Extended Program on Immunization (EPI) coverage in selected Ethiopian zones: A baseline survey for L10K's Routine Immunization Improvement Initiative

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Addis Ababa, Ethiopia

JSI Research & Training Institute, Inc.

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Acronyms

AD	Auto-Disable
ANC	Antenatal Care
BCG	Bacillus Calmette–Guérin vaccine
CHW	Community Health Worker
DPT	Diphtheria-Pertussis-Tetanus vaccine
EDHS	Ethiopian Demographic and Health Survey
EHNRI	Ethiopian Health and Nutrition Research Institute
EOS	Enhanced Outreach Strategy
EPI	Expanded Program for Immunization
ERIA	Enhanced Routine Immunization Activities
FMoH	Federal Ministry of Health
HDA	Health Development Army members
HepB	Hepatitis B
HEW	Health Extension Workers
Hib	Hemophilus influenza type B
HMIS	Health Management Information System
L10K	The Last Ten Kilometers Project
NGO	Non-governmental Organization
OPV	Oral Polio Vaccine
PAB	Protected Against Neonatal Tetanus at Birth
PCV	Pneumococcal Conjugate Vaccine
RED	Reaching Every District
RIIP	Routine Immunization Improvement Plan
SD	Standard Deviation
SNNP	Southern Nations, Nationalities and Peoples Region
TT	Tetanus Toxoid vaccine
USAID	United States Agency for International Development
WHO	World Health Organization
UNICEF	United Nations Children's Fund

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Executive summary

Background: The government of Ethiopia has been delivering routine immunization services through static, outreach and mobile strategies since 1980. Moreover, programs including Supplemental Immunization Activities (SIAs), Reaching Every District (RED) and Enhanced Routine Immunization Activities (ERIA) have been implemented to further expand vaccination services. Despite the huge efforts made over decades, the access and utilization of immunization remains low with wide regional variations and unacceptably high drop-out rates. A national consensus has also been reached that vaccination coverage is stagnating in Ethiopia. The Last Ten Kilometers (L10K) Project of the John Snow, Inc. (JSI) Research and Training Institute is supporting the Federal Ministry of Health (FMoH) in implementing the routine immunization improvement plan in seven selected zones with high numbers of unvaccinated children. Population-based information regarding vaccination status and the reasons for no or incomplete vaccination are essential for monitoring the Expanded Program on Immunization (EPI). As such, this study was conducted to establish baseline vaccination levels and inform implementation of the project.

Methods: Cross-sectional household and facility surveys were conducted as the baseline for a pretest-posttest only evaluation design. A total of 1,597 mothers of children from 12-23 months of age and 1,586 mothers of children 0-11 months of age were interviewed regarding vaccination coverage from December 2014 to January 2015. The facility survey included data collected from health facilities serving the selected kebeles of the household survey. In each kebele the health post and its supervising health center were assessed.

Results: The majority of the health facilities (99% of health posts and 96% of health centers) were providing routine vaccination services at the time of the survey. However, only 37% of functional health centers were providing EPI services on a daily basis. More than a quarter of health facilities missed at least one EPI session in the previous six months.

Almost all health centers and one-third of health posts had at least one refrigerator for EPI activities. However, refrigerators were not functional in 32% health centers and 71% of health posts at the time of the survey. Moreover, at least two-thirds of facilities encountered breakdown of their vaccine refrigerators in the previous three months. Of those facilities which had functional refrigerator, the temperature reading was outside of the recommended range of 2-8°C in 46% health posts and 23% health centers on the day of the visit. Among facilities that stock vaccines overnight, 67% health centers and 40% health posts experienced shortage of vaccines in past six months.

The overall vaccination coverage among children aged 12-23 months for each vaccine was as follows: BCG 86%; Penta1 89%; Penta3 79%; measles 80%; and fully vaccinated 69%. Timely vaccination coverage, as defined by vaccination by 12 months of age and evidenced by written record was as follows: BCG 81%; Penta1 82%; Penta3 72%; measles 68%; and fully vaccinated 60%. Child vaccination coverage significantly varied among zones - for instance; Penta3 coverage ranged from 20% in Zone 3 to 92% in the North Western zone. Valid dose analysis

showed that valid vaccination coverage was as follows: BCG 83%; Penta1 69%; Penta3 57%; measles 50%; and complete vaccination 36%.

Approximately 85% of mothers received at least one antenatal care visit during their most recent pregnancy. More than two-thirds (70%) of infants were protected against neonatal tetanus at birth.

Conclusions: In a significant proportion of facilities, cold chain management was suboptimal which may reduce vaccine potency.

Vaccination coverage was found to be lower in the households with poorest wealth quantile, low parity and no maternal education. Facility level determinants including service interruption, training on EPI and defaulter tracing system were also independent predictors of complete vaccination. Quality of vaccination services as demonstrated by the validity of doses given, BCG scar formation, card retention and client-provider interactions were generally low.

Recommendations: Context-based delivery strategies including mobile-based delivery is crucial to address the low access and utilization of EPI services particularly in pastoralist areas of Afar. Detailed micro-planning with clear mapping of seasonal nomadic movements is required to ensure targeted outreach or mobile services to these populations. Detailed planning by individual health facilities and districts of how to reach the unreached and disadvantaged children in the catchment area is essential for improving equity in immunization. Observations and close monitoring of EPI sessions need to be performed to improve the quality of services. Refresher training is equally important to enhance the knowledge and skills of vaccinators.

There is a need to establish an appropriate and uninterrupted vaccine delivery strategy. There is also an urgent need to improve the cold chain management system through training and monitoring, as vaccines in some facilities were at high risk of losing their potency.

To continuously monitor service delivery, quality and the supply chain, a continuous and regular cycle of planning, monitoring and implementation should be established. Regular and focused supportive supervision needs to be strengthened at all levels to gain the commitment necessary for a successful EPI program. Furthermore, observational studies to assess the quality of routine EPI sessions and field efficacy of vaccines, and operational research to guide program implementation, particularly to cultivate the vaccination culture, is recommended.

Background

Immunization is unquestionably one of the most cost-effective and lifesaving public health interventions that can be used to protect children from vaccine-preventable diseases. Vaccine-preventable diseases constitute a major cause of morbidity and mortality in children under-five years of age in Ethiopia and other developing countries (Mengesha et al. 1995).

The Expanded Program for Immunization (EPI) was launched by the Ethiopian government Federal Ministry of Health (FMoH) in 1980, with the goal of increasing immunization coverage by 10% annually and achieve 100% Diphtheria-Pertussis Toxin Vaccine 3 (DPT3) coverage by 1990[1] (FMoH, 2009). With the intention to realize this goal, the country has developed its EPI strategy and the schedule for providing antigens to the target children based on the recommendations of World Health Organization (WHO) (FMoH, 2009). Accordingly, EPI in Ethiopia provides immunization services through static, outreach, and mobile sites to the target groups residing in every corner of the country. Despite these huge efforts made over decades by the FMoH along with its partners, the expansion of the service fell short of the target set for 1990.

Consequently, the FMoH designed and spearheaded implementation of initiatives (see Annex 3) aimed at furthering the progress made in expanding vaccination coverage. Supplemental Immunization Activities (SIAs), Reaching Every District (RED) and Enhanced Routine Immunization Activities (ERIA) for pastoralist areas and zones with large numbers of unimmunized children has been implemented throughout the country since 2003 with the concerted efforts of various stakeholders (FMoH, 2009). Thus, a significant rise in Penta3 coverage from 63% in 2003 to 82% in 2009 was observed (FMoH, 2012).

However, stagnation of the progress in national vaccination coverage started to be observed after 2009 (FMoH 2013). This was further buttressed by the findings of the recent national vaccination coverage cluster survey, conducted in 2012, which revealed the existence of pockets of inaccessibility and poor utilization of the service in most regions. According to the findings of the survey, vaccination coverage varies significantly among regions, and that urban regions (Addis Ababa, Dire Dawa and Hareri) performed better compared to agrarian regions (Amhara, SNNP, Oromia and Tigray). The predominantly pastoralist regions (Afar, Somali, Gambella and Beneshangul-Gumuz) reported the lowest performance (EHNRI, 2012).

High maternal workload combined with lack of knowledge, and hence less value associated with vaccination were the main reasons to which the unacceptably high dropout rate was ascribed, according to the survey (EHNRI, 2012). Limited access and poor quality vaccination service were also identified as the main factors that limit vaccination coverage nationally. The 2012 national vaccination coverage survey showed that only 5% of health posts and 51% of health centers were providing vaccination services on a daily basis. Moreover, 43% of health posts and

[1] *At the time of launch of the EPI in 1980 it targeted all children under the age of two years. In 1986 this was revised to focus on children under one year of age in order to decrease infection exposure times in children (Birhane et al. 2006).*

38% of health centers had some significant interruptions of routine EPI service. In some places, incomplete vaccination and low vaccination coverage have contributed to outbreaks of vaccine-preventable diseases. Furthermore, inadequate technical and managerial capacity has been observed at all levels, along with missed opportunities and insufficient prioritization of EPI within health and health-related programs. Additionally, a lack of regular technical supervision, high staff turnover and inconvenient service delivery strategies for mothers accounted for the failure to achieve satisfactory results in routine vaccination programs in Ethiopia (Berhane et al. 2006).

In 2013, the FMoH, with the auspices of its partners, developed the Routine Immunization Improvement Plan (RIIP) with the intention of accelerating progress in expanding the EPI service (FMoH, 2013). RIIP is directed towards expanding the cold chain system and enhancing vaccination coverage nationally through; 1) the use of a combination of approaches including RED to reach everyone targeted for immunization, taking into consideration the geographical and socio-economic situations of each region in the country; 2) increasing community demand for immunization with the help of Health Development Army (HDA) members; and 3) improvement and strengthening of vaccine management systems.

The Last Ten Kilometers (L10K) Project of the John Snow, Inc. (JSI) Research & Training Institute, has been selected to support implementation of RIIP by the USAID by the virtue of the strong reputation of L10K in community-based activities in reproductive, maternal, neonatal and child health for the last six years. The project is being implemented in seven selected zones with high numbers of unvaccinated children; namely Awi zone of Amhara region, Zone 3 of Afar, North Western zone of Tigray, East Wolega zone of Oromia, Yem special woreda, Bench Maji, and Gedio zones of SNNP region. The L10K project will continue to support the implementation of RIIP at national level and particularly in the selected zones.

In order to benchmark EPI coverage and inform implementation of the project, L10K conducted this baseline survey. The L10K strategy to support the RIIP is through fostering zonal-level planning and monitoring the effort. As such, this survey was conducted to determined baseline zonal levels of EPI coverage.

Objectives

General objective

The general objective of the study is to set benchmark levels of vaccine use in order to measure progress in project implementation in the targeted zones in Ethiopia.

Specific objectives

1. To measure the EPI vaccination coverage of children by assessing mothers of children 12-23 months of age.
2. To determine neonatal tetanus protected childbirth coverage during the year preceding the survey.
3. To identify factors impacting the utilization of vaccination services.
4. To assess the readiness of health facilities to provide vaccination services.

Methods

Study Area and Population

The study domain is composed of the seven zones of the project area (Figure 1). Ethiopia employs decentralized governance structures where regions are divided into zones, which are internally divided into woredas (districts). Each woreda is further subdivided into the lowest administrative unit called a *kebele*. The seven zones are comprised of a total of 64 woredas and 1,093 kebeles. Based on the 2007 census projection, a total of about five million people reside over these seven zones. One of the selected zones is located in the pastoralist Afar region, which is known to be sparsely populated with pastoralists that move around over a large area in search of pasture and water for their herds. In addition, the region has hard to reach areas with poor infrastructure

