SURVEY FINDINGS AND PROGRAM IMPLICATIONS FROM COMBINED VACCINATION COVERAGE AND SEROLOGY SURVEYS IN THREE WOREDAS (DISTRICTS) OF ETHIOPIA IN 2013 AND 2016

Acronyms

CVD	Center for Vaccine Development
EPHI	Ethiopian Public Health Institute
EPI	Expanded Programme on Immunization
FMOH	Federal Ministry of Health
JSI	JSI Research & Training Institute, Inc.
PRN	plaque reduction neutralization
RED-QI	Reaching Every District using Quality Improvement
UI-FHS	Universal Immunization through Improving Family Health Services
WHO	World Health Organization

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INTRODUCTION

Ensuring that all eligible women and children receive reliable and quality vaccination—universal immunization—is a critical health development goal and one that Ethiopia has been working towards for the past several decades. Ethiopia has made remarkable progress over these years in reducing morbidity and mortality among infants and children. Yet despite nationwide improvements in immunization coverage, access and utilization of routine immunization services at the sub-national level is markedly inequitable, with a significant number of unreached and unimmunized children. As a result, the country experiences frequent outbreaks of vaccine-preventable diseases, particularly measles. The Federal Ministry of Health (FMOH) in Ethiopia wanted to understand why, despite reported high immunization coverage, the country continued to suffer from frequent outbreaks of measles.

In 2011, the Universal Immunization through Improving Family Health Services (UI-FHS) project was awarded to JSI Research & Training Institute, Inc. (JSI) as a learning grant from the Bill & Melinda Gates Foundation. The project was asked to explore the dynamics of vaccination and protection and develop recommendations for what it would take to reach and sustain high immunization coverage in Ethiopia. UI-FHS developed the Reaching Every District using Quality Improvement (RED-QI) model to strengthen the routine immunization system. The RED-QI approach takes the national RED strategy and adds QI elements to strengthen the immunization system and improve the delivery of equitable, high-quality services. The approach enables health personnel to overcome large, complex problems by breaking the problem into smaller, more achievable pieces. Health workers identify the root causes of a problem, prioritize those problems, and implement changes that can be quickly operationalized at the local level.

The RED-QI approach employs a comprehensive strategy (training, reinforcement of skills learned through on-the-job support, and peer learning) to build health worker capacity to manage and implement critical activities that strengthen the RI system. UI-FHS supports health workers to identify and target communities for immunization services and to develop robust immunization microplans to reach those populations. Engagement of the community is critical for the success of RED-QI; community members support health workers in identifying and solving problems within the health system and planning immunization services; and are critical for implementing defaulter and left-out tracking systems. The RED-QI approach also focuses on strengthening data quality and use at the health facility level, under the assumption that greater accountability for program data leads to improved quality of data. The RED-QI approach was first implemented in three learning woredas (districts) in Ethiopia between 2014 and 2016, during which various best practices in routine immunization system strengthening and performance improvements were achieved.

To understand the paradox of high reported immunization coverage and frequent disease outbreaks, UI-FHS conducted combined immunization coverage and serology surveys in the three learning woredas at baseline in 2013, and after RED-QI program implementation in 2016. UI-FHS conducted the combined surveys to examine how estimates compared from various data sources, exploring what percentage of supposedly vaccinated children demonstrated protective levels of antibodies against tetanus and measles.

UI-FHS partnered with two separate Ethiopian firms, Matrix and Institute for Education, Health and Development (InEHD) to conduct the coverage surveys in 2013 and 2016 and with the Ethiopian Public Health Institute (EPHI) (formerly Ethiopian Health & Nutrition Research Institute) and the Center for Vaccine Development (CVD) from the University of Maryland, Baltimore, USA to conduct the serology surveys.

This report presents findings from the combined coverage and serology surveys and provides recommendations for consideration by the FMOH in Ethiopia for how to strengthen the Expanded Programme on Immunization (EPI) in the country.

SURVEY METHODOLOGY

SPECIFIC OBJECTIVES OF THE COMBINED SURVEYS

The combined coverage and serology surveys had the following objectives:

1. Conduct comparative analysis of baseline and endline survey data to study performance, progress, and achievements in the three learning woredas.
2. Estimate the proportion of infants protected against neonatal tetanus.
3. Estimate the proportion of children protected against selected vaccine-preventable diseases.
4. Compare and validate administrative and survey coverage estimated with the more objective serologic evidence of the level of immunity in the community.
5. Identify key elements and characteristics of fully, partially, and unimmunized children.
6. Assess immunization knowledge and practice in the community.

