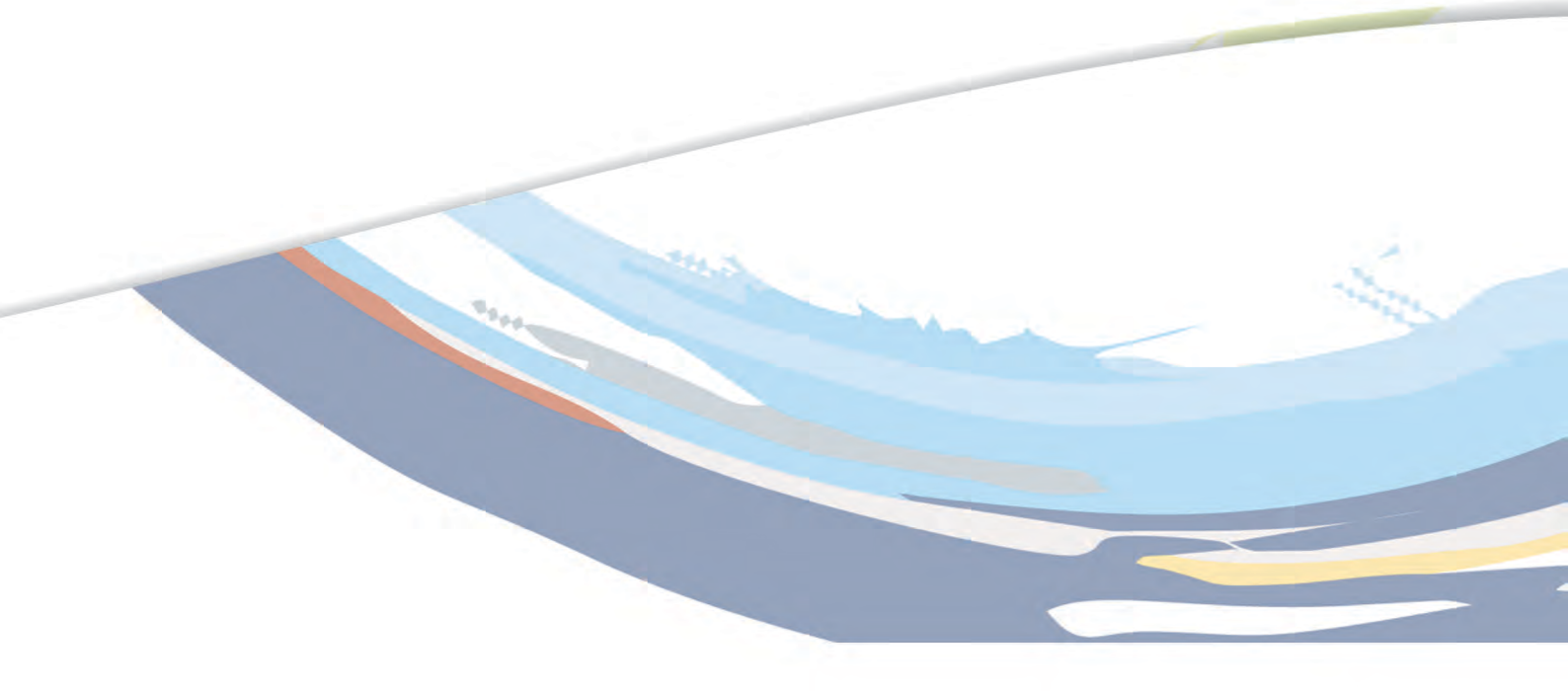
# FINAL REPORT

## IMMUNIZATION COVERAGE SURVEY IN GEORGIA

## 2015 - 2016



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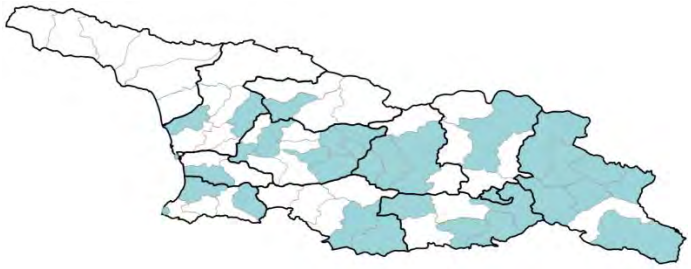


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## Contents

## Executive Summary

- Although immunization services in Georgia have improved in the last decade, national estimates of coverage remain below the national target of 95% for most antigens, and their accuracy is unclear because of difficulties with determining target populations. There has not been any independent validation of the administrative coverage data in Georgia since 2000. Therefore, we conducted a nationwide immunization coverage survey during 2015-2016.
- We assessed coverage with all vaccines included in the routine immunization schedule through 5 years of age. Because of greater uncertainties with accuracy of reported coverage data in large cities, the survey was designed to allow separate estimates for three largest cities of Georgia – Tbilisi, Batumi, and Kutaisi – which together account for 38% of total population of the country, and the rest of Georgia. We included in the survey children who were eligible for routine immunizations in 2014: those born in 2014 (eligible to receive vaccines recommended during the 1$^{st}$ year of life), in 2013 (eligible to receive vaccines recommended during the second year of life), and in 2009 (eligible to receive vaccines recommended during the sixth year of life).
- The lists of children born in 2014, 2013, and 2009 obtained from the Civil Registry database were used as the survey-sampling frame. The Civil Registry database includes all children born in Georgia, whether they are registered with health care facility (HCFs) or not, and is linked to the Immunization Management Module of the e-Health system.
- A complex stratified multi-stage design was used for the survey. The country was divided into four survey domains – the three largest cities and the rest of the country. A sample size of 750 per birth cohort was allocated to Tbilisi, 600 per birth cohort to Batumi and Kutaisi, and 800 per birth cohort to the rest of Georgia, resulting in 2750 children per birth cohort nationwide, and a total sample size of 8250 children. Immunization information was obtained from HCF records. Children who could not be found were not substituted by selecting another child. To accommodate the timeframes of availability of staff and funding, the survey was implemented sequentially (in Batumi - in August 2015, in Kutaisi - in September 2015, in Tbilisi - in March 2016, and in the rest of Georgia – in August-October 2016).
- The statistical software Epi Info 7 was used for data entry. Analysis was conducted using SAS v9.4 and R v3.3. Analyses accounted for the complex survey design and sampling weights. Main outcome measures included per cent coverage (at the time of the survey and timely coverage at standard time points) and Wilson-Score 95% confidence intervals for proportions for each vaccine dose. Estimates of time to reach a specified proportion vaccinated with a given dose (50%, 80%, 90%, and 95%), and the proportion being vaccinated by a given point in time were captured from the Kaplan-Meier curves. The survey estimates were compared to the national target and to corresponding administratively reported coverage. Response rates for the survey were very high; in all birth cohorts and survey sites, >90% of eligible participants were enrolled (range, 90.4%-98.0%).
- Overall, the survey revealed a well-developed, accessible and functioning routine immunization program in place throughout Georgia that has coped with challenges associated with the changing landscape of health care system. The program provides adequate access to immunization services as judged by very high

proportion of children (>95%) who received at least one recommended vaccine dose by the time of the survey. However, not all children utilize the system to full extent and complete the recommended series.

- Immunization program performance, as judged by coverage, timeliness and dropout rates, has a generally improving trend, but geographic variations are present. There are certain weaknesses with various aspects of immunization process – initiating vaccinations, completing the recommended series, and vaccinating on time. These weaknesses lead to suboptimal coverage for some vaccine doses, particularly the ones recommended after the 1st year of life, and prevent the country from consistently achieving the national immunization targets.
- Overall, immunization services appear strongest in Batumi, followed by the rest of Georgia and Tbilisi, and are the weakest in Kutaisi, where the program is underperforming to a substantial extent.
- The overall national target of 95% coverage for all antigens was not met, but by the time of the survey, 95% coverage was achieved nationwide for Penta1/DTP1 and Pol1 in all cohorts. Batumi, with ≥95% coverage for most major vaccines, was closest to achieving the overall target, followed by the rest of Georgia and Tbilisi, which have achieved ≥95% coverage for some vaccine doses.
- Immunization coverage at the time of the survey was moderate to high for most vaccinations recommended during the 1st year of life, but lower for vaccinations recommended after 12 months of age, particularly for vaccine doses recommended at age 5 years. Coverage and timeliness of vaccinations declined with the increase in recommended age for vaccine doses, in the following order: Penta1/DTP1 ≥ Pol1 > Penta3 ≥ MMR1 > Pol3 > DTP4 ≥ MMR2 > Pol4 > DT5 > Pol5.
- Delayed vaccinations were common in all cohorts surveyed but timeliness showed certain improvement in 2014 and 2013 cohorts compared to 2009 cohort. Late initiation of routine vaccinations had negative impact on subsequent coverage (particularly for rotavirus vaccine) and on completion of recommended age-appropriate series of immunizations. Even when the coverage target was met, this usually happened long after the recommended age for the given dose.
- At the time of the survey, nationwide coverage for Penta/DTP was very high for the first dose, but lower for subsequent doses, indicating that not all children complete recommended series. Of particular concern, coverage with DTP4 and DT5 throughout Georgia was suboptimal in most cases. Coverage with polio vaccines (OPV or IPV-containing combination vaccines) was close, but somewhat lower than for Penta/DTP/DT. The vast majority of children in Georgia received at least one dose of MMR vaccine, although often with substantial delays. Coverage for MMR2 was suboptimal.
- Survey coverage for BCG and HepB0 given at birth in maternity hospitals was substantially lower than historically reported administrative coverage, which, particularly for BCG, has been traditionally high. Problems with transmitting information on immunizations from maternity hospitals to HCFs where children receive subsequent vaccinations have likely contributed to this finding. There was a clear increase in HepB0 coverage over time.
- Georgia is advancing well towards meeting the 2020 targets for hepatitis B vaccine recently adopted by WHO European Region. Nationwide coverage with three doses of HepB reached the recently endorsed 90% interim WHO milestone in 2013 cohort and came close to it in 2014 cohort. Nationwide timely coverage with HepB0 in 2014 cohort was close to the 85% WHO interim milestone and this milestone was achieved in 2014 cohort in Batumi and Kutaisi.

- Immunization against Hib was introduced in Georgia in 2010, as part of the pentavalent (Penta) vaccine; therefore, coverage with Hib largely reflects coverage with Penta.
- Relatively low overall coverage with two doses of rotavirus vaccine (introduced in 2013) in the 2014 cohort was associated with delays in initiating vaccination.
- Comparison of the survey estimates with corresponding administratively reported coverage demonstrated that the current administrative system of reporting overestimates coverage for most vaccine doses, and in some cases, to a substantial extent.
- The full implementation of the Immunization Management Module should eventually solve the problem of denominator and lead to more accurate and real-time administrative assessment of coverage in Georgia. However, the implementation of the Immunization Module is still at an early stage and many of its benefits cannot be yet fully utilized. Until the Immunization Module is fully developed and implemented, the current system for administrative reporting of coverage will have to be maintained, but coverage surveys will remain a useful way to obtain accurate information on immunization coverage levels in Georgia.

## 1. Survey background

Immunization coverage in Georgia had been high until 1990[1], but declined in the 1990s, during the immediate period after the regaining of independence and subsequent armed conflicts and economic crisis. Although immunization services have improved in the last decade, major challenges remain, as demonstrated by continued occurrence of outbreaks of vaccine-preventable diseases (VPD) such as measles and rubella.

National coverage estimates for DTP3, Pol3, MMR1 and MMR2 reported by Georgia to WHO (Table 1) are mid-range when compared with national estimates of other Member States of the WHO European Region (Figure 1) but remain below the national target of 95% for most antigens. However, the accuracy of administrative coverage data is unclear because of difficulties with determining target populations, particularly in the cities where the continuous changes to health care system had greatest impact on primary health care facilities (HCFs). The abolition of geographic catchment areas for HCFs, intense population movement, and existence of uncertain number of children not registered with HCFs resulted in greater difficulties with assessing coverage in large cities than in smaller towns and rural areas. Administrative coverage data have not been validated for over a decade, as no independent nationwide coverage surveys have been conducted in Georgia since a Multiple Indicator Cluster Survey was implemented in Georgia in 1999[2].

In 2015, at the time of planning of the present survey, the national immunization schedule included vaccinations against 12 infections: tuberculosis, diphtheria, tetanus, pertussis, hepatitis B, *Haemophilus influenzae* type b (Hib), measles, mumps, rubella, poliomyelitis, rotavirus, and pneumococcal infection (Table 2). In Georgia, nationwide routine infant immunizations against diphtheria, tetanus, pertussis, and tuberculosis have been in place since late 1950s and against poliomyelitis (oral polio vaccine – OPV) and measles since 1960s. Hepatitis B vaccine was introduced in 2000, rubella and mumps vaccines were added in 2004, Hib vaccine in 2010, rotavirus vaccine in 2013, and pneumococcal conjugate vaccine (PCV) in 2014. In the last decade, the national immunization schedule underwent changes to accommodate introduction of new vaccines (rotavirus, PCV) and new combination products, such as pentavalent (Penta) vaccine against diphtheria, tetanus, whole cell pertussis, Hib and hepatitis B, and measles, mumps and rubella (MMR) vaccine. In addition to government-provided vaccines, vaccines are increasingly imported through the private sector, which offers some products not available through the national program, such as hexavalent (Hexa) vaccine containing diphtheria, tetanus, acellular pertussis, Hib, hepatitis B and inactivated polio vaccine (IPV) components[3].

Because of the lack of independent validation of the coverage data in Georgia and ongoing uncertainty with target populations, we conducted a nationwide immunization coverage survey during 2015-2016 to assess coverage with vaccines included in the routine immunization schedule through 5 years of age.