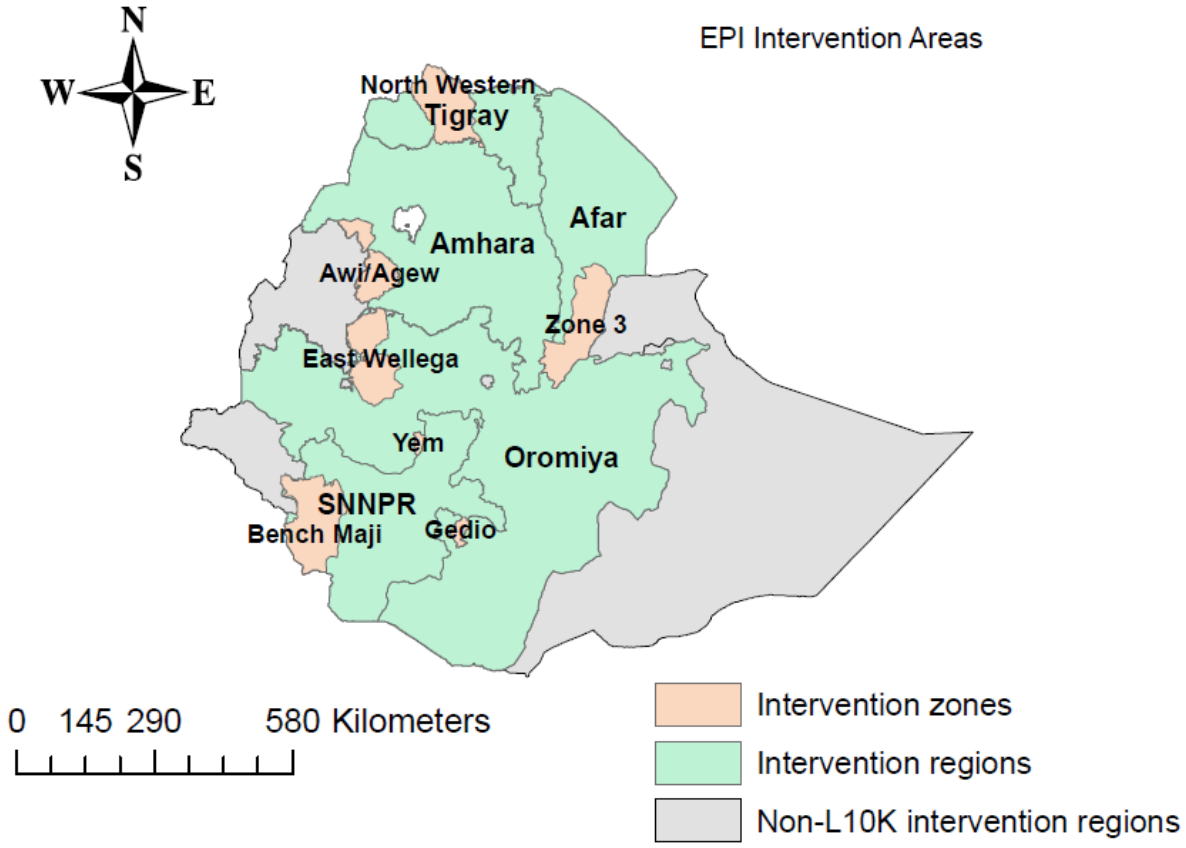


Figure 1: Map showing the seven RIIP intervention zones in the five regions of Ethiopia

Study Design

Cross-sectional household and facility surveys were conducted as the baseline for a pretest-posttest only evaluation design.

The household survey design followed the EPI cluster survey procedures of WHO (WHO, 2005). Two groups of mothers and health facilities were sampled. Mothers of children 12-23 months of age were interviewed to collect data on child vaccination and to determine the reasons for no or incomplete vaccination. Likewise, mothers of children 0-11 months of age were interviewed to collect data on tetanus toxin (TT) vaccination to determine the levels of neonatal tetanus protected childbirths. Socio-economic and demographic characteristics were also collected from both groups of mothers to obtain information on wealth index[2] and the socio-demographic profile of households.

The facility survey included data collected from health facilities serving the selected kebeles of the household survey. In each kebele the health post and its supervising health center were assessed. Data was obtained through observation, record review and interviews of service providers.

Sample Size and Sampling Technique

The list of woredas and kebeles with updated population statistics was obtained from the zonal health departments. The required sample size was calculated for each zone considering the regional vaccination coverage (EHNRI, 2012). Sample size was determined for measuring change over time for the pretest-posttest only study design. For the purpose of this study, a two population proportion formula was devised with equal sample size for comparing baseline and end-line vaccination coverage. The assumption was made that Pentavalent3/ DPT3 coverage would increase on average from 68% at baseline to 84% at the end of the project, and protected at birth against neonatal tetanus (PAB) would increase from 66% to 83%.
A design effect of 2.0, power of 90% and two-sided alpha error set at 0.05 were used to calculate the sample size;

$$\mathbf{n} = \frac{\mathbf{D} \times \left[\mathbf{Z_\alpha}\sqrt{\mathbf{2P(1-P)}} + \mathbf{Z_\beta}\sqrt{\mathbf{P_1(1-P_1) + P_2\,(1-P_2)}}\right]^{\mathbf{2}}}{\mathbf{(P_1 - P_2)^2}}$$

Where, $P = \frac{P1 + P2}{2}$

n = required minimum sample size
D = design effect is taken to be 2.0
Z_α = is a standard score corresponding to 95% confidence interval, and is thus equal to 1.96 for two sided test
P_1 = estimated baseline vaccination coverage *(EHNRI 2012)*
P_2 = estimated vaccination coverage at the end of the project
Z_β = is a standard score corresponding to 90% power, and is thus equal to 1.282 for one-sided β-error

Substituting the above values and adding a 10% non-response rate gives a sample size of 1,442 and 1,544 for groups of mothers with children aged 12-23and 0-11 months respectively.

2 The wealth index is a composite measure of a household's ownership of assets, such as: televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities. - See more at: http://www.dhsprogram.com/topics/wealth-index/Index.cfm#sthash.lJsHXYGn.dpuf.

A two-stage cluster sampling technique was used to select the households to be targeted for interviewing suitable respondents. During the first stage of cluster sampling, it was decided that 30 clusters would be selected from each zone as the primary sampling units with the probability proportional to their population size. Thus, a total of 210 kebeles as clusters were selected for the purpose of the baseline household survey. In each cluster, 6-10 mothers were interviewed. Accordingly, the final sample sizes were rounded to be 1,620 for each group of mothers (Table 1).

Table 1: Estimated coverage, required sample size and cluster size for vaccination coverage survey in selected zones

Zone	Estimated Baseline coverage		Estimated End line coverage		Required sample size		Cluster size (Children per cluster)	
	Penta 3	PAB	Penta 3	PAB	Women with children 12-23 Months	Women with children 0-11 months	Women with children 12-23 months	Women with children 0-11 months
Zone 3	23%	39%	45%	60%	180	210	6	7
Awi	62%	51%	82%	75%	240	180	8	6
North Western	88%	76%	97%	91%	300	240	10	8
East Wollega	63%	69%	82%	85%	270	270	9	9
Gedio	79%	76%	94%	91%	210	240	7	8
Bench Maji	79%	76%	94%	91%	210	240	7	8
Yem	79%	76%	94%	91%	210	240	7	8
Total	**68%**	**66%**	**84%**	**83%**	**1,620**	**1,620**	-	-

In the second stage of sampling, the first household was identified by spinning a pen. To do so, interviewers went to the center of the kebele (the point in the kebele where the population is about equally distributed on all sides) to randomly choose the direction to follow. The interviewers span a pen on a smooth level spot at the center of the kebele. Then, they went along the directional line to which the ball point end of the pen pointed until reaching the edge of the kebele. The first household was the one located at the periphery of the kebele in the direction chosen and interviewing was started in this household. Once the first household was identified, interviewers went to the nearest household with mothers of children 12-23 months or 0-11 months of age. Then mothers were interviewed until the desired sample size per cluster was achieved. Interviewers were instructed that in households with more than one eligible child, data should be collected on the youngest eligible child in order to avoid duplication of information from a single household.

Field Work and Data Collection

A total of 55 enumerators, 10 supervisors and 7 zonal survey coordinators were recruited for data collection. The interviewers and supervisors were all health professionals working for health

departments at zonal, woreda or health center levels and were recruited in close consultation with the zonal health departments. Interviewers who could speak the local language were recruited. The supervisors and data collectors were assigned to woredas outside of their routine area of work, in order to ensure the quality and reliability of the data collected. Moreover, in each cluster, a local guide was used to help the interviewers familiarize themselves with the clusters.

Two-day training for data collectors and supervisors was organized in three sessions. Survey field teams who used the Amharic version of the questionnaire - specifically, the Afar, Amhara and SNNP teams - were trained together in one session in Addis Ababa; the Oromia team was trained in Nekemte; and the team from Tigray was trained in Shire. The training consisted of EPI essentials, survey tools and data quality maintenance. The survey supervisors reviewed the responses of each questionnaire for completeness, ensuring proper selection of the first household in each cluster, and that the coordinators randomly visit the survey teams and then visit households to validate their responses.

The data were collected from December 2014-January 2015. The standard WHO and Ethiopian Demographic and Health Survey (EDHS) EPI questions were used. Mothers were asked to show vaccination cards for the child or TT vaccination, and the dates of vaccination were read and recorded. If vaccination cards were lost, the maternal report of vaccinations was recorded and verified from facility registers. Presence of a BCG scar was recorded in surveyed children. Reasons for not being immunized were also recorded. The survey questionnaires were administered in three local languages - Amharic (in Afar, Amhara and SNNP), Oromifa (in Oromia) and Tigregna (in Tigray). In cases when respondents couldn't speak their local languages, interviewers translated into local languages.

Data Management and Analysis

Five experienced data entry clerks who knew the local languages were recruited. In order to control for possible errors during data entry a number of checking mechanisms were employed including spot checking and running intermediate frequencies. Data were entered using EpiData version 3.1. Data were cleaned and analyzed using Stata version 12.1. Post-stratification sampling weights were used to adjust the non-proportional allocation of the sample to the different zones. Thus, weighted analysis was used to ensure representativeness of the survey estimates at the program level. Socio-demographic data were summarized by frequency tables and summary statistics. Bivariate logistic regression analyses were used to describe the association between independent and dependent variables. The p-values for the statistical tests were two-tailed and set at 0.05.

Ethical Considerations

Ethical clearance was obtained from ethical review committees of the regional health bureaus. All the study participants were informed about the purpose of the study and their right to opt out or to respond to questions. Informed verbal consent was obtained prior to interviewing any study subject. The values, rights and norms of the study subjects, the community, enumerators and supervisors were respected.

Results

1. Health Facility Assessments

A total of 136 health posts and 128 health centers were assessed to investigate the EPI service delivery, cold chain and vaccine stock management (Table 2).

Table 2: Health facilities assessed by zone, December 2014-January 2015

Health facility	Zones							Total
	Awi	Bench Maji	East Wolega	Gedio	North Western	Yem	Zone 3	
Health post	25	27	18	19	16	27	4	136
Health center	24	26	28	18	21	6	5	128

1.1.EPI service delivery

The majority of the health facilities (99% of health posts and 96% of health centers) were providing routine vaccination services at the time of the survey. About 83% of health posts and 35% of health centers were providing the service on monthly basis. However, only 37% of health centers and 4% of health posts were providing vaccination services on a daily basis. The EPI micro-plan for the fiscal year was available in 29% of health posts and 47% of health centers on the day of the survey. The assessment data also showed that health facilities require on average six children to be present in order to open a vial of measles vaccine (Table 3). About 84% of health posts and 85% of health centers used outreach and static service delivery strategies respectively. No facility reported the use of a mobile strategy to provide routine EPI services (Table 3).

Nearly 28% of health facilities missed at least one EPI session in the past six months mainly due to the following reasons: unavailability of vaccines from a higher level (53%); the vaccinator may have had other priorities and was unable to attend sessions (26%); and the vaccine not collected in a timely manner (11% of cases). Eighty-six percent of health posts and 87% of health centers had a defaulter tracing mechanism available primarily through register review (Table 4). Less than 5% of facilities used a defaulter tracing box or tickler file as a defaulter tracing mechanism. Most of the time, HDAs and health extension workers (HEWs) were involved in tracing defaulters.

Table 3: EPI service provisions and interruptions, December 2014-January 2015

Variables	Health facility		Total
	Health post	Health center	
	n=136	n=128	n=264
Health facility providing EPI service (%)	98.5	96.1	97.4
Frequency of vaccination sessions (%)	**n=134**	**n=123**	**n=157**
Daily	3.7	37.4	19.9
Weekly	12.7	24.4	18.3
Monthly	82.8	35.0	59.9
Less than monthly	0.8	3.3	2.0

Micro-plan available (%)	29.0	47.1	37.7
Mean number of children required to open a measles vaccine vial	5.8	6.0	5.9
Service delivery strategies of facilities			
Static	15.6	85.6	49.2
Outreach	84.4	14.4	50.8
Mobile	0.0	0.0	0.0
EPI service interruption in the last 6 months (%)			
Never	74.6	69.9	72.4
Once or twice	12.7	14.6	13.6
Three or more times	12.7	15.5	14.0
Reasons for service interruption (%)			
Vaccines not collected timely	3.0	19.5	12.2
Lack of transport for regular supply	3.0	4.9	4.1
Vaccine was spoiled/expired	0.0	0.0	0.0
Vaccine not available	63.6	41.5	51.4
Vaccinator had other priorities and unable to attend sessions	30.3	22.0	25.7
No kerosene available for refrigerator	0.0	2.4	1.4
Refrigerator required maintenance	0.0	0.0	0.0
Other	0.0	4.9	2.7
Unknown	0.0	4.9	2.7

Table 4: EPI defaulter tracing mechanism of health facilities, December 2014-January 2015

	Health facilities		Total
	Health post	Health center	
Defaulter tracing mechanism (%)	**n=107**	**n=105**	**n=212**
Review of register by HEW	67.3	30.5	49.1
Review of register by other health worker	0.9	60.0	30.2
Register kept by HDA/CHW	5.6	0.0	2.8
Family folder review	13.1	0.0	6.6
Defaulter box (card box)	5.6	1.9	3.8
Box with child card with month of expected return	0.9	0.0	0.5
Other	6.5	3.8	5.2
Unknown	0.0	3.8	1.9
Persons involved for defaulter tracing (%)			
HDA/CHW	64.9	46.7	55.9
Kebele Administrator	15.7	23.8	19.7
HEW	60.5	37.1	48.9
NGO staff	2.2	4.8	3.5

The availability and utilization of EPI recording tools were low at health posts rather than health centers. Moreover, almost half of the surveyed health posts were not using EPI monitoring charts (Figure 2).

