Zero dose and incomplete vaccination and associated factors among street children aged 12-35 months, West Arsi zone, Southeast Ethiopia

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Abstract

Background: Vaccine-preventable diseases are among the major causes of child morbidity and mortality. Immunization is one of the most successful and cost effective public health interventions worldwide. However, an estimated 1.13 million children in Ethiopia were not fully protected by vaccines. One-fifth (19%) of children received no vaccinations. Ethiopia's share of zero-dose vaccination was 1.1 million from 2019-2021. Half of Ethiopia's unvaccinated children live in the Oromia in 2019. Outbreaks of vaccine preventable diseases are commonly occurring in Ethiopia in the last couple of years. Clustering of unvaccination among street children could be the pocket of out outbreaks. Studies of vaccination status among street children are limited.

Objective: To determine the proportion of full vaccination, incomplete vaccination (dropout) and non vaccination (zero-dose) and identify factors associated with vaccination status of street children and children of beggars 12-35 months old residing in West Arsi Zone

Methods: A community based cross-sectional study was conducted from April 15 to June 30, 2024 in Shashemene city and towns of West Arsi Zone. Convenience sampling technique was used to select 292 children aged 12-35 months. Data were collected by face-to-face interview of mothers or caretakers using ODK questionnaire. Stata 16 was used for data cleaning and analysis. Proportions and corresponding 95% CIs of vaccination statuses were computed. Binary logistic regression model was developed to identify the factors associated with zero-dose vaccination of a child.

Results: The prevalence of zero dose vaccination was 28.4% (95% CI: 23.6% - 33.9%). The overall prevalence of incomplete vaccination was 37.32% (95% CI: 30.76%-43.88%). Measles vaccine dose-1 (MCV1) coverage was 56.16% (95% CI: 50.47%-61.86%). Measles vaccine dose-2 (MCV2) coverage was 34.46% (95% CI: 28.76%-40.16%). A child whose care taker had two children aged 1-3 years (AOR = 2.62; 95% CI: 1.06, 6.49) and a child whose care taker did not receive information on vaccination at health facility (AOR = 2.24; 95% CI: 1.16, 4.32) had higher odds of zero dose vaccination. A child born at health facility (AOR = 0.41; 95% CI: 0.23, 0.75) and a child whose care taker heard about vaccination from health worker (AOR = 0.24; 95% CI: 0.06, 0.92) and multiple sources (AOR = 0.35; 95% CI: 0.15, 0.83) had lower odds of zero dose vaccination.

Conclusions: The level of zero dose vaccination in the current study was unacceptable. Factors associated with vaccination status were mainly linked to exposure to information about immunization. Number of 1-3 years old children currently living with mother/caregiver was also associated with zero dose vaccination

Keywords: fully vaccinated, zero-dose, incomplete vaccination, defaulter, dropout

Declaration

Researchers:- I/We, the undersigned, solemnly declare that this RESEARCH REPORT entitled "**Zero dose and incomplete vaccination and associated factors among street children aged 12-35 months, West Arsi zone, Southeast Ethiopia**", funded by and carried out in Madda Walabu University under the ARTTCE Vice President Office and the Research, Publication, Ethics & Extension Directorate. I assert that the statements made and conclusions drawn are the outcome of the research/project work. I further declare that to the best of my knowledge and belief the project report does not contain part of any research work which has been previously conducted, published or submitted for the award of a degree/diploma/certificate in Madda Walabu University or any other University. I/We am/are aware that I/we will be held accountable.

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List of Acronyms and Abbreviations

ABMHSU – Andersen's Behavioral Model of Health Service Use

AIC – Akaike Information Criteria

ANC – Antenatal Care

BCG – Bacillus Calmette-Guerin

BSc – Bachelor of Science

CBHI – Community Based Health Insurance

COVID-19 – Coronavirus Disease 2019

DHIS2 – District Health Information Software 2

DTP3 – Diphtheria-Tetanus-Pertussis

EDHS – Ethiopian Demographic and Health Surveillance

EPHI – Ethiopian Public Health Institute

EPI – Expanded Program on Immunization

FGD – Focus Group Discussion

GPS – Global Positioning System

HDA – Health Development Army

HE – Health Education

HEW – health extension workers

HF – Health Facility

HH – Household

HI – Health Information

HSDP – Health Sector Development Program

HSTP – Health Sector Transformation Plan

IRT – Integrated Refresher Training

KII – Key Informant Interview

km – kilo meter

LMICs – Low- and Middle-Income Countries

MCV1 – measles-containing vaccine dose-1

MCV2 – measles-containing vaccine dose-2

ODK – Open Data Kit

OPV – Oral Polio Vaccine

ORHB – Oromia Regional Health Bureau

PHF – Public Health Facility

PSNP – Productive Safety Net Program

RCS – Rapid Convenient Surveys

ROC – Receiver Operating Curve

SDG – Sustainable Development Goal

TT – Tetanus Toxoid

UNICEF – United Nations Children Fund

VPDs – Vaccine-Preventable Diseases

WDA – Women Development Army

WHO – World Health Organization

WUENIC – WHO UNICEF Estimates of National Immunization Coverage

1 Introduction

1.1 Background

Infectious diseases are still a major cause of morbidity and deaths in low- and middle-income countries (LMICs) (LSHTM, 2021). Vaccine-preventable diseases (VPDs) such as pertussis, diarrhea, pneumonia, measles, and meningitis are among the major causes of child morbidity and mortality (WHO, 2022).

A vaccine is a tiny weakened non-dangerous antigen (fragment of the organism). It is sufficient that the body can learn to build a specific antibody. Antibody is helpful to defeat real organism when the body encounters it later. Immunization is a process of inducing a protective antibody against a specific disease through vaccination (administering vaccines) (WHO, 2020). Immunization is one of the most successful and cost effective public health interventions worldwide. It has successfully eliminated or eradicated severe childhood diseases (WHO, 2022, Li et al., 2021, Nour et al., 2020, Mohamud et al., 2014, WHO, 2021). WHO introduced the Expanded Program on Immunization (EPI) in 1974 (Li et al., 2021, Nour et al., 2020, MOH-E, 2015a, Mohamud et al., 2014). Ethiopia launched EPI in 1980 (Nour et al., 2020, MOH-E, 2015a).

Vaccination programs against the 10 diseases have averted 36 million deaths in children under-five years in LMICs over the last 20 years (2000-2019) alone (LSHTM, 2021, Li et al., 2021). Globally, 4 million deaths are prevented by childhood vaccination every year. Between 2021 and 2030, more than 50 million deaths can be prevented through immunization. It is estimated that measles and hepatitis B vaccinations can save nearly 19 and 14 million lives respectively by 2030 (CDC, 2023).

Despite the achievements over the decades, more than 1.5 million people worldwide die from vaccine-preventable diseases each year (Offit, 2020). The global coverage of third dose of diphtheria-tetanus-pertussis (DTP3) vaccine dropped from 86% in 2019 to 81% in 2021. An estimated 25 million infants did not receive basic vaccines through routine immunization (WHO,

2022, CDC, 2023, Rachlin, 2022). This figure is the highest number since 2009 (WHO, 2022) and 6 million higher than before the start of COVID-19 pandemic in 2019 (CDC, 2023). In 2021, 18 million children were "zero-dose" vaccinated (did not receive any vaccine) which was the highest reported number since 2005 (CDC, 2023).

Almost all zero-dose vaccinated children live in LMICs, primarily in Africa and South-East Asia. Approximately 62% (11 million) of these children live in just 10 countries including Ethiopia (WHO, 2022, CDC, 2023). Ethiopia is fifth among GAVI-supported countries and fourth largest contributor to the global zero-dose vaccinated children (ProjectHOPE and MoHEthiopia, 2022).