## 2. Participating institutions and funding

The following institutions were responsible for planning and implementation of the survey:

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[1] Direct comparisons of the pre-1990 coverage data are not possible due to the differences in methodologies for estimating coverage.

[2] State Department of Statistics, National Center for Disease Control, and UNICEF. Republic of Georgia Multiple Indicator Cluster Survey, 1999. Tbilisi, 2000. Available at https://mics-surveys-prod.s3.amazonaws.com/MICS2/Central%20and%20Eastern%20Europe%20and%20the%20Commonwealth%20of%20Independent%20States/Georgia/1999/Final/Georgia%201999%20MICS_English.pdf. Accessed March 14, 2017

[3] Beginning in 2015, Penta was replaced by Hexa for the first three doses given at 2, 3, and 4 months (primary series) in the national immunization schedule. However, children eligible for the present survey were not affected by this change.

- US Centers for Disease Control and Prevention (CDC), Center for Global Health (CGH)
  - Global Immunization Division
  - CDC South Caucasus office, Field Epidemiology and Laboratory Training Program (FELTP)
- National Center for Disease Control and Public Health (NCDC), MOLHSA, Tbilisi, Georgia

Funding for the survey was provided by US CDC and Gavi, the Vaccine Alliance. The World Health Organization Country Office in Georgia facilitated implementation of the survey part funded by Gavi, the Vaccine Alliance.

## 3. Objectives

- To obtain nationwide estimates of immunization coverage for vaccines included in the national immunization schedule through 5 years of age
- To obtain estimates of immunization coverage for vaccines included in the national immunization schedule through 5 years of age for major cities (Tbilisi, Batumi, and Kutaisi)
- To assess timeliness of immunization by vaccine dose in Georgia

## 4. Methods

### 4. 1. Survey design

#### *4. 1. 1. Survey population and vaccine doses assessed*

Most standard protocols for immunization coverage surveys (MICS, DHS, epi cluster survey) only include vaccines given during the first 12 months of life, but this approach leaves out later doses, such as MMR2, DTP4, DT5 and Pol4-5. Ensuring high coverage with the vaccines given later in a child's life is important, since Georgia is committed to maintaining its polio-free status, has a goal to eliminate measles and rubella, and needs to maintain adequate population immunity against other VPDs to prevent outbreaks such as diphtheria outbreak in the 1990s. The coverage with vaccine doses recommended after 12 months of age in Georgia has not been independently assessed previously. Therefore, we decided to assess coverage with all vaccines included in the immunization schedule before the age 6 years (with few exceptions noted below).

Per NCDC request, and because of greater uncertainties with accuracy of reported coverage data in cities, the survey was designed to allow obtaining separate estimates for three largest cities of Georgia. Therefore, the three largest cities of Georgia – Tbilisi (2015 population 1,100,000), Batumi (154,000), and Kutaisi (148,000), which together account for 38% of total population of the country[4] – and rest of Georgia were surveyed separately and nationwide estimates were obtained by pooling the data from these surveys. The areas currently not under Georgian Government control (South Ossetia and Autonomous Republic of Abkhazia) were excluded because of lack of population data, inaccessibility and security concerns.

We included in the survey children eligible for routine immunizations in 2014, the most recent year with available coverage data at the time of planning and initiation of the survey. These included three birth cohorts:

- Children born in 2014, eligible to receive vaccines recommended during the 1st year of life
- Children born in 2013, eligible to receive vaccines recommended during the second year of life
- Children born in 2009, eligible to receive vaccines recommended during the sixth year of life.

[4] National Statistics Office of Georgia (GEOSTAT). 2014 General Population Census -Main results, general information. Available at: http://census.ge/files/results/Census_release_ENG.pdf. Accessed March 14, 2017

We estimated immunization coverage with age-appropriate vaccines for each birth cohort based on the national immunization schedule applicable to each one (Appendix 1). The differences applicable between schedules are related to introduction of new vaccines during this period. As shown in Table 3, in the 2014 birth cohort, coverage was assessed for vaccine doses recommended before 12 months of age (corresponding to 2014 reported coverage). In the 2013 birth cohort, coverage was assessed for vaccines recommended before 12 months of age (corresponding to 2013 reported coverage for respective doses) and for vaccines recommended between 12-23 months of age (corresponding to 2014 reported coverage for these doses). In the 2009 birth cohort, coverage was assessed for vaccines recommended before 12 months of age (corresponding to 2009 reported coverage), between 12-23 months of age (corresponding to 2010 respective reported coverage) and between 60 and 71 months of age (corresponding to 2014 reported coverage for respective doses). Thus, the survey design allowed us to assess coverage for vaccines recommended by 12 months of age for all three birth cohorts, for vaccines recommended between 12 and 23 months for two birth cohorts (2013 and 2009), and for vaccines recommended between 60 and 71 months for the birth cohort of 2009.

Because of very recent introductions, we did not assess coverage for PCV for 2014 birth cohort or for Hib vaccine for 2009 birth cohort. Tetanus-diphtheria (Td) vaccine recommended at 14 years was not included in the survey.

It was not practical to conduct a household survey for the purpose of coverage assessment in three age strata. The small average household size (3.3 persons; range, from 2.5 in Racha-Lechkhumi to 4.0 in Achara)[2] and small birth cohort in Georgia (approximately 60,000) would have required selecting a very large sample of households to identify sufficient number of households with children from targeted birth cohorts. The existence of the Civil Registry database linked to the Immunization Management Module provided an opportunity to conduct the survey targeting individual children rather than households.

Since very few families in Georgia keep their children's immunization cards at home[5] and parental recall is not considered a reliable source of a child's immunization history, we obtained information on immunizations from HCFs where children receive immunization services, in accordance with recently revised WHO guidance on conducting immunization coverage surveys[6].

#### *4. 1. 2. Sampling frame.*

The lists of children born in 2014, 2013, and 2009 obtained from the Civil Registry database and linked to the recently introduced electronic Immunization Management Module of the Health Information Management System were used as a sampling frame for the survey. The availability of a highly accurate sampling frame allowed us to include all children in the survey, not only those registered with HCFs on which officially reported administrative coverage data are based.

[5] In the 2005 MICS in Georgia, it was not possible to assess immunization coverage because the survey was based on immunization cards kept at home, but the survey found that only 15% of children had immunization records at home (https://mics-surveys-prod.s3.amazonaws.com/MICS3/Central%20and%20Eastern%20Europe%20and%20the%20Commonwealth%20of%20Independent%20States/Georgia/2005/Final/Georgia%202005%20MICS_English.pdf; accessed March 14, 2017). The pilot for the present immunization survey conducted in 2014 in Kvemo Kartli region also confirmed that immunization cards are not generally available at home.

[6] WHO. 2015 Update of vaccination coverage survey manual. Available at: http://www.who.int/immunization/monitoring_surveillance/Briefing_note_CSManual.pdf. Accessed March 14, 2017.

The Civil Registry database includes information on all children who are born and receive a birth certificate in Georgia. Based on a UNICEF assessment in 2010, the rate of registration at the time of birth was very high (97%)[7], and it has likely increased since then with further substantial improvement of Civil Registry services. The information available included child's name, date of birth, personal ID number, legal address, and, for a subset of children, the actual address and the name of HCF where the child receives health services. Children living outside Georgia where considered ineligible for the survey. Therefore children with foreign address listed in the Civil Registry database were excluded from the survey (301 [0.5%] children in 2014 cohort, 326 [0.6%] in 2013 cohort, and 497 [0.8%] in 2009), as well as children who were initially sampled but were subsequently found to have moved overseas.

#### *4. 1. 3. Design and sample size*.

A complex, stratified, multi-stage design was used for the survey (Table 4). The country was divided into four survey domains consisting of the three largest cities (Tbilisi, Kutaisi, and Batumi) and the rest of the country. In the three large city domains, simple random sampling (SRS) was used to select children [primary sampling units (PSU)] from each of the three age groups.

The fourth domain, consisting of the populations not residing in one of the three largest cities, was divided into seven strata. In the first stratum, which included Rustavi and Poti, participants within each age group were selected by SRS because the sampling frame had no easily identifiable subdivisions to be used as sampling units for cluster survey. Five strata required a two-stage cluster design. In the first stage, settlements (village/town) were selected by probability proportionate to population size (PPS), followed by a SRS of children within each age group. The last stratum, representing the remaining 54 districts of Georgia, required a 3-stage cluster design. In the first stage, districts were selected by PPS, followed by selection of settlements (village/town) by PPS, followed by a SRS of children within each of the three age groups. Very small settlements were pooled to create sampling unit with $\geq$10 children in it.

A sample size of 750 per birth cohort was allocated to Tbilisi (3.8% of all children), and 600 per birth cohort to Batumi (20.0%) and Kutaisi (22.1%), resulting in 1950 children per birth cohort for the three cities combined. In the rest of Georgia domain, a sample size of 50 per birth cohort was allocated to Gori and combined Rustavi/Poti stratum. A sample size of 25 per birth cohort was allocated to the next five strata (five per PSU). In the seventh stratum, a sample size of five children per SSU was allocated, resulting in 25 children per PSU. This resulted in 800 children per birth cohort in the fourth domain (2.4% of all children). In total, 2750 children per birth cohort were selected, which resulted in a sample size of 8250 children for all three birth cohorts included in the survey. Selection of sampling units was performed using the population data for the 2014. Individual children were selected from the sampled units using line-lists for respective birth cohorts.

#### *4. 1. 4. Survey procedures*

The relevant population subsets were extracted from the Civil Registry birth registration database via the Immunization Management Module link. The residence codes were assigned to each administrative unit based on child's address. If actual address was different from the child's legal address, the actual address was used to assign the child to sampling unit, accounting for some population movement and reducing the proportion of children who could not be located.

[7] UNICEF Georgia. Birth registration. http://unicef.ge/10/Birth-registration/34. Accessed March 14, 2017

Participant selection process was performed by survey coordinators. SRS was applied using an online random number generator (www.random.org). The survey field teams were given lists of selected children with their addresses and, if known, HCF indicated in the Immunization Management Module (the list and contact information of HCF is available through the Health Information Management System). For children with known HCFs, the teams visited HCFs to locate the immunization records of children selected for the survey.

If the child's immunization records could not be located at the listed HCF or no HCF was listed, the teams visited the child's residence and, after providing an information sheet about the survey (Appendix 2), asked parents/guardians if the child had received at least one vaccination. If the answer was positive, parents/guardians were asked to provide information about HCF where the child receives immunizations. If the immunization card was available at home, the data were obtained on-site. Otherwise, the team visited the HCF indicated by a parent/guardian to obtain immunization records. If the child was unvaccinated per parent/guardian report, this information was noted in the interview form (Appendix 3) and no further attempts to locate records for this child were undertaken (Appendix 4). Children who could not be found were not replaced by selecting another child.

The information collected on survey participants included date of birth, sex, residence district/city, HCF, vaccine doses received and dates of vaccination. The information was recorded on a survey data collection form (Appendix 5).

To accommodate the timeframes of availability of staff and funding, the survey was implemented sequentially in Batumi in August 2015, in Kutaisi in September 2015, in Tbilisi in March 2016, and in the rest of Georgia in August-October 2016. To reduce the impact of sequential timing of survey implementation, immunization records for the children in Batumi and Kutaisi who had not reached full year of the cohort age at the time of initial field work (were born in the late months of year) and had not received all age-eligible vaccines were reviewed again at HCFs or via Immunization Management Module in early 2016, and any additional doses received were noted.

The survey field teams were comprised of personnel from NCDC, CDC/GID, CDC South Caucasus Office, FELTP graduates and from local Public Health Centers of survey areas. Before beginning fieldwork, the survey personnel received comprehensive training on the survey objectives, methodology, and procedures for data collection.

**4. 2. Data management and analysis**

The statistical software Epi Info 7 was used for data entry. Analysis was conducted using SAS v9.4 and R v3.3. Analyses accounted for the complex survey design and sampling weights. We report Wilson-Score confidence intervals for proportions using survey procedures in SAS 9.4. Main outcome measures included per cent coverage for each vaccine dose or series assessed. The definitions for outcomes and the time points at which they were assessed are listed in Table 5. The proportion of children who had not received at least one dose of routine vaccines recommended at $\geq$2 months of age was calculated. Also assessed was the proportion of children who had received full series of age-appropriate "major vaccines" (against diphtheria, pertussis, tetanus, hepatitis B, measles, mumps, and rubella) and full series of all age-appropriate vaccines included in the national immunization schedule.

The analysis included calculation of overall coverage at the time of the survey for each vaccine dose or series and assessment of timely coverage assessed at standard time points (Table 5). To account for differences in the time of observation, comparisons across cohorts were made based on the timely coverage. The dropout between the first and third dose of Penta/DTP vaccines was calculated by subtracting coverage with the third dose from coverage with the 1$^{st}$ dose. In addition, to remove the impact of the sequential implementation of the survey in

different domains on the coverage levels, we calculated coverage for each dose by the time of the end of the initial field work in Batumi (the city surveyed first), by excluding any vaccine doses administered after September 1, 2015. Direct comparisons across survey sites were made based on the status as of September 1, 2015. The following definitions were used for coverage levels: very high (≥95%), high (90%-94%), moderate (80%-89%), low (70%-79%), and very low (<70%).

Timeliness of vaccinations was estimated by plotting (1 -estimated Kaplan-Meier curve) using the survey package in R v3.3. Estimates of time to reach a specified proportion (50%, 80%, 90%, and 95%) of children vaccinated with a given antigen, and the proportion vaccinated by a given point in time were captured from the Kaplan-Meier curve. This analysis was focused on vaccine doses considered key program performance indicators – Penta1/DTP1, Pol1, Penta3/DTP3, Pol3, DTP4, DT5, Pol4, Pol5, MMR1, and MMR2.

