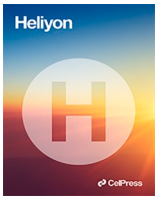
Heliyon 10 (2024) e30764

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon



Research article

Determinants of second-dose measles vaccination dropout in Ethiopia: A community-based matched case-control study

Bogale Adugna [a], Assefa Tola [b], Meseret Belete Fite [c], Aboma Motuma [d,*]

[a] East Bale Zone Health Office, Oromia, Ethiopia
[b] School of Public Health, College of Health and Medical Sciences Haramaya University, Harar, Ethiopia
[c] Department of Public Health, Institute of Health Sciences, Wollega University, Nekemte, Ethiopia
[d] School of Nursing and Midwifery, College of Health and Medical Sciences, Haramaya University, Harar, Ethiopia

ARTICLE INFO

Keywords:
Second dose of measles
Vaccination dropout
Children
Determinants
Ethiopia

ABSTRACT

Background: Measles vaccination is the most important public health intervention and a cost-effective strategy to reduce morbidity and mortality in under-five children. Although Ethiopia's government developed a measles elimination strategic plan by 2020, the full coverage of immunization was 43 %. Therefore, this study aimed to identify determinants of second-dose measles vaccination (MCV2) dropout among children aged 24–35 months in East Bale Zone, Ethiopia.

Method: A community-based matched case-control study was conducted among 351 children (117 cases and 234 controls). Children who received the first dose of measles vaccine but did not receive the second dose were cases, and children who received both doses of measles vaccine were control. The matches were based on age and residence. The data were collected using a structured questionnaire, entered into Epi Data 3.1, cleaned, exported, and analyzed using Stata version 16.1. A multivariable conditional logistic regression analysis was performed. Variables with a P value of <0.05 were considered significant determinants of the dependent variable at the 95 % confidence level.

Results: Mothers who were unable to read and write (mAOR: 4.0; 95 % CI: 1.59–10.2), did not receive counseling (mAOR: 3.19; 95 % CI: 1.62–6.27), spent $\geq$30 min to reach health facilities (mAOR; 2.76, 95 % CI: 1.25–6.1), and did not attend postnatal care (mAOR; 3.46, 95 % CI: 1.58–7.57) were significantly and positively associated with second-dose measles vaccination dropout. In addition, mothers who had poor knowledge of second-dose measles vaccination (mAOR; 3.20, 95 % CI: 1.50–6.70) and waited more than an hour for measles vaccination at health facilities (mAOR; 2.61, 95 % CI: 1.0–6.20) were significantly more likely to experience second-dose measles vaccine dropout.

Conclusions: The key factors associated with second-dose measles vaccination dropout are maternal illiteracy, lack of PNC, inadequate maternal knowledge and poor counseling about MCV2 vaccination, long distances travel to healthcare facilities and extended waiting times at vaccination providing sites. Health extension workers emphasize strengthening home visit programs in catchment households to improve mothers' awareness of measles vaccination.

Abbreviations: HEWs Health extension workers, HF Health Facility; mAOR Matched Adjusted Odd Ratio, mCOR Matched Crude Odd Ratio; MCV Measles-Containing Vaccine, MCV1 first dose of the measles-containing vaccine; MCV2 second dose of the measles-containing vaccine, Penta 3 Pentavalent vaccine third dose; PNC postnatal care, TT Tetanus Toxoid.

* Corresponding author.

https://doi.org/10.1016/j.heliyon.2024.e30764
Received 12 January 2024; Received in revised form 3 May 2024; Accepted 3 May 2024
Available online 4 May 2024

1. Introduction

Measles is one of the most contagious diseases [1] and a risk of death [2] in under five years of age [3]. Globally, in 2021, it was estimated that 9 million of cases and 128,000 deaths were attributed to measles [4]. Similarly, in 2019, over 207,000 measles deaths occurred globally, and the highest number of cases reported in sub-Saharan Africa [5].

In sub-Saharan Africa, the number of measles cases has increased by 400 % [6,7], mainly in Ethiopia, Somalia, and the Democratic Republic of the Congo [6]. In Ethiopia, there was a nearly 5-fold increase in confirmed measles cases from 2021 to 2022, with an incidence rate of 82 cases per 100,000 people, 16,814 confirmed measles cases and 182 deaths reported nationally from August 2021 to May 2023 [8].

In 2011, the African Regional Immunization Technical Advisory Group adopted a measles elimination strategy by 2020 [9]. The milestone was to reduce an annual incidence of 1 per 1000,000 children and to achieve 95 % of the second dose of MCV2 [9]. Despite these ambitious goals, nearly 14.7 million children miss MCV2 globally, and millions of them remain susceptible to measles infection [10]. Children in low- and middle-income countries are more likely to have missed measles vaccinations [11]. Moreover, a study conducted in 23 African countries showed that more than half (52.2 %) of the respondents reported MCV2 dropout rate was greater than 20 %, which is alarming for the region [12].