Immunization coverage surveys, in combination with serologic surveys, were conducted in the three UI-FHS learning woredas in Ethiopia in 2013 and again in 2016; the RED-QI approach was implemented in the three woredas between April 2014 and December 2015. Toddlers (12-23 months) were randomly selected using World Health Organization (WHO) vaccination survey protocols in 2013[1] and 2016.[2] Immunization coverage was estimated using administrative data, the EPI vaccination registers at health facilities, vaccination cards, and parental recall. Serum antibody titers to antigens from two vaccines (tetanus, as a part of pentavalent vaccine, and measles) were measured in toddlers to provide serologic evidence on whether vaccinated infants and children were immunologically protected against tetanus and measles.

In 2019, CVD analyzed 600 stored serum samples from 12 to 23 month-old toddlers who enrolled in the 2013 and 2016 Ethiopian serosurvey studies using measles plaque reduction neutralization (PRN) assay (the gold standard methodology). The specimens chosen were a random sample of 100 specimens from each woreda in 2013 and a random sample of 100 from each woreda in 2016. The results from the assay are highlighted in this report.

Vaccination coverage data were obtained using WHO cluster coverage survey methodology. The coverage survey team visited each cluster, canvassing all homes for children 12 to 23 months old. During the visits to households with children in the eligible age range, the team recorded the data from vaccination cards and completed the questionnaires for the coverage survey with the parents or caregivers. The coverage survey team also verified immunization records of children at the local health facility in the event of parents or caregivers verbally reporting vaccination but not being able to exhibit the child's vaccination card, and when there was no card and no parental recall.

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[1] *Immunization Cluster Survey Reference Manual* (WHO 2005), online at https://www.who.int/immunization/monitoring_surveillance/Vaccination_coverage_cluster_survey_with_annexes.pdf

[2] Ibid.

STUDY POPULATION

The three UI-FHS learning woredas were surveyed: Assaieta in the Afar region, Arbegona in the Southern Nations, Nationalities and People's Region and Hintalo Wajerate in Tigray region (Figure 1). In each of the three woredas a sample of 300 toddlers (12-23 months) were randomly selected for the survey with a goal of enrolling 900 toddlers in total. In 2013, study participants (infants and toddlers) were surveyed once over a period of approximately three months (February to early April); then in early 2016, three years later, toddlers residing in the same woredas were surveyed over approximately the same time period (February to late March). These surveys were unique in that the combined surveys examined immunization coverage and protection on the same population by age, in the same geographic area, and at the same time of year.

Figure 1: Map of Survey Woredas Hintalo Wajerate, Assaieta, and Arbegona, 2016

The serosurvey protocol was approved by the Ethiopian National Research Ethics Review Committee and the University of Maryland, Baltimore Institutional Review Board. Informed and signed consent was obtained from parents of each child enrolled in the serosurvey. Participation in the vaccination coverage survey, a routine FMOH public health endeavour, did not require informed consent.

FINDINGS

TETANUS

SEROLOGIC BACKGROUND ON TETANUS

Tetanus antibodies are only formed after immunization, and not as a result of tetanus infection. The presence of protective levels of tetanus antibodies in toddlers or infants is a classic indicator of immunization with tetanus vaccine. In toddlers, there are no residual maternal antibodies and using a cut-off of ≥ 0.05 IU/mL is a strong indicator that the child has received at least two doses of pentavalent vaccine. Tetanus immunological protection is a proxy for protection against all of the pathogens covered in the pentavalent vaccine (diphtheria, tetanus, pertussis (whooping cough), hepatitis B and Haemophilus influenzae type b (Hib), which is administered through the routine immunization system in Ethiopia.

SURVEY RESULTS

Survey results from all three woredas show that **immunological protection from tetanus significantly increased from 2013 to 2016** (Table 1). In 2016, the proportion of children with serologic protection

against tetanus ranged from 79-99% among survey woredas. As such, results indicate performance improvement of the routine immunization system from 2013 to 2016 in all three districts. It should be noted that documented vaccination coverage range from 28-66%, substantially underestimating serological protection.

Table 1. Tetanus antibody levels, vaccination coverage (penta3) and administrative report among children 12-23 months of age by the time of the survey in three Ethiopian woredas, 2013 and 2016

Woreda	Tetanus (sero) protected (≥ 0.05 IU/mL) (%)		Documented† coverage (%)		Crude†† coverage (%)		Administrative††† report (%)	
	2013	2016	2013	2016	2013	2016	2013	2016
Arbegona	73	84*	36	29	40	59	98	102
Assaieta	60	79*	27	28	35	46	79	109
Hintalo Wajerate	94	99*	83	66	85	87	95	89

* Results in 2016 statistically significant from 2013 (p-value < 0.05) by McNemar test

†Documented coverage = percent of 12-23-month-olds with 3 doses of pentavalent vaccine given no younger than 39 days of life as recorded on the vaccination card or in the health facility register.

††Crude coverage = percent of 12-23-month-olds with 3 doses of pentavalent vaccine as determined by vaccination card, health facility register, or parental recall.