The estimates of coverage were compared to the national target of ≥95% coverage for all doses[8]. The survey results were also compared to corresponding administrative coverage reported through GEOVAC system. GEOVAC, the existing system for administrative reporting of coverage in Georgia, is based on the data provided by HCFs to NCDC and only reflects children registered with HCFs.

## 5. Ethical issues

The coverage survey protocol was reviewed by Human Subject Research Coordinator, GID/CGH/CDC and Ethical Committee, NCDC, and determined to be an evaluation of public health program rather than human subject research.

## 6. Results

### 6. 1. Response rate

Response rates for the survey were very high. Of 8,250 children selected in the three birth cohorts, 103 (1.2%) were found to have moved to other countries, resulting in 8,147 children eligible for the survey. We obtained immunization information for 7,723 (94.5%) of them, and 424 (5.2%) could not be found. In all birth cohorts and cities, >90% of eligible participants were enrolled (range, 90.4%-98.0%). Response rates were slightly lower for 2009 birth cohorts than for 2013 and 2014 cohorts, and were comparable across survey sites (Table 6).

### *6. 2.* Coverage at the time of the survey

Estimates of national coverage at the time of the survey by birth cohort are presented in Table 7. In each birth cohort, the vast majority of children (96%-97%) have received at least one dose of routine vaccines recommended at ≥2 months of age. Of the remaining children who have not initiated routine vaccinations recommended at ≥2 months, 3% in 2014 cohort, 2% in 2013 cohort and <1% in 2009 cohort received BCG and/or HepB0 at birth, but no other doses, and 1%-2% in the three cohorts were completely unvaccinated.

Of the two vaccines given in Georgia at birth, BCG coverage was moderate in all cohorts (83%-86%), and coverage with the birth dose of HepB vaccine increased from 46% in the 2009 cohort to 87% in the 2014 cohort (Table 7).

Of the vaccine doses recommended during the first year of life, coverage with the first dose of Penta/DTP and polio vaccines (Penta1/DTP1 and Pol1) was uniformly high, at 95%-97% and 94%-96%, respectively (Table 7). Coverage with the third dose (Penta3/DTP3 and Pol3) was high (≥90% for all) in 2009 and 2013 cohorts, and

[8] The target does not specifically refer to timely coverage, therefore, in the analysis we applied it to overall coverage by the time of the survey.

moderate (88% and 87%, respectively) in 2014 birth cohort. Penta1/DTP1-Penta3/DTP3 dropout ranged between 5%-7% among the three cohorts. Coverage with HepB3 was very low (40%) in 2009 cohort, but much higher in 2013 (90%) and 2014 (87%) cohorts. Coverage with Hib3 was identical to Hep3 coverage in 2013 and 2014 cohorts. In addition, 23% (95% CI, 21%-26%) of children in the 2009 cohort received at least three doses of Hib vaccine. These were the children who received commercially available combination vaccines or were vaccinated after the introduction of Penta in the national schedule in 2010. Coverage with newly introduced rotavirus vaccine was low for both eligible cohorts but had an increasing trend (Table 7). Rotavirus vaccine coverage varied substantially by the time of Penta1 receipt (i.e, initiation of routine vaccinations). Among children who received Penta1 by 16 weeks, the maximum recommended age for Rota1, Rota1 coverage was 77% in 2013 cohort and 91% in 2014 cohort, and coverage for Rota2 was 72% and 85%, respectively. Among children who received Penta1 after 16 weeks of age, Rota1 coverage was 12% in 2013 cohort and 13% for 2014 cohort (unweighted analysis). Children who did not receive Penta1 were unvaccinated for rotavirus as well.

Coverage with MMR1 recommended at 12 months was 93% in 2009 birth cohort and just below 90% in 2013 cohort. Coverage with the two vaccine doses (DTP4 and Pol4) recommended at 18 months was moderate in the 2009 cohort (85% for DTP4 and 83% for Pol4), but low in the 2013 cohort ($\leq$80% for each) (Table 7). Coverage with vaccine doses recommended at 5 years of age was uniformly low in 2009 birth cohort, particularly for DT5 and Pol5 (Table 7).

The proportion of children who received age-appropriate recommended combined series with major vaccines as defined in Table 5, increased from 46% in 2009 birth cohort to 85% in 2014 cohort. The proportion of children who received combined series with all age-appropriate vaccines ranged between 34% in 2013 cohort and 54% in 2014 (Table 7). The status of completion of age-appropriate combined series of vaccines was associated with the age of initiation of routine vaccinations. In all cohorts, the median age of administration of Penta1/DTP1 was lower for children who received all age-appropriate vaccines than for children who did not complete the combined series: 2.4 versus 3.6 months for the 2014 cohort, 2.3 versus 2.9 months for the 2013 cohort, and 2.7 versus 3.2 months for the 2009 cohort (unweighted analysis).

Generally, coverage was highest for doses schedules earlier in life and declined with subsequent doses, with lowest coverage observed for DT5 and Pol5. In addition, for doses recommended at the same age, coverage tended to be slightly higher for DTP-containing vaccines than for polio vaccines, and MMR coverage tended to be higher than for other vaccines scheduled in the same year of life. For example, at the time of the survey, in the 2009 cohort, coverage with vaccine doses recommended at 5 years was 76% for MMR2, and 72% for DT5 and Pol5. Similarly, in the 2013 cohort, coverage with vaccine doses recommended during the 2$^{nd}$ year of life was 89% for MMR1, 80% for DTP4, and 76% for Pol4. In each birth cohort, 3%-5% of children received at least one dose of commercially available vaccines (Table 7), most of which was received by children living in Tbilisi (Table 8).

Subnational variations were analyzed by comparing coverage across survey sites based on the vaccination status of children as of September 1, 2015 (Table 8, Figure 2). There were substantial geographic differences in immunization coverage in Georgia. In all cohorts and for almost all vaccine doses, the highest coverage was found in Batumi, followed by the rest of Georgia, with lower coverage in two other large cities – Tbilisi, and, particularly, Kutaisi. The differences in coverage between Batumi and other survey sites were most prominent in 2009 cohort, when coverage levels in other sites were quite similar. In 2013 cohort, Batumi and the rest of Georgia had substantially higher coverage than the other two sites, and Tbilisi had slightly higher coverage than Kutaisi. In 2014 cohort coverage in Tbilisi improved, reaching the levels similar to Batumi and rest of Georgia for some antigens, while Kutaisi retained lowest coverage. It should be noted, however, that the "rest of Georgia" domain

represents a combination of administrative units in all regions of Georgia outside the three major urban centers, pooled into one unit for statistical sampling purposes only. Therefore, these results provide general information on trends in coverage in other cities and rural areas of Georgia, but are not directly applicable to individual districts as substantial variations within the domain are likely.

### 6. 3. Timely coverage

Nationwide estimates of timely coverage tended to be substantially lower than overall coverage, reflecting delays in vaccinations (Table 9). For BCG and HepB0, the difference was between 3% and 5% in all cohorts. For other vaccines, differences between overall and timely coverage were greater for the older cohorts (2009 and 2013), because these children had more time to catch-up with their vaccinations. Greatest differences were observed for DTP4 (>20% in both cohorts) and Pol4 (10% and 21% in the 2013 and 2009 cohorts, respectively).

Timely BCG coverage slightly increased in 2014 compared with 2009 and 2013. Timely coverage for HepB0 improved substantially from 2009 to 2014. For other vaccines, Penta1/DTP1, Penta3/DTP3, Pol3, DTP4, Pol4, and MMR1, the highest timely coverage was observed in 2013 cohort (Table 9). Timely coverage was particularly low for vaccine doses recommended after 12 months of age.

General trends in timely coverage observed across survey sites were similar to national trends (Table 10). For all vaccines in all cohorts surveyed, timely coverage was clearly highest in Batumi and lowest in Kutaisi. The differences in timely coverage between Batumi and other sites were greatest for the 2009 cohort and least prominent for 2014 cohort.

### 6. 4. Timing of vaccinations

The probability of being vaccinated at a given time after the recommended age for each vaccine dose was analyzed for the 2013 and 2009 birth cohorts, each of which had had sufficiently long observation period. As shown in Figure 3, there were differences in timeliness of receipt of vaccines. Overall, Penta1/DTP1 and Pol1 had the best timeliness, followed by Penta3/DTP3 and MMR1, followed by Pol3, then DTP4, MMR2 and Pol4[9]. The timeliness of receipt of MMR doses closely corresponded to that of the preceding Penta/DTP doses, i.e., the curve for MMR1 closely followed the one for Penta3/DTP3 and the curve for MMR2, the one for DTP4. The worst timeliness was observed for DT5 and Pol5. Timeliness of vaccination mainly varied by recommended age for the vaccine dose, generally declining with increasing age (similar to the trend observed for coverage) as shown on the examples of Penta/DTP/DT and polio vaccines (Figure 4).

Table 11 shows the age at which selected levels of coverage were achieved for each vaccine dose and the time after the recommended age needed to achieve those selected levels of coverage (i.e., the lag time). For any given dose, there was a substantial period of time needed to achieve high coverage, and for a number of vaccine doses these high levels were not achieved by the time of the survey. However, there was a trend towards improvement over time: timeliness indicators for 2014 and 2013 cohorts were similar or close to each other and consistently better than those for 2009 cohort (Table 11, Figure 4).

The age of administration of Penta1/DTP1 reflects the actual timing of initiation of the primary series of vaccination with DTP-containing vaccines. Penta1/DTP1 in 2014 and 2013 cohorts had the best indicators of

[9] The data for Pol1 and Pol3 are not shown in Figure 3 as their trends were very close to Penta1/DTP1 and Penta3/DTP3 and the curves were overlapping to a substantial extent.

timeliness of all vaccine doses in all cohorts (Table 11, Figure 4), with 90% of children having received it by age 8 months (within 6 months of the recommended age). However, achieving 95% Penta1/DTP1 coverage took 19 months in the 2013 cohort and 21 months in the 2014 cohort, a lag of 17 and 19 months, respectively. The rate of increase over time in proportion of children vaccinated with DTP1 in 2009 cohort was substantially slower, with 80%, 90% and 95% coverage achieved by seven months, 21 months, and 67 months of age, or five, 19, and 65 months after the recommended time, respectively. The timeliness of Penta3/DTP3, which reflects the time of completion of the three-dose primary series, was initially similar to Penta1/DTP1, but slowed after 80% level (Table 11, Figure 4). Trends in timeliness for the primary series of polio vaccine were close to those for Penta/DTP/DT doses recommended at the same time, but delays in vaccination were more common for polio vaccines. The timing of MMR1 followed closely the trends for Penta3/DTP3 in 2013 cohort. Delays in vaccination were common for vaccine doses recommended at 18 months of age, particularly for Pol4, and even more so, for vaccine doses recommended at 5 years of age (Table 11, Figure 4). The only vaccine recommended at 5 years, received by at least 80% of children was MMR2, but this did not happen until 34 months after the recommended age (at 94 months of age) (Table 11).

For vaccine doses recommended at birth, based on relatively small difference between timely and overall coverage, most children who were vaccinated with BCG and HepB0 received them within recommended time frame (Table 9). As shown in Table 11, improvement was observed in timeliness of receipt of BCG, recommended by day 6 after birth. In the 2014 cohort, 80% of children received BCG by age four days, compared with 80% BCG receipt by 17 days and 18 days in the 2013 and 2009 cohorts, respectively. Also, most children who received rotavirus vaccine were vaccinated within the recommended time frame, but 2%-3% in both eligible cohorts received rotavirus vaccines after the recommended cut off age (16 weeks for Rota1 and 24 weeks for Rota2; unweighted analysis).

Subnational trends in the timeliness of vaccination, presented in Table 10 and Figures 5-12, followed the same trends as coverage, with Batumi having the best performance, followed by the rest of Georgia, and Kutaisi underperforming. For Penta1/DTP1 (Table 10, Figure 5), the nationwide improvement in timeliness observed in 2013 and 2014 cohorts (Figure 4) was achieved due to improvements in Tbilisi and rest of Georgia, but there were no changes in Kutaisi. Subnational trends for Penta3/DTP3 timeliness were similar to Penta1/DTP1, but at a lower overall level and demonstrated worsening of timeliness in Kutaisi and improving in the rest of Georgia (Figure 6). There were considerable differences across sites in timeliness of MMR1 administration. The nationwide improvement in 2013 cohort was related to improvement in timeliness in the rest of Georgia, and to a lesser extent, in Tbilisi, with no changes in Batumi and Kutaisi (Table 10, Figure 7). The improvement at the national level in timeliness of DTP4 and, to a lesser extent, Pol4 was related to improvements in Tbilisi and rest of Georgia (Figures 8-9). For all three vaccine doses recommended at 5 years, Batumi had least delays, followed by rest of Georgia, and delays in vaccination were most common in Kutaisi (Table 10, Figures 10-12).

### 6. 5. Survey coverage versus administrative coverage

The comparison of timely coverage estimates from the survey with timely coverage reported through GEOVAC system (for selected doses where the information by age of vaccinated population was available in GEOVAC), revealed that in most cases administrative reporting system overestimated coverage, in some cases to a substantial degree (more than 15%-20%) (Tables 12-13).

### 6.6. Progress towards achieving the national coverage target

The status of achieving the national 95% target by vaccine dose is presented in Table 14. Nationwide, the target was consistently achieved for the first doses of Penta/DTP and polio vaccines, but not for other vaccine doses. However, substantial progress was made for Penta3/DTP3, Pol3 and MMR1 in 2013 and 2009 cohorts with ≥90%. At the subnational level, Batumi was closest to achieving the overall target, followed by rest of Georgia and Tbilisi. Batumi had achieved (or almost achieved[10]) ≥95% coverage for most major vaccine doses, including Penta1 and Pol1 in 2014 cohort, Penta1-3 and Pol1-3 in 2013 cohort, and DTP1-4, Pol1-4 and MMR1 in 2009 cohort. Tbilisi achieved ≥95% target for Penta1/DTP1 and Pol1 in all cohorts, and almost achieved it for MMR1 in 2009 cohort. In the rest of Georgia, the target was achieved for Penta1/DTP1 and Pol1 in all cohorts, and almost achieved for Penta3 and Pol3 in 2013 cohort. All these sites outperformed Kutaisi, where only DTP1 and Pol1 coverage in 2009 cohort met the ≥95% target by the time of the survey (Table 14).

