immunization to complete their children's immunizations. The other possible justification might be, urban residents may also be exposed to different medias and might have better awareness, attitude and practice toward childhood immunization services. This implies that there is a need for behavior change public health intervention programs, particularly targeting mothers with under-five children in rural areas.

This study also showed that having antenatal care service during pregnancy is one of the variables significantly associated with defaulters in the immunization status of the child according to the schedule. Children whose mothers/caretakers had ANC follow-up during their pregnancy were 76% less likely to default on childhood immunizations than children whose mothers/caretakers had no ANC follow-up during their

Table 2. Bivariable and multivariable binary logistic regression analysis of determinants of immunization defaulters among children aged 12–23 months in Ambo town, Oromia, Ethiopia, 2021.

Variable		Immunization status			P-Value		
		Default N (%)	Complete N (%)	COR (95%CI)	COR	AOR	AOR (95%CI)
Residence	Rural	73 (68.9%)	180 (85.7%)	1			1
	Urban	33 (31.1%)	30 (14.3%)	0.369 (0.210,0.648)	<.001	<.001	0.179 (0.057,0.565)
Sex of the child	Male	48 (45.3%)	95 (45.2%)	1			
	Female	58 (54.7%)	115 (54.8%)	1.164 (0.688,1.971)	.994		
Age of the child	12–18	74 (69.8%)	147 (70.0%)	0.991 (0.596,1.649)	.973		
	19–23	32 (30.19%)	63 (30%	1			
Child caretaker	Mother	89 (84%)	194 (92.4%)	1			
	Father	8 (6.6%)	7 (2.68%)	2.180 (0.837,5.678)	.111	<.001	0.288 (0.146,0.570)
	Grandparent	9 (7.5%)	9 (4.3%)	0.875 (0.222,3.451)	.849	.121	0.219 (0.021,0.521)
Mother/caretaker age	≤20	6 (5.66%)	11 (5.24%)	1	.		
	21–25	22 (20.8%)	55 (26.2%)	1.364 (0.449,4.141)	.584		
	26–30	37 (34.9%)	87 (41.43%)	1.283 (0.441,3.726	.647		
	30–34	17 (18.02%)	33 (15.71%)	1.059 (0.033,3.358	.923		
	≥35	24 (22.64%)	24 (11.43%)	0.545 (0.174,1.713	.299		
Educational status	No formal education	28 (26.4%)	30 (14.29%	0.286 (0.126,0.648)	.003	.154	0.208 (0.024,1.801)
	(1-8)	34 (32.1%)	75 (35.7%)	0.588 (0.277,1.251)	.168	.930	1.122 (0.085,14.754
	(9-12)	32 (30.2%)	65 (31%)	0.500 (0.232–1.078)	.077	.434	0.444 (0.058,3.390)
	Certificate and Above	12 (11.3%)	45 (21.4%)	1			1
Occupation	Farmer	8 (7.5%)	37 (17.6%)	1			1
	Gov't employee	23 (21.7%)	19 (9%)	1.930 (0.837–4.450)	.123	.003	0.179 (0.057,0.565)*
	Daily laborer	27 (25.5%)	39 (18.6%)	0.345 (0.172,0.691	.003.	.127	0.428 (0.144,1.273)
	Housewife	48 (45.3%)	115 (54.8%)	0.603 (0.332–1.093)	.096	.394	0.653 (0.245,1.740)
Marital status	Married	81 (76.4%)	184 (87.6%)	1			1
	Single	12 (11.3%)	13 (6.2%)	0.477 (0.209,1.090)	.079	.412	1.6240 (.510,5.173)
	Divorced	13 (12.3%)	13 (6.2%)	0.440 (0.195,0.992)	.048	.486	1.726 (0.078,3.373)
Religion	Orthodox	43 (40.6%)	78 (37.1%)	0.816 (0.816,1.362)	.437		
	Muslim	18 (32.2%)	32 (15.2%)	0.800 (0.407,1.573)	.518		
	Protestant	45 (42.5%)	100 (47.6%)	1			
Family member in the households	≤3	14 (13.2%)	69 (32.9%)	1			1
	4–5	68 (64.2%)	93 (44.3%)	0.277 (0.144,0.534)	.001	.023	2.696 (1.143–6.358)
	≥6	24 (22.6%)	48 (22.9%)	0.406 (0.191,0.863)	.019	.320	0.714 (0.367,1.387)
Total child born by mother	≤3	85 (80.2%)	168 (80%)	1			
	4–5	10 (9.4%)	22 (10.5%)	1.113 (0.504,2.457)	.791		
	≥6	11 (10.4%)	20 (9.5%)	0.920 (0.421,2.008)	.834		
Preceding birth interval in months	≤24	28 (26.42%)	61 (29.05%)	1	.		
	25–49	65 (61.32%)	109 (51.9%)	0.770 (0.447,1.324)	.345		
	≥49	13 (22.26%)	53 (25.24%)	1.412 (.654,3.048)	.379		
Average monthly income	≤1000 (ETB)	38 (35.8%)	77 (36.7%)	0.392 (0.189,0.814)			1
	1001–2000 ETB	29 (27.36%)	28 (13.33%)	0.187 (0.083,0.419)	.012	.002	0.223 (0.086,0.576)
	2001–3000 ETB	27 (25.47%)	43 (20.47%)	0.308 (0.141–0.675)	.003	.004	0.250 (0.099,0.628)
	≥3001 ETB	12 (11.32%)	62 (29.52%)	1	.001	.015	0.345 (0.147,0.812)
Attended ANC	No	85 (80.2%)	193 (91.9%)	1			1
	Yes	21 (19.8%)	17 (8.1%)	2.805 (1.409,5.584)	.002	<.001	0.237 (0.107,0.525)
Received TT	Yes	84 (79.25%	184 (87.62%)	1			1
	No	22 (20.75%)	(12.38%)	0.563 (0.30,1.047)	.059	1.011	1.011 (0.335,3.050)
Attended PNC	Yes	73 (77.2%)	157 (74.8%)	1			
	No	33 (81.13%)	53 (25.2%)	0.747 (0.446,1.251)	.267		
Place of delivery	Home	15 (14.2%)	21 (10%)	0.830 (0.393.1.754)	.626		
	Hospital	40 (37.7%)	103 (49.0%)	1.527 (0.923,2.526)	.990		
	Health center	51 (48.1%)	86 (41%)	1			