†††Administrative coverage = proportion of 12-23-month-olds with 3 doses of pentavalent vaccine as reported by the WHO Joint Reporting Form and the Ethiopian Ministry of Health

MEASLES

SEROLOGIC BACKGROUND ON MEASLES

Measles antibodies derive either from measles infection or from immunization with measles vaccine. The presence of measles antibodies in toddlers at a titer ≥ 120 mIU/mL indicates that the child is protected from the measles virus and thus will contribute to a barrier to dampen transmission of wild-type virus in the community. To achieve herd immunity for measles at least 90-95% of the population need to be vaccinated.[3]

[3] U.S. Centers for Disease Control (CDC), "Vaccine for Measles" (CDC 2019), online at https://www.cdc.gov/measles/vaccination.html

SURVEY RESULTS

Review and interpretation of data on measles is more complex. As shown in Table 2,[4] the number of children protected against measles increased between 2013 and 2016 in all three survey woredas; however, the level of protection indicated by serology is still too low to prevent measles outbreaks. Increases and decreases in documented and crude coverage data are inconsistent across the three woredas. Administrative data provided a coverage estimate considerably above the serologic evidence.

Table 2. Measles antibody levels, vaccination coverage and administrative report among children 12-23 months of age by the time of the survey in three Ethiopian woredas, 2013 and 2016

Woreda	Measles (sero) protected (≥ 120 mIU/mL) (%)		Documented† coverage (%)		Crude†† coverage (%)		Administrative††† coverage (%)	
	2013	2016	2013	2016	2013	2016	2013	2016
Arbegona	26	36	24	22	49	68	91	100
Assaieta	31	50	16	29	40	66	69	98
Hintalo Wajerate	63	76	67	55	78	78	89	85

Note: due to smaller sample sizes, testing for significance was not possible

†Documented coverage = percent of 12-23-month-olds with measles vaccine (MCV1) given no younger than 267 days of life as recorded on the vaccination card or in the health facility register.

††Crude coverage = percent of 12-23--month-olds with measles vaccine (MCV1) as determined by vaccination card, health facility register, or parental recall.

†††Administrative coverage = proportion of 12-23 -month-olds with measles vaccine (MCV1) as reported by the WHO Joint Reporting Form and Ethiopian Ministry of Health

There are many possible reasons for the discrepancies between the serology, coverage survey, and administrative data sources for measles. A few of the most likely reasons are: 1) issues with the handling of the vaccine and/or vaccination services (i.e., the cold chain is ineffective, use of expired vaccine, vaccines are reconstituted with diluent that is at an inappropriate temperature); 2) issues with data quality of administrative data (i.e., numerators are inaccurate, denominators are too low or too high, incorrect or incomplete recording); 3) the fact that not all vaccinated infants will seroconvert (at 9 months the proportion of infants that seroconvert is about 85%[5]); and 4) the fact that in children who

[4] Note: In Table 2, the (n) for the serologic data is based on a sub-sample of just 100 randomly sampled toddlers from each woreda.

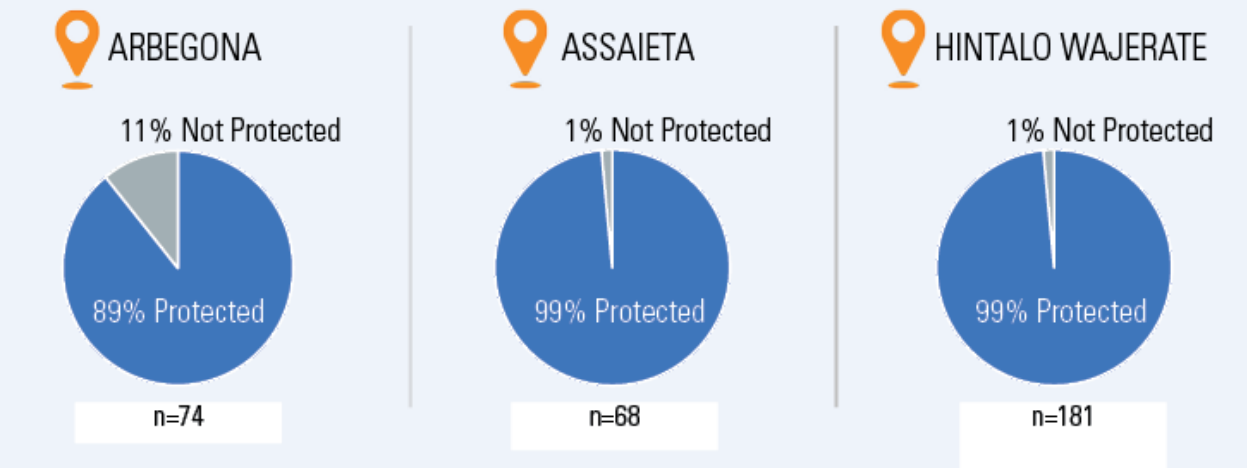
[5] WHO, *Immunological Basis for Immunization Series Module xx: Measles* (WHO 2008), online at https://www.who.int/immunization/sage/Module_on_Measles_Immunology_26Aug08.pdf

mount only modest levels of measles antibodies, determination of the exact proportion of children protected, as reported by serologic assay, may be difficult.