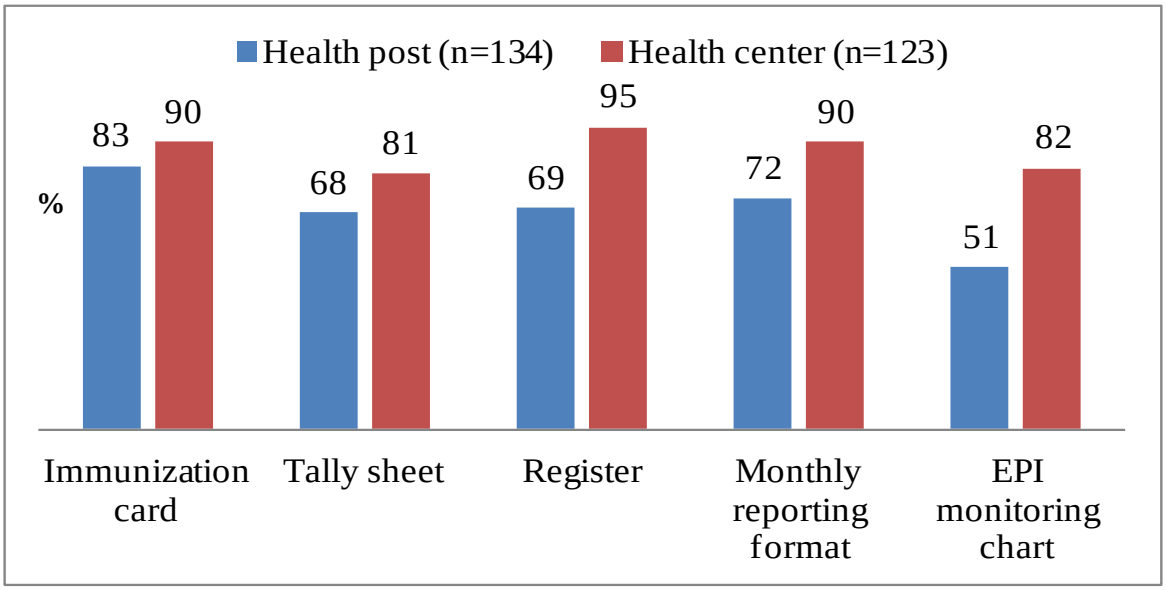


Figure 2: EPI record keeping tool use at the time of the survey, December 2014-January 2015

1.2.Cold chain and vaccine stock management

Almost all health centers and one-third of health posts had at least one refrigerator for EPI activities. However, in 32% of health centers and 71% of health posts their refrigerator was not functional at the time of the survey mainly due to either unavailability of energy/fuel (20%) or that the refrigerator was not installed (19%) (Table 5). The assessment also revealed that over 90% of health posts and health centers received vaccines at least once a month.

More than two-thirds of facilities encountered break-down of the vaccine refrigerators in the previous three months before the study. The median time that refrigerators were broken-down in this time was 90 days for health posts and 17 days for health centers. Of facilities which had functional refrigerators, the temperature reading was out of the recommended range of 2-8°C in 46% of health posts and 23% of health centers on the day of the visit (Table 5).

Table 5: Cold chain management of health facilities, December 2014-January 2015

	Health facilities		Total
	Health post	**Health center**	
Availability of vaccine refrigerator (%)	**n=134**	**n=123**	**n=257**
None	66.4	0.8	35.0
One	30.6	23.6	27.2
Two or more	3.0	75.6	37.8
Health facilities that all vaccine refrigerators were in use (%)	28.9	68.3	47.8
Reasons for non-use of vaccine refrigerator (%)	**n=38**	**n=37**	**n=75**
Not installed	23.7	13.5	18.7

Not needed because of extra fridge	0.0	13.5	6.7
Energy/fuel not available	31.6	37.8	20.0
Needs maintenance	2.6	8.1	2.7
Other	0.0	5.4	2.7
Unknown	42.1	21.6	32.0
Encountered break down of the vaccine refrigerator in the last 3 months (%)	37.8	22.1	26.6
Median number of days the refrigerator were broken-down in the last 3 months	90 .0	17 .0	30.0
Temperature of the refrigerator currently in use (%)	**n=13**	**n=140**	**n=153**
<+2^{0}C	7.7	5.0	5.2
+2 to +8^{0}C	53.9	77.1	75.2
>+8^{0}C	38.5	17.9	19.6
Mean	10.0	6.3	6.7
Range	-2 to +30^{0}C	0 to +27^{0}C	-2 to +30^{0}C

Ninety-five percent of health centers and 48% of health posts stored vaccines overnight. However, 67% of health centers and 40% of health posts experienced stock shortages of vaccines in the previous six months. BCG, Rota, OPV and TT vaccines were stocked-out in most health facilities. Additionally, the median stock-out time for BCG, Rota and TT antigens was more than a week (Table 6).

Table 6: Vaccine stock management of health facilities, December 2014-January 2015

	Health facilities		Total (n=257)
	Health post (n=134)	**Health center (n=123)**	
Health facilities stored vaccines overnight (%)	47.8	95.1	70.4
Facilities that experienced stock-out of vaccines in the last 6 months (%)	**n=64**	**n=117**	**n=181**
Stocked-out for any vaccine	**40.3**	**66.7**	**52.9**
BCG	31.3	48.0	39.3
OPV	7.5	17.9	12.5
DPT-HepB-Hib	3.0	3.3	3.1
PCV	6.7	5.7	5.8
Rota	16.4	17.1	16.7
Measles	1.5	4.1	2.7
Tetanus toxoid	8.2	21.1	14.4
AD syringe	1.5	2.3	1.9
Safety boxes	0.0	1.6	0.8
Mean duration of stock-out of antigens in the last 6 months (in weeks)			
BCG	7.2	6.8	7.0
OPV	0.8	1.0	0.9
DPT-HepB-Hib	0.2	0.2	0.2
PCV	0.6	0.3	0.4
Rota	2.5	1.2	1.7
Measles	0.1	0.4	0.3

Tetanus toxoid	1.2	1.5	1.4
AD syringe	0.1	0.2	0.2
Safety boxes	0.0	0.1	0.07

1.3.Supervision and EPI in-service training

Supportive supervision and feedback

About 70% of health facilities received integrated or specific EPI supervision visits within the three months prior to the study. Moreover, slightly more than 50% of facilities received written feedback that mentioned EPI within the last three months. However, about 18% and 31% facilities had never received any supervisory visit related to EPI or written feedback that mentioned EPI, respectively (Table 7).

Table 7: Supportive supervisory visit for EPI, December 2014-January 2015

	Health facilities		Total (n=243)
	Health post (n=128)	Health center (n=115)	
Supervisory visit			
Never	18.0	18.3	18.1
Within the last 3 months	70.3	69.6	70.0
More than 3 months ago	11.7	10.4	11.1
Unknown	0.0	1.7	0.8
Written feedback			
Never	33.3	28.2	30.7
Within the last 3 months	54.1	56.4	55.3
More than 3 months ago	11.7	9.4	10.5
Unknown	0.9	6.0	3.5

EPI in-service training

About 37% of HEWs and 22% health workers who were working on EPI did not receive EPI in-service training (Table 8).

Table 8: EPI in-service training, December 2014-January 2015

EPI in-service training (%)	Health facilities		Total (n=257)
	Health post (n=134)	Health center (n=123)	
Health workers/HEW with no in-service training	37.3	22.0	30.0
Health workers /HEW with in-service training within 12 months	10.4	42.3	25.7
Health workers /HEW with in-service training > 12 months ago	50.7	34.1	42.8
Unknown	0.7	1.6	1.2

2. Child Vaccination

2.1.Socio-demographic characteristics of mothers surveyed for child vaccination

A total of 1,597 mothers of children aged 12-23 months were interviewed to determine coverage of child vaccination. The response rate was 98.6%. The mean age of the children was 17.2 months with standard deviation (SD) of 3.5 months. The data showed that 66% of respondents had no formal education and 17% of respondents resided in urban areas. The socio-demographic characteristics of study participants are summarized in Table 9.

Table 9: Socio-demographic characteristics of mothers surveyed for child vaccination, December 2014-January 2015

Background Characteristics	Awi (n=239)	Bench Maji (n=203)	East Wollega (n=268)	Gedio (n=206)	North Western (n=295)	Yem (n=210)	Zone 3 (n=176)	Total (n=1,597)
Educational status								
No education	72.5	68.0	56.2	74.0	57.3	52.2	83.4	65.6
Primary education	16.5	24.6	23.0	18.6	32.4	35.4	13.1	22.4
Secondary+	11.0	7.4	20.8	7.4	10.2	12.4	3.4	12.0
Residence								
Urban	13.8	13.8	16.4	19.4	23.4	11.9	19.9	17.3
Rural	86.2	86.2	83.6	80.6	76.6	88.1	80.1	82.7
Marital status								
Not in union	3.4	3.9	3.7	1.0	5.1	4.3	7.4	3.5
Married	96.7	96.1	96.3	99.0	94.9	95.7	92.6	96.5
Age								
< 20 years	3.9	7.4	6.3	1.5	5.4	10.1	5.9	5.0
20-34 years	60.3	61.4	80.4	48.7	70.4	83.3	40.2	64.7
35+ years	17.1	21.3	11.4	8.1	23.5	4.8	10.7	15.0
Don't know	18.8	9.9	2.0	41.6	0.7	1.9	43.2	15.3
Mean age	28.9	27.9	26.3	27.5	28.9	24.7	27.7	27.7
Religion								
Orthodox	96.2	26.6	34.0	13.1	96.6	71.4	11.4	50.4
Catholic	0.4	0.0	0.4	3.9	1.0	0.0	0.0	1.1
Protestant	0.4	70.4	59.7	80.6	0.0	8.1	6.8	41.3
Muslim	1.7	3.0	6.0	1.5	2.4	20.5	80.7	6.8
Other	1.3	0.0	0.0	1.0	0.0	0.0	1.1	0.5
Parity								
1	20.9	24.3	27.4	18.5	22.0	27.6	19.8	22.9
2	17.6	21.3	16.9	15.1	16.6	21.0	19.8	17.4
3	22.6	19.8	19.6	14.6	13.6	14.8	15.7	18.0
4+	38.9	34.7	36.1	51.9	47.8	36.7	44.8	41.7
Mean parity	2.8	2.6	2.6	3.0	2.9	2.6	2.9	2.8
Wealth quantile								
Lowest	18.4	32.5	6.7	8.7	18.0	16.7	48.9	16.6
Second	20.9	21.2	25.4	13.1	20.7	21.9	13.6	20.3
Middle	23.9	15.8	25.8	18.9	19.0	24.3	9.1	20.9
Forth	18.0	19.2	19.9	36.4	19.0	19.5	6.8	21.8
Highest	18.8	11.3	22.4	22.8	23.4	17.6	21.6	20.3

2.2.Vaccination coverage

Information on child vaccination was collected from vaccination cards, mothers' reports and facility registers. Mothers were asked to show vaccination cards and the dates of vaccination were recorded. If vaccination cards were lost, the maternal report of vaccinations was recorded and verified from the facility register.

The overall vaccination coverage among children aged 12-23 months was found to be as follows: BCG 86%; Penta1 88%; Penta3 79%; measles 80%; and fully vaccinated 69%; combining all sources of data (card, register and history). Timely vaccination coverage, as defined by vaccination by 12 months of age was: BCG 81%; Penta1 82%; Penta3 72%; measles 68%; and fully vaccinated 60% (Table 10).

Table 10: Percentage of children age 12-23 months who received specific vaccines at any time before the survey and by 12 months of age, by source of information, December 2014-January 2015

Source of information	BCG	Penta			Polio				Measles	All vaccination[3]	No vaccination
		1	2	3	0	1	2	3			
Vaccinated at any time before the survey											
Vaccination card	59.9	61.1	60.2	57.6	29.2	60.8	59.8	57.5	54.1	51.3	0.0
Facility register	7.0	13.7	13.0	11.8	2.5	13.6	13.2	12.8	11.8	9.6	0.0
Mothers' report	19.4	13.1	11.6	9.3	5.7	14.6	13.3	11.4	13.8	7.8	6.3
Either source	86.3	87.9	84.8	78.8	37.4	89.0	86.4	81.7	79.7	68.6	6.3
Vaccinated by 12 months[4]	80.9	81.6	79.1	72.3	37.4	83.4	80.8	75.1	67.5	59.8	0.0

Child vaccination coverage significantly varied among zones. For instance; Penta3 coverage ranged from 20% in Zone 3 to 92% in the North Western zone. It was also significantly higher amongst children of mothers with education attainment, those in the highest wealth quantile and low parity ($p < 0.05$). However, being in an urban or rural residence, maternal age and sex of the child had no significant effect on child vaccination coverage (Table 11).

