Science Discovery Pediatrics
2026, Vol. 1, No. 1, pp. 19–34
https://doi.org/10.11648/j.sdpediatr.20260101.13

Research Article

# Immunization Status [Zero Dose and Underimmunized] and Associated Factors among Children Aged 12 – 35 Months in Addis Ababa, Ethiopia. A Mixed-Method Study

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## Abstract

*Background:* In 2023, the World Health Organization reported that approximately 14.5 million children worldwide received no routine vaccinations, with Ethiopia ranking fourth globally. This highlights the need to explore the factors contributing to gaps in routine childhood immunization coverage in Ethiopia. Therefore, this study aimed to assess the immunization status and factors associated with child immunization uptake among children aged 12-35 months in Addis Ababa, Ethiopia. *Method:* A sequential exploratory mixed-method design [QUAL→ QUAN] was employed. Quantitative study included 501 children aged 12–35 months, and participants [caregivers] selected through a multistage cluster sampling technique involving 72 clusters of 54 households per cluster. The quantitative data were collected using the Kobo toolbox and analysed by using SPSS version 29.00; whereas qualitative data was obtained through three focus group discussions and six key informant interviews. Thematic analysis was conducted by ATLAS.ti version 25.00 for qualitative data, and quantitative and qualitative results were integrated using joint integration to conclude the study findings. *Results:* The study found that 91.4% [95% CI: 90 - 95] of children were fully immunized according to the recommended routine immunization schedule, based on vaccination card review. However, 8.62% were under immunized, of these 0.41 were identified as zero-dose children based on card review and caregiver recall. In this research, transportation cost, travel time, provider friendliness, information access, and community support were significantly associated with immunization uptake. Qualitative findings revealed that awareness, health education, and support from health care providers, community, and religious leaders as key facilitators. *Conclusion and Recommendation:* Routine immunization coverage in Addis Ababa was suboptimal; however, full completion remains constrained by accessibility barriers, supply disruption, and communication gaps. To sustain and improve coverage, establish appointment reminders and follow up mechanisms, provider-client communication, and community-based advocacy and mobilization is recommended to reduce dropout rates for multi-dose schedules and to improve timely completion of all recommended routine immunization doses is recommended.

## Keywords

Immunization Status, Zero Dose, Underimmunized, 12 – 35 Months Age, Mixed-methods Study, Addis Ababa, Ethiopia

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**Received:** 14 October 2026; **Accepted:** 9 November 2026; **Published:** 25 November 2026

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# 1. Introduction

In 2023, the World Health Organization [WHO] reported that approximately 14.5 million children worldwide had not received any routine vaccination [zero-dose children] [1]. Approximately 75% of these children lived in 14 countries: Angola, Brazil, Chad, China, the Democratic Republic of Congo, Ethiopia, India, Indonesia, Mexico, Nigeria, Pakistan, the Philippines, Somalia, and South Africa [1, 2]. Notably, Ethiopia ranked fourth globally in terms of zero-dose [ZD] children, with an estimated 1.1 million children affected [3]. Zero Dose [ZD] and under-immunized [UI] children are disproportionately concentrated in underserved populations, particularly those living in urban slums, remote rural areas, and conflict-affected settings [3, 4]. These persistent immunization gaps highlight the importance of exploring the barriers that prevent children from accessing and completing routine immunization services.

Despite considerable progress in expanding routine immunization services, many children in sub-Saharan Africa [SSA] remain either zero-dose or under immunized. Zero-dose children are those who have not received any routine vaccine, commonly identified by the absence of the first dose of diphtheria-tetanus-pertussis-containing vaccine [DPT1], whereas under-immunized children are those who have received at least one vaccine dose but have not completed the recommended routine immunization schedule [5]. Sub-Saharan Africa continues to bear a disproportionate share of the global burden of vaccine-preventable diseases. Although the region accounts for approximately one-Sith of the world's population, it is home to more than 60% of the world's zero-dose children. Furthermore, an estimated 8.7 million zero-dose children and 12.7 million under-immunized children live in Africa [5]. These figures highlight persistent inequalities in access to and utilization of routine immunization services across the region. Exploring the barriers contributing to zero-dose and under-immunization, including socioeconomic, geographical, sociocultural, and health-system-related factors, is therefore essential to inform context-specific strategies for improving equitable immunization coverage and reducing the burden of vaccine-preventable diseases.

Despite the proven benefits of vaccination, Ethiopia remains a contributor to the number of zero dose children in Africa. Nationally, 14% of children are zero-dose and 62% are under-immunized. Low coverage is linked to weak health systems, limited awareness, and marked regional disparities, with vaccination rates substantially lower in pastoral than agrarian regions. Both individual and community factors influence childhood immunization uptake [2, 5, 6]. However, urban averages can mask inequalities; although Addis Ababa has very low zero-dose prevalence [0.9%], under-immunized children remain in marginalized groups. National immunization coverage is about 60%, below global targets, despite EPI efforts. Immunization is highly cost-effective, yet global gaps still contribute to 4–5 million preventable deaths annually from vaccine preventable diseases [VPD] [7-9].

Moreover, about 20.5 million infants globally did not receive important vaccines in 2022, resulting in sluggishness disparities in immunization coverage [10]. This undermines immunization efforts undermines progress toward the Sustainable Development Goals [SDG 3.2] related to reducing child mortality and morbidity.

In Ethiopia and similar settings, immunization program is constrained by weak cold chain system, health workforce shortage, limited financing, and frequent vaccine stock out [11]. Socio cultural barriers and poor transport access further reduce service utilization [11, 12]. Consequently, outbreaks of measles, polio, and other vaccine-preventable diseases persist, reflecting program fragility. Despite Ethiopia's large population, full immunization coverage remains below the 90% global target, with marked urban–rural and regional disparities [11-14].

In Addis Ababa, immunization coverage is above the national average, but zero-dose and under-immunized children still exist, particularly in informal settlements, slum urban, and among mobile or marginalized groups. Studies focus on the prevalence, causes, and interventions for ZD [no vaccines] and UI [incomplete vaccination, e.g., missing DPT3 or measles] in line with Immunization Agenda 2030 [15-18]. Furthermore, socioeconomic and sociocultural barriers are key drivers of zero dose and under-immunized children, alongside weak health systems, inequitable access to services, vaccine hesitancy, and conflict-related disruptions [20, 21]. Furthermore, Ethiopia has made notable progress through the EPI, yet regional disparities and inequities persist. Factors such as rural residence, low maternal education, limited health facility access, vaccine stock outs, and sociocultural influences are strongly associated with UI [15-19, 22-24].

In summary, the magnitude of zero dose and underimmunized children varies across region and geographical settings, including in Addis Ababa. Therefore, identifying and addressing the needs of these children through targeted interventions is essential for improving immunization coverage and equity. Therefore, this research survey summarizes the global, national, and local evidence on the burden of zero-dose and under-immunized children and the factors associated with their occurrence.

# 2. Methods and Materials

## 2.1. Study Setting

This study was conducted in three selected sub-Cities and nine selected districts (woredas) of Addis Ababa, Ethiopia. Addis Ababa, the capital city of Ethiopia and the headquarters of the African Union (AU), is located at 9°1′48" North latitude and 38°44′24" East longitude and covers an area of approxi-

mately 527 square kilometers. The city has an estimated population of more than five million people [25]. Based on the 2007 Ethiopian Population and Housing Census projections and conversion factors, the number of surviving infants is estimated to constitute 2.24% of the total population.

Addis Ababa is administratively divided into eleven sub-cities and has a wide range of public and private health facilities that provide both curative and preventive health services, including child immunization. For this study, three sub-cities comprising three sub-cities comprising more than 30 districts were selected. The selected sub-cities included Lideta, Yeka and Kolfe Keranio which are characterized by considerable socioeconomic diversity, a high proportion of low-income households, and a substantial concentration of urban slum settlement [26] (Figure 1).

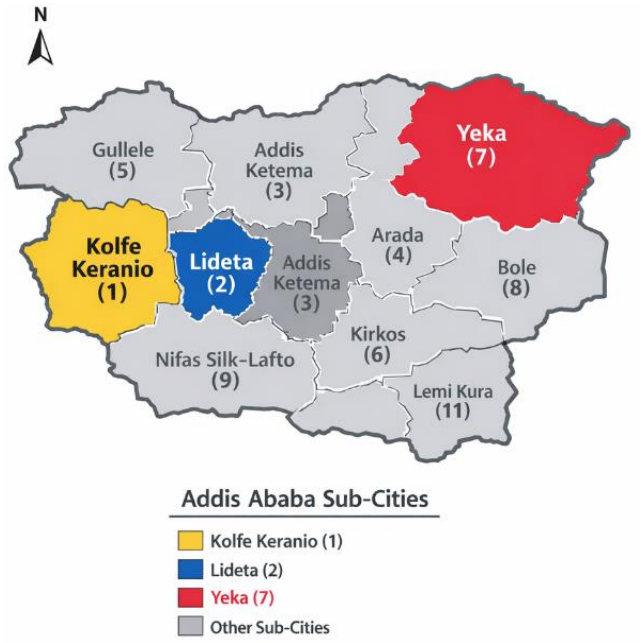


***Figure 1.*** *Map of the study area; 2026.*

## 2.2. Study Period

The study period for this study was March 01, 2026, to April 25, 2026, GC and involved two sequential phases: a qualitative phase followed by quantitative phase. This mixed-methods approach was employed to obtain a comprehensive understanding of immunization status and the factors associated with it among the study population.