In 2021, the number of completely unvaccinated children increased by 5 million since 2019. By the end of 2021, 81% of children had received 1 dose of measles vaccine by their second birthday, and 71% of children received 2 doses of measles vaccine according to national immunization schedules (WHO, 2022).

Ethiopia follows WHO recommendations; universal immunization is offered for free in all regions. The first dose of vaccination is given at birth or at 6 weeks of age. Children should be vaccinated with Bacillus Calmette-Guerin (BCG), four doses of oral polio vaccine (OPV), three doses of Penta-valent vaccine, three doses of pneumococcal vaccine, two doses of rotavirus vaccine, and first dose of measles vaccine before they celebrate first birth date (MOH-E, 2015a, Nour et al., 2020, Mohamud et al., 2014). Ethiopia launched the second dose of measles vaccine in February 2019 and it is given at 15 months of age (Nour et al., 2020, Tadesse et al., 2022, WHO, 2019). Therefore, children are expected to be fully vaccinated before they celebrate second birth date.

EPI has been one of the core priorities in Ethiopia's past Health Sector Development Program (HSDP) and the current Health Sector Transformation Plan (HSTP) (MOH-E, 2015b). The government has shown strong commitment to increase EPI access and utilization by training health extension workers (HEW) and setting up 15,000 health posts (Nour et al., 2020). Strategic plan was developed in April 2015 with the primary objective to achieve at least 90% national coverage and 80% in every district with all vaccines by 2020 and reduce the incidence of VPDs (MOH-E, 2015a).

It has also endorsed sustainable development goal (SDG) target 3.2 that is aimed at reducing preventable deaths of newborns and under five children by 2030 (Nour et al., 2020). However, achieving high coverage of full vaccination for all children has continued to be challenging in Ethiopia.

1.2 Problem statement

In Ethiopia, the magnitude of children aged 12-23 months who received all basic vaccinations has increased from 39% in 2016 to 44% in 2019. Forty percent received these vaccinations by the appropriate age or before their first birthday. Three in five children (59%) received first dose of measles vaccine (MCV1) and 9% of children 24-35 months old received the second dose of measles vaccine (MCV2). One in five (19%) of children received no vaccinations (EPHI and ICF, 2021). Despite promising improvements in coverage of child vaccination in Ethiopia, the country still has a large number of unvaccinated children. From 2019-2021, 1.1 million children are without any vaccinations ("zero-dose") in Ethiopia (Magome, 2023). A 2022 UNICEF's report showed that an estimated 1.13 million children in Ethiopia were not fully protected by measles vaccines (O'Neill, 2023).

Large scale population-based longitudinal study in eastern Ethiopia indicated that only 39% of 14,198 children aged 12-24 months included in the study were fully vaccinated from 2017 to 2021. The highest proportion (45%) was recorded in 2020 and the lowest (32%) was in 2019 (Dheresa et al., 2021). A study that included 635 children aged 12–23 months in Wolaita zone, southwest Ethiopia from January to March 2021 reported that 66.1% were fully vaccinated (Asmare et al., 2022). In 2021, a study conducted by Oromia Regional Health Bureau (ORHB), Ministry of Health (MOH) and CDC across selected districts of the Oromia region showed that there was approximately 46% dropout rate between the first and second dose of the measles vaccine. As indicated by data gathered by the EPHI in 2019, as many as 50% of Ethiopia's unvaccinated children live in the Oromia region (O'Neill, 2023).

Today, Ethiopia has the third highest number of cases associated with measles outbreaks (O'Neill, 2023). A total of 16,814 laboratory-confirmed cases of measles and 182 deaths reported

nationally (Case Fatality Ratio = 1.1%) from 12 August 2021 to 1 May 2023. The number of confirmed cases of measles was almost five-fold increase between 2021 and 2022 (from 1953 in 2021 to 9291(>375%) in 2022 and 6933 as of 01 May 2023). In 2022, 45% of all these cases were children aged less than 5 years (WHO, 2023).

The dramatic increase in measles cases may be explained by a low population immunity combined with other factors. Only 36% of confirmed cases have received one dose or more of the measles-containing vaccine (MCV). However, 95% population vaccination coverage is required to achieve herd immunity and stop measles circulation. Low population immunity (MCV1 and MCV2 coverage) in 2021 was estimated at 54% and 46% respectively according to WHO UNICEF Estimates of National Immunization Coverage (WUENIC). Concurrent epidemics, conflict and forced displacement, behavioral characteristics, cultural beliefs, and insufficient awareness are also other contributing factors for such increment in measles cases (WHO, 2023). Moreover, clustering of unvaccination among street children could be the pocket of outbreaks.

Although vaccination services are provided to the target groups through routine, outreach, and mobile sites, we believe that street children and children of beggars are neglected groups. Studies that sought to assess the vaccination status of these groups are limited in the country. Therefore, this study is planned to determine the proportion of children fully vaccinated, incompletely vaccinated (defaulter or dropout) and not vaccinated at all (zero-dose) and identify factors associated with vaccination status of street children or children of beggars 12-35 months old residing in towns of West Arsi Zone.

2 Conceptual framework

Andersen's Behavioral Model of Health Service Use (ABMHSU) will be used to guide the selection of explanatory variables that will be assessed in our study. The framework was first developed in the 1960s and has gone through four phases since then. The fourth phase was

developed in 1990s. The framework is helpful to identify conditions that either facilitate or impede service utilization. The model considers that an individual's access to and use of health services is a function of three core factors: predisposing, enabling and need factors. The model explains that environmental (i.e., external environment and health system) and person characteristics (i.e., predisposing, enabling, need factors) combine to influence health behavior (i.e., personal health practices and health service use), which influences health status outcomes (i.e., perceived and evaluated health status) (James, 1973, Andersen, 1995, Seidu, 2020, Travers et al., 2020, Hajek et al., 2021, Lederle et al., 2021, Pengid et al., 2022, Babitsch et al., 2012, Fisher, 2019, Zou et al., 2022, Andersen RM et al., 2013).

1. **Predisposing Factors**: The predisposing factors are socio-cultural characteristics that exist prior to individual's illness (Andersen, 1995, Andersen RM et al., 2013).
    - Demographic characteristics: Age and Gender
    - Social Structure: Education, occupation, ethnicity, social networks, social interactions, and culture
    - Health Beliefs: Attitudes, values, and knowledge that people have concerning and towards the health care system
2. **Enabling Factors**: The logistical aspects of obtaining care (Andersen, 1995, Andersen RM et al., 2013).
    - Personal/Family: The means and know how to access health services, income, health insurance, a regular source of care, travel, extent and quality of social relationships
    - Community: Available health personnel and facilities, and waiting time
    - Possible additions: Genetic factors and psychological characteristics
3. **Need Factors**: The most immediate cause of health service use, from functional and health problems that generate the need for health care services (Andersen, 1995, Andersen RM et al., 2013).