Despite the Ethiopian government launching the Reaching Every District (RED) Health Extension Program (HEP) to reduce the dropout of MCV2 [13] and to attain the national target of MCV2 50–80 %; recent evidence showed that only 9 % of the children received MCV2, while 54 % of the children were vaccinated for MCV1 [14,15]. Moreover, the Ministry of Health report showed that the second dose measles vaccination dropout was >50 % [16]. However, WHO forward if the 2-dose measles vaccine dropout is greater than 10 % the service has a serious quality problem that needs to be addressed [17]. In Ethiopia, even if the basic immunization coverage was good the outbreaks, morbidity, and mortality from measles vaccine-preventable disease is still high [18].

Unlike previous studies in Ethiopia, this work was a community-based matched case-control design that addressed large geographical locations in urban and rural settings where high measles dropout rate. Moreover, previous studies in Ethiopia mainly focused on incomplete immunization and associated factors of MCV1 [7,19,20]. Despite widespread recognition of the problem, the predictors of second-dose measles vaccination dropout is not widely known in Ethiopia. Therefore, the current study aimed to identify determinants of second-dose measles vaccination dropout in Ethiopia.

2. Methods

2.1. Study setting, design, and period

This study was conducted in the Southeast Bale Zone, Oromia Region, Ethiopia. It is located 557 km from southeastern Addis Ababa, the capital city of Ethiopia. It has 32 rural and 4 urban *kebeles (the smallest administrative unit in Ethiopia)* with a total of 169,617 population [21]. It has also eight health centers (four urban and four rural) and 32 health posts that provide immunization services at static and outreach program and the health service coverage was 57 % [22]. A community-based matched case-control study was conducted among households in southwest Bale Zone Ethiopia from January 1–30, 2023.

2.2. Study population, sampling, and sample size

The study population included 24 to 35-month-old children who were living in the selected kebeles. Children who were vaccinated first dose of measles but dropped the second dose of the measles vaccine were considered as cases, while children who received both doses of the measles vaccine were considered as controls. If the households had more than one eligible child, the youngest child was selected using the lottery method.

Children with mothers or caregivers who were mentally ill and unable to listen or respond during data collection house-to-house visits were excluded. Households who were not permanent residents were also excluded. The cases and controls were matched by the age of the child (±1 month) and residential location (urban or rural).

The sample size was determined using double population proportion formulas with their corresponding assumptions, and the largest sample was considered. Factors significantly associated with the second-dose measles vaccination dropout were considered to determine the sample size. Sample size was calculated using Open Epi 3.1.2 version software was used for matched case-control study with the following assumptions: a two-sided confidence level of 95 % ($z\alpha = 0.05$); 80 % power ($Z\beta = 0.84$); a case-control ratio of 1:2; a design effect of 2; and a coefficient of 0.2 phi, as suggested by DuPont [23]. Because the correlation coefficient for exposure between the matched cases and controls was unknown, the assumption of a 3-fold greater odds ratio (OR) for the dropout of MCV2 in exposed children relative to unexposed children and 10 % of nonresponse rate was considered. The final sample size required for this study was 357 participants (119 cases and 238 controls).

The study participants were selected using a multistage sampling technique. The district was classified into two strata: urban and rural kebeles. In the first stage, 8 (25 %) rural kebeles and 1 (25 %) urban kebele were selected randomly from 32 rural and 4 urban kebeles, respectively. For each selected kebele, a list of cases and controls with their full addresses was taken from the Expanded Program Immunization (EPI) registration logbook of nearby health centers and health posts. Then, a sampling frame was prepared for each selected kebele for the case and control groups separately and sorted in consecutive order. To provide an equal chance in the selection of both cases and controls, a proportional allocation technique was performed across each selected kebele. All eligible households were identified through house-to-house visits with the help of health extension workers. Finally, a random sampling

technique was applied to access cases and age and residence-matched controls from the sampling frame of both cases and controls.

2.3. Data collection

The English version of the questionnaire was developed by reviewing relevant literature and standard questionnaire [24–26], translated into the local language (Afan Oromo), and checked by bilingual experts to ensure the consistency and accuracy of the translation. The questionnaire was pretested among women who were residing in a similar setting outside of the study area. Before data collection, questions and the translation were refined based on the feedback obtained during the pretest.

The data were collected by health professionals who were familiar with the local language and sociocultural conditions of the community. Three-day training focused on the content of the questionnaire, the data collection techniques, and the ethical conduct of human research was offered. The field supervisors closely supervised the data collection processes and checked daily base for the completeness of the questionnaire.

The data were collected using a pretested structured questionnaire through face-to-face interviews with the mother/caregiver of the child. The immunization history was collected in two ways based on the availability of the immunization card and the verbal report of the mother/caregiver. After identifying a child's age, the mother/caregiver was asked if they had a child immunization card.

2.4. Variables and measurements

According to Ethiopian national immunization guidelines, MCV2 is given as a final vaccine at two years of age [18]. We obtained information about measles vaccine among those who had an immunization card. However, data collectors asked the mothers/caregivers on immunization history for those whose did not have immunization cards. Knowledge related to measles vaccination was assessed using nine items. Study participants were asked "yes or no" questions about knowledge at the time of the survey. If mothers responded with a correct answer, we coded it as one, and if mothers responded with an incorrect answer, we coded it as zero.