The qualitative phase, which constituted the first stage of the study, was carried out from March 1 to March 15, 2026. During this phase, in-depth information was gathered from key informants and relevant stakeholders to explore perceptions, experiences, barriers, and facilitators related to childhood immunization. Findings from the qualitative inquiry were used to enrich the study and provide contextual insights into the quantitative results.

The quantitative phase represented the second stage of the study and was conducted from April 15 to April 25, 2026. During this period, a community-based household survey was undertaken among the selected study participants using a structured questionnaire. Data were collected on immunization status and various socio-demographic, maternal, child-related, and health service factors potentially associated with childhood immunization.

The sequential implementation of the qualitative and quantitative phases enabled the integration of contextual and numerical evidence, thereby enhancing the comprehensiveness and validity of the study findings.

## 2.3. Study Design

A sequential exploratory mixed-method study design was conducted. The qualitative phase utilized an exploratory qualitative study design. Findings from this phase informed were used to develop quantitative data collection and complemented the subsequent quantitative investigation. The quantitative phase employed a retrospective community-based cross-sectional household survey using a cluster sampling approach. This component was designed to determine the magnitude of immunization status and identify factors associated with childhood immunization among the study population. The integration of qualitative and quantitative findings provided a comprehensive understanding of the research problem and enhanced the validity of the study results.

## 2.4. Populations

### 2.4.1. Source Populations

The source populations consisted of children aged 12 to 35 months who were born between January 10, 2023, and January 08, 2025, and residing in Addis Ababa, Ethiopia.

### 2.4.2. Study Populations

The study populations for this study consisted of children aged 12 to 35 months prior to the study period, who were born between January 10, 2023, and January 08, 2025, and who were selected and included in this study during the study period.

## 2.5. Inclusion and Exclusion Criteria's

Inclusion and exclusion criteria are eligibility criteria used to determine participants' suitability for a study.

### 2.5.1. Inclusion Criteria

The quantitative component of the study included caregivers of children aged 12–35 months who were born between January 10, 2023, and January 8, 2025, and residing in Addis Ababa, Ethiopia. The qualitative component included six traditional healers for Key Informant Interviews (KII), and Four

Focus Group Discussions (FGD) comprising 24 discussants among husbands of mothers, to explore community perceptions and experiences related to childhood immunization.

#### 2.5.2. Exclusion Criteria

Mothers who had given birth within the last two years, but whose children had died from any cause were excluded from the study. Caregivers of eligible children who were not available at home after two revisits were also excluded. In addition, children who were temporary visitors to the selected households were excluded at the time of data collection were not included in the study.

For qualitative component, traditional healers and husbands who were not residents of Addis Ababa were excluded. Individuals who were unavailable during the scheduled Key Informant Interviews [KIIs] or Focus Group Discussions [FGDs] despite repeated contact attempts, as well as those who declined to provide informed consent, were also excluded from participation.

### 2.6. Sample Size Determination

#### 2.6.1. Sample Size for Qualitative Phase

For the qualitative phase of the study, key informants (traditional healers) were interviewed on routine immunization for barriers and enablers of immunization uptake (ZD and UI). Furthermore, husbands of mothers used focus group discussion [FGD]. The sample size for the qualitative study was determined based on data saturation.

#### 2.6.2. Sample Size for Quantitative Phase

The sample size for all study objectives was determined using the single-population proportion formula in Epi Info version 7.4.1. Separate sample size calculations were performed to estimate the magnitude of zero-dose (ZD) and incomplete immunization (UI), as well as to identify factors associated with both outcomes. The largest sample size obtained from these calculations was selected as the final sample size for the study. This approach was informed by the WHO immunization cluster survey manual and by a study conducted in Ethiopia on immunization surveys for ZD and UI [2, 6]. The total number of surviving infants at the age of one year in Addis Ababa is assumed to be 2.24% [8]. The total population of Addis Ababa city Administration is assumed to be more than five million in the year 2025 based on the 2007 Ethiopian population conversion rate [25]. Taking this into account, the eligible surviving infants at the age of one year are estimated to be 2.24% of the total population. From the previous study the sample size calculated as follows:

The proportion of children receiving ZD was noted to be 14%. Additionally, the proportion of ever-born children from households classified as wealthy [rich] was 5.8% [6]. Furthermore, the proportion of partially immunized children was 27.7% [19]. By taking these proportions into consideration; and assuming 5% margin of error, a design effect of 1.5, and 10.0% no response rate; the sample size for ZD and UI and associated factors is estimated as follows:

*Sample size for ZD*: Assuming the proportion of children receiving zero doses is 14% gives the optimal sample size, utilizing a 5% margin of error, a design effect of 1.5, and a 10.0% non-response rate, the optimal sample size was calculated to be 275. After accounting for the 10.0% non-response rate, the final sample size was determined to be 301.

*Sample size for UI*: Assuming the proportion of children receiving under immunization or partial immunization is 27.7% gives the largest sample size, utilizing a 5% margin of error, a design effect of 1.5, and a 10.0% non-response rate, the optimal sample size was calculated to be 455. After accounting for the 10% non-response rate, the final sample size was determined to be 501.

*Factors associated with zero doses and incomplete immunization*: Assuming 5.80% of mother with the highest wealth quintile [rich] were more likely received vaccination. By utilizing a 5% margin of error, a design effect of 1.5, and a 10% non-response rate, the maximum sample size was calculated to be 126. After accounting for the 10% non-response rate, the final sample size was determined to be 139. Based on the above information, the largest sample size was considered in this study, which was 501.

### 2.7. Sampling Procedure

#### 2.7.1. Sampling Procedure for Qualitative Phase

In this research, purposive sampling of key informant persons (traditional healers), husbands of mothers, were participated to gather in-depth information about the barriers and enablers of immunization uptake (ZD and UI). Local guiders, gatekeepers, and researchers were purposively select these population groups.

#### 2.7.2. Sampling Procedure for Quantitative Phase

To achieve the desired number of clusters, based on WHO immunization cluster survey, 30% of the sub cities in Addis Ababa were selected randomly [3.3 sub cities, which approximated to three out of eleven, which are Lideta, Kolfe Karanio and Yekka sub cities]. From each sub city three woreda (districts) were selected randomly using proportional to size allocation. Each woreda then be classified according to its ketenas (the smallest administrative level within the community). The list of ketenas and households was obtained from the Sub-city Health Office [26]. In each ketenas cluster, segmentation and mapping was done every 54 households. According to the WHO, one cluster typically consists of 54 households [2]. Based on estimates from the Ethiopia Mini DHS 2019 data, there is an average of 7 children aged 12–23 months per cluster (enumeration area) [8].

Therefore, 72 clusters of 3888 households [i.e., 501 children ÷ 7 children per cluster enumeration = 72 clusters] were surveyed in the selected districts of Lideta Sub-city, Yekka Sub-city and Kolfe Keraniyo sub cities to get the desired number of eligible children. After cluster segmentation, proportional to size allocation of clusters was employed to determine the number of clusters in each district, and the desired clusters were randomly selected for surveying every 54 households to identify eligible children (Figure 2). Furthermore, among households within the selected clusters, for an eligible child, the caregivers were interviewed retrospectively for their child's immunization status.