## 7. Discussion

### *7*. 1. Overall implications

Overall, the survey revealed a well-developed, functioning immunization program in Georgia. It appears that despite challenges associated with the ongoing reforms in primary health care, the system is successful in providing access to and delivering immunization services to children across the country. However, the survey also revealed geographic variations in immunization coverage and certain weaknesses with various aspects of immunization process – initiating vaccinations, completing the recommended series, and vaccinating on time. These weaknesses lead to suboptimal coverage for some vaccine doses, particularly the ones recommended after the first year of life, and prevent the country from consistently achieving the national immunization targets. Across major urban centers, immunization services appear strongest in Batumi, which consistently had highest immunization coverage, fewer dropouts and better timeliness, and appear weakest in Kutaisi. Immunization services outside these major urban centers performed better than in Tbilisi, and particularly, in Kutaisi, but mostly at a lower level than in Batumi. At the time of the survey, immunization coverage among the surveyed birth cohorts was in moderate to very high range for most vaccinations recommended during the first year of life, but much lower for vaccinations recommended during the second year of life, and, particularly, those recommended at 5 years of age.

The 95% coverage target was met nationwide for Penta1/DTP1 and Pol1 and certain areas, e.g. Batumi, have made substantial progress towards achieving the target of ≥95% for all antigens. However, the overall national target of ≥95% for all vaccine doses is very high and difficult to achieve without well-defined strategy. Establishing interim milestones for coverage levels with clear timeframe for their achievement would help to better monitor the progress and help achieve the target. Setting coverage milestones would be particularly helpful in underperforming areas and for later vaccine doses with current coverage far below the target. The milestones could be customized for geographic areas, setting higher milestones and shorter timeframe for better performing areas and allowing more time for gradual improvement in places requiring particular support, such as Kutaisi.

Generally, the highest coverage and best adherence to the recommended time of vaccination was observed for the first doses of routine vaccines recommended at 2 months of age, but both coverage and timeliness declined with each consecutive dose. This trend applied to all vaccines with multiple doses recommended. In each cohort and for every vaccine, lowest coverage was observed with the most recently scheduled doses: e.g., Penta3 and Pol3 in 2014, DTP4 and Pol4 in 2013, and DT5, Pol5 and MMR2 in 2009 cohorts. Suboptimal coverage for vaccine

[10] Upper limit of 95% CI of an estimate is ≥95%

doses recommended after 12 months of age, particularly at 5 years, was a consistent problem. Of particular concern was very low coverage for vaccines recommended at 5 years of age in most survey sites (except in Batumi, which had moderate coverage with all three recommended vaccines).

The very high (>95%) proportion of children who received at least one vaccine dose recommended at ≥2 months of age in most groups demonstrates that the vast majority of children in Georgia access immunization system at some point in time. However, there was a considerable problem in Kutaisi where 13% or approximately 1 in 8 children in 2014 cohort had not begun routine immunizations by the time of the survey. This proportion remained substantial even in older cohorts – 8% or 1 in 12 children in 2013 cohort, and 4% or 1 in 25 children in 2009 cohort. Although some of these children received BCG and/or HepB0 at birth, they remain susceptible to all major VPDs. Considering that not all children who initiate vaccination complete the full recommended series or do so with substantial delays, the immunity gap in Kutaisi is likely even greater.

Substantial dropout between the first and third doses of Penta/DTP, particularly in Tbilisi and Kutaisi, confirms that many children in Georgia fail to complete the primary series. In addition, many children who completed the primary series, did not receive the 4$^{th}$ and 5$^{th}$ doses recommended at 18 months and 5 years. Similar trends were observed for MMR, polio, and rotavirus vaccines. The increase in the proportion of children who received applicable age-appropriate recommended series of vaccinations from 2009 to 2014 cohort was a positive development. In 2014 cohort nationwide, 85% of children were age-appropriately vaccinated against major VPDs but only 54% had received all age-appropriate vaccines included in the national schedule.

Most children who initiated vaccinations received Penta1/DTP1 within few months of recommended age. A small proportion of children initiating vaccinations after 1-2 years of age suggests that if a child did not begin vaccinations by at least 2 years, he/she would likely remain unvaccinated, contributing to population susceptibility. Georgia has the immunization visit at 5 years (before school entry at 6 years) included in the current immunization schedule. Based on the slight increase in vaccinations with Penta1/DTP1 and MMR1 around 5 years of age, it appears that at least some of the previously unvaccinated children use this opportunity to begin vaccinations, even though Georgia at present has no legally mandated school entry immunization requirements. It is important that providers attempt to bring in previously unvaccinated, as well as under-vaccinated children for 5 year visit to initiate or complete their vaccinations, using catch-up schedules. The immunization visits at 12 month and 18 months could also be used as an opportunity to initiate or complete vaccination series.

There is a need for improvement in the timeliness of vaccination throughout the country, although the situation tends to be more favorable in Batumi. Timeliness showed certain improvement in 2014 and 2013 cohorts compared to 2009 cohort, but the timely coverage measured at standard age points rarely exceeded 80%-85% and was much less for later doses. The present survey was not designed to look into causes for not vaccinating but widespread use of false contraindications and parental refusals have been previously recognized in Georgia as a problem. Delays in vaccine administration without true medical causes prolong the period of susceptibility and put children at unnecessary risk of developing VPDs.

In the last decade, vaccines imported by private companies have become increasingly available in Georgia, particularly Hexa. The survey found that Tbilisi was the only place where commercial vaccines were utilized to a substantial extent. In coming years, the contribution of commercial market might decline, since the Government has provided Hexa free of charge through the national program since 2015.

The very high response rate achieved in the survey ensured that the results are highly representative of surveyed population and demonstrated wide availability of immunization information which was of concern before the

survey, considering challenges with record keeping in the rapidly changing landscape of primary health care services in large cities.

**7. 2. DTP-containing vaccines**

At the time of the survey, nationwide coverage for Penta/DTP was very high for the first dose but lower for subsequent doses, indicating that not all children complete recommended series. One of the main indicators of performance of immunization system, nationwide coverage for Penta3/DTP3 at 12 months of age, needs improvement. Overall Penta3/DTPs coverage at the time of the survey was considerably higher than timely coverage, suggesting that delayed vaccinations account for low timely coverage to substantial extent. Reducing the dropout between the first and third doses of Penta/DTP is important because a minimum of three doses is needed to complete primary series and ensure adequate protection from included VPDs. Because vaccine-induced immunity against diphtheria, tetanus, and pertussis wanes with time after immunization, particular attention should be paid to ensuring high coverage with booster doses at 18 months and 5 years. Of concern, coverage with DTP4 and DT5 throughout Georgia was suboptimal in most cases. Considering the history of a large-scale diphtheria outbreak in Georgia in the 1990s, it is important to ensure improved coverage with all recommended doses of diphtheria-containing vaccines to prevent recurrence of diphtheria. The increasing use of combination vaccines offers an obvious advantage of allowing immunization against several diseases simultaneously; however, it can be associated with additional risks, if high coverage with multi-component vaccines is not achieved and maintained, as the resulting immunity gap will affect all of these VPDs.

**7. 3. Polio vaccines**

Georgia was certified free of wild polioviruses (WPV) in 2002, along with the rest of the European region. However, there is still an ongoing risk of reintroduction of wild polioviruses from the remaining endemic areas or emergence and spread of vaccine-derived polioviruses (VDPVs) in OPV-using areas with low coverage. The recent experiences in the European region, including outbreak in Tajikistan and three other countries in 2010[11] following importation of WPV1, circulation of imported WPV1 in Israel in 2013[12], as well as circulating VDPV1 outbreak in Ukraine in 2015[13], clearly demonstrate that this risk is real. The country is currently ranked by WHO at intermediate risk of poliovirus spread in case of WPV importation or VDPV emergence, primarily because of suboptimal population immunity[14], and needs to maintain high level of preparedness for any polio-related event, including achieving and sustaining high population immunity.

In this survey, coverage with polio vaccines (OPV or IPV-containing combination vaccines) was close, but somewhat lower than for Penta/DTP/DT. As part of the polio "Endgame strategy," Georgia introduced IPV for the primary series by replacing Penta with Hexa beginning in 2015, and in April 2016, along with all other countries in the world, switched from the trivalent OPV to bivalent OPV, containing polioviruses 1 and 3[15]. Although these

[11] Khetsuriani N, Pallansch MA, Jabirov S, et al. Population immunity to polioviruses in the context of a large-scale wild poliovirus type 1 outbreak in Tajikistan, 2010. Vaccine 2013;31:4911–6.

[12] Anis E, Kopel E, Singer SR, et al. Insidious reintroduction of wild poliovirus into Israel, 2013. Eurosurveillance 2013;18:2–6. <http://www.eurosurveillance

[13] Khetsuriani N et al. Responding to a cVDPV1 outbreak in Ukraine: Implications, challenges and opportunities. Vaccine (2017), http://dx.doi.org/10.1016/j.vaccine.2017.04.036

[14] World Health Organization. Report of the 30th meeting of the European regional certification commission for poliomyelitis eradication. Sarajevo, Bosnia and Herzegovina, 31 May-2 June 2016. <http://www.euro.who.int/__data/assets/pdf_file/0006/318651/Meeting-report-30th-RCC.pdf?ua=1>[accessed 28 September 2016].

[15] Transmission of wild poliovirus type 2 has been interrupted in 1999, and its eradication was declared by the Global Certification Commission in 2016. After this, type 2 component was removed from OPV in a synchronized manner to

recent changes in Georgian immunization schedule did not affect the cohorts included in the current survey, they have substantial polio-related implications for subsequent cohorts. Beginning in 2015, Hexa is the only source of the immunity against poliovirus type 2, and coverage with Hexa determines coverage for polio. This transition could reduce the number of polio susceptible children in in the future, if the coverage with Hexa is maintained at least at the current level of Penta. Also, with this change, the OPV doses given at 18 months and 5 years have become the only source of live polio vaccine. Unless improved, the current problem with delivering vaccinations after 12 months of age in Georgia could have substantial impact on the state of population immunity against polioviruses, because IPV provides protection from clinical disease but only OPV induces mucosal immunity necessary to prevent infection and reduce shedding and further transmission of polioviruses. In addition, high coverage with OPV is critical for preventing emergence and spread of vaccine-derived polioviruses.

**7. 4. MMR**

Georgia has adopted the European Regional goal of achieving measles and rubella elimination. However, substantial population susceptibility exists as evidenced by recurring large-scale measles outbreaks. Because of extremely high contagiousness of measles, very high coverage ($\geq$95%) with two vaccine doses is needed for achieving herd immunity necessary to interrupt measles virus transmission. The survey data demonstrates that the vast majority of children in Georgia receive at least one dose of MMR vaccine, although often with substantial delays. As a result, high coverage with MMR1 is not achieved until around the time of school entry, much later than recommended. Because of delays in vaccinations, suboptimal coverage for MMR2, and <100% effectiveness of MMR vaccine, many children in Georgia likely remain unprotected for these diseases, particularly for measles, unless they became ill and acquired natural immunity during the 2013-2014 measles outbreak. Notably, it appears that the immunization activities in response to this outbreak may have had a certain impact as judged by higher coverage for MMR than for DTP-containing and polio vaccines scheduled at the same time, but did not succeed in increasing MMR coverage sufficiently to reach the national target.

**7. 5. BCG**

BCG coverage in the survey was substantially lower than historically reported administrative coverage. Considering the existence of well-accepted BCG vaccination program with traditionally high coverage since the 1950s, and the current system of transmitting the BCG immunization information, problems with documentation have likely contributed to this finding to a certain extent. BCG, along with HepB0, is given at birth by maternity hospitals,[16] and the immunization information is provided to HCFs by parents as part of the transfer form issued at discharge from maternity hospital. It's the parent's responsibility to register the child with a HCF of their choice and provide the transfer form to the HCF, where the information should be entered in child's record and into the immunization card (Form 063). Problems at any stage of this process would result in missing information. In this survey, sometimes, BCG and HepB0 immunization from the transfer form was not included in immunization section of the chart and/or Form 063. In some cases, checking the Immunization Management Module records allowed to locate missing information on BCG and HepB0 immunizations entered by maternity hospitals. Also, at one PSU (Khulo district), where most children were born at a local maternity ward, we cross-checked the maternity hospital records and were able to obtain some missing immunization information. These findings indicate that

reduce the risk of emergence and circulation of type 2 VDPVs. Global Polio Eradication Initiative. Polio eradication and endgame strategic plan 2013–2018.
<http://www.polioeradication.org/Portals/0/Document/Resources/StrategyWork/EndGameStratPlan_20130329_ENG.pdf> [accessed 28 September 2016].

[16] The vast majority of births in Georgia occur at hospitals (98% in 2010). (Serbanescu F, Egnatashvili V, Ruiz A, Suchdev D, and Goodwin M. Reproductive Health Survey, Georgia, 2010. Summary report. CDC, Atlanta, 2011. Pp.1-278).

HCF might not be the best place to obtain information on vaccines administered at maternity hospitals due to potential problems with transmitting this information and that relying on HFC records alone could underestimate coverage. Additional efforts are needed to determine the relative contribution of lack of vaccination and lack of documentation to apparent low BCG coverage in the survey. Improvement of the quality of transfer forms and widespread utilization of the Immunization Management Module by maternity hospitals could help with improving documentation of vaccinations given at birth. Also, primary health care providers should ensure that all the immunization information is accurately entered in child's record, irrespective of where the vaccine was given.