Sociodemographic characteristics such as the age of the mother and the child, marital status, religion, ethnicity, parity, educational status, occupation, residence, household income, and family size were measured through face-to-face interviews. In addition, maternal and child health services utilization like antenatal care (ANC) follow-up during the last pregnancy, place of delivery, postnatal care (PNC), tetanus immunization status, pentavalent vaccine third dose (Pant 3) and pneumococcal conjugate vaccine third dose (PCV3), vaccination schedule, waiting time for vaccinations, distance to the nearest health facility, counseling services and knowledge of the MCV2 vaccination were also assessed using chart review and/or face to face interviews.

2.5. Operational definitions

Distance to health facility refers to the distance between the service user's residence and the immunization facility. It was classified as a walk of <30 min or ≥ 30 min [27].

Knowledge of vaccine: This scale contains nine items ranging from 0 to 1 that sum to a total score ranging from 0 to 9. A total score of four and above indicates good knowledge of the measles vaccine and poor knowledge if the score is less than four [28].

The waiting time for immunization: mothers who wait ≥ 30 min for immunization services after arrival at facilities was considered as a long waiting time, and <30 min as an acceptable waiting time [29].

2.6. Data processing and analysis

The data were entered into EpiData version 3.1, cleaned, coded, and checked for missing data and outliers before being exported to STATA version 16.1 for further analysis. Descriptive statistics like frequencies, mean, cross-tabulations, and percentages were performed to summarize the data and present categorical variables. A conditional logistic regression model was used for the analysis. The fitness of the model was checked by the Hosmer-Lemeshow statistic ($P = 0.476$) and omnibus tests. All variables with $p < 0.25$ in the bivariable analysis were candidates for the multivariable conditional logistic regression analysis to control confounders. A multicollinearity test was performed to determine the correlation between independent variables using the variance inflation factor was 0.46. The backward regression was used with selected variables in the final model. Explanatory variables that were significantly associated with the outcome variables in the multivariable analysis with a P value < 0.05 were identified. To measure the strength of the association between predictors and outcome variables the odds ratios were calculated with a 95 % confidence interval.

2.7. Ethical considerations

Ethical approval was obtained from the Institutional Research Ethics Review Committee (Ref. No. IHRERC/119/2020) of the Haramaya University College of Health and Medical Sciences. A supportive letter was taken from the School of Graduate Study to the southwest administrative. Data were collected after informed voluntary written consent was obtained from the mothers or caregivers. No personal identification was used in the data collection form, and the collected data were analyzed confidentially and anonymously.

3. Results

3.1. Sociodemographic characteristics

Among 357 sampled women, 351 (117 cases and 234 controls) were interviewed, with a 98.3 % response rate. The majority, 315 (89.7 %) of the study participants were from rural areas, and 190 (54.1 %) were female. The total mean age of the mothers was 27.7 (SD ± 5.89) years. The mean age of the mothers in the case group was 27.6 years (SD ± 6.01), and in the control group was 27.9 years (SD ± 5.80). Regarding educational status, 41 mothers of cases (35 %) and 38 mothers of controls (16.2 %) were unable to read or write. Among mothers, 64 (54.7 %) cases and 114 (48.7 %) control were housewives. The majority of mothers, 101 (86.3 %) cases, and 211 (90.2 %) control were married. Most of the children age, 65 (55.6 %) of cases and 130 (55.5 %) of control were 28–31 months (Table 1).

3.2. Maternal health service utilization and MCV2 vaccination knowledge

Of the total study participants, 25 (21.4 %) cases and 40 (17.1 %) control mothers did not attend ANC visits during pregnancy. Only 38 (32.5 %) cases and 75 (32.1 %) control mothers had received at least one dose of the TT vaccine. A total of 64 (54.7 %) cases and 105 (44.9 %) control mothers delivered the index child at a health facility. Furthermore, 57 (48.7 %) cases and 54 (23.1 %) control did not attend postnatal care follow-up for the index child. Regarding MCV2 vaccination knowledge, 50 (42.7 %) cases and 140 (59.8 %) control mothers had good knowledge. Furthermore, 24 (6.8 %) cases and 46 (13.1 %) control had experienced five or more births (Table 2).

3.3. Access to health services

A total of 72 (61.5 %) cases and 113 (48.3 %) control mothers had received home visits. About half (47.9 %) of cases and two-third of (76.5 %) control mothers were advised about the measles vaccine being administered in two doses and at what age the second vaccine should be administered. Regarding the distance among the study participants, 50 (42.7 %) cases and 160 (68.4 %) control walk less than 30 min from their houses to health facilities. Of all the study participants, 24 (20.5 %) cases and 22 (9.4 %) control mothers mentioned more than 1 h waiting time to vaccinate immunization services after arriving at the health facility. Furthermore, 39 (33.3 %) cases and 70 (29.9 %) control mothers were reported that they had experience of went to home without receiving the immunization service for their children due to lack of measles vaccine at the health facility (Table 3).

Table 1
Socio-demographic characteristics of mothers and children aged from 24 to 35 Months in ginnir district, east bale zone Ethiopia January 2023 *(n = 351)*.