VACCINATION STATUS AND LEVELS OF PROTECTION

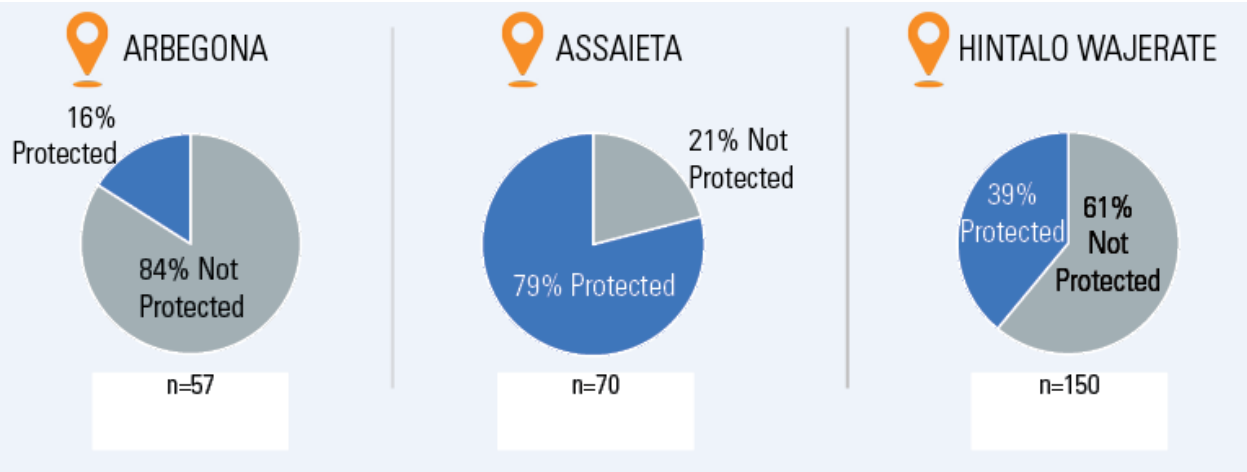
As shown in Figure 2, the majority of children with documented evidence of vaccination (by card or health facility register) with pentavalent vaccine demonstrate serologic protection against tetanus, 99% in Assaieta, 89% in Arbegona and 99% in Hintalo Wajerate.

Figure 2: Serologic protection from tetanus among children in the three survey woredas with documented evidence of vaccination, 2016



Conversely, among those children with documented evidence (by card or register) of vaccination against measles, only 16% of children in Arbegona, 39% in Hintalo Wajerate and 79% in Assaieta, showed serologic evidence of protection (Figure 3).

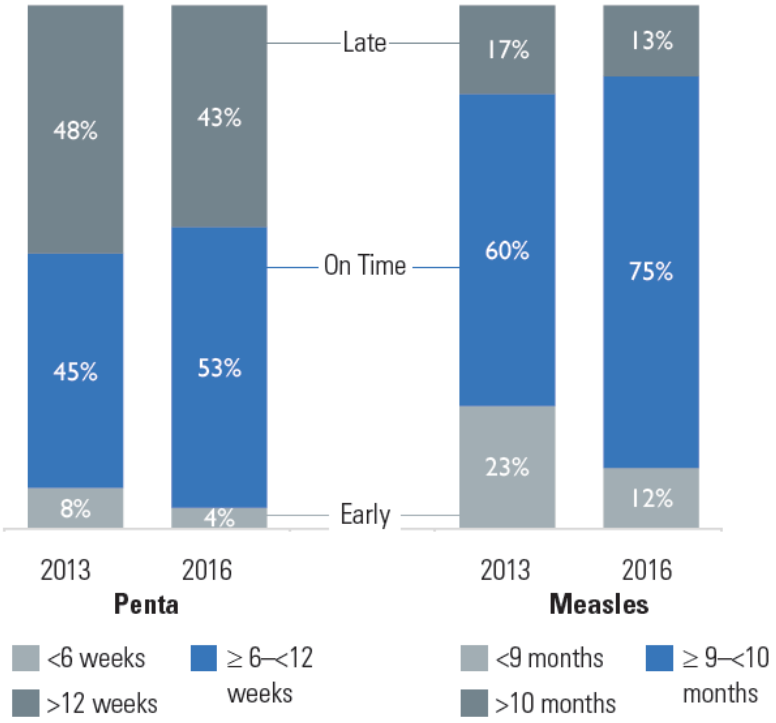
Figure 3. Serologic protection from measles among children with documented evidence of vaccination in the three survey woredas, 2016



TIMELINESS OF IMMUNIZATION

In Ethiopia, the immunization schedule for vaccination is to receive first, second, and third doses of pentavalent vaccine at 6, 10 and 14 weeks of age, respectively, followed by a first dose of measles-containing vaccine when the child reaches 9 months of age.[6] The number of children receiving a vaccine on time, at 6 to <12 weeks for penta1 and between 9 and <10 months for measles, improved for both penta1 (8 percentage point increase) and measles (15 percentage point increase) vaccination between 2013 and 2016 (Figure 4). However, a large number of children continue to be vaccinated after the recommended schedule, particularly for penta1 (43% in 2016), leaving children susceptible to disease. Children are also being vaccinated before the recommended age, compromising their ability to produce antibodies that protect against disease.