[3] *Children who took BCG, measles and three doses each of pentavalent and polio vaccines (excluding polio vaccine given at birth).*

[4] *This is based on a written record of vaccinations (either by card or from facility register.*

Table 11: Percentage of children aged 12-23 months who received specific vaccines at any time before the survey, by background characteristics (univariate analysis), December 2014-January 2015

Background Characteristics	BCG	Penta			Polio			Measles	All vaccination	No vaccination
		1	2	3	1	2	3			
Child's sex (n=1,596)										
Male	86.4	87.7	85.0	78.9	89.6	86.2	81.6	80.6	69.3	6.5
Female	86.2	88.1	84.6	78.6	88.3	86.6	81.9	78.8	68.0	6.1
Parity (n=1,590)										
1	88.2	91.3*	87.3	82.9	91.3*	88.7**	83.9	83.3**	72.9	4.3*
2	86.3	89.8	86.3	78.2	93.6	90.7	84.2	80.1	68.5	2.4
3	89.2	88.9	86.2	80.6	88.9	87.0	83.0	80.5	69.2	6.0
4+	84.3	85.1	82.4	76.2	86.1	83.4	79.4	77.6	66.4	8.9
Residence (n=1,597)										
Urban	90.5	88.5	87.3	83.0	89.1	88.8	85.2	83.3	75.7	6.3
Rural	85.4	87.8	84.2	77.9	88.9	85.9	81.0	79.0	67.2	6.3
Zone (n=1,597)										
Awi	91.2*	92.9*	92.9*	89.1*	91.2*	90.4*	88.7*	87.0*	79.9*	7.1**
Bench Maji	86.7	90.6	84.2	72.9	88.7	84.2	77.8	76.4	56.7	2.5
East Wollega	90.7	93.3	88.1	79.9	93.3	90.7	83.6	81.7	69.0	2.6
Gedio	77.2	77.2	75.2	72.8	82.0	79.6	76.2	76.7	66.0	10.7
North Western	96.6	97.6	97.0	91.9	96.6	96.3	92.9	87.8	82.4	1.4
Yem	93.8	90.0	88.1	87.6	89.5	89.5	90.0	89.1	86.7	9.1
Zone 3	35.8	34.7	26.1	19.9	55.7	40.9	31.8	25.6	8.0	35.2
Mother's age (n=1,330)										
<20 years	82.8	89.7	82.0	75.3	88.8	85.5	78.7	74.9	62.3	4.2
20-34 years	89.8	90.2	87.0	80.5	91.2	88.9	84.2	82.9	71.7	4.4
35+ years	88.1	89.8	89.6	83.5	88.4	85.6	82.1	80.6	70.7	6.1
Mother's education (n=1,585)										
No education	83.8*	85.8*	82.3*	76.2*	87.8**	84.9**	79.8**	77.3*	66.0**	7.9*
Primary	89.6	90.4	87.3	80.7	88.9	86.3	83.0	82.5	69.6	3.6
Secondary +	93.6	95.1	93.5	88.8	95.7	94.9	89.4	88.2	80.6	2.1
Marital status (n=1,597)										
Not in union	81.7	81.3	77.8	74.1	81.4	74.4**	72.9	76.7	60.8	10.7
Married	86.5	88.1	85.0	79.0	89.3	86.8	82.1	79.8	68.9	6.1
Distance from vaccination site (n=1,539)										
< 1hour	87.8*	89.0	86.2**	79.9	89.7	87.1	82.4	80.8	69.8	5.5
>=1 hour	78.8	83.9	77.6	73.7	87.4	85.3	80.5	74.7	62.3	8.5
Wealth quantile (1,597)										
Lowest	71.2*	74.2*	68.4*	61.2*	77.2**	72.8**	67.0*	63.8*	46.0*	15.5**
Second	90.0	91.6	89.2	82.1	93.3	91.8	87.3	81.7	70.8	3.0
Middle	88.1	90.9	86.3	81.6	92.1	89.1	83.3	80.2	70.9	4.6
Fourth	86.8	88.7	85.5	79.6	87.6	83.9	80.5	83.7	69.2	6.1
Highest	92.5	91.4	91.2	86.1	92.5	91.8	87.9	86.0	78.7	4.0
Total	**86.3**	**87.9**	**84.8**	**78.8**	**89.0**	**86.4**	**81.7**	**79.7**	**68.6**	**6.3**

*p-value<0.01; ** p-value <0.05

2.3.Comparison between survey coverage and routine HMIS data

Routine EPI health management information system (HMIS) data were collected from surveyed health posts for the period of December 2012-December 2013, which covers the birth cohort of the surveyed children for vaccination.

As such, a comparative analysis was done for HMIS reports of rural health posts and survey coverage of rural areas. As indicated in figure 2 below, there were a 13% and 12% disparities in PAB and complete vaccination coverage between routine HMIS and survey coverage respectively (Figure 3).

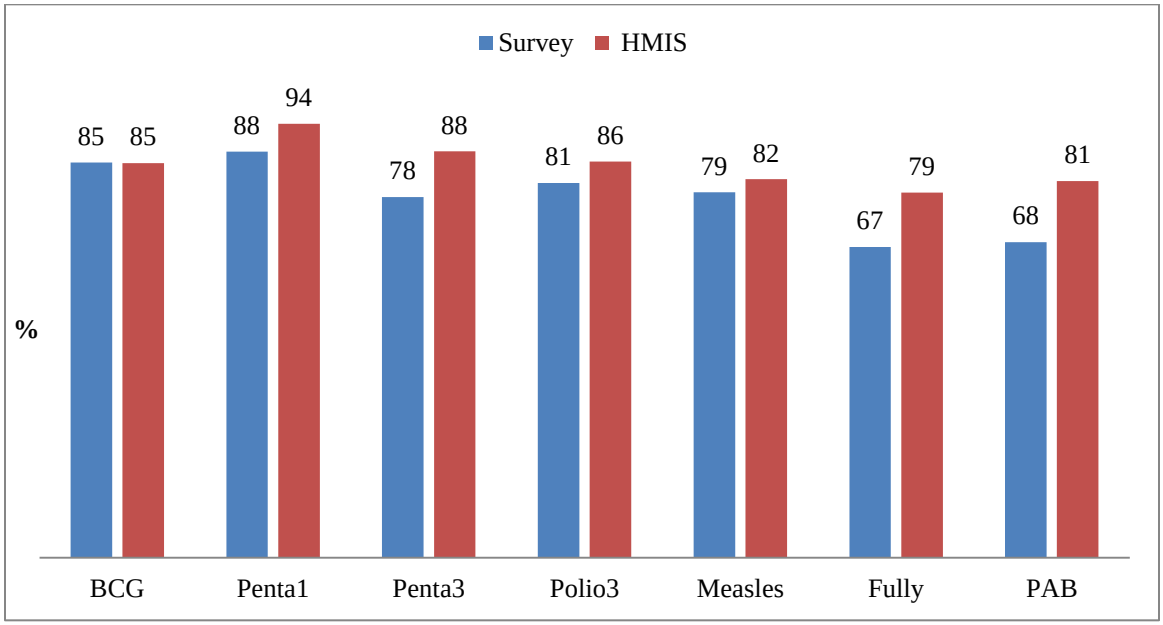


Figure 3: Comparison of vaccination coverage between survey and HMIS reports, December 2014-January 2015

1.1.Access, utilization and quality of vaccination services

Access and utilization

Penta1 coverage was used as a proxy indicator to measure access to vaccination services. The overall access to vaccination services was about 88%. The best access to vaccination services was recorded in North Western, East Wolega, Awi, Bench Maji and Yem zones. Access to vaccination was lowest in the Afar and Gedio zones.

Penta3 coverage and drop-out rates were used to measure utilization and program continuity respectively. The survey revealed that the overall Penta3 coverage was 79% with wide zonal variations (Table 11).

Drop-out rate

The total drop-out rate (by card, register and history) between Penta1 and Penta3 was 10%, ranging from 3% in Yem to 43% in Zone 3. Likewise, the overall drop-out rate for Penta1-measles was 9%, ranging from 0.6% in North Western to 23% in Zone 3. The drop-out rate varied by source of information; the Penta1-3 drop-out rate was considerably higher when measured by history than by card and register. Likewise, the negative result for the Penta1-measles drop-out rate might be due to the fact that history includes measles vaccines given through both routine and campaign strategies.

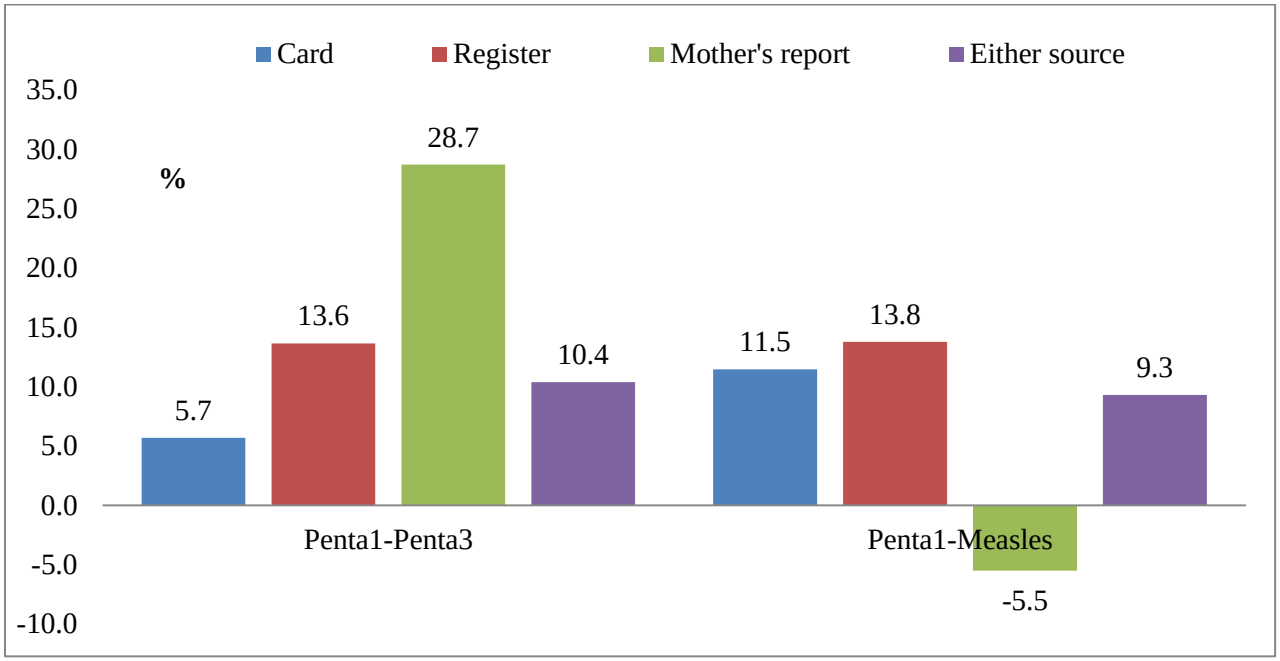


Figure 4: Drop-out rate of vaccinations by source of information, December 2014-January 2015

The drop-out rate was significantly higher in Zone 3, Bench Maji and East Wolega zones, and also in mothers of younger age and in the lowest wealth quantile (Table 12).