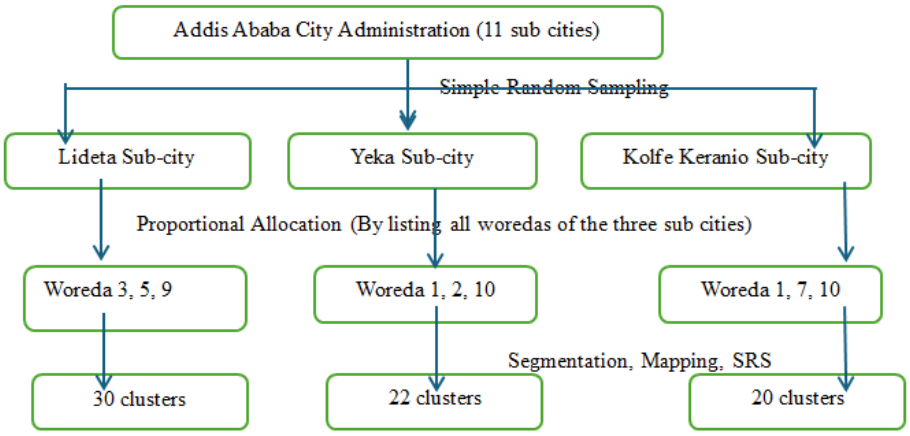


***Figure 2.*** *Sampling procedure of the study; 2026.*

## 2.8. Data Collection Tools and Techniques

### 2.8.1. Qualitative Interview Guide

An open-ended focus group discussion [FGD] guide and a key informant interview [KII] guide were developed to explore the barriers and facilitators influencing immunization uptake in the selected sub-cities of Addis Ababa, Ethiopia [Lideta, Kolfe Keranio and Yekka]. To ensure anonymity and confidentiality, KII participants were assigned as KII1 to the final number of interviewees. Similarly, FGD participants were identified using session codes, ranging from using FGD1 to the final discussion session. The interviewer and focus group discussions were facilitated by trained health professionals using the respective interviewee guides. Data collection was supported by audio and note-taking to ensure comprehensive documentation of participants' responses. Key informants were purposively selected based on their relevant knowledge, experience, and ability to provide rich information pertinent to the study objectives and research questions. The confidentiality binding form was prepared and included for field workers and data coders. The researcher was informed and aimed to define the research objectives and questions clearly. To successfully recruit participants, the researcher established a nurture partnership with community gatekeepers, including local administrators and district heads. These gatekeepers were functioned as important links to the mothers in the community, helping to facilitate access to the focus group discussions.

### 2.8.2. Quantitative Data Collection Tool

In this research, a structured closed-ended questionnaire drawing from the WHO immunization cluster survey manual were used to investigate the immunization uptake and factors associated with it in Lideta, Kolfe Keranio and Yekka sub-cities of Addis Ababa, Ethiopia [2]. Furthermore, data collection tools were adapted from previously published literatures, and findings from qualitative study were used to support and complement quantitative results [6-8, 13]. The assessment involved two methods of verification. Immunization status is verified through vaccination cards or caregiver recall [if records are unavailable]. Determinants are measured through structured questionnaires interviewed caregivers. Furthermore, findings explored by qualitative study were incorporated into the quantitative data collection tool. The questionnaire consists of several sections, including reported vaccination status, home-based records [vaccination card], caregiver recall of vaccination history, care-seeking behavior, accessibility, and experiences with vaccination services, information regarding vaccination, attitudes towards vaccination, and mobility-related questions.

### 2.8.3. Data Quality Control and Management

Data quality was managed by designing appropriate data collection tools. The data collectors, facilitators, and supervisors received training. Qualitative interview guide and quantitative data collection tools were tested off-site, away from the data collection locations [Arada sub-city], before the ac-

tual data gathering. Necessary modifications were implemented based on the results of this testing. Three supervisors were assigned in each subcity and district to evaluate the daily data reporting for its cleanliness, completeness, and consistency. The reliability of the questionnaire was assessed using Cronbach's alpha to evaluate internal consistency. Data quality was ensured through careful data entry and quality control procedures. Content validity was established through expert review to confirm that the questionnaire adequately measured the study variables.

## 2.9. Data Analysis and Procedures

### 2.9.1. Qualitative Data Analysis

Data transcripts were ready to identify recurrent themes and to develop a coding tree. The qualitative data coding and analysis was done using computer-aided qualitative data analysis software [Atlas ti version 25.0 software]. Codes were applied to the text. After coding the transcripts, the researcher created memos and display matrices to thoroughly examine each code for sub-themes, themes, and patterns across the interviews and discussion [27-29].

### 2.9.2. Quantitative Data Processing and Analysis

*Data Processing:* Quantitative data were collected using the KOBO TOOLBOX online system. Data editing, coding, classification, and tabulation of the collected data was used. The quantitative data collected by KOBO TOOLBOX then exported to SPSS version 29.0 for statistical analysis. Quantitative results were presented in tables and figures, while categorical data were visualized using cross-tabulation to check for outliers and skewness. The weighted analysis was done for some variables. The statistical analysis was calculated with a 95% confidence interval. Variables with a p-value ≤ 0.25 in bivariate analysis were selected as candidate variables for the multivariate logistic regression model using the stepwise elimination method. The final model was fitted and tested for adequacy using the Hosmer-Lemeshow test [$X^2$=8.26; df =8; p: 0.405]. Multi-collinearity, indicated by a variance inflation factor [VIF] greater than 10, and interaction between independent variables was checked and removed from the analysis. Multivariate binary logistic regression analyses were computed to identify the predictor variables. Adjusted odds ratios, together with 95% confidence intervals, and p-value < 0.05 were considered to determine and measure the strength and level of significance of the association. Finally, the integration involved triangulation; a joint display or matrix was utilized for result integration to identify the immunization uptake and factors associated with child immunization.

## 2.10. Measurements [Operational Definitions]

*Vaccination coverage:* The proportion of a given population (12 to 35 months) that has been vaccinated at each time according to the national immunization schedule. It is estimated for each vaccine and, for multi-dose vaccines, for each dose received [e.g., diphtheria-tetanus-pertussis-containing vaccine (DPT1, DPT2, and DPT) [2].

*Zero-dose children:* Children 12 to 35 months who have not received any routine vaccinations. This group is often used as an indicator of the failure to reach populations with basic health services [2, 5, 15].

*Under-immunized children:* Children aged 12 to 35 months who have received at least one vaccine but have not completed (missed) at least one vaccine according to the national immunization schedule [2, 5, 8].

*Proportion of Fully immunized children:* Calculated as the number of fully immunized children divided by the total number of children assessed, expressed as a percentage.

*Proportion of under-immunized children:* Calculated as the number of children who received some, but not all, recommended vaccines divided by the total number of children assessed, expressed as a percentage.

*Proportion of zero-dose children:* Calculated as the number of children who have not received any vaccines divided by the total number of children assessed, expressed as a percentage.

*Households:* In the WHO Immunization Coverage Cluster Survey, a household is defined as a group of people who normally live together and share meals from the same cooking pot [2, 8].

# 3. Results

## 3.1. Quantitative Results

In this study, a total of 72 clusters comprising 3888 households were initially planned for visit. However, due to insufficient information, and clustering-related challenges, only 68 clusters, comprising 3,672 households (54 households per cluster), were successfully covered. Of the expected sample, 487 participants of eligible children were interviewed, yielding a response rate of 97.2% of the expected sample. The mean cluster size was 7.16 with design effect of 1.49.

### 3.1.1. Sociodemographic Characteristics

Among caregivers with eligible children aged 12 to 35 months, 200 [41.15%] were from Lideta, 155 [31.82%] from Yeka, and 132 [27.10%] from Kolfe Keranio sub-cities of Addis Ababa, Ethiopia based on unweighted analysis. The weighted analysis yielded a similar distribution, with 41.20% of eligible children residing in Lideta, 31.8 in Yeka, and 27.10% in Kolfe Keranio (Table 1).

***Table 1.*** *Distribution of Enrolled Households, Caregivers, and Children by Sub-City in Addis Ababa, Ethiopia, 2026.*

| Household and Cluster | | | | Children | | |
|---|---|---|---|---|---|---|
| **Subcity** | **# of clusters** | **# of households** | **# of care givers** | **# included in analysis** | **12 to 24 months** | **25 to 35 months** |
| Lideta* | 26 | 1404 | 1404 | 200 | 132 | 68 |
| Yekka@ | 22 | 1188 | 1188 | 155 | 92 | 63 |
| Kolfe# | 20 | 1080 | 1080 | 132 | 58 | 74 |
| Total | 68 | 3880 | 3880 | 487 | 282 | 205 |

Note: we surveyed three districts in each subcity, * [district 3,5 9]; @ [1, 2, 10]; #[1, 7, 10]

Overall, each cluster of 54 households contained an average of 6.9 eligible children in unweighted analysis, whereas the weighted analysis estimated an average of 9.6 eligible children per cluster. At the sub-city level, the unweighted analysis indicated that each cluster of 54 households included an average of 6.67 children aged 12 to 35 months in both Lideta and Kolfe Keranio, compared with 7.04 in Yeka sub-city.

### 3.1.2. Sex Distribution by Subcity and Age Group

The sex distribution of eligible children across the three sub cities showed no consistent pattern of dominance. In Lideta subcity 200 (54.5%, 95% CI: females accounted for 54.5% (95% CI: 42.5–65.5) among children aged 12–24 months, while an equal distribution was observed in the 25–35 months group. In Yeka (n = 155), males were more prevalent in the 12–24 months group (60.9%; 95% CI: 48.1–73.7), whereas females slightly predominated in the 25–35 months group (54.0%; 95% CI: 37.2–70.8). In Kolfe Keranio (n = 132), females slightly predominated in the 12–24 months group (53.4%; 95% CI: 35.8–71.0), with equal distribution observed in the older age group. The mean age increased slightly from Lideta (1.34 ± 0.47; 95% CI: 1.27–1.41) to Yeka (1.41 ± 0.49; 1.32–1.48) and Kolfe Keranio (1.56 ± 0.49; 1.47–1.64), while median values and IQRs indicated moderate and comparable variability across sub cities. Age distributions showed mild positive skewness in Lideta (0.68) and Yeka (0.38) and slight negative skewness in Kolfe Keranio (-0.24), suggesting minor differences in age structure; however, overlapping confidence intervals indicate that these differences are not statistically significant (Table 2).