(*Continued*)

Table 2. (Continued).

Variable		Immunization status			P-Value		
		Default N (%)	Complete N (%)	COR (95%CI)	COR	AOR	AOR (95%CI)
Time taken to vaccination site	Less than 15 minute	39 (36.8%)	85 (40.5%)	1			
	15–30 minutes	45 (42.5%)	91 (43.3%)	1.410 (0.731,2.720)	.305		
	30-1 hour	22 (20.8%)	34 (16.2%)	1.308 (0.687,2.492)	.413		
Awareness at which child to begins immunization	At delivery	29 (14.06%)	64 (30.48%)	1			
	Six week after delivery	65 (61.32%	141 (67.14%)	1.103 (0.191,6.370)	.912		
	Not sure/I do not know	9 (8.49|%)	6 (2.86%	0.937 (0.174,5.435)	.975		
Awareness at age the child should complete immunization	I don't know	57 (53.77%)	90 (42.86%)	1		1	
	At one year	40 (38.68%)	110 (52.38%)	0.211 (0.021,2.079	.183	.0.476	1.241 (0.685,2.247)
	After one year	5 (3.77%)	10 (4.76%	1.583 (0.474,5.289	.455	.041	0.070 (0.005,0.308
Do you know at what age to begin immunization?	Yes	79 (74.53%)	141 (67.14%)	1			
	No	27 (25.47%)	69 (32.86%)	1.070 (0.872,1.313)	.520		
Do children grow well with no need for immunization?	Yes	92 (86.79%	178 (84.76%)	1			
	No	14 (13.21%)	32.15.24%)	1.181 (0.601,2.324)	.630		
Immunizations are harmful for your child?	Yes	88 (83.02%)	185 (88.1%)	1			
	No	18 (16.98%0	25 (11.9%)	0.995 (0.765,1.295)	.972		
Do childhood vaccinations prevent life-threatening diseases?	Yes	92 (86.79%)	170 (80.95%)	1			
	No	14 (13.21	40 (19.05%)	0.922 (0.734,1.159)	.489		
Are multiple immunizations on the same visit unsafe?	Yes	68 (64.15%)	132 (62.86%)	1			
	No	38 (35.85%)	48. (22.86%)	1.267 (1.012,1.588)	.338		
Do vaccinations cause health problems for children?	Yes	6 (5.66%)	26 (13.38%)	1			
	No	100 (94.34%)	184 (8.62%)	2.355 (0.938,5.912)	.680		