Variable	Category	Cases n = 119 (%)	Control n = 238 (%)
Age of child	24–27 months	44 (37.6)	90 (38.5)
	28–31 months	65 (55.6)	130 (55.5)
	32–35 months	8 (6.8)	14 (6)
Sex of child	Male	57 (48.7)	104 (44.4)
	Female	60 (51.3)	130 (55.6)
Age of mother	15–24 years	37 (31.6)	75 (32.1)
	25–34 years	63 (53.9)	126 (53.9)
	35 and above	17 (14.5)	33 (14)
Residency	Rural	105 (89.7)	210 (89.7)
	Urban	12 (10.3)	24 (10.3)
Mother marital status	Married	101 (86.3)	211 (90.2)
	Divorce/separated	9 (7.7)	13 (5.6)
	widowed	7 (6)	10 (4.3)
Occupation	Farmer/housewife	64 (54.7)	114 (48.7)
	Merchant	44 (37.6)	96 (41)
	Govnt/employee	9 (7.7)	24 (10.3)
Ethnicity	Oromo	97 (82.9)	184 (78.6)
	Amhara	17 (14.5)	42 (18)
	Others	3 (2.6)	8 (3.4)
Religion	Muslim	81 (69)	160 (68.4)
	Orthodox	24 (20.5)	58 (24.8)
	Protestant	12 (10.5)	16 (6.8)
Educational status of the mother	Unable to read and write	41 (35)	38 (16.2)
	Primary (grade 1–8)	60 (51.3)	119 (50.9)
	Secondary and above	16 (13.7)	77 (32.9)
Family size	≤5	87 (74.4)	188 (80.3)
	>5	30 (25.6)	46 (19.7)

Table 2
Maternal health service utilization, and maternal knowledge determinants of MCV2 vaccination dropout among children aged 24–35 Months in ginnir district east bale zone Ethiopia January 2023 *(n = 351)*.

Variable	Category	Cases n = 119 (%)	Control n = 238 (%)
ANC visit	**No ANC Visit**	**25(21.4)**	**40(17.1)**
	Only 1st Visit	42 (35.9)	84 (35.9)
	Second Visit	33 (28.2)	72 (30.8)
	3rd visit-4thvisit	17 (14.5)	38 (16.2)
Number of TT vaccination	No TT vaccination	48 (41)	96 (41)
	1st dose only	38 (32.5)	75 (32.1)
	2nd dose	23 (19.7)	45 (19.2)
	3rd and above dose	8 (6.8)	18 (7.7)
Delivery place	Home	53 (45.3)	129 (55.1)
	Health institution	64 (54.7)	105 (44.9)
Numbers PNC check-up	No PNC visit	57 (48.7)	54 (23.1)
	1st check-up	35 (29.9)	95 (40.6)
	2nd and above	25 (21.4)	85 (36.3)
Parity	Para 1	32 (27.4)	60 (25.6)
	Para 2-4	61 (52.1)	128 (54.7)
	Para 5 and above	24 (20.5)	46 (19.7)
Childbirth order	1st birth order	32 (27.4)	60 (25.6)
	2nd – 4th	61 (52.1)	124 (53)
	>4	24 (20.5)	50 (21.4)
Mother knowledge	Poor	67 (57.3)	94 (40.1)
	Good	50 (42.7)	140 (59.8)

Legend: ANC, Antenatal Care; TT, Tetanus Toxoid.

3.4. Determinants of second-dose measles vaccination dropout

According to the bivariable conditional logistic regression analysis educational status of mothers, family size, place of delivery, postnatal care utilization, maternal knowledge, counseling on the MCV2 vaccine, distance to reach the health facility, waiting time and postponed vaccination schedule were variables that fulfilled the criteria to be included into the multivariable conditional logistic regression.

The odds of second-dose measles vaccination dropout were 4 times greater among mothers who were unable to read and write (mAOR: 4.0; 95 % CI: 1.59–10.2) than mothers who attended secondary school and above. The odds of second-dose measles vaccination dropout were 3.2 times greater among mothers who did not receive measles vaccination counseling (mAOR: 3.19; 95 % CI: 1.62–6.27) than mothers who received counseling. Moreover, mothers who spent ≥30 min to reach nearby health facility were 2.8 times more likely to drop out of second-dose measles (mAOR; 2.76, 95 % CI: 1.25–6.1) than their counterparts. The odds of second-dose measles vaccination dropout were 3.5 times greater among mothers who did not attend postnatal care (mAOR; 3.46, 95 % CI: 1.58–7.57) than among mothers who attended postnatal care. Mothers who had poor knowledge of second-dose measles vaccination were 3.2 times more likely to drop out than mothers who had poor knowledge (mAOR; 3.20, 95 % CI: 1.50–6.70). In addition, mothers who await more than 1 h for measles vaccination at health facilities (mAOR; 2.61, 95 % CI: 1.0–6.20) were 2.6 times more likely to drop out of second-dose measles vaccination than mothers who await less than half an hour for vaccination (Table 4).

Table 3
Health service accessibility-related determinants of MCV2 vaccination dropout among children aged 24–35 Months in ginnir district east bale zone Ethiopia January 2023 *(n = 351)*.