***Table 2.*** *Demographic Characteristics of Children Aged 12–35 Months by Sub-City, Addis Ababa, Ethiopia, 2026 (n = 487, Unweighted).*

| | **Lideta (n= 200)** | | **Yeka (n= 155)** | | **Kolfe Keraniao (n=132)** | |
|---|---|---|---|---|---|---|
| | **12 to 24 months** | **25 to 35 months** | **12 to 24 months** | **25 to 35 months** | **12 to 24 months** | **25 to 35 months** |
| Female | 72(54.5%) [42.5%, 65.5%)] | 34 (50.0%) [(95% CI: 33.2%–66.8%)] | 36 (39.1%) [(95% CI: 23.2%–55.0%)] | 34 (54.0%) [(95% CI: 37.2%–70.8%)] | 31(53.4%) [(95%CI: 35.8%–71.0%)] | 37 (50.0%) [(95%CI: 33.9%–66.1%)] |
| Male | 60 (45.5%) [(95% CI: 32.9%–58.1%)] | 34 (50.0%) [(95% CI: 33.2%–66.8%)] | 56 (60.9%) [(95% CI: 48.1%–73.7%)] | 29 (46.0%) [(95%CI: 27.9%–64.1%)] | 27(46.6%) [(95%CI: 27.8%–65.4%)] | 37 (50.0%) [(95%CI: 33.9%–66.1%)] |
| Age (mean)* | 1.34 ±0.47 | | 1.41 ±0.49 | | 1.56 ±0.49 | |
| Age (median)* | 1.00 ±1.00 IQR | 1.00 ±1.00 IQR | 2.00 ±1.00 IQR | | 1.00 ±1.00 IQR | |
| CI for mean | [(95% CI: 1.27, 1,41)] | | [(95% CI: 1.32, 1,48)] | | [(95% CI: 1.47, 1.64)] | |
| Skewness | 0.68 (0.17 SE) | | 0.38 (0.19 SE) | | -0.24 (0.21 SE) | |

*Age in months

## 3.2. Overall Routine Immunization Coverage by Subcity (Weighted and Unweighted)

The proportion of zero-dose children (defined as children who had not received at least the first dose of the diphtheria-pertussis-tetanus vaccine [DPT1] was 0.40%. Based on care giver recall, 99.60% of eligible children were reported to have received at least one routine vaccination [(95% CI: 0.98, 0.99)]. However, the proportion of fully immunized children (those who received DPT3), as verified by vaccination cards during the survey, was 91.40% [(95% CI: 0.90, 0.95)] while 3.3% were reported as vaccinated based on caregiver recall. The reasons reported by caregivers for non-vaccination during the interviews included family-related problems such as illness and the mother's busyness.

Moreover, the proportion of children who received the recommended vaccine doses varied across the three sub-cities. In the weighted analysis, coverage was highest in Lideta (94.5%), followed by Kolfe Keranio (91.7%) and Yeka (87.10%). Similarly, the weighted analysis showed vaccination coverage of 89.6% in Lideta, 84.6% in Kolfe Keranio, and 77.1% in Yeka, indicating consistently higher coverage in Lideta and lower coverage in Yeka (Table 3).

***Table 3.*** *Vaccination Status of Children Based on Vaccination Card Records, Addis Ababa, Ethiopia, 2026 (n = 487).*

| Subcity | Unweighted<br>Child received recommended dose (Fully Immunized) | Weighted<br>Child receive recommended dose (Fully Immunized) |
|---|---|---|
| Lideta (n= 200) | 189 (94.50%) (95%CI; 1.89, 1.97) | 211(89.60%) (95% CI: 1.94. 1.98) |
| Yeka (n= 155) | 135 (87.10%) (95%CI: 1.88, 1.97) | 175 (77.10%) (95% CI: 1.94, 1.98) |
| Kolfe Keranio (n=132) | 121 (91.70%) (95%CI: 1.98, 1.98) | 143 (84.60%) (95%CI: 1.95, 1.99) |

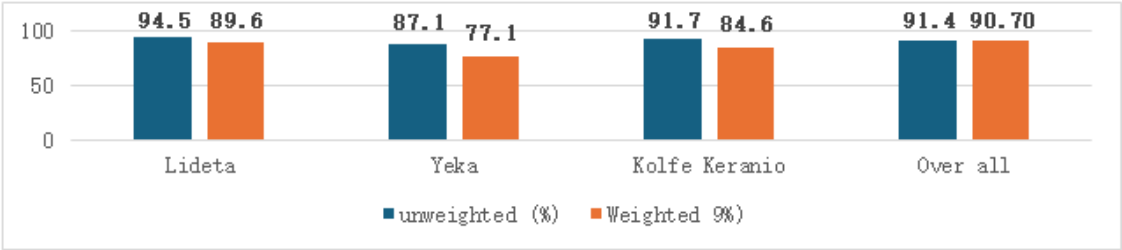


***Figure 3.*** *Distribution of Full Immunization Status in Unweighted and Weighted Analyses; 2026.*

## 3.3. Routine Immunization Coverage by Antigen (Unweighted and Weighted)

Routine immunization coverage among eligible children was high across the surveyed sub-cities and clusters, although notable geographic disparities were observed. Overall, coverage exceeded 90% for most infant vaccines, including BCG (94.0%), Pentavalent-1 (94.9%), PCV-1 (94.0%), Rotavirus-1 (94.7%), Pentavalent-2 (94.7%), PCV-2 (95.1%), Pentavalent-3 (94.5%), and IPV-1 (91.8%). Both weighted and unweighted analyses demonstrated consistently high coverage in Lideta and Yeka sub-cities, where most antigens achieved coverage levels above 95%. In contrast, coverage was substantially lower in Kolfe Keranio, with the lowest uptake observed for OPV0 (58.0% weighted; 60.6% unweighted).

Weighted estimates confirmed these disparities, with overall coverage remaining above 90% for most antigens but declining for OPV0 (84.5%), IPV-2 (83.9%), and Measles-2 (76.2%). Coverage for later vaccine doses showed greater attrition than earlier doses. For example, Measles-1 coverage remained high (91.5%), whereas Measles-2 coverage declined markedly to 76.2%. Similarly, IPV coverage decreased from 90.0% for IPV-1 to 83.9% for IPV-2.

The proportion of children who received all age-appropriate vaccine doses was 84.1% in the weighted analysis, ranging from 77.1% in Yeka to 89.6% in Lideta. Overall, the findings indicate strong routine immunization performance in the surveyed sub-cities; however, persistent coverage gaps in Kolfe Keranio and lower uptake of vaccines administered later in the schedule highlight challenges in achieving equitable access and completion of the full immunization series (Table 4 and Figure 4).

***Table 4.*** *Percentage of children receiving each vaccine dose by Sub-city, Addis Ababa, Ethiopia, 2026 (n = 487; Unweighted and Weighted Estimates).*