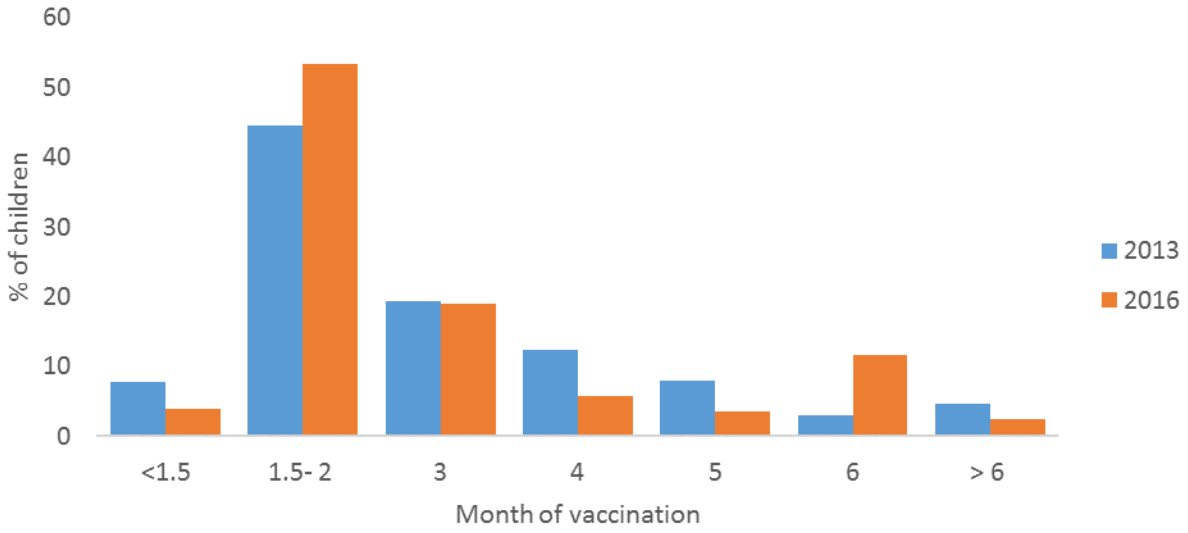
Figure 4. Comparison of timeliness of 1st dose of measles and penta1 vaccines among children aged 12-23 months with documented evidence of vaccination in the three survey woredas



As seen in Figure 5, the percentage of children receiving penta1 vaccination on time (between 6 and <12 weeks) did increase between 2013 and 2016. However, the percentage of children receiving their first dose of penta vaccine late (at 12 weeks of age or later) was largely consistent between the two survey years. This means that in 2016, a considerable percentage of children were still receiving their penta vaccinations later than the recommended schedule.

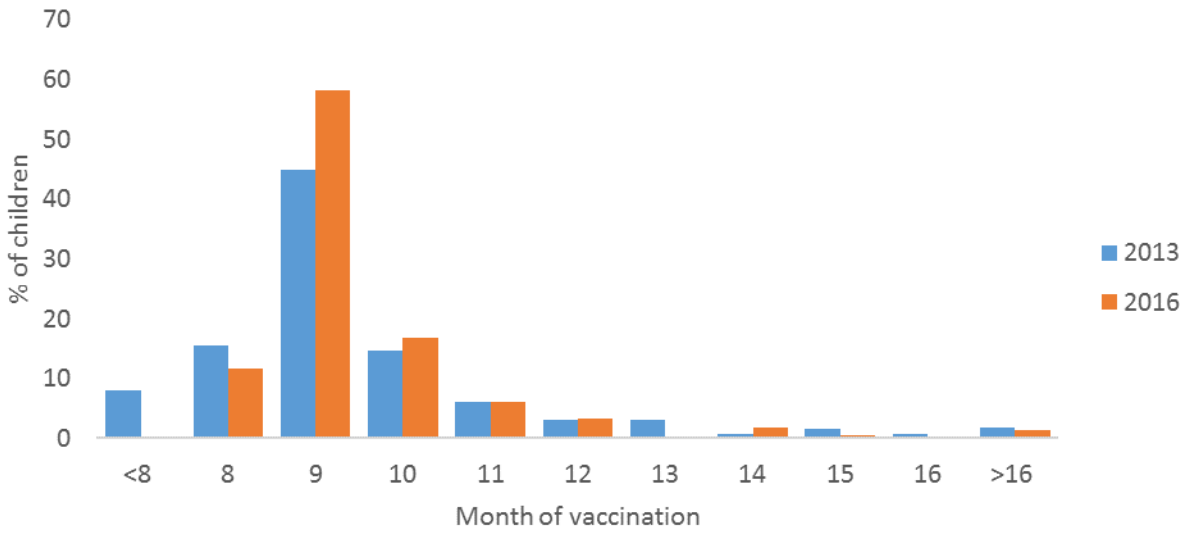
[6] A second dose of measles-containing vaccine was added to the immunization schedule in February 2019.