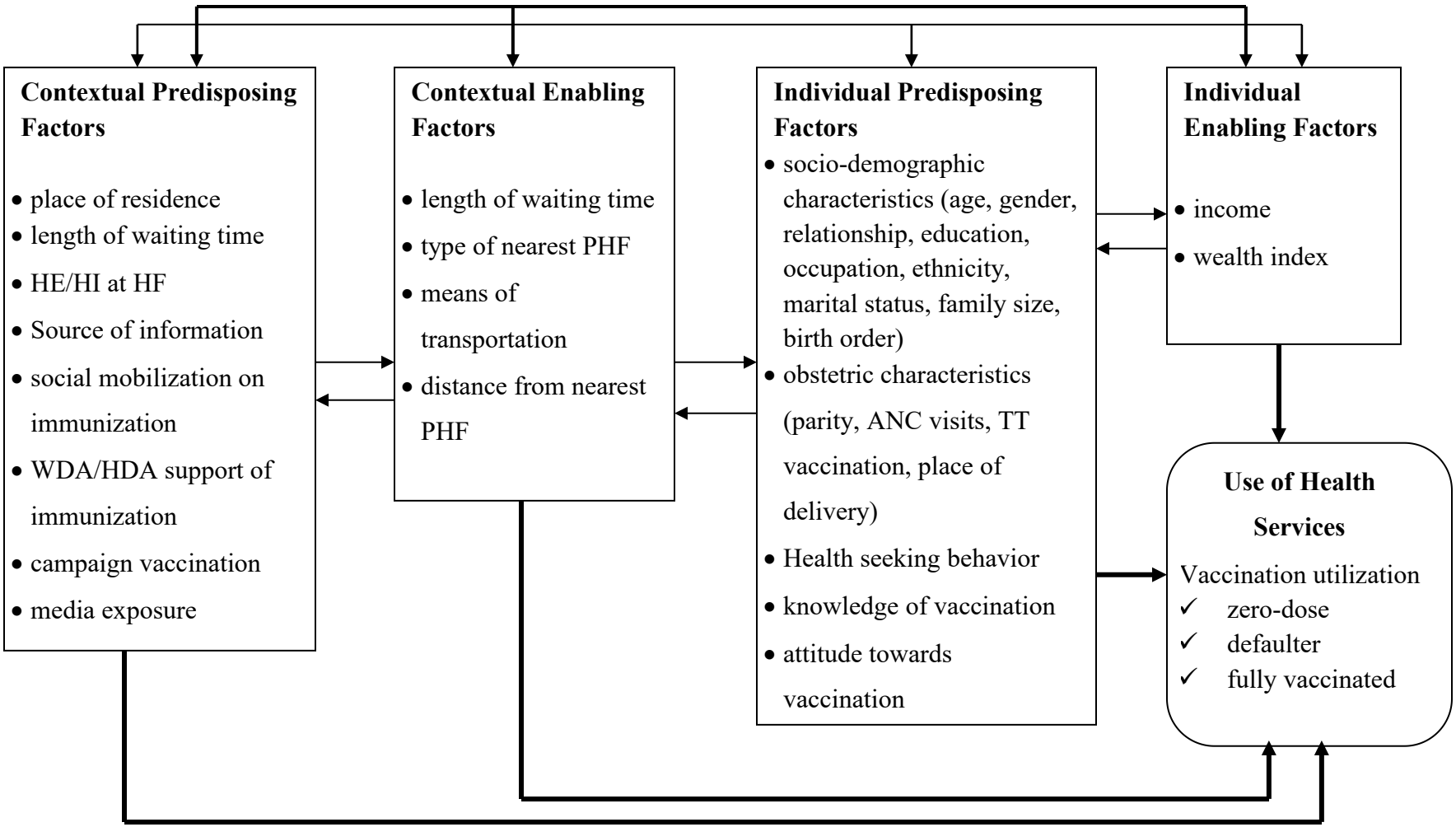

Figure 1. Conceptual framework of factors influencing utilization of childhood immunization in West Arsi Zone, June 2023

(Source: adapted from ABMHSU after reviewing relevant literature)

3 Objectives

3.1 General objective

To assess vaccination status (zero-dose, incomplete and full vaccination) of street children or children of beggars 12-35 months old residing in towns of West Arsi Zone and identify factors associated with vaccination status.

3.2 Specific objectives

- To determine the proportion of street children or children of beggars fully vaccinated
- To estimate the proportion of street children or children of beggars incompletely vaccinated (defaulter or dropout)
- To calculate the proportion of street children or children of beggars not vaccinated at all (zero-dose)
- To identify factors associated with vaccination status of street children or children of beggars

4 Methods and Materials

4.1 Study area and period

The study was conducted from April 15 to June 30, 2024 in Shashemene city and towns of West Arsi Zone, Oromia region. Shashemene town, which is located 250 km southeast of Finfine, is the administrative center of the zone. West Arsi Zone covers an area of 11,776.72 km^2. It is divided into 13 districts (*weredas*) and 4 administrative towns including Shashemene tow. The population of the zone was officially estimated at 2,929,894 in mid 2022.

Major towns in this zone (with estimated populations in mid 2022) include, Negele Arsi (98,114), Dodola (43,186), Hasassa (42,867), Kofele (27,948), Adaba (25,098) and Ajje. There were 5 public hospitals, 85 health centers and 343 health posts which routinely provide vaccination to under five children in the district. Besides, there were also 2 private hospitals and numerous private clinics though they don't give vaccination services.

4.2 Study design

A community based cross-sectional study design was employed.

4.3 Population

4.3.1 Source population

The source population was all mothers/caregivers having a child or children 12-35 months old and a child pairs living on street or begging in towns in West Arsi Zone during the study period. The WHO recommended MCV2 to be given at age 15–18 months through routine services strategies (Chilot et al., 2022). Thus, the age 12-23 months is to assess the coverage of MCV1 vaccination while age 24-35 is to assess the coverage of MCV2 vaccination.

4.3.2 Study population

The study population comprises mother/caretaker and child pairs available on the street or begging in town of West Arsi Zone during the study period.

4.4 Sample size determination

The sample size for the vaccination coverage was determined using the single population proportion formula. We assumed the prevalence of zero dose vaccination is 24.3% (Deressa et al., 2020). We have considered a 95% confidence level and a margin of error 5% for zero dose vaccination. We assumed a non-response rate of 10% which gave a final sample size of 312.

$$n = \frac{Z_{\frac{\alpha}{2}}^2 * P(1-P)}{d^2} + 10\% = \frac{1.96^2 * 0.243(1-0.243)}{0.05^2} + 0.1 * 283 = 312$$

4.5 Sampling technique and procedure

Pairs of street mothers/caregivers or beggars and eligible children were selected by convenience sampling. They were invited and enrolled into the study as data collectors encounter them on the **street,** around **mosque** or **church**, or **wherever** they are likely to be accessed. All available eligible street children or children of beggars were consecutively included till the required sample size was achieved.

4.6 Variables

a) Outcome variable

- Vaccination status [zero dose (not vaccinated at all), drop out (incompletely vaccinated), fully vaccinated]

b) Explanatory variables

Mother's/caregiver's and child socio-demographic characteristics

- ✓ relationship of respondent to the selected child
- ✓ respondent/maternal age
- ✓ sex of the respondent (if not mother)
- ✓ religion of the respondent
- ✓ ethnicity of respondent

- ✓ respondent education
- ✓ mother's marital status
- ✓ sex of the child
- ✓ age of the child
- ✓ birth order of child

Maternal obstetric characteristics

- ✓ ANC visit
- ✓ vaccination during pregnancy
- ✓ place of delivery

Awareness and health seeking behavior of mother/caregiver

- ✓ Awareness of vaccination
- ✓ Health seeking behavior
- ✓ Knowledge of vaccination
- ✓ Attitude towards vaccination

4.7 Data collection methods and tools

Data were collected by face-to-face interview with the mothers or immediate caregivers and. A semi-structured questionnaire was prepared by reviewing EDHS data collection tool and previous similar studies. Open Data Kit (ODK) template of questionnaire was prepared, downloaded to smart phones and used for data collection.

4.8 Measurement

Vaccination status was assessed by mother's/caregiver's **recall** or history of vaccination. Knowledge of vaccination was measured by three questions whose total score is 3 points. A correct answer of 2 and above was considered as good knowledge. Attitude towards vaccination was also be measured by four questions. The total score ranges from 4-20 and scores above 12 were considered as positive attitude.

4.9 Operational definitions:

- **Zero dose vaccination**: A child that did not receive any vaccine as reported by mother/care giver.