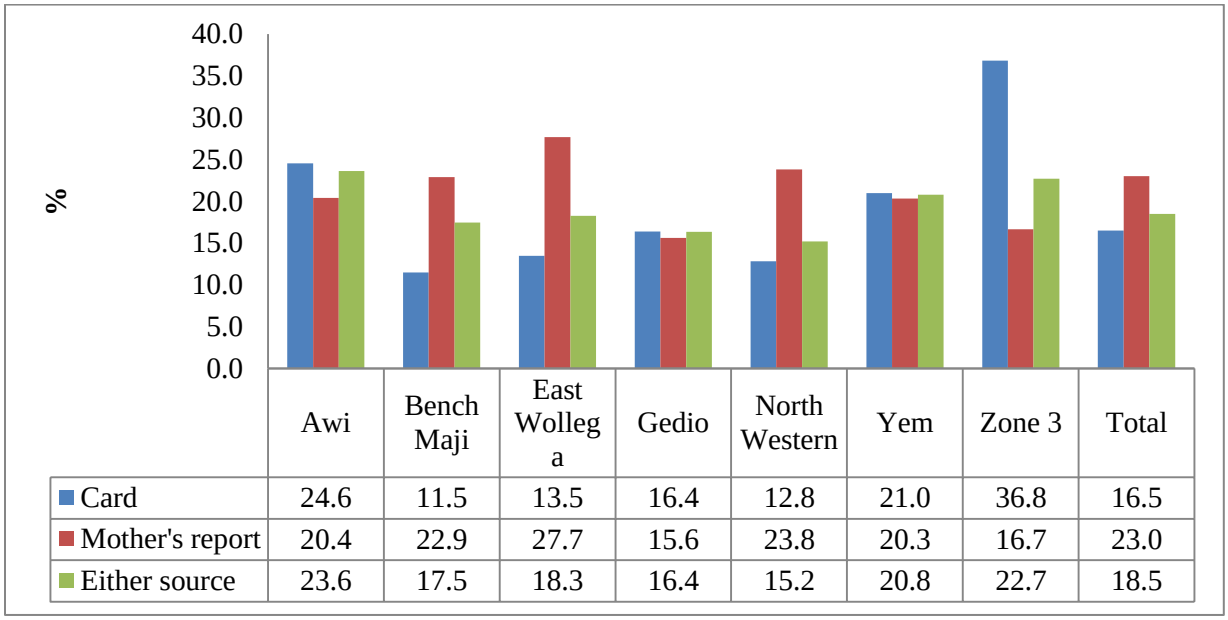
Table 12: Drop-out rate, by background characteristics (univariate analysis), December 2014-January 2015

Background Characteristics	Dropout rate	
	Penta1-Penta3	Penta1-Measles
Child's sex (n=1,596)		
Male	10.1	8.0
Female	10.8	10.6
Parity (n=1,590)		
1	9.3	8.8
2	13.1	10.8
3	9.3	9.4
4+	10.5	8.8
Residence (n=1,597)		
Urban	6.2	5.9
Rural	11.3	10.0
Zone (n=1,597)		
Awi	4.1*	6.3*
Bench Maji	19.6	15.1
East Wollega	14.5	12.1
Gedio	5.8	0.6
North Western	5.9	10.0
Yem	2.7	1.1
Zone 3	42.6	22.5
Mother's age (n=1,330)		
<20 years	16.1**	16.4**
20-34 years	10.8	8.0
35+ years	7.0	10.2
Mother's education (n=1,585)		
No education	11.2	9.9
Primary	10.7	8.7
Secondary +	6.7	7.3
Marital status (n=1,597)		
Not in union	8.9	5.7
Married	10.5	9.4
Distance from vaccination site (n=1,539)		
< 1hour	10.3	9.2
>=1 hour	12.2	11.0
Wealth quantile (1,597)		
Lowest	17.5*	14.0*
Second	10.5	10.8
Middle	10.3	11.8
Fourth	10.5	5.7
Highest	5.8	5.8
Total	**10.4**	**9.3**

*p-value<0.01; ** p-value <0.05

BCG scar formation

The presence of BCG scar was recorded in surveyed children. The data revealed that the BCG scar rate was 81% (83% among those recorded by card versus 77% among those recorded by history). Significant variation in the absence of BCG scar formation was found between zones: Awi (24%) and Zone 3 (22%) and Yem (21%) had the highest proportion of BCG vaccinated children without BCG scars, while the North Western had the lowest (Figure 5).



	Awi	Bench Maji	East Wollega	Gedio	North Western	Yem	Zone 3	Total
Card	24.6	11.5	13.5	16.4	12.8	21.0	36.8	16.5
Mother's report	20.4	22.9	27.7	15.6	23.8	20.3	16.7	23.0
Either source	23.6	17.5	18.3	16.4	15.2	20.8	22.7	18.5

Figure 5: Proportion of children vaccinated with BCG which had no BCG scar on their arms, during December 2014-January 2015.

Valid vaccination coverage

The term valid dose is defined as vaccinations that were given when the child was the appropriate age after an appropriate minimum interval between doses and evidenced by card or register. A vaccine dose administered after an invalid dose was considered as invalid, even when the interval had been respected. BCG vaccination recorded by history was considered valid if there was a scar on the child's arm. All vaccinations (except BCG) not evidenced by written record were considered invalid (WHO, 2005).

The overall valid vaccination coverage was: BCG 83%; Penta1 69%; Penta3 57%; measles 50% and complete vaccination 36%. The findings of the valid dose analysis also showed that invalid doses accounted for up to 32% of vaccinations. Timeliness of the valid doses given, as defined by timely doses provided before 12 months of age, was also assessed. Thus, timely valid dose coverage by antigen was BCG 68%; Penta1 66%; Penta3 53%; measles 39% and complete vaccination 27% (Table 13).

Table 13: Percentage of children age 12-23 months who received valid doses of vaccines at any time before the survey and by 12 months of age, by source of information, December 2014-January 2015

	BCG	Penta			Polio			Measles	All vaccination
		1	2	3	1	2	3		
Valid dose at any time before the survey									
Awi	90.8	84.9	77.8	71.1	84.5	74.9	68.6	65.7	49.4
Bench Maji	80.3	66.0	61.6	54.2	63.6	58.1	53.2	45.3	32.0
East Wollega	86.2	66.8	60.1	52.2	65.8	57.8	49.6	44.0	30.6
Gedio	76.2	57.8	54.4	49.5	57.8	53.4	47.6	48.5	32.0
North Western	93.9	86.1	81.4	72.2	84.4	78.6	68.8	61.4	47.5
Yem	92.9	83.8	75.2	71.0	83.8	74.8	71.0	54.3	42.4
Zone 3	31.8	9.7	8.0	6.8	9.1	7.4	6.8	4.0	2.3
Total	**83.4**	**69.3**	**63.9**	**57.3**	**68.3**	**61.7**	**54.9**	**50.4**	**36.3**
Valid dose coverage by 12 months									
Awi	82.9	82.4	74.5	67.0	82.4	70.7	64.0	51.1	34.7
Bench Maji	62.6	62.6	57.6	50.3	60.6	54.2	49.3	35.0	25.1
East Wollega	69.4	64.9	57.8	48.9	64.2	56.0	46.6	33.2	23.9
Gedio	52.4	48.1	49.5	42.7	48.1	47.1	41.3	34.5	21.4
North Western	86.8	83.4	77.0	70.2	83.1	75.9	66.8	50.5	36.6
Yem	80.5	81.4	73.8	64.3	80.5	72.9	64.8	34.3	23.3
Zone 3	9.1	8.5	8.0	6.8	8.0	7.4	6.8	2.8	1.7
Total	**68.1**	**65.5**	**60.5**	**53.1**	**64.9**	**58.2**	**51.0**	**38.5**	**26.7**

Card retention

The card retention rate was found to be 61%. For example for Penta1, of those children that were reported to be vaccinated, about 14% were verified from facility registers. Card retention was higher in North Western, Awi, Yem, Gedio and East Wolega zones (Figure 6).

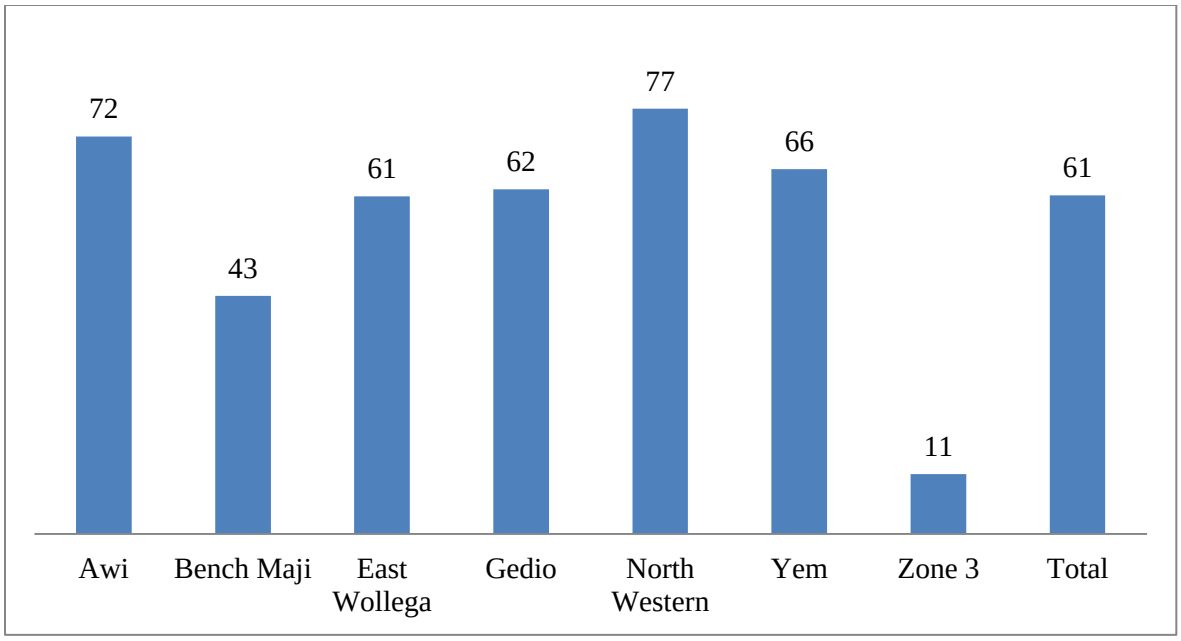


Figure 6: Card retention by zone, December 2014-January 2015

Client-provider interaction

Overall, more than a quarter of mothers were not told about the potential side-effects associated with vaccines. Likewise, nearly two-thirds of mothers were not told what to do if the child experienced side-effects. The communication gap was much higher in Gedio and Zone 3 (Figure 7).

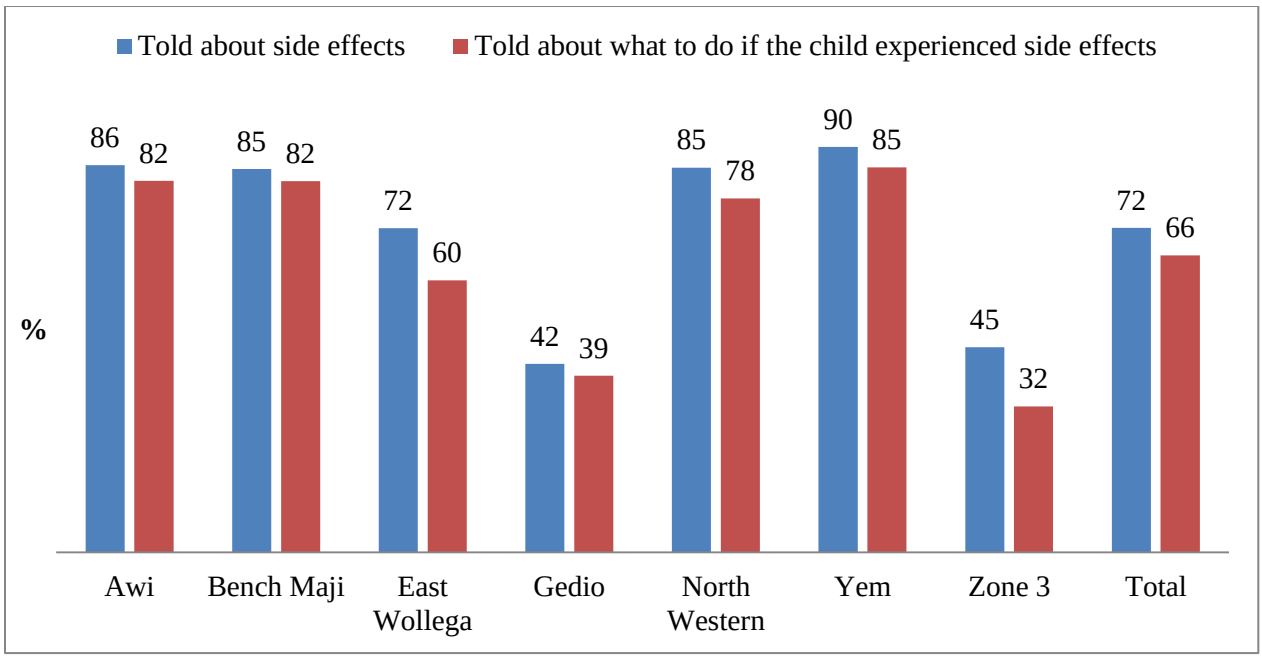


Figure 7: Percentage of mothers that were told about side effects of vaccines, December 2014-January 2015

1.2. Determinants of complete vaccination

Multivariate analysis was carried out to identify determinant factors for complete vaccination. Socio-demographic characteristics of mothers, wealth index, accessibility and readiness of the health facilities were included in the factor analysis.

Socio-demographic characteristics, wealth index and accessibility

Wealth quantile remained significantly associated with complete vaccination for all zones. However, determinant factors varied across zones. In Yem for example, parity and maternal age were independent predictors for complete vaccination. Likewise, maternal education, marital status and wealth quantile were the determinant factors for complete vaccination in Zone 3 (Table 14).