**7. 6. Hepatitis B**

WHO European Region has recently adopted the Action Plan for the health sector response to viral hepatitis in the WHO European Region[17], which envisions the 2020 target of 95% coverage with three doses of hepatitis B vaccine and 90% timely coverage with the birth dose by 2020, and interim milestones of 90% coverage with three doses and 85% timely coverage with the birth dose of hepatitis B vaccine by 2018[18].

In the survey, HepB0 coverage in Georgia was lower than coverage for BCG, another vaccine administered at maternity hospitals. And similar to BCG, the administrative coverage was 10%-15% higher than survey coverage. The very low coverage in 2009 cohort, also reflected in the administrative coverage data, is likely due to the shortage of hepatitis B monovalent vaccine in 2009 in Georgia. The negative impact of an adverse event associated with hepatitis B vaccine in 2002, at the early stage of hepatitis B vaccine introduction in Georgia, and felt for years, could also have contributed. Problems with documentation of vaccines administered at maternity hospitals in the child's records at HCF, as discussed under BCG section, represent another potential contributor to low HepB0 coverage found in the survey. Nevertheless, the clear increasing trend in HepB0 coverage over time is encouraging and suggests the increased trust in hepatitis B vaccine in Georgia.

Successful introduction of Penta led to substantial increase in coverage for hepatitis B. Nationwide coverage with three doses of HepB reached the recently endorsed the 90% interim WHO milestone in 2013 cohort and came close to it with 87% in 2014 cohort. In Batumi, 2013 cohort came close to achieving the 2020 WHO target, with 93% coverage and 95% level within the confidence limits of the estimate (95% CI, 90%-95%). For the birth dose of HepB nationwide timely coverage in 2014 cohort (84%) was close to the 85% WHO interim milestone. Of note, 2014 cohort achieved this milestone in Batumi and Kutaisi (87% and 85%, respectively) (Table 10).

Overall, the situation with hepatitis B vaccination is improving, making progress towards achieving the regional and national coverage targets. It is necessary to sustain an increasing trend in HepB0 coverage. Further improvement in timeliness of vaccination can be a substantial contributor to the progress in this direction. Nevertheless, hepatitis B immunity gap in 2009 cohort is of concern. Additional assessments might be needed to decide on the need for any one-time catch-up immunization in this cohort.

**7. 7. Hib**

[17] Resolution EUR/RC66/R10 of the 66th session of the Regional Committee for Europe, Copenhagen, Denmark, 12–15 September 2016. Action plan for the health sector response to viral hepatitis in the WHO European Region. Available at: http://www.euro.who.int/__data/assets/pdf_file/0003/319206/66rs10e_Hepatitis_160771_R10.pdf?ua=1. Accessed March 7, 2017.

[18] WHO. Action plan for the health sector response to viral hepatitis in the WHO European Region. Adopted by 66th session of the Regional Committee for Europe (EUR/RC66/10), Copenhagen, Denmark, 12–15 September 2016. Available at: http://www.euro.who.int/__data/assets/pdf_file/0008/315917/66wd10e_HepatitisActionPlan_160555.pdf?ua=1. Accessed March 7, 2017.

Immunization against Hib was introduced in Georgia in 2010, with Penta vaccine, therefore coverage with Penta largely reflects coverage with Hib as most children in 2013 and 2014 received combination vaccines containing Hib. In these cohorts, the proportion of children who received DTP/DT for primary series, and thus remain unvaccinated for Hib, was small (usually <2%, with the highest difference between coverage for Penta3 and Hib of 3.8% in Tbilisi in 2013 cohort) (Tables 7 and 8). Reducing to the maximum possible extent the proportion of children receiving DTP or DT for primary vaccination instead of combination vaccines would help to further increase population protection against *H. influenzae* type B.

**7. 8. Rotavirus**

Rotavirus vaccine was introduced in Georgia in 2013 and achieved 66% two-dose coverage in 2014 cohort. Although generally not high, this level of coverage appears to be within expected reasonable range for a newly introduced vaccine, particularly the one with strict time limits for administration. The association of rotavirus vaccine coverage with the timing of Penta1 receipt indicates that the main reason for not getting vaccinated for rotavirus is the delay in beginning routine vaccinations: some children are delayed in getting Penta1 until an age when rotavirus vaccine can no longer be administered. Therefore, improving timeliness of vaccinations in general will likely lead to improving coverage for rotavirus vaccine in Georgia. The survey also demonstrated that a small proportion of children in Georgia receive rotavirus vaccine later than recommended maximum age, which should be discouraged.

**7. 9. Administrative versus survey coverage**

The comparison of the survey estimates with corresponding administratively reported coverage confirmed weaknesses of the current administrative reporting system. Since the coverage survey sampling frame incorporated all children in Georgia, including those not registered with HCFs, discrepancies in coverage between administrative and survey coverage were expected.

One potential source for discrepancies could be migration to foreign countries. In the survey, only 0.7% of children in 2014 cohort, 0.8% in 2013 cohort and 1.7% in 2009 cohort, were residing outside Georgia at the time of the survey (Table 6). Even taking into account additional <1% of children with foreign address in each cohort in the Civil Registry data base, the contribution of foreign migration appears relatively minor.

Another more significant source of discrepancy between the survey and GEOVAC estimates is the substantial difference between GEOVAC target populations for BCG (which is very close to birth cohort) and Penta1/DTP1 consistently observed in Georgia over the past decade (in the surveyed cohorts, between 9% and 12% of the cohort)[19], leading to underestimating the target used for assessing coverage for Penta1/DTP1 and other doses of the primary series.

However, for some vaccine doses the difference was far greater than the difference that could be explained by the existence of non-registered populations or migration to foreign countries (e.g. for Pol5 in 2009 cohort – 64% in survey versus 87% in GEOVAC, Table 12). Likely additional contributors to the discrepancy in coverage between the survey and the administrative system could be inaccuracies in reporting numbers of vaccinated persons and target populations, or both, to GEOVAC.

Detailed review of immunization data quality at the HCF level would help in determining specific reasons for these inaccuracies. Of note, addressing the issue of data quality at the HCF level would improve accuracy of the

[19] The difference between GEOVAC target populations for BCG and Penta1/DTP1 in 2014 was 7,100 children in 2013 –5,400 children, and in 2009 – 7,800 children, accounting for 11%, 9% and 12 % of BCG target population, respectively.

estimates within the system, but would not solve the problem of unregistered children. This problem is related to the current health care system in Georgia, where most of the HCF are private entities, immunizations are included in a package of services funded on a per capita basis and provided through primary health care providers and maternity hospitals (for BCG and HepB0). Notably, these private facilities do not have specified catchment areas; thus, individuals can register with any provider of their choice independent of its location. The registration with a HCF is an individual's responsibility and is not mandatory. Under such circumstances, HCFs lack the motivation and the mechanisms to identify children not registered with their HCF.

The full implementation of the Immunization Management Module as part of the Health Management Information System should eventually solve the problem of denominator and lead to more accurate and real-time administrative assessment of coverage in Georgia. The Immunization Module is built around the citizen's national ID number assigned at birth that enables monitoring of migration of beneficiaries as well as tracking vaccinations administered to individuals. The module enables instant access to the person's vaccination history to any provider countrywide, using the child's national ID assigned at birth. However, the implementation of the Immunization Module is still at early stage and many of its benefits cannot be yet fully utilized. The quality of data populating the system has not been assessed and its analytical capacity needs strengthening. Until the Immunization Module is fully developed and implemented, the current system for administrative reporting of coverage will have to be maintained, but coverage surveys will remain the optimal way to obtain reliable information on immunization coverage levels in Georgia.

## 8. Conclusions

1. Georgia has a well-developed, accessible and functioning routine immunization program, which has coped with challenges associated with changing landscape of health care system.

2. The national immunization program in Georgia provides adequate access to immunization services as judged by the very high proportion of children who received at least one recommended vaccine dose by the time of the survey. However, not all children utilize the system to full extent and complete the recommended series.

3. Immunization program performance, as judged by coverage, timeliness and dropout rates, have generally shown an improving trend, but geographic variations are present.

4. Overall, immunization services appear strongest in Batumi, followed by the rest of Georgia and Tbilisi, and weakest in Kutaisi, where the program is underperforming to a substantial extent.

5. The overall national target of 95% coverage for all antigens was not met, but by the time of the survey, $\geq$95% coverage was achieved nationwide for Penta1/DTP1 and Pol1 in all cohorts. Batumi, with $\geq$95% coverage for most major vaccines, was closest to achieving the overall target, followed by rest of Georgia and Tbilisi, which have achieved $\geq$95% coverage for some vaccine doses.

6. Kutaisi has considerable problems in delivering immunization services, with substantial proportion of children who have not initiated routine vaccinations, widespread delays, and high dropouts, which resulted in suboptimal levels of coverage achieved.

7. Immunization coverage at the time of the survey was in the moderate to high range for most vaccinations recommended during the first year of life. However, coverage was lower for vaccinations recommended after 12 months of age, particularly, for vaccine doses recommended at 5 years.

8. Delayed vaccinations were common in all cohorts surveyed. Even when the coverage target was met, this usually happened with substantial delay after the recommended age for the given dose. Late initiation of routine vaccinations had negative impact on subsequent coverage (particularly, for rotavirus vaccine) and on completion of recommended age-appropriate series of immunizations.

9. Coverage and timeliness of vaccinations decline with the increase of recommended age for vaccine doses in the following order: Penta1/DTP1 $\geq$ Pol1 > Penta3 $\geq$ MMR1 > Pol3 > DTP4 $\geq$ MMR2 > Pol4 > DT5 > Pol5.

10. Relatively low coverage for rotavirus vaccine was related to delays in initiating routine vaccinations.

11. Georgia is well advanced towards meeting the 2020 targets for hepatitis B vaccine recently adopted by WHO European Region.

12. Primary HCFs may not be the best place to assess coverage with the vaccine doses administered at maternity hospitals. Problems with transmitting immunization information from maternity hospitals to primary HCFs could have resulted in underestimating BCG and HepB0 coverage in the survey.

13. The current administrative system of reporting overestimates coverage for most vaccine doses, in some cases, to a substantial extent.

14. Not having interim milestones and defined time frames makes the national coverage target of $\geq$95% coverage for all antigens difficult to achieve, particularly in underperforming areas and for later vaccine doses for which current coverage is far below the target.

15. The Immunization Management Module has the potential to become an extremely useful tool for monitoring immunization system performance. The linkage of the Module with the Civil Registry data set was critical for the design and implementation of this survey allowing access to the sampling needed frame.

**9. Recommendations**

1. To increase coverage and ensure better timeliness of immunizations in Georgia, a complex of measures aimed at strengthening information systems and decreasing parental and provider hesitancy should be implemented. National public health authorities should continue working with stakeholders among national and local government entities, legislative bodies, insurance companies, HCFs, professional organizations, as well as international partners, to ensure an adequate regulatory framework and technical and financial support for strengthening the immunization program in Georgia.

2. National public health authorities should consider setting the interim milestones for coverage levels and develop the timeline for achievement of the national targets that would allow to better monitor progress, particularly in underperforming areas and to increase usefulness of having national goals as a tool for the system strengthening.

3. To improve the situation with immunization services in Kutaisi, a special targeted intervention to strengthen immunization services should be developed and implemented.

4. With the transition of Georgia's national immunization program from Penta to Hexa in late 2015, public health authorities and health care workers should pay particular attention to achieving and maintaining high coverage with three doses of Hexa, which currently is the only vaccine against type 2 poliovirus. In addition, high coverage with three doses of Hexa, which contains acellular pertussis vaccine, is critical for ensuring population protection against pertussis.

5. With the transition of Georgia to IPV as part of Hexa for primary immunization series against polio, bOPV at 18 months and 5 years are the only doses given as live polio vaccine, which provides mucosal immunity, necessary for reducing poliovirus shedding and transmission. Therefore, it is extremely important to improve coverage with both doses of bOPV.

6. To prevent further outbreaks and achieve measles and rubella elimination in Georgia, targeted efforts to increase coverage and timeliness of both doses of MMR, particularly MMR2, should be implemented. The section aimed at increasing MMR coverage in all population groups should be included in the National Plan for Measles and Rubella Elimination, currently under development.

7. Maternity hospitals and primary HCFs should be reminded of the need for accurate documentation of BCG and HepB0 doses in child's records, including entering BCG and HepB0 immunizations into the Immunization Management Module by maternity hospitals. The reasons for lower than expected coverage with BCG and HepB0 in the survey should be verified.

8. To meet WHO European Regional 2018 milestones and 2020 targets for hepatitis B vaccines, measures to ensure every newborn receives the birth dose of hepatitis B vaccine within the first 24 hours of life should be implemented, including increasing awareness about the need for the birth dose among both providers (maternity hospitals) and parents.

9. To improve already good access to immunization services, measures should be implemented to help reduce the number of children unregistered with primary HCFs. Parents should be provided, at maternity hospitals, or at the time of obtaining child's birth certificate, with information explaining importance and procedures for having children registered with a primary HCFs as early as possible.

10. A complex of measures should be implemented to improve timeliness of vaccinations and reduce the impact of delays on coverage:
    - Measures to reduce false contraindications should be implemented, focusing on providers and opinion-makers in relevant clinical disciplines. These measures should include informing and training them, monitoring use of contraindications by providers, requiring written justification for delays or exemptions and documentation of the condition recognized as contraindication by the Ministerial Decree regulating immunizations in Georgia.