- **Incomplete vaccination**: when any child stopped vaccination before 9 months of age or when a child 24-35 months old stopped vaccination at 9 months of age. i.e. full vaccination is when a child 12-23 months old stopped vaccination at 9 months of age and when a child 24-35 months old stopped vaccination at ≥ 15 months of age.
- Knowledge of vaccination: Good knowledge is correct answer for ≥2 out of total 3 knowledge questions.
- Attitude towards vaccination: Positive attitudes are scores above 12, while 12 is neutral and below 12 is a negative attitude.

4.10 Data processing and analysis

The collected data were cleaned and analyzed using Stata 16. Descriptive statistics were calculated to summarize the data. Proportions and corresponding 95% CIs of vaccination statuses were computed. To identify the factors associated with the vaccination statuses of a child, Binary Logistic Regression model was developed. First, univariate models were developed for each explanatory variable. Then, variables with p-value < 0.25 and variables with clinical/practical significance were selected for multivariable regression model.

Multicollinearity and statistical interactions (association modifications) were checked among variables candidate for multiple regression and none was found. Multiple logistic regression model was developed by including all non-collinear variables that satisfied model assumption and their interaction terms (if any). Statistical significance of a variable in multiple regression model was declared at p-value < 0.05. Model fitness was evaluated by Hosmer-Lemeshow test (p-value = 0.116 for zero dose and 0.4258 for incomplete vaccination).

4.11 Data quality management

Level IV and above nursing graduates collected the data. Bachelor of Science (BSc) graduate supervisor and research team checked completeness and consistency of the collected data each day. One day training was provided to data collectors and supervisor on sampling approach, data collection methods and tools, and ethics considerations during data collection.

Electronic data collection (Open Data Kit - ODK) was used to improve the quality of data. The ODK template was prepared in English and Afan Oromo. The questionnaire was translated into Afan Oromo by language expert. The questionnaire translated to Afan Oromo was back translated to English by different language expert to ensure consistency of translation. Afan Oromo version of the ODK template was used to interview the respondent. For some respondents Amharic was used for interview. In such cases, Afan Oromo version of ODK template was translated to Amharic on spot either by data collector or translator. The questionnaire was pre-tested on 5% of the sample and modification was made based on the findings of pre-test.

4.12 Ethical considerations

Ethical approval was obtained from Research Ethics Committee of Shashemene Campus, Madda Walabu University. Support letter was obtained from West Arsi Zone Health Office and respective District Health Offices. The study was conducted in accordance with the Declaration of Helsinki. The fundamental ethical principles (respect for person, beneficence/non-maleficence, and justice) were respected. Informed verbal consent was obtained from child's parent/caregiver. Confidentiality of obtained information was maintained. No personal information such as names or other identifying data was obtained. Participants were involved into the study on a voluntary basis and they were informed the right to refuse participation or to discontinue the interview at any time.

4.13 Dissemination plan

The findings of this study were presented to Mada Walabu University Shashemene Campus. Summary reports will be submitted to Town Health Offices of towns included in the study, West Arsi Zone Health Office and stakeholders working on child immunization. Findings will also be presented at scientific conferences and symposiums. Attempts will also be made to publish the results in peer-reviewed reputable scientific journals.

5 Results

5.1 Socio-demographic characteristics of respondents

A total of 292 respondents were interviewed, giving a response rate of 93.6%. Nearly one-fourth of participants (24.7%) were from Shashemene city. The rest of study participants were from Negele Arsi town (9.9%), Dodola town (7.9%), Hasasa town (7.5%), Adaba town (7.2%), Aje town (6.2%) Wondo town (5.5%), Kofale town (5.5%), Bishan Guracha town (5.1%), Heraro town (5.1%), Serofta town (4.1%), Qore town (3.8%), Wabe town (2.7%), Lephis town (2.7%) and Edo town (2.1%). Most participants (73.3%) were in the age group 25-34 years with median age of 30 (IQR: 32-28) (Figure 2).

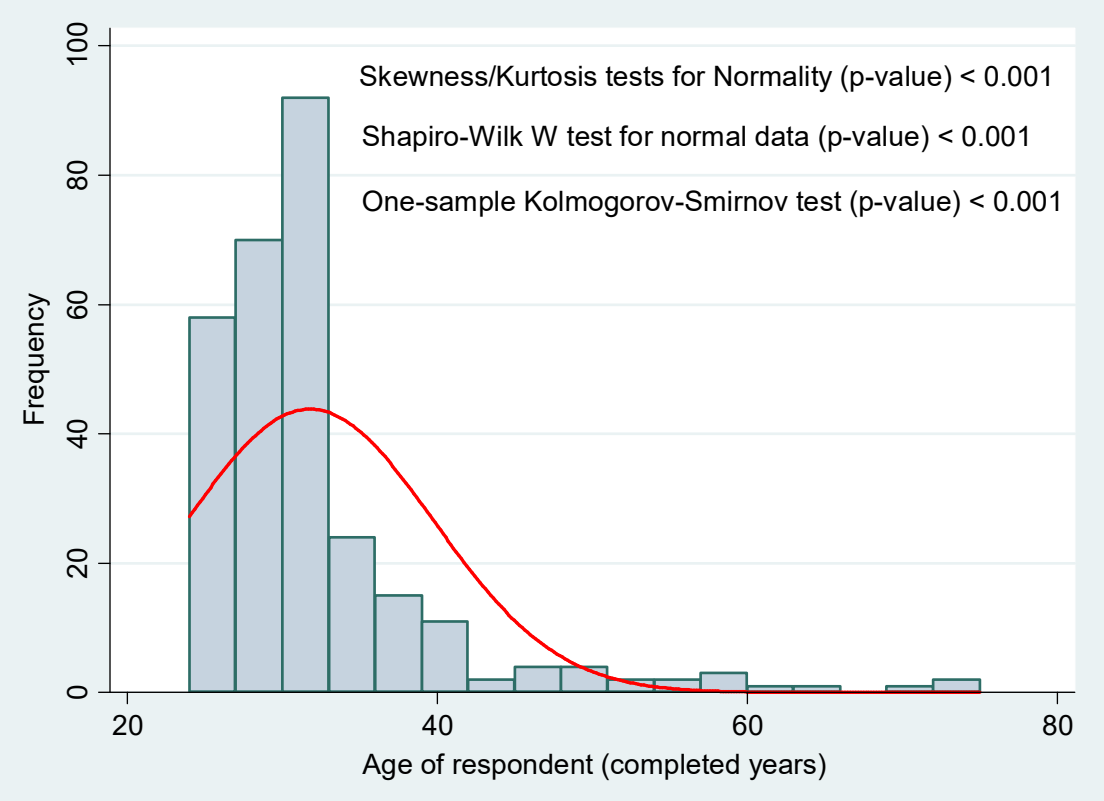

Figure 2 Histogram of age of respondents, West Arsi Zone, April 15-June 30, 2024

Nine in ten (91.8%) respondents were mothers and 5.1% were grandmothers and the remaining were fathers. Most participants (66.1%) were Oromo and the majorities (50.7%) were Muslim. Almost half (49.7%) of the respondents were married. Most respondents (82.2%) cannot read and write and only 12.3% had attended grades 1-4 (Table 1).