| Antigen | Lideta (n=200) | | Yeka (n=155) | | Kolfe Keranio (n=132) | | Overall (n= 487) | |
|---|---|---|---|---|---|---|---|---|
| | **Unweight (n=200)** | **Weight (n=211)** | **Unweight (n=155)** | **Weight (n =175)** | **Unweight (n=132** | **Weight (n=143)** | **Unweight (n=487)** | **Weight (n=529)** |
| | Unweighted No (%) | Weighted N (%) | Unweighted No (%) | Weighted N (%) | Unweighted No (%) | Weighted No (%) | Unweighted No (%) | Weighted N (%) |
| BCG | 195 (97.5%) | 205 (97.2%) | 154 (99.4%) | 173 (98.9%) | 109 (82.5%) | 112 (78.3%) | 458 (94.0%) | 495 (93.6%) |
| OPV0 | 187 (93.5%) | 195 (92.4%) | 152 (98.1%) | 169 (96.6%) | 80 (60).6% | 83 (58.0%) | 419 (86.0%) | 447 (84.5%) |
| Penta 1 | 200 (100%) | 211 (100%) | 154 (98.4%) | 171 (97.7%) | 108 (81.8%) | 107 (74.8%) | 462 (94.9%) | 495 (93.60%) |
| Polio 1(OPV) | 200 (100%) | 211 (100%) | 153 (98.7%) | 171 (97.7%) | 104 (78.8%) | 107 (74.8%) | 457 (93.8%) | 489 (92.4%) |
| PCV 1 | 197 (98.5%) | 208 (98.8%) | 153 (98.7%) | 171 (97.7%) | 108 (81.8%) | 110 (76.9%) | 458 (94.0%) | 489 (92.4%) |
| Rota 1 | 200 (100%) | 211 (100%) | 154 (99.4%) | 173 (98.9%) | 107 (81.10%) | 110 (76.9%) | 461 (94.7%) | 489 (92.4%) |
| Penta 2 | 198 (98.5%) | 209 (99.1%) | 154 (99.4%) | 173 (98.9%) | 109 82.5%) | 112 (78.3%) | 461 (94.7%) | 494 (93.4%) |
| Polio 2 (OPV) | 200 (100%) | 211 (100%) | 153 (98.7%) | 172 (98.3%) | 107 (81.10%) | 110 (76.9%) | 460 (94.5%) | 493 (93.2%) |
| PCV 2 | 200 (100%) | 211 (100%) | 154 (99.4%) | 173 (98.9%) | 109 82.5%) | 112 (78.3%) | 463 (95.1%) | 496 (93.8%) |
| Rota 2 | 200 (100%) | 211 (100%) | 153 (98.7%) | 171 (97.7%) | 108 (81.8%) | 111 (77.6%) | 461 (94.7%) | 493 (93.2%) |
| Penta 3 | 199 (99.5%) | 210 (99.5%) | 152 (98.1%) | 169 (96.6%) | 109 (82.5%) | 112 (78.3%) | 460 (94.5%) | 491 (92.8%) |
| Polio 3 (OPV) | 200 (100%) | 211 (100%) | 151 (97.4%) | 168 (96.0) | 107 (81.1%) | 110 (76.9%) | 458 (94.0%) | 489 (92.4%) |
| Measles 1 | 200 (100%) | 211 (100%) | 150 (96.7%) | 165 (94.3%) | 107 (81.1%) | 108 (75.5%) | 457 (93.8%) | 484 (91.5%) |
| Measle 2 | 167 (83.5%) | 168 (79.6%) | 139 (89.6%) | 147 (84.0%) | 88 (66.7%) | 88 (61.5%) | 394 (80.9%) | 403 (76.2%) |
| IPV 1 | 194 (97.0%) | 204 (96.7%) | 152 (98.1%) | 169 (96.6%) | 101 (76.5%) | 103 (72.0%) | 447 (91.8%) | 476 (90.0%) |
| IPV 2 | 182 (91.0%) | 192 (1.0%) | 140 (90.3%) | 147 (84.0%) | 103 (78.03%) | 105 (73.45) | 425 (87.3%) | 444 (83.9%) |
| Recom-mended dose received | 189 (94.5%) | 189 (89.6%) | 135 (87.1%) | 135 (77.1%) | 121(91.7%) | 121 (84.6%) | 445 (91.4%) | 445 (84.1%) |

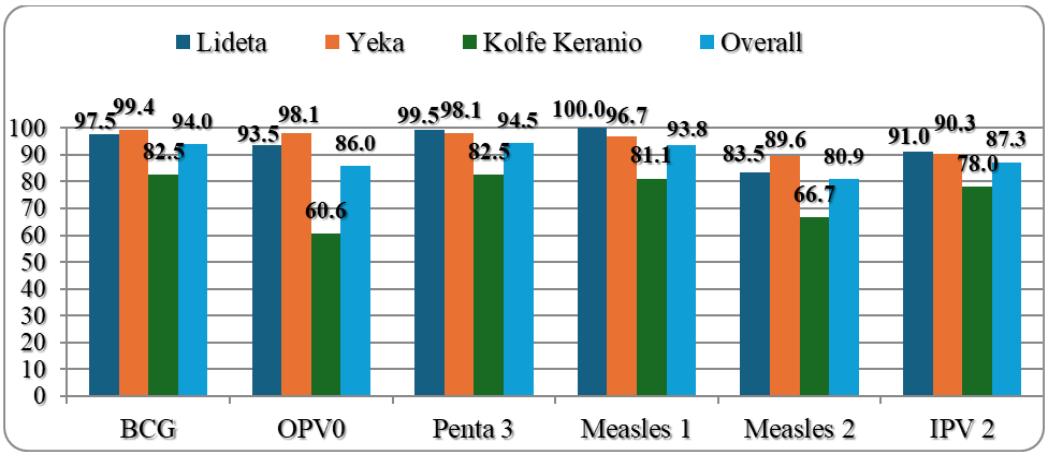


***Figure 4.*** *Unweighted vaccination coverage by key antigens and sub-city; 2026.*

## 3.4. Accessibility of Health Services for Routine Immunization [Caregiver Response]

The round-trip travel time from leaving home to a nearby health facility providing routine immunization services ranged from 5 to 240 minutes, with a mean time of 28.1 ± 22.8 minutes. Concerning distance from the health facility based on care giver response (perceive), 240 (53.9%) of fully immunized children lived near a health facility, 144 (32.4%) lived far, and 61 (13.7%) lived too far. Among those who did not receive the full dose of immunization, 22 (52.4%) lived nearby, 16 (38.1%) lived far, and 4 (9.5%) lived too far from a health facility. Regrading to the travel time to reach the vaccination site showed that most fully immunized children, 340 (76.4%) lived within 30 minutes of a health facility, while 87 (19.6%) required 31–60 minutes and 18 (4.0%) required more than 60 minutes. In contrast, among children who were not fully immunized, 25 (59.5%) lived within 30 minutes, 11 (26.2%) required 31–60 minutes, and 6 (14.3%) required more than 60 minutes to reach a health facility. Moreover, concerning transportation costs, most fully immunized children (359, 80.7%) incurred transportation expenses of ≤30 birr, while 16 (3.6%) spent 31–45 birr and 70 (15.7%) spent ≥46 birr. Among children who did not complete routine immunization, 32 (76.2%) spent ≤30 birr, 6 (14.3%) spent 31–45 birr, and 4 (9.5%) spent ≥46 birr. Overall, full routine immunization coverage was higher among younger children, those living closer to health facilities, those requiring shorter travel times, and those with lower transportation costs.

## 3.5. Accessibility of Health Services and Caregiver Decision-Making Power for Routine Immunization

Overall, full routine immunization coverage was positively associated with closer proximity to health facilities, shorter travel times, lower transportation expenses, and younger child age. On average, caregivers spent 28.1 ± 22.8 minutes in round-trip travel time and 16.87 ± 24.02 ETB in transit costs, with the majority of fully immunized children residing within a 30-minute travel radius [76.4%] and spending ≤30 ETB [80.7%]. In contrast, longer travel times [>60 minutes] were more common among children who failed to complete their immunization schedule [14.3% vs. 4.0%]. Alongside these structural access factors, maternal autonomy was notably high; weighted estimates demonstrated that caregivers held strong decision-making power regarding child immunization across Yeka (98.40%), Lideta (83.70%), and Kolfe Keranio (74.30%) sub-cities.

## 3.6. Factors and Barriers Influencing Immunization Uptake in Addis Ababa, Ethiopia

The fitness of the model was checked for its adequacy at (chi square: 4.43, df:8 and P:value: 0.86) indicating the model was adequately fit. After adjusting for potential confounders, transportation cost from routine immunization site, caregivers' perception regarding appropriate childhood vaccination, perceived friendliness and courtesy of health care providers, source of routine immunization information, and community leaders' support remained significantly associated full dose routine immunization.

In this research, routine immunization receipt was significantly associated with geographic accessibility, service perception, communication sources, and community support. Children whose caregivers reported spending ≤ 30.0 Ethiopian Birr on transportation to an immunization site had 5.59 times higher odds of receiving the full dose of routine immunization compared with children whose caregiver spent ≥ 46.0 Ethiopian Birr [(AOR = 5.59; 95% CI: 1.21 – 25.62; $p$ = 0.02)] (Table 5).

The meta inference of quantitative and qualitative result demonstrated that high overall routine immunization coverage among children aged 12–35 months in Addis Ababa (91.4%;

87.1%–94.5%) across sub-cities is driven by multi-level interplay of individual awareness, service accessibility, provider behavior, community structures, high maternal autonomy, and health system performance. However, completion rates drop significantly for late-schedule doses like Measles-2 (80.9%) and IPV-2 (87.3%), indicating critical challenges in maintaining continuity of care.

Caregivers' perceptions regarding appropriate childhood vaccination and healthcare providers' friendly and courteous treatment were significantly associated with full dose of routine immunization. Children whose caregivers perceived that mothers should take their children for appropriate vaccination had lower odds of receiving the full routine immunization dose [(AOR = 0.21; 95% CI: 0.05 – 0.85; $p$ = 0.020)], whereas children whose caregivers agreed that healthcare providers treated them and their children in a friendly and courteous manner had higher odds of receiving the full routine immunization dose than those whose caregivers strongly agreed with the statement [(AOR = 3.77; 95% CI: 1.73 – 8.21; $p$ = 0.001)] (Table 5).