Figure 5. Comparison of timeliness of penta1 vaccination among children aged 12-23 months with documented evidence of vaccination in all three woredas, 2013 (n=422) and 2016 (n=247)



There was a marked improvement in the percentage of children who received a measles vaccination too early (before 9 months of age) from 23% in 2013 to 12% in 2016 (Figure 6). In addition, the percentage of children who received their first dose of measles vaccine on time (between 9 and <10 months of age) increased by 15 percentage points between 2013 and 2016. There are still children who are receiving a delayed first measles vaccination at or after 10 months of age, which is important for health workers to understand, particularly with the rollout of the second dose of measles, which should be provided at 15 months of age.

Figure 6. Comparison of timeliness of 1st dose measles vaccination among children aged 12-23 months with documented evidence of vaccination in all three woredas, 2013 (n=265) and 2016 (n=215)

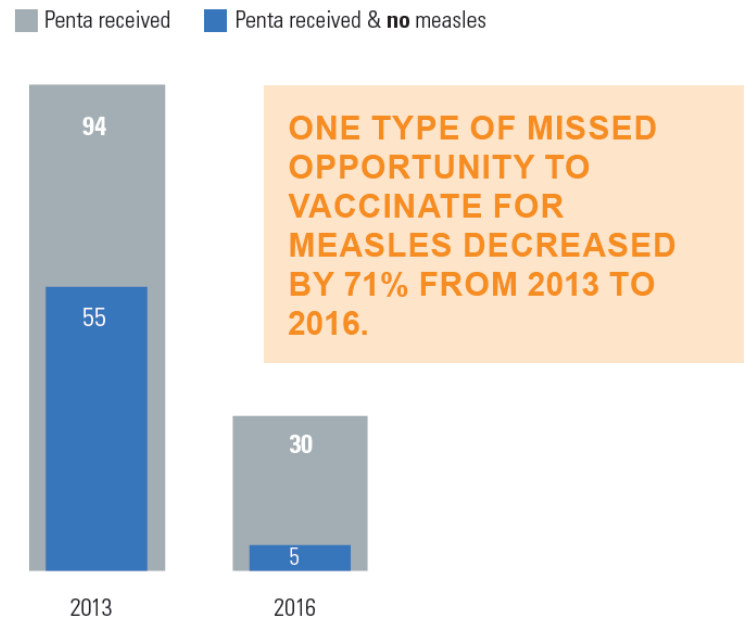


Despite progress, challenges remain with children being given pentavalent and measles vaccination before, or after, the recommended or optimal age. Children who are given vaccines too early are less likely to be immunologically protected against the disease; and those who are given vaccines too late are left unnecessarily susceptible, for prolonged periods, to diseases that could otherwise be prevented.

MISSED OPPORTUNITIES TO VACCINATE FOR MEASLES

In 2013, 94 surveyed children received late dose(s) of pentavalent vaccine at nine months or later (Figure 7). In addition, despite being eligible, most of these children (55 children of 94) did not simultaneously receive measles vaccination when they were given the delayed penta dose. This represents a missed opportunity to vaccinate for measles. In the 2016 survey, the number of children receiving penta vaccine at or after 9 months of age dropped from 94 to 30. Similarly, the number of children who at or after 9 months of age received a late penta dose but did not receive measles vaccine dropped from 55 to only 5. Overall, there was a 71% decrease in this type of missed opportunity to vaccinate for measles. Furthermore, the median age among those who received a measles vaccine in 2013 was 417 days (about 14 months of age), whereas the median age to receive measles vaccine in 2016 declined to 365 days (12 months), getting closer to the optimal age of 9-10 months. This improvement from 2013 to 2016 reflects health workers' efforts, with support from the UI-FHS project, to strengthen the delivery of timely services and reduce missed opportunities for vaccinations.

Figure 7. Number of children with documentation (card or health facility register) who received penta vaccination after 9 months of age and were eligible to receive measles vaccination, among children 12–23 months at time of survey, all woredas, 2013 and 2016



[1] A second dose of measles containing vaccine was added to the immunization schedule in February 2019.