Table 1 Socio-demographic characteristics of respondents, West Arsi Zone, April 15-June 30, 2024

Socio-demographic characteristics		**Number**	**%**
Age of respondent	< 25	16	5.5
(Median age = 30; IQR: 32-28)	25-34	214	73.3
	35-44	42	14.4
	45+	20	6.8
Relationship of respondent to index	Mother	268	91.78
child	Grandmother	15	5.14
	Father	9	3.08
Ethnicity	Oromo	193	66.10
	Amhara	44	15.07
	Gurage	23	7.88
	Wolayta	11	3.77
	Sidama	11	3.77
	Others	10	3.42
Religion	Muslim	148	50.68
	Orthodox	95	32.53
	Protestant	47	16.10
	Catholic	2	0.68
Highest level of education	Cannot read and write	240	82.19
attended	Read and write only	16	5.48
	Grade 1-4	36	12.33
Current marital status	Married	145	49.66
	Divorced	78	26.71

	Widowed	47	16.10
	Never married	22	7.53

5.2 Maternal and child characteristic

The majority of respondents (91.1%) had one child aged 1-3 years old currently living with the respondent. Almost two-thirds (62.2%) of the mothers of the child have given birth to 2-5 children. Near to half (45.9%) mothers of the index child attended ANC during the pregnancy of the index child. In terms of the place of delivery of the index child selected for the study, 70.2% of births took place in a health facility. Majorities of children enrolled in the study (53.8%) were 12-23 months old and majorities were female (56.9%). More than three-fourths of children were second or higher birth order (Table 2).

Table 2 Maternal and child characteristic of respondents, West Arsi Zone, April 15-June 30, 2024

Maternal characteristics		**Number**	**%**
Number of 1-3 years old children currently living with the respondent	1	266	91.10
	2	26	8.90
ANC attendance during the pregnancy of index child	Yes	134	45.89
Place of delivery	Home/street	87	29.79
	HF	205	70.21
Age of child	12-23	157	53.77
	24-35	135	46.23
Sex of index child	Female	166	56.85
Birth order	1	72	24.66
	2+	220	75.34

5.3 Respondents' knowledge of child vaccination

Nearly two-thirds (63.7%) of the participants responded that the appropriate age to start child vaccination is at 6 weeks after birth. Less than half (44.5%) responded that the age at which one child completes his/her vaccination schedule is when 15 months and above. Almost two-thirds (65.4%) of the participants responded that there is no problem if a child drops from vaccination schedule. The majorities of the participants (56.2%) had poor knowledge of child vaccination (Table 3).

Table 3 Respondent's knowledge of child vaccination, West Arsi Zone, April 15-June 30, 2024

Knowledge questions		Number	%
What is the appropriate age to start child vaccination?	At birth	19	6.5
	At 6 weeks	186	**63.7**
	Any time	32	11.0
	Don't know	55	18.8
Is there any problem if a child drops from vaccination schedule?	Yes	77	26.4
	No	191	**65.4**
	Don't know	24	8.2
At what age does one child completes his/her vaccination schedule?	Before 9 months old	64	21.9
	When 9 months old	98	33.6
	When ≥15 months old	130	**44.5**
Knowledge	Poor	164	**56.2**
	Good	128	43.8

5.4 Respondents' attitude towards vaccination

Most participants agree that children should be immunized (83.9%) and children should get full dose of vaccination (82.9%). Similar proportion of participants agree (40.1%) and disagree (38.7%) that vaccines provided at once are too many. Similar proportion of participants agree (36.0%) and disagree (32.5%)

that vaccination is painful to a child. Less than half (49.0%) had positive attitude towards child vaccination (Table 4).

Table 4 Respondent's attitude towards child vaccination, West Arsi Zone, April 15-June 30, 2024

Attitude statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Children should be immunized	15 (5.1)	14 (4.8)	12 (4.1)	245 (83.9)	6 (2.1)
Children should get full dose of vaccination	1 (0.3)	16 (5.5)	21 (7.2)	242 (82.9)	12 (4.1)
Vaccines provided at once are too many.	2 (0.7)	113 (38.7)	24 (8.2)	117 (40.1)	36 (12.3)
Vaccination is painful to a child	64 (21.9)	95 (32.5)	21 (7.2)	105 (36.0)	7 (2.4%)
Positive attitude = 143 (49.0%)	Neutral = 68 (23.3%)		Negative attitude = 81 (27.7%)		

5.5 Vaccination status and reasons reported for zero dose or missed doses

A total of 209 (71.6%) children received at least one dose of a vaccine during routine immunization (73.25% for children aged 12-23 months and 69.63% for children aged 24-35 months). The overall prevalence of zero-dose vaccination was 28.4 % (95% CI: 23.6%-33.9%). Out of 209 children who took at least one dose of vaccination, only 62.68% (95% CI: 56.12%-69.24%) were fully vaccinated (79.13% for 12-23 months old; 42.55% for 24-35 months old). The overall prevalence of incomplete vaccination was 37.32% (95% CI: 30.76%-43.88%). Out of 292 children, only 164 had received Measles vaccine dose 1 (MCV1) making its coverage 56.16% (95% CI: 50.47%-61.86%). Out of 267 children eligible for Measles vaccine dose 2 (MCV2), only 92 took it make its coverage 34.46% (95% CI: 28.76%-40.16%) (Table 5).

Table 5 vaccination status of street children and children of beggars, West Arsi Zone, April 15-June 30, 2024

Vaccination status		Age group	
		12-23 months	24-35 months
Did your child receive routine vaccination?	Yes	115	94
	No	42	41
If your child has received routine vaccination, at what age did he/she stop vaccination?	before 9 months old	24	21
	when 9 months old	39	33
	when ≥15 months old	52	40

Incomplete

Fully vaccinated

Most (70.8%) were vaccinated at health center, 15.3% were vaccinated at health post and the remaining 13.9% were vaccinated at hospital. A vaccination card was provided for 97.6% (97.4% for children aged 12-23 months and 97.9% for children aged 24-35 months). However, only 45.1% had a vaccination card (48.2% for children aged 12-23 months and 43.1% for children aged 24-35 months). The main reasons for not vaccinating their child (zero dose) or dropping vaccination were unaware of the need to return for the next dose (34.5%), unaware of the need for immunization (31.5%) and family problem including illness of the caregiver (13.0%) (Figure 3).

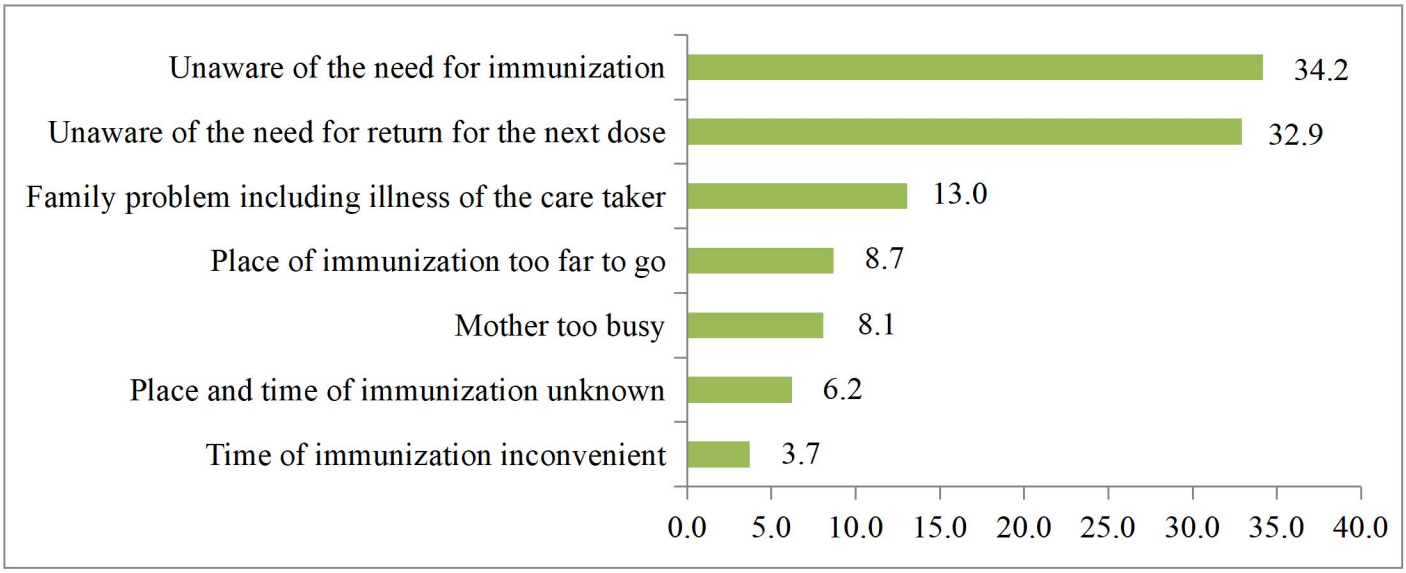

Figure 3 Reported reasons for not vaccinating their child (zero dose) or dropping vaccination, West Arsi Zone, April 15-June 30, 2024

Regarding sources of information about vaccination, 13.7% did not hear about vaccination. Most (69.0%) of those who heard about vaccination heard it from multiple sources (Figure 4).