    - National public health authorities should recommend and assist HCFs in developing/strengthening "reminder and recall" systems for vaccinations. Measures should be implemented to increase parental awareness and use of existing smartphone applications, to increase SMS reminders to parents about vaccinations, and to encourage further development of such systems.

- Involving child care institutions and schools in reviewing/monitoring children's immunization status and reminding parents of the need for immunizations should be considered. The possibility of immunization requirements for kindergarten/school entry for at least some VPDs (e.g. poliomyelitis, diphtheria, tetanus, measles, and rubella) could be considered. This is a very complex, multi-faceted issue and all aspects need to be carefully assessed before making the decision.

- The potential for using of the Immunization Management Module for identification of children not registered with HCFs, as well as for identification and tracking of unvaccinated and under-vaccinated children registered with HCFs ("defaulter tracing"), should be explored.

- The possibility of expanding the capacity of the Immunization Management Module to allow parental access to child's record to look up their child's immunization status and get information on vaccinations that are due, should be explored.

11. To mitigate the impact of vaccination delays, providers should be reminded and encouraged to utilize catch-up schedules defined in national guidelines for children who have fallen behind the immunization schedule.

12. To reduce missed opportunities for immunizations, any visit to primary HCF should be used to offer applicable vaccinations. As a minimum, child's immunization status should be reviewed and parents should be informed on vaccinations needed.

13. Interventions need to be implemented to decrease to parental refusals, a common reason for children not getting vaccinated in Georgia. Communication interventions directed toward parents are needed to counteract the various influences leading to the decision not to vaccinate. Georgian legislation allows parental refusal with written documentation but has no defined non-medical criteria for eligibility for exemptions from vaccinations. Therefore, the possibility for better defining regulatory criteria allowing parental refusal should be explored.

14. Immunization coverage monitoring should be improved to ensure that the system capable of providing timely and accurate coverage estimates is in place.
    - The Immunization Management Module, particularly its analytical capacity, should be strengthened to allow accurate, up-to-date reporting of coverage at HCF, district and national level, as well as provide flexibility for additional analyzes.

    - Measures to increase acceptance and utilization of the Immunization Management Module by providers should be implemented, such as ensuring access to computers and Internet, additional training, technical support, and monitoring of the extent of use of the system to help with identification of underperforming areas.

    - Until the Immunization Management Module has become fully functional, it will be necessary to work with providers and district public health authorities on improving quality of data reported to the existing system (GEOVAC). Relevant public health authorities at district and national level should closely and systematically monitor the quality of coverage data (both denominator and numerator) reported through GEOVAC, and request reporting entities to correct any identified inconsistencies.

## 10. Tables

**Table 1. Official country estimates of immunization coverage reported to WHO — Georgia, 1990-2014**
(http://apps.who.int/immunization_monitoring/globalsummary/coverages?c=GEO, Accessed Jan 28, 2017)

| Vaccine | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 | 2001 | 2000 | 1999 | 1998 | 1997 | 1996 | 1995 | 1994 | 1993 | 1992 | 1991 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCG | 96 | 95 | 95 | 96 | 97 | 95 | 95 | 96 | 95 | 95 | 91 | 87 | 80 | 97 | 95 | 95 | 94 | 76 | 70 | 32 | 30 | 30 | 67 | 91 | 95 |
| DTP3 | 91 | 98 | 92 | 95 | 91 | 88 | 92 | 98 | 87 | 84 | 78 | 76 | 85 | 86 | 98 | 98 | 89 | 92 | 92 | 54 | 58 | 54 | 58 | 45 | 69 |
| HepB3 | 91 | 93 | 92 | 92 | 95 | 54 | 89 | 94 | 83 | 74 | 64 | 49 | 51 | 61 | 55 | | | | | | | | | | |
| HepB-BD | 95 | 80 | 93 | 93 | 90 | 55 | 95 | 93 | 87 | 93 | 75 | 90 | | 69 | | | | | | | | | | | |
| Hib3 | 91 | 93 | 92 | 92 | 67 | | | | | | | | | | | | | | | | | | | | |
| MCV1 | 92 | 97 | 93 | 94 | 94 | 83 | 96 | 97 | 95 | 92 | 86 | 80 | 99 | 100 | 97 | 97 | 90 | 95 | 88 | 61 | 63 | 61 | 16 | 81 | 99 |
| MCV2 | 87 | 89 | 84 | 77 | 84 | 71 | 87 | 92 | 88 | 87 | 75 | 57 | 40 | 8 | | | | | | | | | | | |
| Pol3 | 91 | 94 | 93 | 91 | 88 | 93 | 90 | 88 | 88 | 84 | 66 | 75 | 90 | 81 | 98 | 98 | 95 | 98 | 94 | 82 | 82 | 82 | 68 | 45 | 87 |
| Rota1 | 77 | 74 | | | | | | | | | | | | | | | | | | | | | | | |
| Rota2 | 69 | 56 | | | | | | | | | | | | | | | | | | | | | | | |
| RCV1 | 92 | 97 | 93 | 94 | 94 | 83 | 97 | 97 | 95 | 92 | 31 | | | | | | | | | | | | | | |

**Table 2. Recommended national immunization schedule as of October 2014 — Georgia**

| Age / Diseases | 0-12 hrs | 0-5 d | 2 mos | 3 mos | 4 mos | 12 mos | 18 mos | 5 yrs | 14 yrs |
|---|---|---|---|---|---|---|---|---|---|
| Hepatitis B | **HepB0** | | | | | | | | |
| Tuberculosis | | **BCG** | | | | | | | |
| Diphtheria, tetanus, pertussis, Hib, hepatitis B | | | **Penta1** | **Penta2** | **Penta3** | | | | |
| Diphtheria, tetanus, | | | | | | | **DTP4** | | |
| Poliomyelitis | | | **OPV1** | **OPV2** | **OPV3** | | **OPV4** | **OPV5** | |
| Rotavirus | | | **Rota1** | **Rota1** | | | | | |
| Pneumococcal infection* | | | **PCV1** | **PCV2** | | **PCV3** | | | |
| Measles, mumps, rubella | | | | | | **MMR1** | | **MMR2** | |
| Diphtheria, tetanus | | | | | | | | **DT5** | |
| Tetanus, diphtheria | | | | | | | | | **Td** |

* 10-valent PCV introduced in late 2014

**Table 3. Birth cohorts included in the survey and coverage assessed for each vaccine by year and dose — Georgia, 2015-2016**

| Birth cohort | Birth dates | Coverage assessed for: | Years corresponding coverage reported |
|---|---|---|---|
| 2014 | 1/1/-12/31/2014 | Penta1, 3*, Pol1, 3**, BCG, HepB0, HepB3***, Rota1-2 | 2014 |
| 2013 | 1/1-12/31/2013 | Penta1, 3, Pol1-3, BCG, HepB0, HepB3 | 2013 |
| | | DTP4, Pol4, MMR1 | 2014 |
| 2009 | 1/1-12/31/2009 | DTP1, 3, Pol1, 3, BCG, HepB0, HepB3 | 2009 |
| | | DTP4, Pol4, MMR1 | 2010 |
| | | DT5, MMR2, Pol5 | 2014 |

* Other age-appropriate vaccines containing diphtheria-tetanus components (e.g. DTP, DT, Hexa) are also included in coverage calculations for Penta and DTP;

** Both types of polio vaccines, OPV and IPV, are included in coverage calculations for Pol.

*** Both monovalent HepB vaccine and combination vaccines containing HepB component are included in coverage calculations for HepB3.

**Table 4. The design of the coverage survey — Georgia, 2015-2016**

| Domain | Stratum name | PSU definition | # of PSUs | SSU definition | # of SSU | # of TSU | Total children per birth cohort | Design | PSU size |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Tbilisi (capital city) | Child | 750 | N/A | N/A | N/A | 750 | SRS | 1 |
| 2 | Kutaisi (city) | Child | 600 | N/A | N/A | N/A | 600 | SRS | 1 |
| 3 | Batumi (city) | Child | 600 | N/A | N/A | N/A | 600 | SRS | 1 |
| | *Three large cities* | | | | | | *1950* | | |
| 4 | Rustavi and Poti* (cities) | Child | 50 | N/A | N/A | N/A | 50 | SRS | 1 |
| | Kobuleti (district) | Village | 5 | Child | 5 | N/A | 25 | 2-stage cluster | 5 |
| | Marneuli (district) | Village | 5 | Child | 5 | N/A | 25 | 2-stage cluster | 5 |
| | Gardabani (district) | Village | 5 | Child | 5 | N/A | 25 | 2-stage cluster | 5 |
| | Zugdidi (district) | Village | 5 | Child | 5 | N/A | 25 | 2-stage cluster | 5 |
| | Gori (district) | Village | 10 | Child | 5 | N/A | 50 | 2-stage cluster | 5 |
| | Remaining 54 districts | District | 24 | Village/town | 5 | 5 | 600 | 3-stage cluster | 25 |
| | *Rest of Georgia* | | | | | | *800* | | |
| | *Georgia* | | | | | | *2750* | | |

PSU, primary sampling unit; SSU, secondary sampling unit; TSU, tertiary sampling unit; SRS, simple random sampling; N/A, not applicable.

* Rustavi and Poti were combined in one unit for sampling purposes.

**Table 5. Definitions of main outcome measures and time points for assessing coverage by birth cohort — Georgia, 2015-2016**

| Vaccine dose/series | Definition | Time point for assessing: | |
|---|---|---|---|
| | % of children who received: | **Overall coverage** | **Timely coverage** |
| BCG | BCG | Time of the survey | by day 6 |
| HepB0 | HepB vaccine (monovalent) | Time of the survey | by day 2 |
| Penta1/DTP1 | 1st dose of Penta/DT/Hexa or other comb. vaccine | Time of the survey | by 12 months |
| Penta3/DTP3 | 3rd dose of Penta/DT/Hexa or other comb. vaccine | Time of the survey | by 12 months |
| DTP4 | 4th dose of Penta/DT/Hexa/or other comb. vaccine | Time of the survey | by 24 months |
| DT5 | 5th dose of DT vaccine | Time of the survey | by 72 months |
| Pol1 | 1st dose of polio vaccine (OPV or IPV) | Time of the survey | by 12 months |
| Pol3 | 3rd dose of polio vaccine (OPV or IPV) | Time of the survey | by 12 months |
| Pol4 | 4th dose of polio vaccine (OPV or IPV) | Time of the survey | by 24 months |
| Pol5 | 5th dose of polio vaccine (OPV or IPV) | Time of the survey | by 72 months |
| MMR1 | 1st dose of MMR vaccine | Time of the survey | by 24 months |
| MMR2 | 2nd dose of MMR vaccine | Time of the survey | by 72 months |
| HepB3 | 3 doses of HepB-containing vaccine (monovalent or combination) | Time of the survey | |
| Hib3 | 3 doses of Hib-containing vaccine | Time of the survey | |
| Rota1 | 1st dose of rotavirus vaccine | Time of the survey | by 16 weeks |
| Rota2 | 2nd dose of rotavirus vaccine | Time of the survey | by 24 weeks |
| Dropout DTP1-DTP3 | Coverage with Penta1/DTP1 minus coverage with Penta3/DTP3 | Time of the survey | by 12 months |
| Combined series - major vaccines: | | | |
| 2014 cohort | 3 doses of vaccines against diphtheria, tetanus, pertussis, HiB, HepB and polio | Time of the survey | by 12 months |
| 2013 cohort | 4 doses of vaccines against diphtheria, tetanus, pertussis, and polio, 3 doses against HiB and HepB, and 1 dose of MMR vaccine | Time of the survey | by 24 months |
| 2009 cohort | 5 doses of vaccines against diphtheria, tetanus, and polio, 4 doses against pertussis, 3 doses against HepB, and 2 dose of MMR vaccine | Time of the survey | by 72 months |
| Combined series - all vaccines: | | | |
| 2014 cohort | 3 doses of vaccines against diphtheria, tetanus, pertussis, HiB, and polio, 4 doses against HepB, 1 dose of BCG, and 2 doses of rotavirus vaccine | Time of the survey | by 12 months |
| 2013 cohort | 4 doses of vaccines against diphtheria, tetanus, pertussis, polio, and HepB, 3 doses against HiB, 1 dose of MMR vaccine, 1 dose of BCG, and 2 doses of rotavirus vaccine | Time of the survey | by 24 months |
| 2009 cohort | 5 doses of vaccines against diphtheria, tetanus, and polio, 4 doses against pertussis, 3 doses against HepB, 1 dose of BCG, and 2 dose of MMR vaccine. | Time of the survey | by 72 months |