CI (Confidence Interval), COR (Crude Odds Ratio), AOR (Adjusted Odds Ratio), 1 = Reference.

pregnancy. This result is consistent with studies conducted in Assosa town, Ethiopia, and Shewa Robit, Ethiopia.[15,19] This can be due to mothers who had visits to antenatal care services having a chance to communicate with health workers to hear about the benefits of vaccination for their children better than mothers who did not follow such health care services. The ANC visit may help as a bridge to enhance continuum of care and get counseling services about routine childhood immunization. This recommends that there should be a public health initiative to enhance ANC contact among pregnant women to enhance their intention and practice to vaccinate their children.

Family size was significantly associated with immunization defaulters. Those having family sizes greater than four were more likely to be defaulters compared to those with less than three family members in their households. This result is consistent with a study conducted in Australia.[17] This might be due to mothers having a large family size, which might affect the mothers' ability to care for younger children, or the mother might not have enough time to travel for immunization due to parent workload in larger families, or that vaccination timeliness reduces for high birth-order children. The other reason might be due to the mothers past experience, that is if the mother faced any maltreatment or negative experience while vaccinating her other older children, then she might refuse to go to vaccinate the current child. Interventions should give more emphasis on mothers with a higher number of children.

The average monthly income of a household is another determinant that has an association with the completion of vaccination. According to this study, primary caretakers/mothers who had an average monthly income of greater than 3000 ETB were less likely to default on childhood immunization than children whose mothers/caretakers had an average monthly income of less than 1000 ETB, an average monthly income of between 1000 and 2000 ETB and an average monthly income of between 2000 and 3000 ETB. This finding is consistent with the study conducted in Gindhir District, Southeastern Ethiopia.[10] Children in the richest wealth quintile were more likely to be fully vaccinated when compared to children in the poorest quintile. This could also be due to mothers of children with a stated average monthly income being able to afford hidden or indirect costs during vaccination service uptake, such as transportation. This may also be attributed to the issue of prioritizing health in the richest mothers, i.e the mothers from the richest families may prioritize their children's health more than those from the poorest families, who might give more emphasis on their daily livelihood and work.

The occupational status of mothers or caregivers is another variable that has an association with the determinant of immunization defaulter. Mothers or immediate caretakers whose occupations of government employee were less likely to default from childhood immunization than children whose mothers/caretakers were farmers. This finding is consistent with the study conducted in Ghana.[20] In contrast, a study done in Yirgalem town, Ethiopia, found that occupation was not statistically associated with full immunization status.[21] The possible justification might be that mothers who are government employee might get different health information related with immunization and would have better awareness, attitude and practice as compared to farmer caregivers.

Mothers/caretakers who had a lack of understanding about when the child's immunizations should be completed were more likely to default on their childhood immunizations than mothers who had awareness of when their child should finish immunization. This finding is consistent with the study conducted in Woldia Town, Northeast Ethiopia and Yirga Cheffe district South Ethiopia.[12,21] This might be due to poor immunization counseling at facility and inadequate advice regarding the next appointments, which have been found to contribute to the problem of incomplete vaccination because only three health institutions give immunization services in the study areas.

Strength and limitation of the study

This study used immunization card and EPI records to minimize recall bias and misclassification of age and immunization status of the child. However, some of the children had no vaccination cards. This leads to lack of objective information about the vaccination status of the child and dependence on the the mother's verbal responses that might be liable to recall bias and misclassification of cases and controls. The study was not supported by a qualitative study to explore the reasons of mothers' or caregivers' default to complete immunization of children. Data related with continuum of maternal care such as antenatal, and postnatal care number of visits for index pregnancy were collected by self-report which might be prone to recall and socially desirable bias.