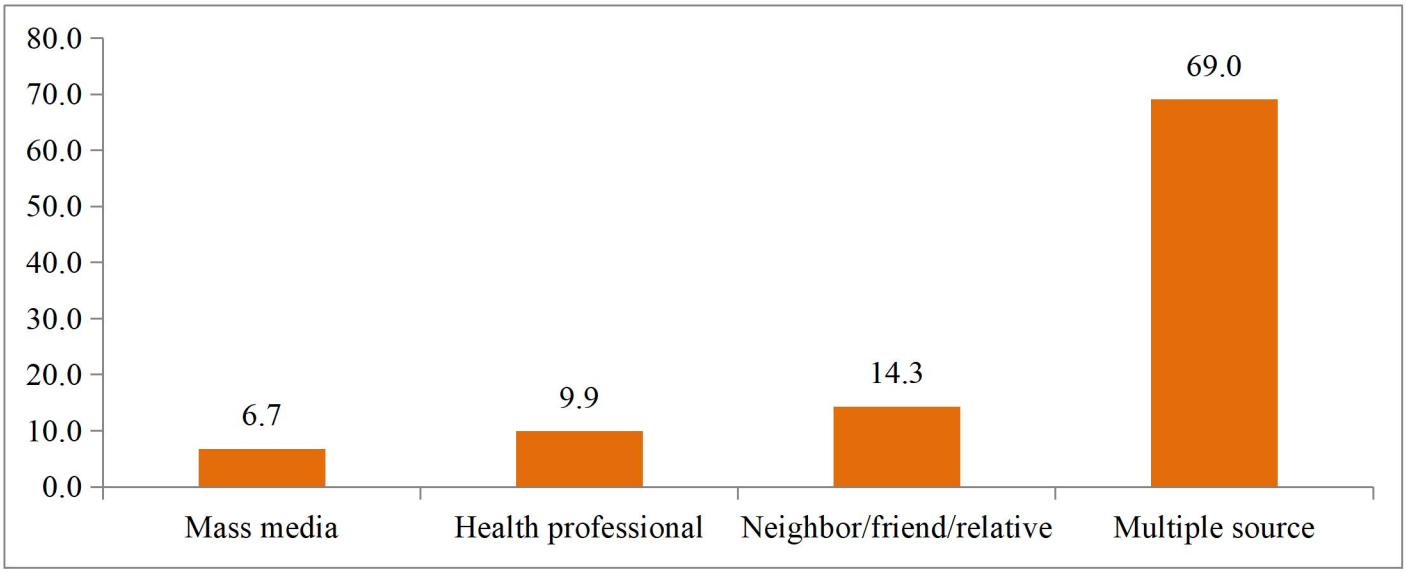

Figure 4 Reported sources of information about vaccination, West Arsi Zone, April 15-June 30, 2024

5.6 Factors associated with zero dose vaccination

In bivariate binary logistic regression, number of 1-3 years old children living with caregiver, religion, ANC, place of delivery, child sex, source of information about vaccination, receiving information on vaccination at health facility, knowledge of child vaccination and attitude towards child vaccination were candidates for multiple binary logistic regression at p-value < 0.25. However, in multiple binary logistic regression, number of 1-3 years old children living with caregiver, place of delivery, source of information about vaccination, and receiving information on vaccination at health facility were significantly associated with zero dose vaccination (Table 6).

Table 6 Factors associated with zero dose vaccination, West Arsi Zone, April 15-June 30, 2024

Variables	Category	COR (95% CI)	AOR (95% CI)
Number of 1-3 years old children living with respondent	1	1	1
	2	2.35 (1.04,6.49)[c]	**2.62** (1.06,5.33)[c]
Religion	Muslim	1	1
	Others	0.58 (0.35,0.98)[c]	0.72 (0.40,1.29)
ANC	Yes	1	1
	No	2.02 (1.19,3.43)[b]	1.72 (0.95,3.10)
Place of Delivery	Health facility	**0.31** (0.18,0.53)[a]	**0.41** (0.23,0.75)[b]
	Home/street	1	1
Child sex	Female	0.66 (0.39,1.09)[d]	0.64 (0.36,1.14)
Source of information about vaccination	Health Worker only	**0.29** (0.08,0.99)[c]	**0.24** (0.06,0.92)[c]
	Neighbor/Friend/Relative only	0.50 (0.19,1.34)[d]	0.57 (0.19,1.66)
	Mass media only	1.05 (0.33,3.33)	0.49 (0.14,1.81)
	Multiple source	**0.56** (0.27,1.14)[d]	**0.35** (0.15,0.83)[c]
	Didn't hear from any source	1	1
Received information on	Yes	1	1

vaccination at health facility	No/Don't remember	**3.02** (1.75,5.21)[a]	**2.24** (1.16,4.32)[c]
Knowledge of child vaccination	Poor	1	1
	Good	0.79 (0.47,1.33)	0.92 (0.51,1.64)
Attitude towards child vaccination	Negative	1	1
	Neutral	0.91 (0.46,1.79)	0.78 (0.35,1.71)
	Positive	0.57 (0.31,1.04)[d]	0.54 (0.25,1.17)

[d] = < 0.25 [c] = < 0.05 [b] = < 0.01 [a] = < 0.001

Regarding factors associated with incomplete vaccination, only child age was significantly associated with incomplete vaccination (Table 7).

Table 7 Factors associated with incomplete vaccination, West Arsi Zone, April 15-June 30, 2024

Variables	**Category**	**COR (95% CI)**	**AOR (95% CI)**
Age of the child	12-23	1	1
	24-35	5.12 (2.79,9.40)[a]	**5.05** (2.73,9.34)[a]
Knowledge of child vaccination (continuous)		0.75 (0.55,1.04)[d]	0.83 (0.58,1.18)
Attitude towards child vaccination	Negative	1	1
	Neutral	0.51 (0.22,1.19)[d]	0.52 (0.21,1.29)
	Positive	0.81 (0.41,1.57)	0.82 (0.39,1.66)

[d] = < 0.25 [c] = < 0.05 [b] = < 0.01 [a] = < 0.001

6 Discussion

We conducted a community-based cross-sectional study from 15 April to 30 June 2024 in West Arsi Zone, Oromia region, to determine the prevalence of zero dose and incomplete vaccination and identify factors associated with vaccination status among children aged 12-35 months. We found that more than one-fourth of children were zero dose vaccinated. And less than two-thirds of those who started vaccination were fully vaccinated for age. The main reasons reported by respondents for zero dose or incomplete vaccination were unawareness of the need for vaccination and unawareness of the need to return for next dose. Factors independently associated with zero dose vaccination were, number of 1-3 years old children living with the respondent, index child's place of birth, respondent receiving information about vaccination at health facility and source of information about child vaccination. Factor independently associated with dropout from vaccination (incomplete vaccination) was age the child.