The qualitative findings provided crucial context and explanatory depth for these patterns across four central themes. Regarding Attitudes Toward Vaccination, caregivers overwhelmingly recognized the fundamental value of immunization for child growth and disease prevention, with one focus group participant affirming that *"Vaccination is very important for children's health… it prevents diseases and is very good for our children's development."* Nevertheless, persistent misconceptions and safety fears led to deliberate non-adherence in certain communities; as one key informant described, *"People with misconceptions hide their children by registering that only one child is vaccinated."*

Concerning the Integration of Traditional and Modern Medicine, participants noted distinct perceived boundaries between traditional healing and routine vaccines, emphasizing that sustainable coverage requires bridging this divide through joint knowledge-sharing and formal collaboration. Highlighting this opportunity, respondents expressed that *"It would be beneficial if we could work with the involvement of traditional medicine practitioners in our country."*

In terms of Community Health Education and Barriers to Vaccination Uptake, the two data strands strongly converged. Quantitative multivariable analysis established that the source of routine immunization information was significantly associated with full-dose routine immunization. Children whose caregivers received routine immunization information from community members and religious had higher odds of receiving full routine immunization dose [(AOR = 20.90, $p$ = 0.036)]. Furthermore, children whose caregivers reported receiving support from community leaders had 11.98 times higher odds of receiving the full dose of routine immunization compared with whose caregivers reported no community leader support [AOR = 11.98; 95% CI: 2.08 - 68.80, $p$ = 0.005) (Table 5). Qualitative narratives mirrored these results, confirming that Health Extension Workers, family health teams, and respected social figures served as vital facilitators of trust and service utilization.

Conversely, qualitative insights revealed that vaccine stockouts, financial transit burdens, disrespectful provider attitudes, gendered intra-household decision-making, and deep-seated cultural beliefs accounted for the dropouts observed in multi-dose vaccine schedules. Conversely, qualitative findings provided vital explanatory context for the observed dropouts and non-completion. Key multi-level barriers include physical and financial transit burdens, health system constraints [e.g., vaccine stockouts, resource shortages, and abrasive provider attitudes], gendered family dynamics, and persistent sociocultural factors such as safety fears, reliance on traditional medicine, and deliberate vaccine avoidance due to misinformation. Ultimately, achieving universal completion across all sub-cities requires a holistic approach that pairs supply-chain reliability and friendly facility services with targeted community engagement to dismantle sociocultural misconceptions.

Taken together, these integrated findings indicate that while baseline awareness and community support in Addis Ababa are robust, achieving universal completion requires addressing structural accessibility barriers, eliminating facility supply disruptions, reforming provider–client communication, and actively involving traditional and religious leaders to combat misinformation.

***Table 5.*** *Independent Predictors of Childhood Immunization Uptake in Addis Ababa, Ethiopia, 2026: Unweighted Analysis [n = 487]*.

| | Category | Full Dose of Routine Immunization (n = 487) | | P:value of AOR | AOR | 95% C.I for AOR | |
|---|---|---|---|---|---|---|---|
| | | Received | Not received | | | Lower | Upper |
| Age of an eligible child _ in months | 12–24 months | 263 (59.1) | 19 (45.20) | 0.23 | 0.62 | 0.28 | 1.35 |
| | 25–35 months | 182 (40.9) | 23 (54.80) | | 1.00 | | |
| Distance of immunization site (Taxi cost) _caregiver response | ≤ 30 birrs | 359 (80.7%) | 32 (76.2%) | .02[@] | 5.59 | 1.21 | 25.62 |
| | 31 to 45 birrs | 16 (3.6%) | 6 (14.3%) | .008[@] | 11.15 | 1.87 | 66.26 |
| | ≥ 46 birrs | 70 (15.7%) | 4 (9.5%) | | 1.00 | | |
| Seeking _ is appropriate RI | No | 4 (9.5) | 38 (90.5) | 0.45 | 2.19 | 0.27 | 17.22 |

| | Category | Full Dose of Routine Immunization (n = 487) | | P:value of AOR | AOR | 95% C.I for AOR | |
|---|---|---|---|---|---|---|---|
| | | Received | Not received | | | Lower | Upper |
| DOSE is received | Yes | 20 (4.5) | 425 (94.5) | | 1.00 | | |
| Seeking _ Perceived of mothers take their child unappropriated VACCINE | Yes | 421(95.5) | 35 (87.5) | .02® | 0.21 | 0.05 | 0.83 |
| | No | 20 (4.5) | 5 (12.5) | | 1.00 | | |
| The healthcare provider treats me and my child in a friendly and courteous manner RI | Agree | 130 (29.2) | 24 (57.1) | .001@ | 3.77 | 1.73 | 8.21 |
| | Strongly agree | 315 (70.8) | 18 (42.9) | | 1.00 | | |
| Information_ Who is your contact as source of information on RI (n = 487) | Family Health Team | 235 (52.8) | 28 | 0.11 | 5.70 | 0.65 | 49.57 |
| | Health Professionals | 155 (34.8) | 9 | 0.80 | 1.35 | 0.12 | 14.38 |
| | Community members and religious leaders | 7 | 4 | 0.01@ | 20.90 | 1.81 | 63.27 |
| | Community members | 48 (10.8) | 1 | | 1.00 | | |
| Information_ What information you heard about RI | Benefits of immunization | 256 (59.7) | 25 (65.8) | 0.92 | 0.95 | 0.37 | 2.43 |
| | Side effects of immunization | 71(16.6) | 2 (5.3) | 0.80 | 0.78 | 0.11 | 5.52 |
| | Date of next contact and keeping card | 13 (3.0) | 2 (5.3) | 0.51 | 0.47 | 0.05 | 4.44 |
| | Time and place of immunization | 89 (20.7) | 9 (23.7) | | 1.00 | | |
| Decision towards RI _ Self decision by care giver | Decide my self | 326 (73.3) | 27 (64.3) | 0.46 | 0.72 | 0.31 | 1.70 |
| | Discussion with partner | 119 (26.7) | 15 (35,7) | | 1.00 | | |
| Parent support towards RI | No | 5 (1.1) | 3 (7.1) | 0.41 | 0.72 | 0.31 | 1.760 |
| | Yes | 440 (98.9) | 39 (92.9) | | 1.00 | | |
| Gender Norm _ Community Leader support to RI | No | 12 (2.7) | 9 (21.4) | | 1.00 | | |
| | Yes | 433 (97.3) | 33 (78.6) | 0.005@ | 11.98 | 2.08 | 68.8 |
| Gender Norm _ HWs support family daily on RI | No | 5 (1.1) | 5 (11.9) | 0.56 | 1.89 | 0.22 | 16.25 |
| | Yes | 440 (98.9) | 37 (88.1) | | 1.00 | | |
| Mobility _ Is one of the care givers move to another place in the lats one year (487) | No | 393 (88.3) | 32 (76.2) | 0.67 | 0.61 | 0.06 | 5.68 |
| | Yes | 41 (9.2) | 6 (14.3) | 0.41 | 2.64 | 0.25 | 27.32 |
| | Don’t know | 11 (2.5) | 4 (9.5) | | 1.00 | | |
| Overall care givers decision making power | Has no decision-making power | 110 (24.70) | 5 (11.90) | 0.64 | 1.32 | 0.39 | 4.42 |
| | Has decision making power | 335 (75.3) | 37 (88.1) | | 1.00 | | |

®: Significant at p:value 0.05

## 4. Discussions

This study employed a convergent mixed-methods design to examine factors influencing routine immunization uptake among children aged 12–35 months in Addis Ababa. The integrated findings demonstrated that routine immunization coverage was relatively high [91.4%], but several individual, community, and health system factors continued to influence vaccination completion. The findings provide important insights into facilitators and barriers affecting immunization uptake and are consistent with evidence reported from Ethiopia and other low- and middle-income countries [30, 31].

The study found that overall routine immunization coverage was high, with most antigens achieving coverage rates above 90%. However, lower coverage was observed for Measles-2 and IPV-2, indicating challenges in completing vaccinations administered later in the immunization schedule. This finding is consistent with reports from the World Health Organization [WHO] and the United Nations Children's Fund [UNICEF], which have documented declining coverage for later vaccine doses due to caregiver fatigue, missed appointments, and inadequate follow-up mechanisms [30, 32]. Similar findings have been reported in Ethiopia, where dropout rates increase as children progress through the immunization schedule [6, 33]. The qualitative findings further supported this observation by highlighting service interruptions, vaccine stock-outs, and caregiver-related barriers that contributed to incomplete vaccination.

The integrated findings demonstrated that caregiver awareness and access to reliable immunization information were important determinants of vaccine uptake. Quantitative results showed that information received from community members and religious leaders significantly increased the likelihood of complete immunization, while qualitative findings emphasized the important role of health extension workers, family health teams, and healthcare providers in promoting vaccination. These findings align with previous studies indicating that trusted community-based communication channels improve vaccine acceptance and reduce hesitancy [5, 34]. Community engagement has been identified as a critical strategy for increasing immunization coverage, particularly in urban settings where diverse social networks influence health-seeking behavior [32].