Conclusions

In conclusion, this study has found that urban residences, government employee by occupation, family numbers greater than four and above, higher monthly income, attending ANC, and knowing the age at which the child should complete immunization were identified as determinants of childhood immunization defaulters. It is better to work to raise the awareness of mothers by provision of health education to increase the utilization of ANC visits and when to complete child immunizations, which in turn leads to vaccinating their children. Social Behavior Change (SBC) intervention programs should focus on providing health information about the importance of the vaccine, and vaccine schedule. Due attention should be given for rural residents and farmers who had limited access to information and are more prone to defaulting. Program designers, health managers and policy-makers should consider those identified factors while they are designing intervention programs to enhance immunization coverage. Tailored or targeted intervention should be designed based on identified factors and for specific segments of the population. Moreover, further qualitative research is needed to identify other important contextual factors which contributed to defaulting.

Abbreviations and acronyms

ANC: Antenatal care; AOR: Adjusted Odds Ratio; BCG: Bacillus Calmette Guerin; CHI: Childhood Immunization; COR: Crude Odds Ratio; DHS: Demographic Health Survey; DOR: Dropout Rate; DPT: Diphtheria, pertussis, tetanus; EDHS: Ethiopian Demographic Health Survey; eHMIS: electronic Health Management Information System; EPI: Expanded Program on Immunization; ETB: Ethiopian birr; HEWs: Health extinction workers; HPV: Human papilloma virus; HSTP: Health Sector Transformation Plan; MCH: Maternal and Child Health; MCV: Measles Vaccine; OPV: Oral Polio Vaccine; PCV: Protein conjugated polysaccharide vaccine; PNC: Postnatal Care; SBA: skill birth attendant; SPSS: Statistical Package for Social Science software; TTBA: traditional birth attendant; TT: Tetanus toxide; UHEPs: Urban Health Extension professionals; VPD: Vaccine-Preventable Disease; WHO: World Health Organization.

Acknowledgments

We would like to express our deepest gratitude to Ambo University, College of Health Sciences, and Department of Public Health for timely approval of the topic. Our special thanks go to the Ambo town Administrative and Health office staff that supported me in providing preliminary information about the study subjects' family health team for giving me the town information relevant to this thesis. Last but not least, we are also pleased to thank the study participants, data collectors, and supervisors for their time and contribution to the study.

Author contributions

All authors made substantial contributions to the 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.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

Ethical approval and consent to participate

Ethical clearance was obtained from Ambo University, College of Medicine and Health Sciences by institutional review board. Permission letter was obtained from the district health office and from each selected Kebeles. After the purpose and objective of the study was informed, written informed consent was obtained from each study participants. All participants were informed that participation was on a voluntary basis and they could withdraw from the study at any time if they were not comfortable with the questionnaire. To maintain confidentiality, data were collected and analyzed anonymously. All methods were carried out in accordance with the Declaration of Helsinki.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the first author on reasonable request.