HOME-BASED RECORDS

In the 2016 survey, many caregivers (70%) across all three woredas reported receiving a vaccination card; however, nearly one-third (30%) of caregivers reported never receiving a vaccination card. Among caregivers who reported having received vaccination cards, a sizable proportion (35.2%) had either lost their card or were unable to show it at the time of the survey. As the overall percentage of caregivers able to produce a vaccination card at the time of the coverage survey was low (35% average among the three woredas), UI-FHS visited health facilities and looked at health facility registers to confirm reports of vaccination for children without vaccination cards. Even with additional documentation from health facilities, only 55% of the children included in the 2016 survey had documented evidence of vaccination (Table 5).

Table 5. Availability of home-based records in children 12-23 months by time of survey, 2016

Source of data	% reported ever received	% observed day of survey	% Not able to produce card*	% reported never received
Arbegona	60.2	20.1	40.1	39.8
Assaieta	68.8	35.5	33.3	31.2
Hintalo Wajerate	81.2	49.3	31.8	18.9
*Not able to produce card = (% who ever received - % observed on day of survey)/ % who ever received				

During the immunization coverage survey, if a caregiver reported that a child was not vaccinated, that caregiver was asked to explain the reasons. Since this question was asked only if the child was not vaccinated, the sample size is quite small. In Hintalo Wajerate, half of the caregivers (13 of 22, or 59%) indicated that the reason for non-vaccination was a long wait at the vaccination site. This same response was among the top three reasons in both Assaieta and Arbegona. In both Assaieta and Arbegona, the other two main reasons for non-vaccination were that there was a family problem, such as the mother being ill, or that the caregiver did not know when to return for the follow-up dose. These findings suggest that additional focus should be placed on improving the quality of immunization services to reduce wait time for vaccination, and to ensure health workers are counseling verbally and using the vaccination card to clarify when to return for subsequent vaccinations.

DISCUSSION

From baseline (2013) to endline (2016), routine immunization improved in all three program woredas as evidenced through increases in coverage and sero-protection for both tetanus and measles.

UI-FHS technical support to the RI program in each of the three woredas contributed to increased reach and quality of vaccination services. The RED-QI approach builds the capacity of health management and health staff to identify all target populations, plan robust vaccination services to reach those populations, and implement quality vaccination services. As observed in Figures 4, 5 and 6 above, survey data show improvements in the timeliness of vaccinations from 2013 and 2016, and an increase in the percentage of children who received their first dose of pentavalent vaccine and measles vaccine on time. In addition, survey data show a marked reduction in one type of missed opportunity to vaccinate for measles (Figure 7). The RED-QI approach builds the capacity of health workers to identify and solve

their own problems using local data. In each of the three survey woredas, health staff indicated that one of the main problems was that children start but do not complete the full course of vaccinations. Health staff worked to address the problem through the establishment of a defaulter tracking system and engagement of the community in identification and tracking of pregnant women and newborns. These activities may have contributed to improved coverage and timeliness of vaccination in the woredas. UI-FHS also focuses on reducing missed opportunities for vaccination and the endorsement of FMOH policy to open a vial of vaccine for even a single eligible child. This advocacy and support may have contributed to the improvements in missed opportunities for measles vaccination.

Despite notable progress in the each of the three woredas, survey findings suggest a need to strengthen a number of elements of the routine immunization system. Based on a review of the measles data, potential issues with the handling of the vaccine and/or vaccination services could compromise quality and is an area that deserves immediate attention. Survey findings suggest that children are getting vaccinated, but are not seroconverting (demonstrating protective levels of measles antibodies). There is a need to focus on strengthening cold chain management, from the delivery and storage of vaccines to their handling along with diluent during vaccination sessions. Without a serious investment in strengthening the quality of vaccination for measles, as well as coverage for both the first and second doses of measles vaccine, Ethiopia will continue to experience recurring outbreaks of measles. There is a need to reach more children with measles vaccine, and to ensure that when those children are reached, the vaccine is potent and delivered optimally.

Data quality is another area where focus is needed. Administrative coverage reports are considerably higher than were found in the coverage and serologic survey. High reported administrative coverage may mask large numbers of unvaccinated children, increasing the risk of measles virus circulation and potential outbreaks. There are many possible reasons for the unreliable administrative reports. These include inaccurate numerators; denominators used to calculate targets and measure coverage that are too low or too high; and incorrect or incomplete recording in tally sheets, registers, and monthly reports. In addition, in Assaieta, administrative reports for 2016 may improperly commingle data from a recent mass measles vaccination campaign. This could account for administrative reports above 100% in Assaieta. Data quality needs to be addressed at each level of the health system, from recording of doses during a vaccination session to updating national guidelines for estimating denominators.