Accessibility emerged as another significant factor influencing immunization uptake. Caregivers living closer to health facilities and incurring lower transportation costs were more likely to complete their children's vaccination schedules. These findings are consistent with previous Ethiopian studies showing that geographical accessibility and transportation affordability remain important determinants of maternal and child health service utilization [13, 35]. Similar evidence from sub-Saharan Africa indicates that long travel distances and indirect costs continue to limit immunization service utilization despite vaccines being provided free of charge [36]. The qualitative findings reinforced this relationship by demonstrating how transportation expenses and financial constraints create barriers for low-income households.

Healthcare provider behavior was also found to significantly influence immunization uptake. Caregivers who perceived healthcare workers as friendly and respectful were more likely to complete childhood vaccination schedules. This finding is consistent with evidence showing that positive provider-client interactions enhance trust in healthcare systems and encourage continued utilization of preventive health services [18, 37]. Qualitative participants reported that disrespectful treatment and poor communication discouraged some caregivers from returning for subsequent vaccine doses. Similar findings have been documented in Ethiopia and other African countries, where respectful care has been recognized as an important determinant of immunization completion and maternal health service utilization [6, 29, 38].

Community engagement and leadership support emerged as strong facilitators of immunization uptake. Quantitative findings showed a significant association between community leader support and vaccination completion, while qualitative findings highlighted the influential roles of religious leaders, community elders, and community dialogue platforms. These findings support growing evidence that social mobilization and community participation improve vaccine acceptance and strengthen trust in immunization programs [5, 10, 32]. Religious and community leaders often serve as trusted sources of health information and can play a critical role in countering misinformation and encouraging positive health behaviors.

The qualitative findings further expanded the quantitative results by revealing the influence of misconceptions, cultural beliefs, and traditional medicine on vaccination decisions. Participants described instances in which caregivers avoided vaccination due to fears regarding vaccine safety, misinformation, or reliance on traditional healing practices. Similar concerns have been reported globally and remain among the leading causes of vaccine hesitancy [13, 39]. In Ethiopia, misconceptions regarding vaccine side effects and beliefs in alternative healing methods have been identified as barriers to complete immunization [33]. These findings suggest that addressing vaccine misinformation requires culturally appropriate communication strategies and active involvement of trusted community actors.

The study also identified the influence of gender norms and family decision-making processes on childhood immunization. Although most caregivers reported having decision-making authority regarding vaccination, qualitative findings indicated that household dynamics and family support influenced immunization completion. Similar findings have been reported in low- and middle-income countries, where paternal involvement, family support, and women's autonomy significantly affect child healthcare utilization [8, 34]. These results suggest that interventions aimed at improving vaccination uptake

should involve both mothers and other influential household members.

Furthermore, the coexistence of traditional and modern healthcare systems emerged as a recurring theme. Participants emphasized the potential value of engaging traditional healers and integrating indigenous knowledge into public health strategies. Health system challenges constituted another important barrier identified through the integration of findings. While quantitative results indicated lower coverage for later vaccine doses, qualitative findings revealed underlying issues such as vaccine shortages, inadequate resources, workforce limitations, and service delivery gaps. Similar challenges have been reported across many African countries, where supply chain disruptions and resource constraints continue to affect immunization program performance [5, 20]. Missed opportunities resulting from stock-outs and service interruptions contribute significantly to incomplete vaccination and may undermine public confidence in immunization services.

This finding suggests that culturally sensitive approaches that recognize existing belief systems may enhance community acceptance of vaccination services. Collaboration between health professionals, traditional practitioners, and community leaders could facilitate more effective health promotion interventions.

Overall, the findings support the Social Ecological Model, which emphasizes that health behaviors are influenced by multiple interacting factors operating at individual, interpersonal, community, organizational, and policy levels. Immunization uptake in Addis Ababa was shaped not only by caregiver knowledge and attitudes but also by accessibility of services, healthcare provider interactions, community support structures, cultural beliefs, and health system performance. Therefore, interventions aimed at increasing vaccination coverage should adopt a comprehensive approach that simultaneously addresses demand-side and supply-side barriers.

The study concludes that sustaining and improving routine immunization coverage in Addis Ababa requires strengthening community-based health education, improving service accessibility, enhancing healthcare provider communication skills, engaging religious and community leaders, addressing vaccine misinformation, and ensuring reliable vaccine supply chains. Such integrated interventions will be essential for achieving universal immunization coverage and reducing the burden of vaccine-preventable diseases among children.

# 5. Strength and Limitations

## 5.1. Strengths of the Study

The study's strength lies in its exploratory mixed-methods design, which provided a comprehensive understanding of immunization uptake by combining qualitative and quantitative evidence. While the quantitative component estimated the magnitude of immunization uptake and identified associated factors, the qualitative component provided in-depth insight into caregivers' perceptions, experiences, and contextual factors that influenced immunization practices. The use of cluster sampling enhanced representativeness, while data triangulation through FGDs and KIIs improved the credibility of findings. The study also generated practical evidence to inform immunization policies and programs.

## 5.2. Limitations of the Study

The cross-sectional design limits causal inference, and caregiver-reported information may be subject to recall bias. Social desirability bias may also have influenced participants' responses. In addition, the findings may not be fully generalizable beyond Addis Ababa, and some perspectives may not have been captured despite achieving thematic saturation. Nevertheless, the mixed-methods approach and data triangulation strengthened the validity of the findings. Although cluster sampling is an efficient and practical approach for community-based surveys, participants within the same cluster may share similar characteristics, thereby reducing statistical efficiency. Although, measures such as the use of trained interviewers, standardized interview guides, verbatim transcription, and independent coding were employed to enhance the trustworthiness of the qualitative findings, some degree of researcher interpretation bias may still have occurred.

# 6. Conclusions

The findings revealed that routine immunization coverage among children aged 12–35 months in Addis Ababa was 91.4%; although disparities in coverage and schedule completion persisted. Immunization uptake was significantly influenced by healthcare access, transportation costs, provider–client interactions, information sources, and community support. Qualitative findings further highlighted the roles of awareness, cultural beliefs, misinformation, and health system challenges. Overall, routine immunization uptake is shaped by interconnected individual, community, and health system factors, underscoring the need for integrated interventions to sustain and improve immunization coverage. Therefore, establishing appointment reminders and follow-up mechanisms, provider-client communication, and community-based advocacy and mobilization to improve timely completion of all recommended routine immunization doses is recommended.

# Abbreviations

| | |
|---|---|
| AOR | Adjusted Odds Ratio |
| BCG | Bacille Calmette-Guerin |
| DPT | Diphtheria Pertussis and Tetanus |
| FGD | Focus Group Discussion |
| IPV | Injectable Polio Vaccine |
| KII | Key Informant Interview |
| PCV | Pneumococcal Conjugate Vaccine |

| | |
|---|---|
| SDG | Sustainable Development Goal |
| UI | Under Immunized |
| UNICEF | United Nations Children's Fund |
| WHO | World Health Organization |
| VPD | Vaccine Preventable Disease |
| ZD | Zero Dose |

## Acknowledgments

The authors would like to give thank and glory to God together with their family's support. Next the authors extend their sincere gratitude to Menelik II Medical and Health Science College, the data collectors and study participants.

## Ethical Declarations

Ethical approval to conduct this research was obtained from the Institutional Review Board of Menelik II Medical and Health Science College [Ref No: አጤ5/38/12/4757]. Additionally, letters of support and permission further obtained from the Addis Ababa City Administration Health Bureau [Ref No: አ/አ/ጤ/2/1364/18] and from the selected subcity health offices [Lideta, Yeka and Kolfe Keranio Subcities].

## Author Contributions

**Asefa Taresa:** Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Writing – original draft

**Admasu Ketsela:** Conceptualization, Supervision, Validation, Writing – review & editing

**Solomon Girma:** Validation, Visualization, Writing – review & editing

**Lakechi Haile:** Software, Validation, Visualization, Writing – review & editing

## Data Availability Statement

The data sets used and analyzed during the study are available from the author on reasonable request.

## Conflicts of Interest

The authors declare no conflicts of interest.

## References

[1] WHO. Immunization Coverage. [Online]. Geneva: WHO; 2024 [cited 2025 September 15]. Available from: https://www.who.int/news-room/fact-sheets/detail/immunization-coverage

[2] WHO. Vaccination Coverage Cluster Surveys: Reference Manual. [Online].; 2018 [cited 2025 September 15]. Available from: Retrieved from https://www.who.int/teams/immunization-vaccines-and-biologicals/immunization-analysis-and-insights/global-moni

[3] Galles, N. C. et al. Measuring routine childhood vaccination coverage in 204 countries and territories, 1980–2019: a systematic analysis for the Global Burden of Disease Study. Lancet. 2021, 398(10299), 503–521.