References

1. World Health Organization. A guide for conducting an Expanded Programme on Immunization review. Geneva: World Health Organization; 2017. (WHO/IVB/17.17). Licence: CC BY-NC-SA 3.0 IGO.
2. Strategic Advisory Group of Experts on Immunization W. The global vaccine action plan 2011–2020. Review and lessons learned. Geneva World Heal Organ; 2019. (WHO/IVB/19.07). p. 1–30.
3. Secretariat A, Report A. Global Vaccine Action Plan; 2015.
4. Tamirat KS, Sisay MM. Full immunization coverage and its associated factors among children aged 12–23 months in Ethiopia: further analysis from the 2016 Ethiopia demographic and health survey. BMC Public Health. 2019;19(1):1–7. doi:10.1186/s12889-019-7356-2.
5. Troeger CE, Blacker BF, Khalil IA, Zimsen SRM, Albertson SB, Abate D, Abdela J, Adhikari TB, Aghayan SA, Agrawal S. Mortality, morbidity, and hospitalisations due to influenza lower respiratory tract infections, 2017: an analysis for the Global Burden of Disease Study 2017. Lancet Respir Med. 2019 Jan;7(1):69–89. doi:10.1016/S2213-2600(18)30496-X.
6. World Health Organization. Global difusion of eHealth: making universal health coverage achievable. Report of the third global survey on eHealth. Geneva: World Health Organization; 2016. Licence: CC BY-NC-SA 3.0 IGO. https://iris.who.int/bitstream/handle/10665/252529/9789241511780-eng.pdf?sequence=1.
7. Ethiopian Ministry of Health. Health sector transformation plan II 2020/2021–2024/2025. Ethiop Ministry Health. 2021;25 (February):1–128.
8. Peck M, Gacic-Dobo M, Diallo MS, Nedelec Y, Sodha SS, Wallace AS. Global routine vaccination coverage, 2016. Relev Epidemiol Hebd. 2017;92:701–7.
9. Ethiopian Public Health Institute (EPHI) [Ethiopia] and ICF. Ethiopia mini demographic and health survey 2019: final report. Rockville (MD): EPHI and ICF; 2021.
10. Zenbaba D, Sahiledengle B, Debela MB, Tufa T, Teferu Z, Lette A, Gezahegn H, Solomon D, Tekalegn Y. Determinants of incomplete vaccination among children aged 12 to 23 months in Gindhir district, southeastern Ethiopia: unmatched case–control study. Risk Manag Healthc Policy. 2021;14:1669–79. doi:10.2147/RMHP.S295806.
11. Adedokun ST, Uthman OA, Adekanmbi VT, Wiysonge CS. Incomplete childhood immunization in Nigeria: a multilevel analysis of individual and contextual factors. BMC Public Health. 2017;17(1):1–0. doi:10.1186/s12889-017-4137-7.
12. Abebe AM, Wudu Kassaw M, Zemariam AB, Estifanos Shewangashaw N. Coverage, opportunity, and challenges of expanded program on immunization among 12–23-month-old children in Woldia Town, Northeast Ethiopia, 2018. Biomed Res Int. 2019;2019:1–9. doi:10.1155/2019/5302307.
13. Ndwandwe D, Nnaji CA, Mashunye T, Uthman OA, Wiysonge CS. Incomplete vaccination and associated factors among children aged 12–23 months in South Africa: an analysis of the South African demographic and health survey 2016. Hum Vaccines Immunother. 2021;17(1). doi:10.1080/21645515.2020.1791509.
14. Maina LC, Karanja S, Kombich J. Immunization coverage and its determinants among children aged 12–23 months in a peri-urban area of Kenya. Pan Afr Med J. 2013;14:3. doi:10.11604/pamj.2013.14.3.2181.
15. Shewasinad S. Journal of pediatric neurological disorders vaccine dropout rate and associated factors among children age 12–23 month in Shewa Robit. Ethiopia. 2020;3:2020.
16. Chanie MG, Ewunetie GE, Molla A, Muche A. Determinants of vaccination dropout among children 12-23 months age in north Gondar zone, northwest Ethiopia, 2019. PLOS ONE. 2021;16 (2 February):1–13. doi:10.1371/journal.pone.0246018.
17. Lim C, Currie GE, Waddington CS, Wu Y, Setijo S, Leask J, Marsh JA, Snelling TL. Identification of the determinants of incomplete vaccination in Australian children. Vaccine. 2019 Apr;1:100010. doi:10.1016/j.jvacx.2019.100010.

18. Sarker AR, Akram R, Ali N, Sultana M. Coverage and factors associated with full immunisation among children aged 12–59 months in Bangladesh: insights from the nationwide cross-sectional demographic and health survey. BMJ Open. 2019;9(7): e028020. doi:10.1136/bmjopen-2018-028020.
19. Jimma MS, GebreEyesus FA, Chanie ES, Delelegn MW. Full vaccination coverage and associated factors among 12-to-23-month children at Assosa Town, Western Ethiopia, 2020. Pediatr Heal Med Ther. 2021 Dec 31;12:279–88. doi:10.2147/PHMT.S306475.
20. Wemakor A, Helegbe GK, Abdul-Mumin A, Amedoe S, Zoku JA, Dufie AI. Prevalence and factors associated with incomplete immunization of children (12-23 months) in Kwabre East district, Ashanti Region, Ghana. Arch Public Health. 2018;76(1):1–9. doi:10.1186/s13690-018-0315-z.
21. Nenko G, Addisu Y, Eifa A, Ketema W. Predictors of partial immunization among children aged 12–23 Months in Yirga Cheffe district, South Ethiopia – a community-based unmatched case-control study. Pediatr Heal Med Ther. 2021;12:395–404. doi:10.2147/PHMT.S326319.