Also, the percent of children in 2016 with documentation (either through a vaccination card or register) was relatively low in each of the program woredas: 75% in Hintalo Wajerate, 48% in Arbegona, and 40% in Assaieta. Low levels of documentation provide obvious challenges for coverage surveys, but also mean that health managers have less access to accurate, timely information on program performance for use in real-time decision-making. Given low levels of documentation, there is a need to focus on the distribution of health cards to all caregivers (with encouragement from health workers to keep cards safe and to bring them on each visit to a health facility or vaccination session) and on strengthening recording and reporting at the health facility level. Verification of caregiver recall at the health facility was challenging, as many of the children did not have records in the health facility register at their corresponding health facility. Home-based records also provide caregivers with critical information on when to return for subsequent doses of vaccine, and what disease(s) their child has been protected against.

Despite low availability of documentation (particularly in Arbegona and Assaieta), documented coverage was the closest data source to the serologic findings for measles. In the face of known issues with the quality and accuracy of administrative data, and the time, complexity and expense of serologic surveys, documented report from the immunization card or register represent the best real-time source of information for immunization program managers to understand vaccination rates.

RECOMMENDATIONS

Based on survey findings, JSI has a number of recommendations for consideration by the Ethiopian Federal Ministry of Health. These recommendations are grouped by thematic area.

STRENGTHEN DATA QUALITY, RECORDING, AND REPORTING

Strengthening data quality, recording, and reporting will be essential for improving Ethiopia's EPI. Our recommendation to the FMOH is to strengthen data quality, use, and accountability at each level of the health system; and to build in incentives to report more accurate data. The FMOH should prioritize activities such as EPI-specific supportive supervision to improve documentation of vaccinated children through improved recording and maintenance of tools such as EPI registers. During these same visits, health workers should be coached on how to record doses in the tally sheet, EPI register, and monthly reports.[7] There should also be a focus on strengthening the recording of vaccinations given at the health facility and during mobile and outreach visits, including checking for data consistency as the data are sent upward. Another recommendation is to commit to distribution of a home-based record, so that parents can be aware of and share responsibility for their children's vaccinations, particularly as the immunization schedule grows with the addition of new and additional vaccines over the life course. Health workers should be able to explain how to use the card, encourage caregivers and families to keep the card, and advise them to bring it to each contact with the health system. It is also critical that health workers provide the caregiver with a replacement card without punishment if the card is lost, as reprimanding the caregiver may deter return visits in the future.

ADDRESS THE QUALITY OF MEASLES VACCINE HANDLING AND VACCINATION SERVICES

Address quality issues with the handling of vaccines and vaccination sessions, particularly for measles. Strengthen cold chain monitoring during supportive supervision visits to ensure that vaccines are stored at the correct temperature, vaccine vial monitors are used correctly, and expired vaccines are not used. During vaccination sessions, supervisors should observe vaccination sessions to confirm that health workers handle vaccines and diluents properly. It is critical that the Ethiopian FMOH prioritize strengthening coverage of both first and second doses of measles-containing vaccine through routine immunization and periodic supplemental immunization activities (to reach unvaccinated children and children over two years of age).

STRENGTHEN PARTNERSHIPS BETWEEN COMMUNITIES AND HEALTH FACILITIES

Strengthen partnerships between communities and health facilities, which promotes a sense of shared accountability and makes communities more likely to use services. Work with health personnel to build managerial and technical capacity to plan how to identify and reach all target populations, and how to track infants from birth. Include communities in planning how to reach all targets, identify left-out children, and track defaulter children. Each health facility should set up a system for registering

[7] A job aid with step-by-step instruction on how to record data on immunization tools is available online at: http://mpffs6apl64314hd71fbb11y-wpengine.netdna-ssl.com/wp-content/uploads/2018/08/Immunization-Data-Quality-Job-Aid_A4.pdf

pregnant women and tracking all newborns and infants; and should use a tickler file to proactively bring children in for on-time vaccination. Lastly, provide technical assistance and funding so that all health facilities can provide a mix of services with an appropriate mix of strategies (static, outreach, mobile) to reach all eligible children efficiently, predictably, and with good quality.

SUPPORT HEALTH WORKERS TO DO THEIR JOBS WELL

Support health workers with flexible policies to provide timely, potent vaccines. Implement the existing policy, which allows health workers to open a vial even for a single child; and encourage health workers to use every opportunity to vaccinate.

MONITOR PROGRESS OF THE EPI

In the absence of serologic evidence, documented coverage through immunization cards and registers are the best source of real-time, available data to monitor the progress of Ethiopia's EPI. In the short term, use survey data (such as WHO coverage surveys) periodically to measure progress. Invest in strengthening the quality and accuracy of administrative data so that over the long term, these data can be used to measure progress at every level of the health system and in every administrative area of the country. Consider strengthening the capacity of the lab at the Ethiopian Public Health Institute to perform serologic analysis as a long-term option to complement other data sources; focus should not be on serum analysis, but on exploring more sustainable methods, such as dried blood spots or oral fluid.