Variable	Category	Cases n = 119 (%)	Control n = 238 (%)
HEW/HW home visit	No visit	72 (61.5)	113 (48.3)
	Monthly	19 (16.2)	42 (17.9)
	Every 2 month	14 (12)	51 (21.8)
	Quarterly	12 (10.3)	28 (12)
Counseling on MCV2	yes	56 (47.9)	179 (76.5)
	no	61 (52.1)	55 (23.5)
Distance traveled to the health facility	<30 min	50 (42.7)	160 (68.4)
	≥30 min	67 (57.3)	74 (31.6)
Waiting time for vaccination at HF	<30 min	33 (28.2)	113 (48.3)
	30–60 min	60 (51.3)	99 (42.3)
	>1 h	24 (20.5)	22 (9.4)
Schedule postponed	yes	60 (51.8)	99 (42.3)
	no	57 (48.7)	135 (57.7)
Absent of vaccine on schedule day	yes	39 (33.3)	70 (29.9)
	no	78 (66.7)	164 (70.1)

Legends: HEW, Health Extension Workers; HW, Health Workers; MCV2, Measles-Containing-Vaccine Second-Dose; HF, Health Facility.

4. Discussion

This study aimed to assess the determinants of second-dose measles vaccination dropout in East Bale Zone Ethiopia. Maternal illiteracy, lack of PNC, poor maternal knowledge and absence of counseling on MCV2, distance to reach the health facility, and waiting time at the site of the vaccine center were identified as significant independent associated factors for second-dose measles vaccination dropout. It has implications in terms of preventing infection and averting epidemics of measles.

This finding suggested that children born from mothers unable to read and write had greater odds of dropping out of the second-dose measles vaccine. This work is consistent with previous studies in Ethiopia [30–32], Kenya [33], and studies in sub-Saharan Africa [34]. A possible explanation might be that educated mothers have a better understanding and decision-making skills in child health services like vaccination [35]. Moreover, previous studies show that being less educated and having limited basic information increases the likelihood of not adhering to the vaccination schedule [36]. Inconsistent findings have been reported in Uganda, which showed no significant association between mother's education and completion of vaccination [37]. A possible explanation for this could be that the Ugandan study participants had similar levels of education (79.8 % had not completed primary school) leading them to have similar experiences [37].

This study showed that mothers with no postnatal care were more likely to drop out of the second dose of the measles vaccine. Most rural women in Ethiopia do not attend postnatal care and a large proportion of women deliver at home [38]. This result consistent with studies conducted in Ethiopia [39,40], and in sub-Saharan Africa [34]. A plausible explanation could be that mothers who received postnatal care within the first 45 days started early vaccination, and received adequate information on the importance of completing measles vaccination [41]. Health extension workers emphasize home visiting and outreach services to promote immunization activity, trace dropout children, and collaborate with voluntary community health workers [42].

The study revealed significant odds of second-dose measles vaccine dropout among mothers who had poor knowledge of measles immunization. In line with this result, previous studies were conducted in Ethiopia [27,31,39,43–45]. Evidence shows that mothers who had adequate knowledge and awareness of childhood vaccination adhered to immunization schedules [25] and vaccinated their children [7]. In contradiction to a previous study in Ethiopia reported that maternal knowledge was not statistically associated with incomplete vaccination [46]. These discrepancies could be due to differences in the study area (country-wide), study design (secondary data analysis), and due to sociocultural differences.

Poor counseling is another important finding in the determinant of second-dose measles vaccination dropout. Children whose mothers/caregivers had not received counseling during the first dose measles vaccination session and other maternal health services failed to vaccinate their children for MCV2 [47]. This result was consistent with studies in Ethiopia [45], and in Tanzania [48]. However, this finding is different from those of studies in Ethiopia [49,50]. A possible explanation for the discrepancy might be that mothers have inadequate information on the importance of completing child vaccination and sociocultural differences in the study population [4].

Moreover, in support of previous evidence, mothers/caregivers who had spent more than or equal to 30 min to reach a health facility were more likely to drop out of second-dose measles vaccination. This result was in line with other previous studies in Ethiopia [31,45,51] [52], and sub-Saharan African countries [34]. Moreover, this finding is consistent with the studies conducted in Indonesia [53]. This may be due to onerous household duties, inability to pay for the bus fare, and lack of available transportation on the

Table 4
Determinant of measles second dose vaccination dropout among children aged 24–35 Months in ginnir district, east bale zone Ethiopia January 2023 *(n = 351)*.

Variable	Category	Cases n = 119 (%)	Control n = 238 (%)	mAOR	*P*-value
Mother Educational status	Unable to read and write	41 (35)	38 (10.8)	4.0 (1.59–10.2)	0.004 **
	Primary	60 (51.3)	119 (33.9)	1.8 (0.84–4.2)	0.121
	Secondary and above	16 (13.7)	77 (21.9)	1	
Family Size	≤5	87 (74.4)	188 (80.3)	1	
	>5	30 (25.6)	46 (19.7)	1.02 (0.47–2.2)	0.993
Delivery place	Home	53 (45.3)	129 (55.1)	0.74 (0.4–1.34)	0.324
	Health institution	64 (54.7)	105 (44.9)	1	
No PNC checkup	No PNC checkup	57 (48.7)	54 (23.1)	3.49 (1.60–7.61)	0.002 **
	1st check-up	35 (29.9)	95 (40.6)	1.03 (0.47–2.24)	0.931
	2nd and above	25 (21.4)	85 (36.3)	1	
Mother knowledge	Poor	67 (57.3)	94 (40.1)	3.16 (1.49–6.66)	0.003**
	Good	50 (42.7)	140 (59.8)	1	
Counseling on MCV2	yes	56 (47.9)	179 (76.5)	1	
	no	61 (52.1)	55 (23.5)	3.18 (1.62–6.25)	0.001**
Distance to the health facility	<30 min	50 (42.7)	160 (68.4)	1	
	≥30 min	67 (57.3)	74 (31.6)	2.69 (1.22–5.9)	0.014**
Waiting time for vaccination at HF	<30 min	33 (28.2)	113 (48.3)	1	
	30–60 min	60 (51.3)	99 (42.3)	1.13 (0.56–2.27)	0.739
	>1 h	24 (20.5)	22 (9.4)	2.78 (1.17–6.59)	0.020**
Schedule post pond	yes	60 (51.8)	99 (42.3)	1.60 (0.84–3.03)	0.145
	no	57 (48.7)	135 (57.7)	1	