The prevalence of zero dose vaccination in the current study (28.4%) among children aged 12-35 months was similar to the prevalence of zero dose vaccination (24.3%) reported in the Sidama Region study, which enrolled children aged 9-23 months (Deressa et al., 2020). However, it was higher than that reported in the 2019 EDHS (19%) (EPHI and ICF, 2021). This could be due to the fact that the EDHS is a national survey, which mainly covers children who were not street children and not children of beggars. Children enrolled in the EDHS survey were more likely to be from parents or caregivers with stable livelihoods, whereas children enrolled in the current study were from parents or caregivers with unstable livelihoods. Therefore, street children or children of beggars had limited access to health services, including immunization, compared to children of parents or caregivers with stable livelihoods. These groups of children are neglected and live in underserved settings so that they are more likely to be under-immunized or devoid of immunizations altogether.

The finding of the current study was lower than the prevalence of zero dose vaccination (33.7%) reported by from hard-to-reach and underserved settings of Ethiopia. The study enrolled children aged 12-35 months from developing regions, pastoralist regions, newly-established regions, hard-to-

reach areas in agrarian community, urban slums in major towns and cities, conflict-affected areas, and special populations like refugees and internally displaced peoples (Biks et al., 2024).

The proportion of children aged 12-23 months who were fully vaccinated (79.13%) was higher than the EDHS 2019 report (44%) (EPHI and ICF, 2021). The finding was also higher than the 45% reported by a large scale population-based longitudinal study conducted in eastern Ethiopia, which included 14,198 children aged 12-24 months in 2020 (Dheresa et al., 2021). It was more than twice of 37.2% reported from hard-to-reach and underserved settings of Ethiopia (ProjectHOPE and MoHEthiopia, 2022).

This difference is expected as differences in time and interventions to improve immunization could have brought a change in immunization coverage and completion. Despite influence of time and interventions to improve child immunization, the use of verbal report to assess immunization status might have overestimated the coverage and completion. The result of the current study was also higher than the 66.1% reported in a study of 635 children aged 12-23 months in Wolaita zone, southwest Ethiopia from January to March 2021 (Asmare et al., 2022).

The low population immunity in the current study was similar to the 54% and 46% low population immunity (MCV1 and MCV2 coverage, respectively) estimated for 2021 by the WHO-UNICEF Estimates of National Immunization Coverage (WUENIC). The low MCV1 (56.16%) and MCV2 (34.46%) coverage among children aged 12-35 months may explain why Ethiopia now has the third highest number of cases associated with measles outbreaks (O'Neill, 2023). There is dramatic increase in measles cases from time to time because 95% population vaccination coverage is required to achieve herd immunity and stop measles circulation (WHO, 2023).

In terms of factors associated with zero-dose vaccination, the odds of zero-dose vaccination for a child whose mother/caregiver lived with two 1-3 years old children was 2.62 times higher compared to a child whose mother/caregiver whose mother lived with one 1-3 years old child. This could be because a mother/caregiver might be busy caring for another child and so that she could not get time to take an index child to health facility for vaccination. Previous cross-sectional study in 85 low- and middle-income countries reported that zero-dose prevalence was about 40% higher in children with

four or more siblings compared to single children. Zero-dose prevalence was higher in households with more children regardless of the index child's birth order (Costa et al., 2024). This tells us that birth spacing (family planning) is linked to improved child outcomes, not only through enhanced cognitive development, but also through child vaccination and lower rates of childhood illnesses.

In the current study, a child born at health facility was 59% lower to be zero dose vaccinated compared to a child born at home or on the street. A previous conducted on the relationship between facility delivery and infant immunization concluded that facility delivery was the strongest single factor associated with infants being immunized, doubling the odds of full immunization (Moyer et al., 2013). This indicates that institutional delivery has dual benefits: reducing the risk of life-threatening conditions for women and their babies, and increasing the chance of child vaccination. Therefore, it should be more strengthened by reducing barriers of institutional delivery such as transportation, service fee, skilled man power and compassionate care (Tamiso et al., 2023, Tarik et al., 2022).

A child whose mother/caregiver heard about vaccination from health worker and from multiple sources had 76% and 65% lower odds of zero dose vaccination, respectively compared to a child whose mother/caregiver did not hear about vaccination from any source. A child whose mother/caregiver did not receive or did not remember of receiving information on vaccination at health facility was more than two times higher odds zero dose vaccination compared to a child whose mother/caregiver received information on vaccination at health facility. This tells us that health workers the trusted source of information about vaccination. Therefore, health workers should inform mothers/caregivers at any contact about the benefits of child immunization. Unaware of the need for immunization was the leading reason reported by respondents for zero doses.

In terms of factors associated with dropout from vaccination, the odds of dropout for a child aged 24-35 years was 5 times higher compared to a child aged 12-35 months. Unaware of the need for return for the next doses was the leading reason reported by respondents for missed doses. In a study by Tadesse et al (2022), unaware of the need to return for second-dose was also the major reason reported by mothers for missing second-dose measles vaccine.

Although this study was community-based and conducted in hard-to-reach and underserved settings, the study was not without limitations. The use of recall (history) might have induced misclassification bias (over/underestimation of zero dose or incomplete vaccination) because of either recall or social desirability biases.

7 Conclusions and recommendations

Although the use of recall (history) might have overestimated zero dose or incomplete vaccination, the level of dose in the current study was unacceptable. Regarding the factors associated with vaccination status of the children, reasons reported by respondents as part the current study, and factors identified by logistic regression have intersection. Unawareness of the need for vaccination and unawareness of the need for the next dose were the main reasons reported for zero dose vaccination and missed doses respectively. Factors associated with vaccination status were mainly linked to exposure to information about immunization. Number of 1-3 years old children currently living with mother/caregiver was also important factor associated with zero dose vaccination.

Sufficient awareness creation about expanded program on immunization and provision of sufficient details and written instructions to mothers/caregivers on when and where to return, could improve the immunization status of street children or children of beggars.

Street children or children of beggars are neglected section of children for routine vaccination. Therefore, extraordinary effort should be made by town health offices, ZHD, and office of women and children affairs, to reach these groups of children. Mobile immunization activities should be planned for these groups of children. Information should be continuously disseminated regarding vaccination at everywhere.

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ANNEXES

ANNEX-1: QUESTIONNAIRE

Identification		
Woreda/district name		
Town name		
Date of interview		

Language of Questionnaire	Language of interview	Native Language of respondent	Translator used (Yes = 1, No = 2)

*LANGUAGE CODES:

01 AMARIGNA 03 SIDAMU AFO 05 ENGLISH

02 AFAN OROMO 04 HALABA 06 OTHER Specify _____

DATA COLLECTOR NAME _____

SUPERVISOR NAME_____

INTRODUCTION AND CONSENT

Hello. My name is _____. I am working with the Madda Walabu University. We are conducting a study on street child vaccination in selected towns of West Arsi Zone. The information we collect will help the government and other stakeholders to plan interventions. You are randomly selected for the survey. I would like to ask you some questions about you and your child. The questions will take about 25 to 30 minutes to complete. Any answers you give will be confidential and will not be shared with anyone other than members of our study team. You don't have to take part in the study, but we hope you will agree to answer the questions as your views are important. If I ask you any question you don't want to answer, just let me know and I will move to the next question or you can stop the interview at any time. If you would more information about the study, you can contact Mr. Musa Kumbi; mobile: 0912906612; Email: mukumbi2@gmail.com