[4] IA2030. Scorecard for Immunization Agenda 2030.; 2024.

[5] WHO & UNICEF. Immunization Report. [Online].; 2025 [cited 2025 September 15]. Available from: https://www.who.int/news/item15-

[6] Bogale, B., Tiruneh, G. T., Belete, N. et al. Risk factors associated with zero-dose and under-immunized children, and the number of vaccination doses received by children in Ethiopia: a negative binomial regression analysis. BMC Public Health. 2025, 25, 1693.

[7] Endehabtu, B. F., Alemu, K., Mengiste, S. A., Zelalem, M., Gullslett, M. K., Tilahun, B. Spatial disparities in zero-dose vaccination coverage for children aged 12–23 months in Ethiopia: A geographically weighted regression analysis. PLoS ONE. 2025, 20(9), 1–19.

[8] EPHI and ICF. Ethiopian Mini Demographic and Health Survey: Key Indicators. Rockville, Maryland, USA: EPHI and ICF; 2019.

[9] WHO. Fact Sheets on Immunization Coverage. [Online].; 2025 [cited 2025 September 22]. Available from: https://www.who.int/news-room/fact-sheets/detail/immunization-coverage

[10] WHO, UNICEF. Global childhood vaccination coverage holds steady, yet over 14 million infants remain unvaccinated. [Online]. Geneva: WHO: WHO/UNICEF Estimates of National Immunization Coverage [WUENIC]; 2024 [cited 2025 September 22]. Available from: https://www.who.int/news/item/15-07-2025-global-childhood-vaccination-coverage-holds-steady-yet-over-14-million-infants-remain-unvaccinated-who-unicef

[11] Ekholuenetale, M., Ochagu, V. A., Ilesanmi, O. S., Badejo, O., Arora, A. Childhood Vaccinations and Associated Factors in 35 Sub-Saharan African Countries: Secondary Analysis of Demographic and Health Surveys Data from 348949 under five children. Global Pediatric Health. 2024, 11, 1–12.

[12] CSA and ICF. Ethiopian Demographic and Health Survey. Five Years Report. Addis Ababa: Ethiopia, Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.; 2016.

[13] Gebrehiwot, G. T., Tilahun, M., Gebrehiwot, H., Kahsay, H., Gebregziabher, G., Haddis, S. et al. Prevalence and determinants of child immunization coverage in Ethiopia: Evidence from the 2019 mini-demographic and health survey. BMC Public Health. 2025, 21(1), 1–10.

[14] Tadese, Z. B., Nigatu, A. M., Yehuala, T. Z. et al. Prediction of incomplete immunization among under-five children in East Africa from recent demographic and health surveys: a machine learning approach. Scientific Reports. 2024, 14, 11529.

[15] Geweniger, A., Abbas, K. M. Childhood vaccination coverage and equity impact in Ethiopia by socioeconomic, geographic, maternal, and child characteristics. Vaccine. 2020, 38(20), 1627–1668.

[16] Juarez, S. P., Honkaniem, H. Guidelines for Use of Literature Review in Master's Theses in Public Health. Pedagogy in Health Promotion. 2024, 11(2), 110–119.

[17] eaulieu, A., Ducharme, J., Thibeault, C., Akani, B. C., Correa, G. C., Reynolds, H. W., & Johri, M. Beaulieu, A., Ducharme, J., Thibeault, C., Akani, B. C., Correa, G. C., Reynolds, H. W., & Johri, M. [2024, November 11]. The Immunization Agenda 2030 strategy to reach zero-dose children in low- and middle-income countries: a living scoping review protoc. [Online].; 2024 [cited 2025 September 22]. Available from: Retrieved from osf.io/cgfw9.

[18] Farrenkopf, B. A., Zhou, X., Shet, A., Olayinka, F., Carr, K. et al. Understanding household-level risk factors for zero dose immunization in 82 low-and middle-income countries. PLoS ONE. 2023, 18(12), 1–24.

[19] Dires, A. A., Workie, D. L., Teklie, A. K. Exploring factors influencing childhood immunization status in East Africa using multilevel ordinal logistic regression analysis. Frontiers in Public Health. 2025, 12, 1–11.

[20] Gavi. the Vaccine Alliance. [Online].; 2022 [cited 2025 September 16]. Available from: https://www.gavi.org

[21] Paterson, P., Meurice, F., Stanberry, L., Glismann, S., Rosenthal, S. L., Larson, H. J. Vaccine hesitancy and healthcare providers. Vaccine. 2016, 34(52), 2–8.

[22] Wondimu, A., Cao, Q., Wilschut, J. C. et al. Factors associated with the uptake of newly introduced childhood vaccinations in Ethiopia: the cases of rotavirus and pneumococcal conjugate vaccines. BMC Public Health. 2019, 19, 1656.

[23] Sako, S., Gilano, G., Hailegebreal, S. Determinants of childhood vaccination among children aged 12–23 months in Ethiopia: a community-based cross-sectional study. BMJ Open. 2023, 13(3), 1–9.

[24] Mihret, B. G., Belay, B. N., Kelkay, J. M., Amare, A. M., Tarekegn, A. D., Asegu, A. A., Belay, G. N., Engdayehu, A. M., Engda, A. A., Mengist, Y. A., Anteneh, D. S., Yesuf, S. H. Design a model to predict incomplete immunization among Ethiopian children using ensemble machine learning algorithms. Scientific Reports. 2025, 16(1), 1933. https://doi.org/10.1038/s41598-025-31716-5

[25] Ethiopia FDRo. Summary and Statistical Report of the 2007 Population and Housing Census. National Report. Addis Ababa: National Statistics Agency; December 2008.

[26] Lideta, Kolfe Keranio, Yekka. Annual Performance Report. Annual Report. Addis Ababa: Lideta Sub-City, Health Extension and Primary Health Care Unit Department; 2025. Report No.: unpublished.

[27] John W. Cresswell, J. David Cresswell. Qualitative, Quantitative, and Mixed Methods Approaches. Fifth Edition ed. Helen salmon CNMODCFAM, editor. Losangeles, London, NewDelhi: SAGE; 2018.

[28] Creswell J. Designing and Conducting Mixed Methods Research. [Online].; 2021 [cited 2025 September 18]. Available from: https://cdn.bookey.app/files/pdf/book/en/designing-and-conducting-mixed-methods-research.pdf

[29] Matthew B. Miles, A. Michael Huberman, Johnny Saldana. Qualitative Data Analysis, A Method Source Book. 3rd ed. Helen Salmon KKLB, editor. Losangeles/London/NewDelhi: SAGE; 2014.

[30] Sekar K, Mickler AK, Forsberg VC. The 2026 childhood immunization schedule. Washington (DC): Congressional Research Service; 2026 Jun 11. Report No.: R48982. Available from: https://www.everycrsreport.com/files/2026-06-11_R48982_237a80a7e913dac7188b088a069f1a8f7abcdcb0.pdf

[31] Ketsela A, Taresa A, Girma S, Haile L, Taresa Eticha A. Barriers and enablers of child immunization (zero-dose and under-immunized) in Addis Ababa, Ethiopia, 2026: exploratory qualitative study design [preprint]. Research Square; 2026. https://doi.org/10.21203/rs.3.rs-9447701/v1

[32] World Health Organization & UNICEF. Estimates of national immunization coverage [WUENIC]. Geneva: WHO and UNICEF., WHO and UNICEF; 2024.

[33] Gebremeskel, T., Bekele, S., Tesfaye, A. Determinants of incomplete childhood immunization in Ethiopia: A multi level analysis. BMC Pediatrics. 2023, 23(1), 456.

[34] Ames, H., Njang, D. M., Glenton, C., Fretheim, A., Kaufman, J., Hill, S., Oku, A. Parental and community factors influencing childhood vaccination uptake: A systematic review. Vaccine. 2023, 41(12), 1981–1992.

[35] Tadesse, H., Nigatu, S., Alemu, K. Geographic accessibility and utilization of child health services in Ethiopia. BMC Health Services Research. 2022, 22(1), 1021.

[36] Bangura, J. B., Xiao, S., Qiu, D., Ouyang, F., Chen, L. Barriers to childhood immunization in sub-Saharan Africa: A systematic review. BMC Public Health. 2023, 23(1), 1127.

[37] Ozawa, S., Stack, M. L., Bishai, D. Trust and vaccine acceptance in low- and middle-income countries. Human Vaccines & Immunotherapeutics. 2023, 19(1), 2187654.

[38] Mekonnen, A. G., Tarekegn, M., Woldemariam, Y. Respectful maternal and child healthcare and service utilization in Ethiopia. PLOS ONE. 2022, 17(11), e0276543.

[39] Larson, H. J., Broniatowski, D. A., Wilson, R. Addressing vaccine misinformation and hesitancy: Global perspectives. *The Lancet*. 2024, 403(10445), 1120–1128.