Legend: **P < 0.05; HF, Health facility; PNC, Postnatal Care; MCV2, Measles-Containing-Vaccine Second-Dose; mAOR, Matched Adjusted Odd Ratio.

scheduled vaccination day. Traveling long distances might be a barrier for mothers who do not have caretakers for their children under five years of age at home [29]. The health workers should be increasing the availability of vaccination opportunities near outreach sites and mass vaccination campaigns, and reducing the barriers to measles vaccination.

Moreover, the result of this study suggests that the duration of waiting time for immunization services upon reaching a healthcare institution is significantly associated with the dropout of second-dose measles vaccination. This finding aligns with a previous study conducted in Ethiopia that mothers who endured a wait exceeding 1 h for their child to receive the initial vaccination upon arrival at the healthcare facility were around 2.8 times more likely to forgo the MCV2 vaccination [7]. Furthermore, our study is comparable with studies conducted in Ethiopia [43,54,55]. This could be because the long waiting time during the previous schedule discouraged and demotivated children from receiving the second dose of the measles vaccine. This finding indicates that a long waiting time for service provision could compromise the use of immunization services and result in vaccination dropout. The findings show that healthcare providers and health facilities should reconsider waiting time to increase the second dose of measles vaccination. Thus, our findings suggest the need for intervention programs that targeted the waiting time and counseling's to improve vaccination service use alongside to prevent dropout.

4.1. Strengths and limitations

The main strength of this study is community-based matched case-control, which covered large geographical areas, including urban and rural locations. This study measured recent immunization program performance and immunization completion coverage. The study relied on self-reported data through face-to-face interviews which introduced a bias. Thus, recall biases cannot be ruled out and could result in under or over-reporting. Furthermore, the study could not determine the effect of the matched variables, age, and residence on the dependent variable. This study did not address cultural and perceptions-related factors that contribute to the second dose dropout of measles vaccination.

5. Conclusion

The findings of this study revealed several key factors associated with dropout of MCV2 vaccination, including maternal illiteracy, lack of PNC checkups, inadequate maternal knowledge and absence of counseling on MCV2 vaccination, long distances to healthcare facilities, and extended waiting time for vaccination. Thus results highlight the need for strengthening home visiting programs in catchment households aimed to trace vaccination dropout and providing health education about the importance of child vaccination completion.

Funding

This study was supported by Haramaya University for data collection. However, the university had no role in designing the study, collecting, analyzing, or interpreting the data or writing the manuscript.

Data availability

All data analyzed for this article is available with the corresponding author and can be provided reasonably upon request.

CRediT authorship contribution statement

Bogale Adugna: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Assefa Tola:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Meseret Belete Fite:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Aboma Motuma:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We would like to thank all the study participants for providing the necessary information and for their cooperation in the success of this study. The authors also thank the data collectors and supervisors for their support in collecting the data carefully. Additionally, we thank Haramaya University for funding this work.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e30764.