Table 14: Factors associated with complete vaccination among mothers of children aged 12-23 months by background characteristics (multivariate analysis), December 2014-January 2015

Background Characteristics	Awi (n=239)	Bench Maji (n=203)	East Wollega (n=268)	Gedio (n=206)	North Western (n=295)	Yem (n=210)	Zone 3 (n=176)	Total (n=1,597)
Child's sex								
Male	80.3	60.0	70.7	65.7	81.2	88.5	9.2	69.3
Female	79.5	54.0	67.2	66.4	83.3	84.5	6.4	68.0
Parity								
1	84.0	61.2	69.9	79.0	83.1	94.8**	11.8	72.9
2	90.5	46.5	68.9	61.3	87.8	81.8	11.8	68.5
3	72.2	55.0	73.1	76.7	80.0	87.1	3.7	69.2
4+	77.4	61.4	66.7	59.8	80.9	83.1	5.2	66.4
Residence								
Urban	93.9	75.0	79.6	62.5	84.1	96.0	17.1	75.7
Rural	77.7	53.7	67.0	66.9	81.9	85.4	5.7	67.2
Mother's age								
<20 years	88.9	53.3	56.3	66.7	68.8	81.0**	20.0	62.3
20-34 years	85.8	58.1	69.3	65.6	83.6	86.8	13.2	71.7
35+ years	80.0	55.8	75.9	62.5	81.2	100.0	0.0	70.7
Mother's education								
No education	76.6	51.5	67.1	68.2	82.7	83.5	4.1**	66.0
Primary	82.1	64.0	70.5	52.6	79.0	87.8	26.1	69.6
Secondary +	96.2	80.0	74.6	73.3	90.0	96.2	33.3	80.6
Marital status								
Not in union	87.5	62.5	60.0	0.0	66.7	77.8	23.1*	60.8
Married	79.7	56.4	69.4	66.7	83.2	87.1	6.8	68.9
Distance from vaccination site								
< 1hour	81.0	56.8	69.6	64.8	83.8	83.9	7.8	69.8
>=1 hour	50.0	55.6	68.4	69.6	73.2	100.0	10.3	62.3
Wealth quantile								
Lowest	65.9**	42.4**	66.7	33.3**	73.6*	80.0	2.3**	46.0*
Second	76.0	65.1	73.5	66.7	77.1	89.1	4.2	70.8

Middle	84.2	50.0	66.7	69.2	83.9	84.3	6.3	70.9
Fourth	79.1	64.1	62.3	65.3	85.7	85.4	25.0	69.2
Highest	93.3	78.3	73.3	76.6	89.9	94.6	18.4	78.7
Total	**79.9**	**56.7**	**69.0**	**66.0**	**82.4**	**86.7**	**8.0**	**68.6**

*p-value<0.01; ** p-value <0.05

Readiness of health facilities

EPI session interruption and number of children required to open multi-dose vials were significantly associated with complete vaccination. Likewise, the availability of defaulter tracing system and receiving training on EPI were also associated with complete vaccination ($p < 0.05$). However, shortage of vaccines and availability of refrigerator had no significant association in this study (Table 15).

Table 15: Factors associated with complete vaccination among mothers of children aged 12-23 months by facility readiness, December 2014-January 2015

Variables	Fully vaccinated		Odds ratio (95% CI)	
	Yes	No	Crude	Adjusted
Availability of EPI micro-plan				
Yes	71.4	28.6	0.9 (0.6-1.2)	
No	63.4	31.5	1.0	
Number of children required to open multi-dose vaccine vials				
Up to 5 children	73.7	26.3	1.5 (1.1-2.0)**	1.5 (1.1-2.1)**
More than 5 children	65.9	34.1	1.0	1.0
Interruption of at least one immunization services				
No	72.6	27.4	1.5 (1.1-2.2)**	1.9 (1.3-2.8)*
Yes	63.4	36.6	1.0	1.0
Availability of vaccination defaulter tracing mechanism				
Yes	73.1	26.9	1.8 (1.2-2.7)*	2.1 (1.3-3.3)*
No	60.2	39.8	1.0	1.0
Availability of vaccine refrigerator				
Yes	74.0	26.0	0.8 (0.6-1.0)	
No	68.7	31.3	1.0	
Experienced shortage of any vaccines				
Yes	72.9	27.1	0.8 (0.6-1.1)	
No	69.0	31.0	1.0	
Received supervision on EPI				
Yes	72.8	27.2	1.5 (1.1-2.3)**	1.3 (0.8-2.0)
No	63.6	36.4	1.0	1.0
Received training on EPI				
Yes	74.3	25.7	1.5 (1.1-2.0)**	1.4 (1.1-2.1)**
No	66.0	34.0	1.0	1.0

*p-value<0.01; ** p-value <0.05

1.3. Reason for not completed or never vaccinated

Mothers were asked about the reasons for failure to vaccinate their children. The survey revealed that 51% of reasons for failure were due to obstacles and 34% and 15% were due to lack of information and lack of motivation respectively (Figure 8).

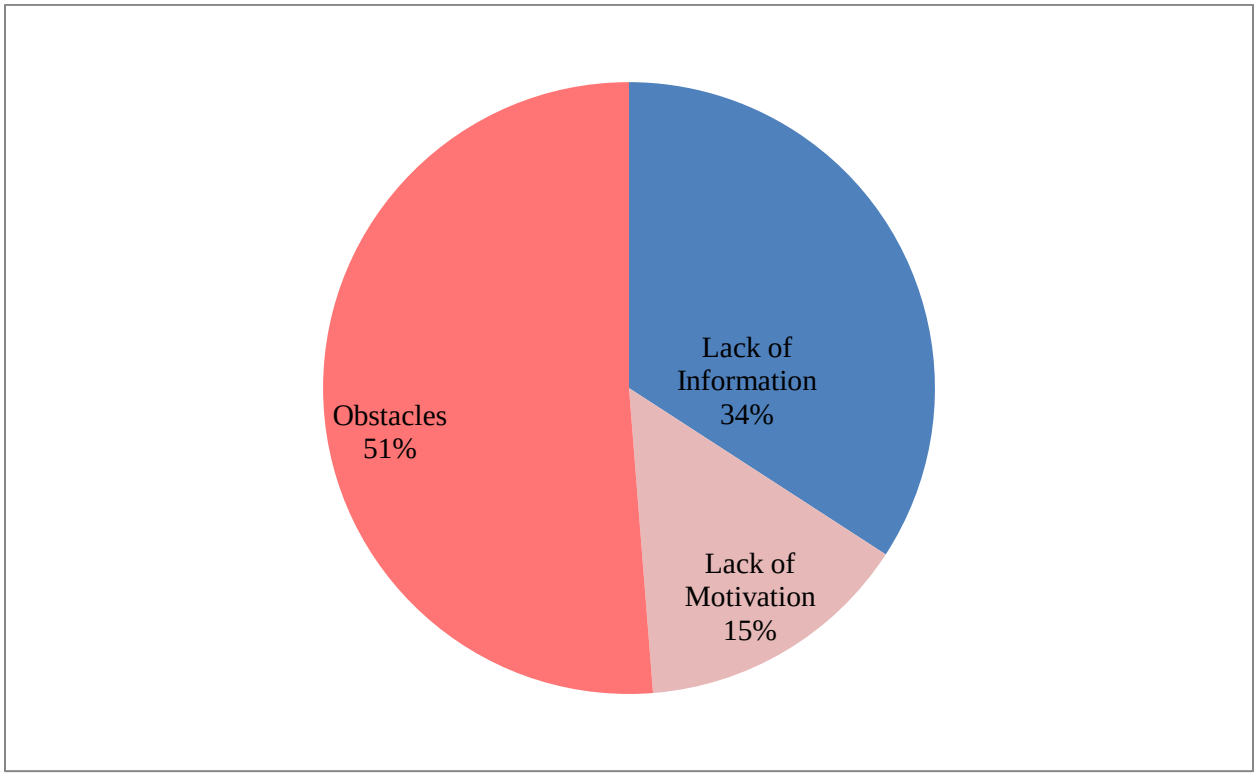


Figure 8: Reasons for not completed or never vaccinated among children aged 12-23 months, December 2014-January 2015

Regarding specific reasons for either incomplete or no vaccination, the main contributing factors were as follows: mother being too busy (27%); being unaware of the need to for vaccination (22%); vaccinator being absent (21%); postponed until another time (21%); being unaware of the need to return for subsequent doses (19%); place and/or time of vaccination unknown (16%); vaccine not available (17%); place of vaccination too far away (10%); and time of vaccination inconvenient (10%) were noted (Table 16).

Some of the reasons were more prominent in specific zones. For instance, mother being too busy appeared to be most common in Gedio (41%) and place of vaccination too far was reported in 28% of cases in Zone 3. Lack of information was more likely to be the reason for failure of vaccine uptake in Bench Maji, Gedio and Afar than the other zones (Table 16).

Table 16: Percentage of mothers of children age 12-23 months who missed any of the vaccination doses with the reasons for not vaccinating, December 2014-January 2015

	Awi (n=48)	Bench Maji (n=84)	East Wollega (n=80)	Gedio (n=71)	North Western (n=49)	Yem (n=23)	Zone 3 (n=162)	Total (n=517)
Lack of Information								
Unaware of need for vaccination	22.9	19.1	13.8	36.6	10.2	4.4	29.0	22.3
Unaware of need to return for subsequent dose	14.6	34.5	15.2	19.7	8.2	21.7	14.8	19.0
Place and/or time of vaccination unknown	18.8	23.8	11.3	11.3	10.2	17.4	24.1	16.1
Fear of side reactions	12.5	7.1	1.3	8.5	0.0	0.0	7.4	6.0
Wrong ideas about contra-indications	3.8	9.8	5.7	12.5	1.6	7.6	6.4	7.5
Lack of motivation								
Postponed until another time	29.2	28.6	16.5	19.7	22.5	21.7	10.5	20.7
No faith in vaccination	10.4	4.8	3.8	8.5	2.0	0.0	6.8	6.0
Rumors	4.2	3.6	2.5	5.6	2.0	4.4	2.5	3.5
Obstacles								
Place of vaccination too far	8.3	9.5	11.3	4.2	0.0	8.7	27.8	10.2
Time of vaccination inconvenient	10.4	16.7	5.0	5.6	8.2	26.1	14.2	9.5
Vaccinators absent	20.8	25.0	25.0	14.1	10.2	0.0	23.5	20.5
Vaccine not available	20.8	15.5	22.5	7.0	20.4	8.7	19.8	17.1
Mother too busy	20.8	25.3	27.5	40.9	16.3	17.4	17.3	26.8
Family problem, including illness of the mother	8.3	14.5	5.0	5.6	18.4	8.7	9.3	9.0
Child ill-- not brought	4.2	8.4	7.5	9.9	6.1	0.0	8.0	7.7
Child ill—brought but not given vaccination	4.2	4.8	1.3	2.8	0.0	4.4	5.6	3.1
Long Waiting time	4.2	2.4	1.3	4.2	0.0	0.0	2.5	2.5

2. TT Vaccination

2.1.Socio-demographic characteristics of mothers surveyed for TT vaccination

A total of 1,586 mothers of children aged 0-11 months participated in the TT vaccination survey. The response rate of 99.3%. The mean age of the children was 5.7 months with a SD of 3.3 months. Nearly two-thirds of respondents had no formal education. The survey result indicated that 16% of respondents resided in urban areas. The socio-demographic characteristics of study participants are summarized in Table 17.

Table 17: Socio-demographic characteristics of mothers surveyed for TT vaccination, December 2014-January 2015

Background Characteristics	Awi (n=179)	Bench Maji (n=212)	East Wollega (n=275)	Gedio (n=239)	North Western (n=238)	Yem (n=237)	Zone 3 (n=206)	Total (n=1,586)
Educational status								
No education	78.1	67.0	55.1	78.3	57.1	47.7	82.9	66.9
Primary	11.8	22.6	23.4	16.6	25.6	40.1	12.7	20.1
Secondary+	10.1	10.4	21.5	5.1	17.2	12.2	4.4	12.9
Residence								
Urban	14.0	11.8	16.7	19.3	18.1	11.4	20.4	16.4
Rural	86.0	88.2	83.3	80.8	81.9	88.6	79.6	83.6
Marital status								
Married	98.9	98.1	97.1	100	95.0	94.1	92.7	97.6
Not in union	1.1	1.9	2.9	0.0	5.0	5.9	7.3	2.4
Age								
< 20 years	5.1	5.7	10.6	10.1	8.0	9.3	9.8	8.6
20-34 years	56.7	69.8	76.2	54.0	71.7	81.9	41.7	65.2
35+ years	20.2	10.4	10.3	7.6	20.3	3.8	4.4	12.0
Don't know	18.0	14.2	2.9	28.3	0.0	5.1	44.1	14.2
Mean age	29.0	26.4	25.4	25.3	27.8	25.0	25.2	26.4
Religion								
Orthodox	95.0	31.6	26.9	14.6	97.5	68.8	11.7	44.0
Catholic	1.7	0.5	1.1	1.9	0.4	0.0	0.0	1.3
Protestant	0.0	66.0	61.8	79.5	0.0	9.3	6.3	45.4
Muslim	1.1	1.4	9.1	2.5	2.1	21.9	82.0	8.4
Other	2.2	0.5	1.1	0.4	0.0	0.0	0.0	0.8
Parity								
1	21.2	36.3	31.4	28.0	24.9	21.1	21.0	28.3
2	17.9	16.0	18.6	12.6	20.3	16.0	22.4	17.1
3	11.7	15.6	16.4	13.8	12.2	15.2	17.1	14.5
4+	49.2	32.1	33.6	45.6	42.6	47.7	39.5	40.1
Mean parity	3.6	2.8	3.0	3.6	3.3	3.6	3.3	2.7
Wealth quantile								
Lowest	15.1	37.7	4.4	15.1	11.8	17.7	45.2	16.5
Second	20.1	19.3	27.3	11.7	19.8	22.4	18.0	20.0
Middle	31.8	16.5	24.7	13.8	21.0	23.2	9.2	20.8
Forth	20.7	14.2	21.1	28.9	21.9	22.8	8.3	21.3
Highest	12.3	12.3	22.6	30.5	25.6	13.9	19.4	21.4