**Table 6. Response rates by survey site and cohort — Georgia, 2015-2016**

| Survey Site/Cohort | Total children, No. | Total targeted, No. (% of total) | Moved overseas, No. (% of targeted) | Total in Georgia, eligible for survey, No. (% of targeted) | Found, data obtained, No. (% of eligible) | Not found, No. (% of eligible) |
|---|---|---|---|---|---|---|
| Tbilisi | | | | | | |
| 2014 | 20,121 | 750 (3.7) | 5 (0.6) | 745 (99.4) | 703 (94.3) | 42 (5.6) |
| 2013 | 19,329 | 750 (3.9) | 2 (0.3) | 748 (99.7) | 712 (95.2) | 36 (4.8) |
| 2009 | 19,706 | 750 (3.8) | 17 (2.3) | 733 (97.7) | 677 (92.4) | 56 (7.6) |
| Batumi | | | | | | |
| 2014 | 2,927 | 600 (20.5) | 3 (0.5) | 597 (99.5) | 572 (95.8) | 25 (4.2) |
| 2013 | 2,978 | 600 (20.1) | 8 (1.4) | 592 (98.6) | 572 (96.6) | 20 (3.4) |
| 2009 | 3,078 | 600 (19.5) | 3 (0.5) | 597 (99.5) | 553 (92.6) | 44 (7.4) |
| Kutaisi | | | | | | |
| 2014 | 2,636 | 600 (22.8) | 5 (0.8) | 595 (99.2) | 581 (97.6) | 14 (2.4) |
| 2013 | 2,731 | 600 (22.0) | 3 (0.5) | 597 (99.5) | 585 (98.0) | 12 (2.0) |
| 2009 | 2,783 | 600 (21.6) | 5 (0.8) | 595 (99.2) | 548 (92.1) | 47 (7.9) |
| Rest of Georgia | | | | | | |
| 2014 | 35,668 | 800 (2.2) | 17 (2.1) | 783 (97.9) | 747 (95.4) | 36 (4.6) |
| 2013 | 33,536 | 800 (2.4) | 13 (1.6) | 787 (98.4) | 750 (95.3) | 37 (4.7) |
| 2009 | 37,628 | 800 (2.1) | 20 (2.5) | 780 (97.5) | 705 (90.4) | 75 (9.6) |
| Georgia | | | | | | |
| 2014 | 61,352 | 2750 | 30 (1.1) | 2720 (98.9) | 2609 (95.9) | 111 (4.1) |
| 2013 | 58,574 | 2750 | 27 (1.0) | 2723 (99.0) | 2623 (96.3) | 100 (3.7) |
| 2009 | 63,204 | 2750 | 46 (1.7) | 2704 (98.3) | 2491 (92.1) | 213 (7.9) |

**Table 7. Nationwide coverage at the time of the survey by birth cohort and vaccine dose — Georgia, 2015-2016**

| Vaccine dose | **2014 cohort** (N=2609) | | **2013 cohort** (N=2623) | | **2009 cohort** (N=2491) | |
|---|---|---|---|---|---|---|
| | **No. vaccinated** | **Coverage, % (95% CI)** | **No. vaccinated** | **Coverage, % (95% CI)** | **No. vaccinated** | **Coverage, % (95% CI)** |
| BCG | 2301 | 86 (83-89) | 2204 | 83 (80-86) | 2151 | 83 (80-86) |
| HepB0 | 2249 | 84 (81-87) | 1857 | 70 (66-73) | 1239 | 46 (43-49) |
| Penta1/DTP1 | 2442 | 95 (94-96) | 2517 | 97 (96-98) | 2424 | 97 (96-97) |
| Penta3/DTP3 | 2221 | 88 (86-90) | 2372 | 92 (90-93) | 2279 | 90 (88-92) |
| DTP4 | | | 1981 | 80 (78-82) | 2176 | 85 (83-87) |
| DT5 | | | | | 1808 | 72 (69-74) |
| Pol1 | 2423 | 94 (93-96) | 2496 | 96 (95-97) | 2414 | 96 (95-97) |
| Pol3 | 2195 | 87 (85-89) | 2353 | 91 (90-92) | 2279 | 90 (88-91) |
| Pol4 | | | 1920 | 76 (74-78) | 2132 | 83 (81-85) |
| Pol5 | | | | | 1788 | 69 (67-72) |
| MMR1 | | | 2281 | 89 (88-91) | 2343 | 93 (92-94) |
| MMR2 | | | | | 1911 | 76 (73-79) |
| HepB3 | 2191 | 87 (84-89) | 2318 | 90 (88-91) | 1017 | 40 (37-44) |
| Hib3 | 2193 | 87 (84-89) | 2320 | 90 (88-91) | | |
| Rota1 | 1821 | 72 (69-75) | 1574 | 60 (57-62) | | |
| Rota2 | 1690 | 66 (63-69) | 1464 | 56 (53-59) | | |
| Combined series with major vaccines[a] | 2154 | 85 (83-87) | 1793 | 71 (69-74) | 1230 | 46 (42-49) |
| Combined series with all vaccines[b] | 1436 | 54 (50-58) | 893 | 34 (31-37) | 1161 | 43 (39-46) |
| Received no vaccines recommended at ≥2 months | 142 | 4 (3-5) | 94 | 3 (2-4) | 52 | 3 (2-4) |
| Received ≥1 dose with commercial vaccine | 113 | 5 (4-6) | 110 | 5 (4-6) | 75 | 3 (3-4) |

[a] Combined series with major vaccines - defined in Table 5. Hib is not included in this series for 2009 birth cohort as this was the year of its introduction.

[b] Combined series with all vaccines – defined in Table 5, tetanus, and polio, 4 doses against pertussis, 3 doses against HepB, and 2 doses of measles-mumps-rubella vaccine. PCV and Hib are not included in this series for 2014 and 2009 birth cohorts, respectively, because for these vaccines these were the years of their introduction.

**Table 8. Subnational coverage at the time of the survey, by birth cohort, survey site and vaccine dose — Georgia, 2015-2016**

| Vaccine dose | Tbilisi | | Batumi | | Kutaisi | | Rest of Georgia | |
|---|---|---|---|---|---|---|---|---|
| | No. vaccinated | Coverage, % (95% CI) | No. vaccinated | Coverage, % (95% CI) | No. vaccinated | Coverage, % (95% CI) | No. vaccinated | Coverage, % (95% CI) |
| **2014 cohort** | (N=709) | | (N=572) | | (N=581) | | (N=746) | |
| BCG | 645 | 91 (89-93) | 524 | 92 (89-94) | 512 | 88 (85-90) | 620 | 83 (77-88) |
| HepB0 | 602 | 85 (82-87) | 521 | 91 (88-93) | 507 | 87 (84-90) | 619 | 83 (77-87) |
| Penta1 | 682 | 96 (95-97) | 544 | 95 (93-97) | 502 | 86 (83-89) | 714 | 95 (93-97) |
| Penta3 | 607 | 86 (83-88) | 501 | 88 (85-90) | 433 | 75 (71-78) | 680 | 91 (87-94) |
| Pol1 | 674 | 95 (93-96) | 538 | 94 (92-96) | 504 | 87 (84-89) | 707 | 95 (91-97) |
| Pol3 | 594 | 84 (81-86) | 492 | 86 (83-89) | 433 | 75 (71-78) | 676 | 90 (86-93) |
| HepB3 | 592 | 83 (81-86) | 499 | 87 (84-90) | 432 | 74 (71-78) | 668 | 89 (85-92) |
| Hib3 | 594 | 84 (81-86) | 499 | 87 (84-90) | 432 | 74 (71-78) | 668 | 89 (85-92) |
| Rota1 | 473 | 67 (63-70) | 441 | 77 (73-80) | 341 | 59 (55-63) | 566 | 75 (71-80) |
| Rota2 | 425 | 60 (56-63) | 420 | 73 (70-77) | 313 | 54 (50-58) | 532 | 71 (66-75) |
| Combined series - major vaccines[a] | 576 | 81 (78-84) | 490 | 86 (83-88) | 426 | 73 (70-77) | 662 | 88 (84-91) |
| Combined series - all vaccines[b] | 368 | 52 (48-56) | 378 | 66 (62-70) | 273 | 47 (43-51) | 417 | 55 (49-62) |
| Received no vaccines recommended at ≥2 months | 20 | 3 (2-4) | 26 | 5 (3-7) | 73 | 13 (10-15) | 23 | 3 (2-5) |
| Received ≥1 dose with commercial vaccine | 95 | 13 (11-16) | 5 | 1 (0-2) | 4 | 1 (0-2) | 9 | 1 (1-2) |
| **2013 cohort** | (N=716) | | (N=572) | | (N=585) | | (N=750) | |
| BCG | 596 | 83 (80-86) | 505 | 88 (85-91) | 485 | 83 (80-86) | 618 | 83 (77-87) |
| HepB0 | 486 | 68 (64-71) | 456 | 80 (76-83) | 389 | 67 (63-70) | 526 | 71 (65-76) |
| Penta1 | 691 | 97 (95-98) | 562 | 98 (97-99) | 534 | 91 (89-93) | 730 | 97 (95-98) |
| Penta3 | 647 | 90 (88-92) | 540 | 94 (92-96) | 486 | 83 (80-86) | 699 | 93 (91-95) |
| DTP4 | 530 | 74 (71-77) | 444 | 78 (74-81) | 367 | 63 (59-67) | 640 | 85 (82-88) |
| Pol1 | 678 | 95 (93-96) | 560 | 98 (96-99) | 530 | 91 (88-93) | 728 | 97 (95-98) |
| Pol3 | 635 | 89 (86-91) | 535 | 94 (91-95) | 484 | 83 (79-86) | 699 | 93 (91-95) |
| Pol4 | 500 | 70 (66-73) | 437 | 76 (73-80) | 370 | 63 (59-67) | 613 | 81 (77-84) |
| MMR1 | 629 | 88 (85-90) | 511 | 89 (87-92) | 456 | 78 (74-81) | 685 | 91 (88-94) |
| HepB3 | 619 | 86 (84-89) | 531 | 93 (90-95) | 479 | 82 (79-85) | 689 | 92 (89-94) |
| Hib3 | 621 | 87 (84-89) | 532 | 93 (91-95) | 478 | 82 (78-85) | 689 | 92 (89-94) |
| Rota1 | 377 | 53 (49-56) | 418 | 73 (69-77) | 293 | 50 (46-54) | 486 | 63 (59-67) |
| Rota2 | 716 | 48 (44-52) | 398 | 70 (66-73) | 261 | 45 (41-49) | 461 | 60 (56-64) |
| Combined series with major vaccines[a] | 452 | 63 (60-67) | 419 | 73 (70-77) | 341 | 58 (54-62) | 581 | 77 (73-81) |
| Combined series with all vaccines[b] | 193 | 27 (24-30) | 267 | 47 (43-51) | 140 | 24 (21-28) | 293 | 38 (33-43) |
| Received no vaccines recommended at ≥2 months | 21 | 3 (2-4) | 7 | 1 (1-3) | 48 | 8 (6-11) | 18 | 2 (1-4) |

Table 8. – continued

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Received ≥1 dose with commercial vaccine | 93 | 13 (11-16) | 6 | 1 (0-2) | 2 | 0 (0-1) | 9 | 1 (1-2) |
| **2009 cohort** | (N=685) | | (N=553) | | (N=548) | | (N=705) | |
| BCG | 608 | 89 (86-91) | 509 | 92 (89-94) | 468 | 85 (82-88) | 566 | 79 (74-84) |
| HepB0 | 279 | 41 (37-44) | 390 | 71 (67-74) | 234 | 43 (39-47) | 336 | 47 (42-52) |
| Penta1/DTP1 | 673 | 98 (97-99) | 550 | 99 (98-100) | 523 | 95 (93-97) | 678 | 96 (94-97) |
| Penta3/DTP3 | 616 | 90 (87-92) | 540 | 98 (96-99) | 489 | 89 (86-92) | 634 | 89 (86-92) |
| DTP4 | 581 | 85 (82-87) | 530 | 96 (94-97) | 460 | 84 (81-87) | 605 | 85 (81-88) |
| DT5 | 461 | 67 (64-71) | 474 | 86 (83-88) | 352 | 64 (60-68) | 521 | 73 (69-77) |
| Pol1 | 667 | 97 (96-98) | 550 | 99 (98-100) | 524 | 96 (94-97) | 673 | 95 (93-96) |
| Pol3 | 608 | 89 (86-91) | 540 | 98 (96-99) | 493 | 90 (87-92) | 638 | 90 (87-92) |
| Pol4 | 560 | 82 (79-84) | 521 | 94 (92-96) | 459 | 84 (80-87) | 592 | 83 (80-86) |
| Pol5 | 440 | 64 (61-68) | 474 | 86 (83-88) | 367 | 67 (63-71) | 507 | 67 (63-71) |
| MMR1 | 646 | 94 (92-96) | 539 | 97 (96-98) | 503 | 92 (89-94) | 655 | 92 (90-94) |
| MMR2 | 484 | 71 (67-74) | 481 | 87 (84-90) | 385 | 70 (66-74) | 561 | 78 (74-82) |
| HepB3 | 323 | 47 (43-51) | 194 | 35 (31-39) | 232 | 42 (38-46) | 268 | 37 (32-42) |
| Hib3 | 191 | 28 (25-31) | 98 | 18 (15-21) | 126 | 23 (20-27) | 152 | 21 (18-25) |
| Combined series with major vaccines[a] | 318 | 46 (43-50) | 340 | 61 (57-65) | 254 | 46 (42-51) | 318 | 44 (38-49) |
| Combined series with all vaccines[b] | 308 | 45 (41-49) | 325 | 59 (55-63) | 235 | 43 (39-47) | 293 | 40 (35-46) |
| Received no vaccines recommended at ≥2 months | 8 | 1 (1-2) | 2 | 0 (0-1) | 22 | 4 (3-6) | 20 | 3 (2-5) |
| Received ≥1 dose with commercial vaccine | 64 | 9 (7-12) | 2 | 0 (0-1) | 6 | 1 (1-2) | 3 | 0 (0-1) |

[a] Combined series with major vaccines - defined in Table 5. Hib is not included in this series for 2009 birth cohort as this was the year of its introduction.

[b] Combined series with all vaccines – defined in Table 5, tetanus, and polio, 4 doses against pertussis, 3 doses against HepB, and 2 dose of measles-mumps-rubella vaccine. PCV and Hib are not included in this series for 2014 and 2009 birth cohorts, respectively, because for these vaccines these were the years of their introduction.