References

[1] K.O. Isezuo, et al., A 5-year review of measles cases admitted into the emergency paediatric unit of a tertiary hospital in Sokoto, North-Western Nigeria, Sahel Med. J. 21 (3) (2018) 122.
[2] F. Kauffmann, et al., Measles, mumps, rubella prevention: how can we do better? Expet Rev. Vaccine 20 (7) (2021) 811–826.
[3] D.T. Hayman, Measles vaccination in an increasingly immunized and developed world, Hum. Vaccines Immunother. 15 (1) (2019) 28–33.
[4] M.G. Chanie, et al., Determinants of vaccination dropout among children 12-23 months age in north Gondar zone, northwest Ethiopia, 2019, PLoS One 16 (2) (2021) e0246018.
[5] E. Conis, Measles and the modern history of vaccination, Publ. Health Rep. 134 (2) (2019) 118–125.
[6] G. Nchasi, et al., Measles outbreak in sub-Saharan Africa amidst COVID-19: a rising concern, efforts, challenges, and future recommendations, Annals of Medicine and Surgery 81 (2022) 104264.
[7] C. Hailu, G. Fisseha, A. Gebreyesus, Determinants of measles vaccination dropout among 12– 23 months aged children in pastoralist community of Afar, Ethiopia, BMC Infect. Dis. 22 (1) (2022) 1–9.
[8] W.H.O. WHO, Measles on the rise in Ethiopia: a number of factors involved, Available from: https://outbreaknewstoday.com/measles-on-the-rise-in-ethiopia-a-number-of-factors-involved-20509/, 2023 may 25/2023.
[9] S.L. Cochi, W.W. Schluter, What it Will Take to Achieve a World without Measles, Oxford University Press US, 2020, pp. 1073–1075.
[10] CDC, Nearly 40 million children are dangerously susceptible to growing measles threat, Available from: https://www.cdc.gov/media/releases/2022/p1123-measles-threat.html, 2022 October 6/2022.
[11] I. Torjesen, Measles Outbreaks Likely as Covid Pandemic Leaves Millions of World's Children Unvaccinated, WHO Warns, British Medical Journal Publishing Group, 2021.
[12] B.G. Masresha, et al., Introduction of the second dose of measles containing vaccine in the childhood vaccination programs within the WHO Africa region - lessons learnt, J Immunol Sci (Suppl) (2018) 113–121.
[13] A. Geweniger, K.M. Abbas, Childhood vaccination coverage and equity impact in Ethiopia by socioeconomic, geographic, maternal, and child characteristics, Vaccine 38 (20) (2020) 3627–3638.
[14] EPHI, Ethiopia Mini Demographic and Health Survey 2019, 2019 October 2/2022. Available from: https://ephi.gov.et/wp-content/uploads/2021/05/Final-Mini-DHS-report-FR363.pdf.
[15] EFMOH, Health Sector Transformation Plan II (HSTP II) 2020/21 - 2024/25 (2013 EFY-2017 EFY, Ministry of Health, 2021.
[16] K. Yibeltal, et al., Trends, projection and inequalities in full immunization coverage in Ethiopia: in the period 2000-2019, BMC Pediatr. 22 (1) (2022) 193.
[17] R.J. Biellik, R. Davis, The new World Health Organization recommendation on the 2-dose measles vaccine schedule and the way forward in African region, The Pan African Medical Journal 27 (Suppl 3) (2017).
[18] F.M.o. Health, Ethiopia National Expanded Programme on Immunization, BMJ Publishing Group FMOE, Addis Ababa, 2015.
[19] A.W. Tadesse, D. Sahlu, M. Benayew, Second-dose measles vaccination and associated factors among under-five children in urban areas of North Shoa Zone, Central Ethiopia, 2022, Front. Public Health 10 (2022) 1029740.
[20] M. Addis, W. Mekonnen, A.S. Estifanos, Health system barriers to the first dose of measles immunization in Ethiopia: a qualitative study, BMC Publ. Health 24 (1) (2024) 665.
[21] CSA, Central Statistical Agency and ORC Macro, Ethiopia Demographic and Health Survey 2011, . Central Statistical Agency, ORC Macro, Addis Ababa, Ethiopia, 2012, p. 2011. Calverton, Md, USA.
[22] F.S. Kalil, et al., Measles outbreak investigation in Ginnir district of Bale zone, Oromia region, Southeast Ethiopia, may 2019, Pan African Medical Journal 36 (1) (2020).
[23] W.D. Dupont, Power calculations for matched case-control studies, Biometrics 44 (4) (1988) 1157–1168.
[24] M.S. Jimma, et al., Full Vaccination Coverage and Associated Factors Among 12-To-23-Month Children at Assosa Town, Western Ethiopia, Pediatric Health, Medicine and Therapeutics, 2020, pp. 279–288, 2021.
[25] G. Biset, et al., Full immunization coverage and associated factors among children age 12-23 months in Ethiopia: systematic review and meta-analysis of observational studies, Hum. Vaccines Immunother. 17 (7) (2021) 2326–2335.
[26] N. Abel, et al., Factors associated with incomplete childhood immunization in Arbegona district, southern Ethiopia: a case-control study, BMC Publ. Health 16 (27) (2016).
[27] A. Girmay, A.F. Dadi, Full immunization coverage and associated factors among children aged 12-23 Months in a hard-to-reach areas of Ethiopia, Int. J. Pediatr. 2019 (2019) 1924941.
[28] A. Debie, B. Taye, Assessment of fully vaccination coverage and associated factors among children aged 12–23 months in Mecha District, north West Ethiopia: a cross-sectional study, Sci. J. Publ. Health 2 (4) (2014) 342–348.
[29] D.K. Mekuria, et al., Determinants of default from full completion of vaccination among children between 12 and 23 months old in Yilmana Densa district, west Gojam zone, Ethiopia, 2019, Front. Public Health 10 (2022).
[30] b. Aschalew, Utilization of Measles Conjugated Vaccine 2 and Associated Factors among Children aged 24-35 Months in North Mecha District, West Gojjam Zone, North West Ethiopia, 2022.
[31] A. Demewoz, et al., Second dose measles vaccination utilization and associated factors in jabitehnan district, northwest Ethiopia, Dose Response 21 (1) (2023) 15593258231164042.
[32] A. Goshu Muluneh, et al., Less than one-fifth of Ethiopian children were vaccinated for measles second dose; evidence from the Ethiopian mini demographic and health survey 2019, Vaccine X 12 (2022) 100217.
[33] S. Mamuti, et al., Measles containing vaccine coverage and factors associated with its uptake among children aged 24–59 months in Cherangany Sub County, Trans Nzoia County, Kenya, PLoS One 17 (2) (2022) e0263780.
[34] D. Chilot, et al., Measles second dose vaccine utilization and associated factors among children aged 24-35 months in Sub-Saharan Africa, a multi-level analysis from recent DHS surveys, BMC Publ. Health 22 (1) (2022) 2070.
[35] D. Zenbaba, et al., Determinants of Incomplete Vaccination Among Children Aged 12 to 23 Months in Gindhir District, Southeastern Ethiopia: Unmatched Case–Control Study (2021) 1669.
[36] E. Oliveira, D.J. Patrícia, et al., Factors associated with the incomplete opportune vaccination schedule up to 12 months of age, Rondonópolis, Mato Grosso, Revista Paulista de Pediatria 40 (2021).
[37] D. Sematimba, Exploring the predictors of vaccination completeness in the first year of life. Analysis of a Community-Based Household Survey in Eastern Uganda, 2016.
[38] G.A. Fekadu, F. Ambaw, S.A. Kidanie, Facility delivery and postnatal care services use among mothers who attended four or more antenatal care visits in Ethiopia: further analysis of the 2016 demographic and health survey, BMC Pregnancy Childbirth 19 (2019) 1–9.