Almost 85% of mothers received at least one antenatal care (ANC) visit during their most recent pregnancy. However, only 42% of mothers received four ANC visits. Overall, health facility delivery coverage was 45% with wide zonal variations and some kind of substance was applied to the umbilical cord of the newborn at birth in 23% of cases (Table 18)

Table 18: Maternal and newborn heath care utilization by mothers of children with 0-11 months, by zone, December 2014-January 2015

	Awi	Bench Maji	East Wollega	Gedio	North Western	Yem	Zone 3	Total
ANC								
No ANC	9.8	14.5	10.8	27.2	2.3	7.6	41.0	15.2
ANC 1^{+}	90.2	85.5	89.2	72.8	97.7	92.4	59.0	84.8
ANC 2^{+}	83.3	79.0	83.9	65.6	91.4	87.0	47.8	78.3
ANC 3^{+}	73.6	67.5	69.6	54.9	80.5	78.0	39.9	66.7
ANC 4^{+}	47.1	47.5	40.8	35.7	47.7	57.4	20.8	41.8
Delivery								
Home	48.3	54.3	42.7	69.6	28.2	44.3	83.2	51.5
Health post	1.1	6.1	6.9	2.1	0.4	7.6	1.0	3.7
Health center/hospital/clinic	50.6	39.2	49.6	28.3	71.4	48.1	15.8	44.5
Other	0.0	0.5	0.7	0.0	0.0	0.0	0.0	0.3
Something applied on the umbilical cord	8.5	18.5	12.0	39.9	23.4	0.4	58.9	22.5

2.2.TT vaccination coverage

Nearly 74% of mothers had received at least two doses of TT prior to the survey. Likewise, more than two-thirds (70%) of infants were protected against neonatal tetanus at birth due to their mothers' TT vaccination. However, only 18% of mothers completed their TT vaccination schedule.

By univariate analysis, TT vaccination and PAB coverage was significantly higher amongst children of mothers with education attainment, in the highest wealth quantile, ANC attendance, and married. However, distance from the nearest health facility had no significant association with TT and PAB vaccination. It also significantly varied across zones (Table 19).

Table 19: TT doses received by mothers of children age 0-11 months of age by background characteristics (univariate analysis), December 2014-January 2015

Background Characteristics	TT 1+	TT 2+	TT 3+	TT 4+	TT 5+	PAB[5]	TT2+ during last pregnancy (n=853)
Mother's age (n=1,247)							
<20 years	82.7	70.7	35.9*	20.5**	14.0	66.8	73.4
20-34 years	86.1	76.4	46.6	26.2	18.1	72.3	78.0
35+ years	86.4	77.5	56.8	35.1	18.4	71.3	72.0
Mother's education (n=1,464)							
No education	79.4*	68.7*	40.3*	23.9*	16.1**	64.6*	74.5
Primary	90.8	82.7	52.8	31.2	20.7	77.7	75.9
Secondary +	95.6	87.6	62.7	34.5	25.0	83.7	83.1
Marital status (n=1,469)							
Not in union	82.3	62.6	26.4**	10.3**	2.3*	57.8	75.0
Married	83.9	74.3	46.3	27.1	18.6	70.0	76.3
ANC visits (n=1,382)							
0	36.3*	30.9*	14.7*	8.6*	5.1*	23.7*	-
1	72.5	50.4	35.7	22.2	20.9	48.4	20.8*
2	91.8	75.8	38.6	22.9	20.1	69.3	72.2
3	91.8	86.3	50.4	27.2	17.1	83.5	81.8
4+	95.1	85.3	58.3	34.6	24.3	81.8	78.8
Parity (n=1,467)							
1	83.7	71.2	42.0	20.4*	14.5**	66.9	75.6
2	87.5	77.0	46.8	26.3	16.4	73.9	80.8
3	85.3	74.9	45.0	26.0	18.5	69.6	71.1
4+	82.0	74.6	48.4	31.7	21.6	70.1	76.6
Residence (n=1,469)							
Urban	90.0	80.9	52.5	34.0	26.0	77.6	79.8
Rural	82.6	72.7	44.5	25.3	16.7	68.2	75.5
Zone (n=1,469)							
Awi	85.5*	68.1*	37.4*	12.1*	6.0*	62.7*	66.7
Bench Maji	84.4	67.8	31.7	10.7	4.9	64.9	75.5
East Wollega	90.0	85.5	62.1	40.2	25.3	81.4	79.2
Gedio	77.1	70.1	37.9	26.2	23.4	66.4	83.7
North Western	86.3	77.7	51.9	33.9	23.2	73.0	74.8
Yem	96.2	87.7	73.5	59.2	47.4	85.3	60.5
Zone 3	56.7	41.5	21.6	6.4	4.1	32.8	76.4
Distance from facility (n=1,463)							
< 1hour	83.2	73.4	44.0	25.0	16.2	69.2*	75.5
>=1 hour	82.5	72.7	46.4	29.9	22.6	67.1	77.0
Wealth quantile (n=1,469)							

[5] *The percentage of children 0-11 months born protected by at least two doses of TT administered to their mother during the index pregnancy or before and the delivery occurred during the period of protection that follows the last protective TT doses (WHO definition).*

Lowest	72.1*	58.5*	29.7*	15.7**	8.6**	53.5	73.8
Second	82.7	70.7	44.9	29.7	18.3	68.7	74.4
Middle	85.4	72.6	43.5	26.5	19.7	67.5	71.4
Fourth	85.0	78.7	51.4	25.7	17.0	74.1	80.0
Highest	91.0	85.5	55.4	33.3	25.2	80.7	80.4
Total	**83.8**	**74.0**	**45.8**	**26.7**	**18.2**	**69.7**	**76.3**

*p-value<0.01; ** p-value <0.05

2.3.Determinants for protected against neonatal tetanus at birth (PAB)

Overall, ANC attendance, maternal education and wealth quantile were independent and significant predictors of PAB in multivariate analysis (Table 20).

Table 20: Factors associated with protected against neonatal tetanus at birth (PAB) among mothers of children aged 0- 11 months (multivariate analysis), December 2014-January 2015

Background Characteristics	Awi (n=166)	Bench Maji (n=205)	East Wollega (n=269)	Gedio (n=214)	North Western (n=233)	Yem (n=211)	Zone 3 (n=171)	Total (n=1,469)
Mother's age								
<20 years	50.0	58.3	77.8	72.7	44.4	68.2	58.8**	66.8
20-34 years	66.3	64.6	83.8	61.7	75.7	90.0	37.1	72.3
35+ years	67.7	81.0	67.9	76.9	73.3	75.0	20.0	71.3
Mother's education								
No education	66.9	60.6	74.0**	60.6	72.0	80.6	26.2**	64.6**
Primary	52.4	71.7	90.3	83.3	68.3	89.4	52.2	77.7
Secondary+	47.1	77.3	92.9	90.0	82.9	89.3	100.0	83.7
Marital status								
Not in union	100	75.0	57.1	-	58.3	42.9	38.5	57.8
Married	62.4	64.7	82.1	66.4	73.8	88.3	32.3	70.0
ANC visits								
0	6.3*	7.7*	30.8*	31.6*	60.0*	71.4**	6.8*	23.7*
1	41.7	30.0	64.3	64.3	35.7	81.8	10.5	48.4
2	62.5	43.5	83.8	68.2	73.9	63.2	33.3	69.3
3	71.4	77.5	90.5	97.3	77.1	83.3	56.7	83.5
4+	71.1	84.0	88.6	80.8	79.6	93.0	65.7	81.8
Parity								
1	50.0	56.6	87.7	63.5	56.9	72.3	43.2	66.9
2	51.6	63.4	90.2	80.0	79.2	88.6	34.2	73.9
3	80.0	70.0	66.7	70.4	79.3	100.0	32.3	69.6
4+	67.9	72.7	79.1	63.6	77.3	85.7	26.2	70.1
Residence								
Urban	45.8	80.0	90.9	84.6	81.0	92.0	38.5	77.6
Rural	65.5	62.8	79.6	62.3	71.2	84.4	31.1	68.2
Distance from facility								
< 1hour	62.3	63.2	81.1	66.1	76.5	84.3	35.9	69.2
>=1 hour	66.7	74.2	88.9	68.9	66.7	92.3	20.5	67.1
Wealth quantile								
Lowest	60.9	55.3	50.0	60.0	60.7	92.1	19.2	53.5*

Second	66.7	64.1	84.0	50.0	56.5	80.4	25.0	68.7
Middle	57.4	62.9	75.4	62.1	77.6	81.3	31.3	67.5
Fourth	74.3	75.9	81.8	65.1	78.0	88.0	46.7	74.1
Highest	52.4	84.6	90.3	78.5	83.3	86.2	62.9	80.7
Total	**62.7**	**64.9**	**81.4**	**66.4**	**73.0**	**85.3**	**32.8**	**69.7**

*p-value<0.01; ** p-value <0.05

Discussion

To achieve immunization goals, delivery of potent vaccines through properly maintained cold chain systems and high quality coverage are indispensable. The aim of this study was to assess vaccination coverage, reasons for incomplete vaccination and health facility service delivery, vaccine stock and cold chain management systems.

Results showed that almost all health facilities were providing EPI services. However, only 37% of health centers provided services on a daily basis. Moreover, more than a quarter of health facilities missed at least one EPI session in the previous six months. This may lead the community to lose trust in health service providers and the health system. It might also be a factor contributing to high drop-out rates and low utilization of vaccination services. The national immunization coverage survey (EHNRI, 2012) reported that 45% of health facilities had interrupted EPI services which is similar to our data.

The survey also revealed that more than 90% of health facilities collect vaccines at least once in a month according to guidelines, nevertheless more than half of them encountered stock-out of any vaccine in the previous three months. This indicates that the availability of vaccines has not been adequate to enable the program run smoothly. This might be due to collection or requisition of inadequate amount of vaccines.

More than half of the facilities' refrigerators were not functional at the time of the survey mainly due to unavailability of energy/fuel and the refrigerators not being installed. An additional 27% of health facilities encountered breakdown of vaccine refrigerators. Furthermore, about a quarter of refrigerators were found to be outside of the recommended temperature range. This indicates that vaccines in these facilities were at high risk of losing their potency. This observation is similar to a study in Cameroon and another study in Ethiopia (Ateudjieu et al. 2013; Rogie et al. 2013). Insufficient refresher training and supervision was also documented in this study, which might contribute to the substandard cold chain and vaccine stock management.

Access to vaccination services as estimated by Penta1 coverage was about 88%. However, there was a significant zonal variation in the access to vaccination services with Zone 3 and Gedio zones having lower coverage. The overall Penta3 coverage, a proxy indicator for utilization of vaccination services, was found to be low, and significantly lower in Zone 3, Bench Maji Gedio and East Wolega zones as compared to the North Western zone.

The drop-out rate was less than 10% in Yem, Awi, North Western and Gedio zones. On the other hand, the drop-out rate was more than 10% at Zone 3, Bench Maji and East Wolega zones indicating poor quality of vaccination services in these zones. This finding is in line with the national immunization coverage survey (EHNRI, 2012) and the WHO/UNICEF 2013 estimates for Ethiopia (WHO & UNICEF, 2013). However, this rate is higher than the EDHS 2005 and 2011 estimates. The observed difference between our survey and EDHS may be attributed to a difference in survey design[6] and time variation as several interventions have ongoing.

[6] *EDHS is a national representative survey employing stratified multistage cluster sampling stratified by residence. Enumeration areas are used as sampling units and 30 households from each enumeration areas were selected.*

Access and utilization of vaccination services were significantly higher amongst children of mothers with education attainment, in the highest wealth quantile and low parity ($p < 0.05$) groups in this study.

Quality of vaccination services were demonstrated by the validity of doses given, BCG scar formation, card retention and client-provider interactions. The survey indicated that about 69% of children with written evidence of vaccination (card and register) were fully vaccinated at any time before the survey. However, only 36% of children received valid doses of the vaccines. This indicates that health workers do not screen children adequately before vaccination. Almost identical findings were reported by national vaccination survey. Scar formation from BCG is a proxy measure for prior BCG vaccination and injection technique. This study found that 19% of children vaccinated with BCG had no BCG scar (card and history). This is likely to be due to poor injection technique or sero-conversion.