Do you have any questions? 1. Yes 2. No

May I begin the interview now? 1. Yes 2. No

RESPONDENT AGREES TO BE INTERVIEWED …. 1 ↓

RESPONDENT DOES NOT AGREE TO BE INTERVIEWED …. 2 → ENDS

SOCIODEMOGRAPHIC CHARACTERISTICS				
Sn	**Questions**	**Responses**	**Code**	**Skip**
101	What is the relationship of respondent to the selected child?	1. Mother 2. Father 3. Grand mother 4. Other's caregiver (specify) _____	1 2 3 4	
102	Is the respondent male or female?	1. Male 2. Female	1 2	
103	Age of respondent (completed years)?	_____		
104	What is your religion?	1. Muslim 2. Orthodox 3. Catholic 4. Protestant 5. Traditional 6. Other (specify) _____	1 2 3 4 5 6	
105	What is your ethnicity?	1. Oromo 2. Sidama 3. Amhara 4. Other (specify) _____	1 2 3 4 5	
106	What is the highest level of education you attended?	Cannot read and write Read and write only Grade 1-4 Grade 5-8 Grade 9-12 College/above	1 2 3 4 6 7	

107	What is the highest level of education child's father attended?	Cannot read and write Read and write only Grade 1-4 Grade 5-8 Grade 9-12 College/above Unknown	1 2 3 4 6 7 8	
108	What is your current marital status?	Married Living together No, not in union/single mam Widowed Divorced Separated	1 2 3 4 5 6	
109	What is your usual occupation?	Farmer House wife Government employee Trader/merchant Daily laborer Other (specify) _____	1 2 3 4 5 6	
110	How many live births have you given?	_____		
111	Did you attend antenatal care during the pregnancy of this child?	1. Yes 2. No	1 2	If no skip to Q 18
112	How many times did you receive antenatal care during pregnancy of this child?	_____	"0" if don't remember	
113	Did you receive vaccine during ANC follow up?	1. Yes 2. No	1 2	If no skip to Q 18
114	How many times did you receive vaccine during the pregnancy of this child?	_____	"0" if don't remember	

115	Where did you give birth to the current child?	Public Hospital Health Center Private health facility Home Other (specify) _____	1 2 3 4 5	
116	What is your status of Productive Safety Net Program (PSNP)?	1. Currently enrolled 2. Previously enrolled 3. Not participated		
117	Are you enrolled in Community Based Health Insurance (CBHI)?	1. Yes 2. No		
118	What is the age of this child?	_____ months		
119	What is the sex of this child?	1. Male 2. Female	1 2	
120	What is the birth order of this child?	_____		
121	Did your child receive routine vaccination?	1. Yes 2. No 3. Don't remember	1 2 3	If Yes skip to Q #28
122	What are reasons for not vaccinating your child?	1. Unaware of the need for immunization 2. Place and time of immunization unknown 3. Fear of side effects 4. Postponement until another time 5. No faith in immunization 6. Place of immunization too far to go 7. Time of immunization inconvenient 8. Vaccinator absent 9. Vaccine not available 10. Mother too busy 11. Family problem including illness of the care taker 12. Family was out of the kebele 13. Child illness 14. Others, specify _____	1 2 3 4 5 6 7 8 9 10 11 12 13 14	
123	Where did your child receive	1. Health post	1	

	immunization?	2. Health center 3. Hospital 4. Outreach 5. Other (specify) _____	2 3 4 5	
124	How many times your child received vaccination?	_____	"0" if don't remember	
125	Did the child receive any other vaccinations, including vaccinations received in campaigns or immunization days or child health days?	1. Yes 2. No 3. Don't remember	1 2 3	
126	Has your child been provided vaccination card?	1. Yes 2. No	1 2	If no skip to Q #31
127	Is it available now?	1. Yes 2. No		
128	Which antigen does the child received?	1. BCG 2. ORAL POLIO VACCINE (OPV) 0 3. ORAL POLIO VACCINE (OPV) 1 4. ORAL POLIO VACCINE (OPV) 2 5. ORAL POLIO VACCINE (OPV) 3 6. INACTIVATED POLIO VACCINE (IPV) 7. DPT-HEP.B-HIB/Pentavalent 1 8. DPT-HEP.B-HIB/Pentavalent 2 9. DPT-HEP.B-HIB/Pentavalent 3 10. PCV/Pneumoccal 1 11. PCV/Pneumoccal 2 12. PCV/Pneumoccal 3 13. ROTAVIRUS 1 14. ROTAVIRUS 2 15. MEASLES 1 16. MEASLES 2	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	By care taker recall
129	Which antigen does the child received?	17. BCG 18. ORAL POLIO VACCINE (OPV) 0 19. ORAL POLIO VACCINE (OPV) 1 20. ORAL POLIO VACCINE (OPV) 2 21. ORAL POLIO VACCINE (OPV) 3 22. INACTIVATED POLIO	1 2 3 4 5	From the card

		VACCINE (IPV) 23. DPT-HEP.B-HIB/Pentavalent 1 24. DPT-HEP.B-HIB/Pentavalent 2 25. DPT-HEP.B-HIB/Pentavalent 3 26. PCV/Pneumoccal 1 27. PCV/Pneumoccal 2 28. PCV/Pneumoccal 3 29. ROTAVIRUS 1 30. ROTAVIRUS 2 31. MEASLES 1 32. MEASLES 2	6 7 8 9 10 11 12 13 14 15 16	
130	What are the reasons for not vaccinating or finishing vaccination of your child?	1. Unaware of the need for return for the next dose 2. Fear of side effects 3. No faith in immunization 4. Place of immunization too far to go 5. Time of immunization inconvenient 6. Vaccinator absent 7. Vaccine not available 8. Unable to open BCG/Measles due to fear of wastage 9. Mother too busy 10. Family problem including illness of the care taker 11. Family was out of the kebele 12. Child illness 13. Others, specify _____	1 2 3 4 5 6 7 8 9 10 11 12 13	
131	From whom/where did you hear about vaccinating your child?	1. Did not hear 2. Health extension worker 3. Other health professional 4. Neighbor/friend/relative 5. Mass media 6. Other (specify) _____	1 2 3 4 5 6	
132	Have you taken this child to the health facility while sick for medical reason?	1. Yes 2. No	1 2	
133	Has anyone provided you health	1. Yes	1	

	information/education at health facility?	2. No 3. Don't remember	2 3	
134	Which information the health worker provided you at health facility?	1. About vaccination 2. About child feeding 3. About hygiene 4. About sanitation 5. Information dissemination for neighbors 6. Other (specify)	1 2 3 4 5	
Knowledge questions				
201	Is vaccination preventing infectious disease?	1. Yes 2. No 3. I don't know	1 2 3	
202	Can you list childhood routine vaccine preventable diseases in Ethiopia?	1. Polio 2. Measles 3. Tuberculosis 4. Pneumonia 5. Diarrhea 6. Hepatitis 7. Tetanus 8. Diphtheria 9. Pertussis 10. Don't know	1 2 3 4 5 6 7 8 9 10	
203	When is the appropriate time to start child vaccination?	1. At birth 2. At 42 days 3. Any time 4. I don't know	1 2 3 4	
204	There is no problem if a child drops vaccination schedule?	Yes No I don't know	1 2 3	
205	At what age does one child complete his/her vaccination schedule?	_____ months		
Attitude questions				
301	Do you agree with child immunization?	1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree	1 2 3 4 5	
302	Children should get full dose of vaccination	1. Strongly disagree 2. Disagree 3. Neutral 4. Agree	1 2 3 4	

		5. Strongly agree	5	
303	Vaccines provided at once are too many?	1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree	1 2 3 4 5	
304	Vaccination is painful to a child	1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree	1 2 3 4 5	
305	Does your household own this dwelling, occupy this dwelling free of charge (or subsidized), or rent this dwelling from the kebele, an agency, an employer, or from individuals?	a) OWNED . . . . . . b) FREE OF CHARGE OR SUBSIDIZED……... c) RENTED FROM KEBELE/ AGENCY/EMPLOYER…… d) RENTED FROM INDIVIDUALS….	1 2 3 4	
306	What is your household's average monthly income?	_____		

THANK YOU FOR YOUR COOPERATION AND GENUINE RESPONSE!