[39] M. Asnake, et al., Determinants of incomplete childhood vaccination among children aged 12-23 months in Gambela region, southwest Ethiopia: a case control study, Ethiopian Journal of Health Sciences 31 (1) (2021).
[40] Meleko, A., et al., Assessment of Child Immunization Coverage and Associated Factors with Full Vaccination among Children Aged 12–23 Months at Mizan Aman Town, Bench Maji Zone, Southwest Ethiopia.International of Journal Pediatrics 2017.
[41] M.K. Yenit, Y.A. Gelaw, A.M. Shiferaw, Mothers' health service utilization and attitude were the main predictors of incomplete childhood vaccination in east-central Ethiopia: a case-control study, Arch. Publ. Health 76 (2018) 1–9.
[42] N.K. Bilal, et al., Health extension workers in Ethiopia: improved access and coverage for the rural poor. Yes Africa Can: Success Stiroes from a Dynamic Continent, 2011, pp. 433–443, 2011.
[43] T. yitakal, Proportion and associated factors of measles second dose vaccination among 24-35 month of age children, in: Hulet Ejuense Woreda, East Gojam Zone, Amhara Region, Ethiopia, 2022.
[44] A.M. Abebe, T. Mengistu, A.D. Mekuria, Measles case, immunization coverage and its determinant factors among 12-23 month children, BMC Res. Notes 12 (1) (2019) 71. Bassona Worena Woreda, Amhara Region, Ethiopia, 2018.
[45] F. Mulat, Determinants of Drop Out from Immunization Program Among Children Age 15-23 Months in Gonji Kolela District North West Ethiopia, 2021, 2022.
[46] N. Regassa, Y. Bird, J. Moraros, Preference in the use of full childhood immunizations in Ethiopia: the role of maternal health services, Patient Prefer. Adherence 13 (2019) 91–99.
[47] A.D. Dana, D.L. Kebede, K.T. Betru, Prevalence of incomplete vaccination and associated factors among children aged 24-35 months in Dale woreda, Sidama region, Ethiopia, Ethiopian Journal of Medical and Health Sciences 2 (2) (2022) 136–149.
[48] W. Babyebonela, Factors Associated with Non-uptake of Measles Rubella Vaccine Second Dose Among Children Aged 18-36 Months in Kinondoni Municipal Council, Muhimbili University of Health and Allied Sciences, 2018.
[49] J. Senbata, S. M, et al., Full vaccination coverage and associated factors among 12-to-23-Month children at assosa town, western Ethiopia, 2020, Pediatr. Health Med. Therapeut. 12 (2021).
[50] A. Negussie, et al., Factors associated with incomplete childhood immunization in Arbegona district, southern Ethiopia: a case–control study, BMC Publ. Health 16 (2016) 27.
[51] A.H. Guye, et al., Determinants of defaulter to full vaccination among children aged 12-23 months in Siraro district, West Arsi zone, Oromia, Ethiopia: a case-control study, BMC Pediatr. 23 (1) (2023) 230.
[52] E. Legesse, W. Dechasa, An assessment of child immunization coverage and its determinants in Sinana District, Southeast Ethiopia, BMC Pediatr. 15 (2015) 31.
[53] R. Maulida, et al., Coverage and determinants of second-dose measles vaccination among under-five children in Aceh Jaya District, Aceh Province, Indonesia, Jurnal Epidemiologi Kesehatan Indonesia 2 (1) (2019).
[54] R. Magodi, et al., Factors associated with non-uptake of measles-rubella vaccine second dose among children under five years in Mtwara district council, Tanzania, 2017, The Pan African Medical Journal 33 (2019).
[55] A.W. Tadesse, D. Sahlu, M. Benayew, Second-dose measles vaccination and associated factors among under-five children in urban areas of North Shoa Zone, Central Ethiopia, 2022, Front. Public Health 10 (2022) 1029740.