A considerable proportion of children reported to be vaccinated during the survey had no vaccination card for verification. The card retention rate was found to be 61%, slightly higher than reported in the national immunization coverage survey (EHNRI, 2012), but almost in line with the national cluster survey conducted in 2006 (Kidane et al 2006). Card retention was higher in North Western, Awi, Yem, Gedio and East Wolega zones.

Overall, more than a quarter of mothers were not told about side-effects the child might experience with vaccination. This indicates that there is an opportunity to improve the client-provider interaction. There was also other evidence, particularly a lack of counseling and discussion with the mother at outreach sessions as vaccinators were usually rushing to complete the session (Berhane and Yigzaw, 2006).

The major reasons for incomplete vaccinations were that the mother was too busy or unaware of the need to for vaccination or of the need to return for subsequent doses; unknown place and/or time of vaccination were also mentioned by the majority of mothers. On the other hand, vaccinator absence, unavailability of vaccine, place of vaccination too distant, and inconvenient vaccination times were also mentioned by a significant number of mothers. These issues could be improved by conducting regular and focused education and communication activities on the need for vaccination, as well as interpersonal communication and negotiation on the need for subsequent doses of vaccines. It is also equally important to expand the vaccination delivery sites (the outreach, static or mobile sites) to make these more accessible and convenient for mothers.

Access to TT vaccination as estimated by ANC coverage was 85%. In this study, nearly three-quarters (74%) of mothers received at least two doses of TT at any time before the survey. Likewise, more than two-thirds (70%) of infants were protected against neonatal tetanus at birth due to their mothers' TT vaccination. This is in line with national immunization coverage survey findings conducted in 2006 (Kidane et al. 2006) and 2012 (EHNRI, 2012). Based on the criteria used to assess avoidance of risk to neonatal tetanus by achieving clean baby delivery rates of 70% and above, and a routine $TT2^{+}$ vaccination coverage rate of 80% and above (Berhane and Yigzaw 2006). However, only North Western had better performance than these standards. Other

zones had lower clean delivery and TT coverage and are therefore regarded as higher risk for neonatal tetanus. Overall, ANC attendance, maternal education, wealth quantile, parity and residence were the independent and significant predictors of tetanus PAB by multivariate analysis.

Conclusion and Recommendations

Conclusion

Although more than 96% of health centers were providing routine EPI, only 37% provided EPI on a daily basis. More than a quarter of health facilities surveyed had some interruption of EPI services mainly due to vaccine delivery related factors and vaccinators work load. In a significant proportion of health facilities, their cold chain management was suboptimal, and this may hamper the potency of the vaccines provided.

Vaccination coverage was found to be lower in the households with poorest wealth quantile, low parity and no maternal education. Timely and valid dose coverage was found to be low in this study. Mother's being busy, unaware of the need for vaccination, vaccinator absenteeism, lack of awareness of the need for subsequent doses and place and/or time of vaccination unknown were the major reasons mentioned for failure of vaccination. ANC attendance, maternal education, wealth quantile were the independent predictors of PAB.

Recommendations

Based on the findings of the survey the following changes are recommended:

Targeted service delivery: Context-based delivery strategies including mobile-based delivery is crucial to address the low access and utilization of EPI services particularly in pastoralist areas of Afar. Detailed micro-planning with clear mapping of seasonal nomadic movements is required to ensure targeted outreach or mobile services to these populations. Detailed planning by individual health facilities and districts of how to reach the unreached and disadvantaged children in the catchment area is essential for improving equity in immunization.

Quality of vaccination: The administration of invalid doses indicates that vaccinators do not adequately screen children before administering vaccines. Thus, observations and close monitoring of EPI sessions need to be performed to improve the quality of services. Refresher training is equally important to enhance the knowledge and skills of vaccinators.

Integrate services and eliminate missed opportunities: Any child coming to a health facility for any reason or a child coming to a facility for any vaccinations should get the routine EPI doses that the child is eligible for during the time of the visit to eliminate the possibility of missed opportunities. The survey showed that health facilities require on average six children to be present in order to open a vial of measles vaccine. This indicates that the vaccine open vial policy of reconstituted vaccines (measles and BCG) is leading to missed opportunities.

Early ANC booking and screening of TT immunization status of the pregnant women and administering doses to all eligible women could increase PAB coverage. Moreover, utilization of clean facility birth and clean cord practice should be promoted during ANC care.

Cold chain and vaccine management: There is a need to establish an appropriate and uninterrupted vaccine delivery strategy. The use of mobile technology for vaccine chain management could be considered for proper forecasting, requisition, and monitoring wastage.

There is also an urgent need to improve the cold chain management system through training and monitoring, as vaccines in some facilities were at high risk of losing their potency.

Strategic communication and health education: Strategic communication and health education to increase awareness of the need for vaccination and subsequent doses is vital. Enhancement of the interpersonal communication skills of providers is important to improve their interaction with mothers. Involving HDAs in community mobilization is essential to deliver key messages to the community as well as tracing defaulters.

Planning, monitoring and evaluation: To continuously monitor service delivery, quality and the supply chain, a continuous and regular cycle of planning, monitoring and implementation should be established. Use of the EPI monitoring chart as a monitoring tool should be reinforced. A detailed micro-plan and improvement plan to address key challenges should be present at all levels. In addition, a performance review should monitor data quality so that it accurately reflects true immunization coverage at all levels. Furthermore, regular and focused supportive supervision needs to be strengthened at all levels to gain the commitment necessary for a successful EPI program.

To augment routine monitoring, observational studies are recommended to assess the quality of routine EPI sessions, the field efficacy of vaccines and operational processes to guide the program implementation particularly to cultivate the vaccination culture.

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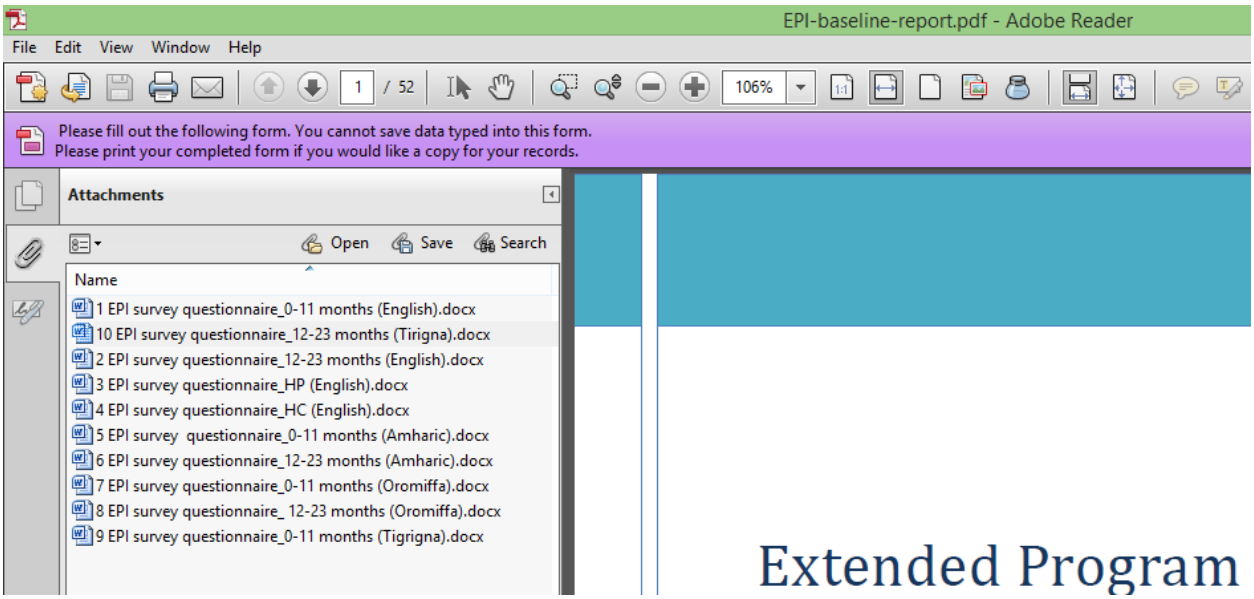
Annexes

Annex 1: Survey tools

Survey questionnaires are attached in the EPI Baseline Report.

To access the questionnaires please open the attachment on the left panel of your pdf reader.



Annex 2: Summary of the key immunization indicators during December 2014-January 2015, by zone

Indicators	Values by zone							Total
	Awi	Bench Maji	East Wollega	Gedio	North Western	Yem	Zone 3	
Immunization card retention								
Percentage of children with a vaccination card at the time of the survey	71.6	42.9	60.8	62.1	76.6	65.7	10.8	**61.1**
Immunization system access (by card, register and history)								
Percentage of children receiving BCG	91.2	86.7	90.7	77.2	96.6	93.8	35.8	**86.3**
Percentage of children receiving Penta1	92.9	90.6	93.3	77.2	97.6	90.0	34.7	**87.9**
Immunization system utilization (by card, register and history)								
Percentage difference in coverage between Penta1 and Penta3	4.1	19.6	14.5	5.8	5.9	2.7	42.6	**10.4**
Percentage difference in coverage between Penta1 and measles	6.3	15.1	12.1	0.6	10.0	1.1	22.5	**9.3**
Immunization coverage for maximum epidemiological impact								
Percentage of fully immunized children (card or card and history)	79.9	56.7	69.0	66.0	82.4	86.7	8.0	**68.6**
Percentage of fully immunized children with valid doses (card + Register)	49.4	32.0	30.6	32.0	47.5	42.4	2.3	**36.3**
Percentage of fully immunized children with valid doses by one year of age (card + Register)	34.7	25.1	23.9	21.4	36.6	23.3	1.7	**26.7**
Invalid dose administration by 12 months of age (by card and register)								
Percentage of children receiving invalid Penta1 doses	10.5	28.1	28.4	29.1	14.2	8.6	26.1	**22.4**
Percentage of children receiving invalid Penta3 doses	22.2	24.1	31.3	30.1	22.4	23.8	13.6	**26.1**
Percentage of children receiving invalid measles doses	36.0	42.9	49.3	42.2	38.0	55.2	22.7	**41.7**
Injection technique								

Percentage of children vaccinated with BCG with BCG scar (by card, register and history)	76.4	82.5	81.7	83.7	84.8	79.2	77.3	**81.5**
Immunization system equity for complete vaccination (by card, register and history)								
Percentage difference between coverage among boys and girls	0.8	6.0	3.5	-0.7	-2.1	4.0	2.8	**1.3**
Percentage difference between coverage among urban and rural residence	16.2	21.3	12.6	-4.4	2.2	10.6	11.4	**8.5**
Percentage difference between coverage among residing < 1hr and >=1 hr distance from vaccination site	31.0	1.2	1.2	-4.8	10.6	-16.1	-2.5	**7.5**
Percentage difference between coverage among mothers of no education and secondary education	19.6	28.5	7.5	5.1	7.3	12.7	29.2	**14.6**
Percentage difference between coverage among highest and lowest wealth quantile	27.4	35.9	6.6	43.3	16.3	14.6	16.1	**32.7**
TT Coverage								
Percentage of women with at least two doses of TT received during their lifetime, of which at least one dose was during the last pregnancy	86.7	87.1	72.6	63.3	55.8	55.7	78.9	**72.0**
TT Utilization								
Percentage difference between ANC attendance and TT1 Coverage	4.7	1.1	-0.8	-4.3	11.4	-3.8	2.3	**1.0**

Annex 3: EPI initiatives in Ethiopia

Routine Immunization: This is a routine immunization service provided as both static and outreach services.

Reaching Every District (RED): In order to improve sustainable and equitable immunization services for every child, RED was developed as a strategy to provide vaccinations for children who are unreached for reasons of geographic isolation, lack of information and their social or cultural environments. RED consists of five strategic components: 1) re-establishing outreach; 2) supportive supervision; 3) monitoring and use of data for action; 4) strengthening planning and management of resources through micro-plans; and 5) increasing community links.

Enhanced routine immunization Activities (ERIA): This is special immunization strategy designed for pastoralist communities of Somali, Afar, Gambella and other areas which have low routine immunization coverage. In this strategy, all children under 12 months of age at kebele level are registered by HEWs and community volunteers, and any unimmunized children are immunized at specific dates and immunization sites in their respective kebeles through mobile immunization teams visiting each village four times a year.

Supplemental Immunization Activities (SIAs): SIAs include any immunization activity conducted in addition to the provision of routine immunization services. SIAs have been carried out to enhance routine immunization coverage and in order to achieve elimination and eradication of measles, polio and neonatal tetanus. Between 2002 and 2005, a series of emergency and catch up measles immunization and vitamin A supplementation campaigns were conducted to accelerate the control of measles and reduce morbidity and mortality in various regions of the country. Measles SIAs were integrated into the six monthly Enhanced Outreach Strategy (EOS) - which was designed to provide high impact child survival interventions (Vitamin A supplementation, de-worming, nutrition screening, and targeted supplementary feeding and bed net distribution) in drought prone districts.