**Table 9. Timely vs overall coverage at the time of the survey nationwide, by birth cohort and vaccine dose — Georgia, 2015-2016**

| Vaccine dose | Age assessed | % Timely coverage* | % Coverage at the time of survey | Difference |
|---|---|---|---|---|
| **2014 cohort** | | | | |
| BCG | 6 days | 83 | 86 | 3 |
| HepB0 | 1 day | 81 | 84 | 3 |
| Penta1 | 12 months | 92 | 95 | 3 |
| Penta3 | 12 months | 81 | 88 | 7 |
| Pol3 | 12 months | 81 | 87 | 6 |
| **2013 cohort** | | | | |
| BCG | 6 days | 78 | 83 | 5 |
| HepB0 | 1 day | 66 | 70 | 4 |
| Penta1 | 12 months | 94 | 97 | 3 |
| Penta3 | 12 months | 84 | 92 | 8 |
| DTP4 | 24 months | 68 | 80 | 22 |
| Pol3 | 12 months | 83 | 91 | 8 |
| Pol4 | 24 months | 66 | 76 | 10 |
| MMR1 | 24 months | 86 | 89 | 3 |
| **2009 cohort** | | | | |
| BCG | 6 days | 78 | 83 | 5 |
| HepB0 | 1 day | 43 | 46 | 3 |
| Penta1 | 12 months | 88 | 97 | 9 |
| Penta3 | 12 months | 78 | 90 | 12 |
| DTP4 | 24 months | 64 | 85 | 21 |
| DT5 | 72 months | 66 | 72 | 8 |
| Pol3 | 12 months | 77 | 90 | 13 |
| Pol4 | 24 months | 62 | 83 | 21 |
| Pol5 | 72 months | 64 | 69 | 5 |
| MMR1 | 24 months | 80 | 93 | 13 |
| MMR2 | 72 months | 70 | 76 | 6 |

* Probability of being vaccinated by the reference time x 100%

**Table 10. Timely versus overall overage at the time of the survey, by cohort, survey site and vaccine dose — Georgia, 2015-2016**

| Vaccine dose | Age assessed | Tbilisi, % coverage | | | Batumi % coverage | | | Kutaisi, % coverage | | | Rest of Georgia, % coverage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Timely | At the time of survey | Difference | Timely | At the time of survey | Difference | Timely | At the time of survey | Difference | Timely | At the time of survey | Difference |
| **2014 cohort** | | | | | | | | | | | | | |
| BCG | 6 days | 88 | 91 | 3 | 88 | 92 | 4 | 86 | 88 | 2 | 78 | 83 | 5 |
| HepB0 | 1 day | 82 | 85 | 3 | 87 | 91 | 4 | 85 | 87 | 2 | 80 | 83 | 3 |
| Penta1 | 12 mos | 93 | 96 | 3 | 95 | 95 | 0 | 86 | 86 | 0 | 92 | 95 | 3 |
| Penta3 | 12 mos | 77 | 86 | 9 | 86 | 88 | 2 | 69 | 75 | 6 | 84 | 91 | 7 |
| Pol3 | 12 mos | 76 | 84 | 8 | 84 | 86 | 2 | 69 | 75 | 6 | 84 | 90 | 6 |
| **2013 cohort** | | | | | | | | | | | | | |
| BCG | 6 days | 79 | 83 | 4 | 85 | 88 | 3 | 82 | 83 | 1 | 76 | 83 | 6 |
| HepB0 | 1 day | 64 | 68 | 4 | 75 | 80 | 5 | 65 | 67 | 2 | 67 | 71 | 5 |
| Penta1 | 12 mos | 93 | 97 | 4 | 97 | 98 | 1 | 89 | 91 | 2 | 94 | 97 | 3 |
| Penta3 | 12 mos | 80 | 90 | 10 | 89 | 94 | 5 | 74 | 83 | 9 | 87 | 93 | 6 |
| DTP4 | 24 mos | 60 | 74 | 14 | 77 | 78 | 1 | 57 | 63 | 7 | 73 | 85 | 12 |
| Pol3 | 12 mos | 78 | 89 | 11 | 88 | 94 | 6 | 74 | 83 | 9 | 86 | 93 | 7 |
| Pol4 | 24 mos | 57 | 70 | 13 | 75 | 76 | 1 | 57 | 63 | 7 | 71 | 81 | 10 |
| MMR1 | 24 mos | 83 | 88 | 5 | 89 | 89 | 0 | 75 | 78 | 3 | 88 | 91 | 3 |
| **2009 cohort** | | | | | | | | | | | | | |
| BCG | 6 days | 86 | 89 | 3 | 87 | 92 | 5 | 79 | 85 | 6 | 74 | 79 | 5 |
| HepB0 | 1 day | 39 | 41 | 2 | 68 | 71 | 3 | 40 | 43 | 3 | 43 | 47 | 4 |
| Penta1 | 12 mos | 89 | 98 | 9 | 96 | 99 | 3 | 87 | 95 | 8 | 86 | 96 | 10 |
| Penta3 | 12 mos | 77 | 90 | 13 | 86 | 98 | 12 | 76 | 89 | 13 | 78 | 89 | 11 |
| DTP4 | 24 mos | 63 | 85 | 22 | 73 | 96 | 23 | 59 | 84 | 25 | 65 | 85 | 20 |
| DT5 | 72 mos | 61 | 67 | 6 | 85 | 86 | 1 | 61 | 64 | 3 | 68 | 73 | 5 |
| Pol3 | 12 mos | 76 | 89 | 13 | 86 | 98 | 10 | 75 | 90 | 15 | 77 | 90 | 13 |
| Pol4 | 24 mos | 58 | 82 | 24 | 71 | 94 | 23 | 56 | 84 | 28 | 64 | 83 | 19 |
| Pol5 | 72 mos | 58 | 64 | 6 | 85 | 86 | 1 | 64 | 67 | 3 | 66 | 67 | 4 |
| MMR1 | 24 mos | 79 | 94 | 15 | 88 | 97 | 9 | 76 | 92 | 16 | 80 | 92 | 12 |
| MMR2 | 72 mos | 63 | 71 | 8 | 86 | 87 | 1 | 67 | 70 | 3 | 72 | 78 | 6 |

**Table 11. Age at which selected proportions of children (50%, 80%, 90% and 95%) received a given vaccine dose and time delay in receipt of dose, by birth cohort and vaccine dose — Georgia, 2015-2016**

| Vaccine dose | Recommended age | Age at which a given proportion of children are vaccinated & delay in receipt of dose (in parenthesis) | | | |
|---|---|---|---|---|---|
| | | 50% | 80% | 90% | 95% |
| **2014 cohort** | | | | | |
| BCG | 6 days | 2 (0[a]) | 4 (0[a]) | Not achieved | Not achieved |
| HepB0 | 1 day | 0 (0[a]) | 1 (0[a]) | Not achieved | Not achieved |
| Penta1 | 2 months | 3 (1) | 5 (3) | 8 (6) | 21 (19) |
| Penta3 | 4 months | 6 (2) | 11 (7) | 29 (25) | Not achieved |
| OPV1 | 2 months | 3 (1) | 5 (3) | 8 (6) | 29 (27) |
| OPV3 | 4 months | 6 (2) | 11 (7) | Not achieved | Not achieved |
| **2013 cohort** | | | | | |
| BCG | 6 days | 2 (0[a]) | 17 (11) | Not achieved | Not achieved |
| HepB0 | 1 day | 0 (0[a]) | Not achieved | Not achieved | Not achieved |
| Penta1 | 2 months | 3 (1) | 5 (3) | 8 (6) | 19 (17) |
| Penta3 | 4 months | 6 (2) | 10 (6) | 25 (21) | Not achieved |
| DTP4 | 18 months | 21 (3) | 34 (16) | Not achieved | Not achieved |
| OPV1 | 2 months | 3 (1) | 5 (3) | 8 (6) | 22 (20) |
| OPV3 | 4 months | 6 (2) | 11 (7) | 27 (23) | Not achieved |
| Polio4 | 18 months | 21 (3) | 44 (26) | Not achieved | Not achieved |
| MMR1 | 12 months | 13 (1) | 18 (6) | 38 (26) | Not achieved |
| **2009 cohort** | | | | | |
| BCG | 6 days | 3 (0[a]) | 18 (12) | Not achieved | Not achieved |
| HepB0 | 1 day | Not achieved | Not achieved | Not achieved | Not achieved |
| Penta1 | 2 months | 3 (1) | 7 (5) | 21 (19) | 67 (65) |
| Penta3 | 4 months | 7 (3) | 14 (10) | Not achieved | Not achieved |
| DTP4 | 18 months | 21 (3) | 60 (42) | Not achieved | Not achieved |
| DT5 | 60 months | 64 (4) | Not achieved | Not achieved | Not achieved |
| OPV1 | 2 months | 3 (1) | 7 (5) | 22 (20) | 73 (71) |
| OPV3 | 4 months | 7 (3) | 14 (10) | Not achieved | Not achieved |
| Polio4 | 18 months | 21 (3) | 63 (45) | Not achieved | Not achieved |
| Polio5 | 60 months | 65 (5) | Not achieved | Not achieved | Not achieved |
| MMR1 | 12 months | 14 (2) | 25 (13) | 66 (54) | Not achieved |
| MMR2 | 60 months | 64 (4) | 94 (34) | Not achieved | Not achieved |

[a] Within recommended age range.

Note – reference time intervals are given in days for BCG and HepB0 and months for all other doses.

**Table 12. Survey coverage versus administrative coverage nationwide, by cohort and vaccine dose — Georgia, 2015-2016**

| Vaccine dose | Age assessed | Survey coverage, timely, % | Admin. coverage, timely, % | Difference |
|---|---|---|---|---|
| **2014 cohort** | | | | |
| BCG | 6 days | 83 | 95 | 12 |
| HepB0 | 1 day | 81 | 91 | 10 |
| Penta3 | 12 mos | 81 | 88 | 7 |
| Pol3 | 12 mos | 81 | 88 | 7 |
| **2013 cohort** | | | | |
| BCG | 6 days | 78 | 94 | 16 |
| HepB0 | 1 day | 66 | 80 | 14 |
| Penta3 | 12 mos | 84 | 93 | 9 |
| DTP4 | 24 mos | 68 | 93 | 25 |
| Pol3 | 12 mos | 83 | 94 | 11 |
| Pol4 | 24 mos | 66 | 86 | 20 |
| MMR1 | 24 mos | 86 | 90 | 4 |
| **2009 cohort** | | | | |
| BCG | 6 days | 78 | 93 | 15 |
| HepB0 | 1 day | 43 | 55 | 12 |
| Penta3 | 12 mos | 78 | 88 | 10 |
| DTP4 | 24 mos | 64 | 78 | 14 |
| DT5 | 72 mos | 66 | 87 | 21 |
| Pol3 | 12 mos | 77 | 93 | 16 |
| Pol4 | 24 mos | 62 | 77 | 15 |
| Pol5 | 72 mos | 64 | 87 | 23 |
| MMR1 | 24 mos | 80 | 94 | 14 |
| MMR2 | 72 mos | 70 | 86 | 16 |

**Table 13. Survey coverage versus administrative coverage across survey sites, by cohort and vaccine dose — Georgia, 2015-2016**

| Vaccine dose | Age assessed | Tbilisi, % coverage | | | Batumi, % coverage | | | Kutaisi, % coverage | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Survey | Admin. | Difference | Survey | Admin. | Difference | Survey | Admin. | Difference |
| **2014 cohort** | | | | | | | | | | |
| BCG | 6 days | 88 | 96 | 8 | 88 | 94 | 6 | 86 | 94 | 8 |
| HepB0 | 1 day | 82 | 84 | 2 | 87 | 98 | 11 | 85 | 96 | 11 |
| Penta3 | 12 mos | 78 | 82 | 4 | 86 | 98 | 12 | 69 | 90 | 21 |
| Pol3 | 12 mos | 76 | 82 | 6 | 84 | 97 | 13 | 69 | 90 | 21 |
| **2013 cohort** | | | | | | | | | | |
| BCG | 6 days | 79 | 96 | 17 | 85 | 97 | 12 | 82 | 98 | 16 |
| HepB0 | 1 day | 64 | 76 | 12 | 75 | 87 | 12 | 65 | 76 | 11 |
| Penta3 | 12 mos | 80 | 82 | 2 | 89 | 95 | 6 | 74 | 93 | 19 |
| DTP4 | 24 mos | 60 | 85 | 25 | 77 | 105 | 28 | 57 | 93 | 36 |
| Pol3 | 12 mos | 78 | 83 | 5 | 88 | 94 | 6 | 74 | 93 | 19 |
| Pol4 | 24 mos | 57 | 82 | 25 | 75 | 95 | 20 | 57 | 92 | 35 |
| MMR1 | 24 mos | 83 | 84 | 1 | 89 | 99 | 10 | 75 | 93 | 18 |
| **2009 cohort** | | | | | | | | | | |
| BCG | 6 days | 86 | 87 | 1 | 87 | 94 | 7 | 79 | 95 | 16 |
| HepB0 | 1 day | 39 | 52 | 13 | 68 | 80 | 12 | 40 | 48 | 8 |
| Penta3 | 12 mos | 77 | 90 | 13 | 86 | 84 | -2 | 76 | 79 | 3 |
| DTP4 | 24 mos | 63 | 78 | 15 | 73 | 79 | 6 | 59 | 78 | 19 |
| DT5 | 72 mos | 61 | 85 | 24 | 85 | 100 | 15 | 61 | 85 | 24 |
| Pol3 | 12 mos | 76 | 99 | 23 | 86 | 90 | 4 | 75 | 86 | 11 |
| Pol4 | 24 mos | 58 | 77 | 19 | 71 | 76 | 5 | 56 | 69 | 13 |
| Pol5 | 72 mos | 58 | 87 | 29 | 85 | 94 | 9 | 64 | 91 | 27 |
| MMR1 | 24 mos | 79 | 94 | 15 | 88 | 99 | 11 | 76 | 87 | 11 |
| MMR2 | 72 mos | 64 | 83 | 19 | 86 | 97 | 11 | 67 | 91 | 24 |

Admin. – administrative; mos – months

**Table 14. Coverage levels and progress towards achieving 95% national target, by birth cohort and vaccine dose — Georgia, 2015-2016**

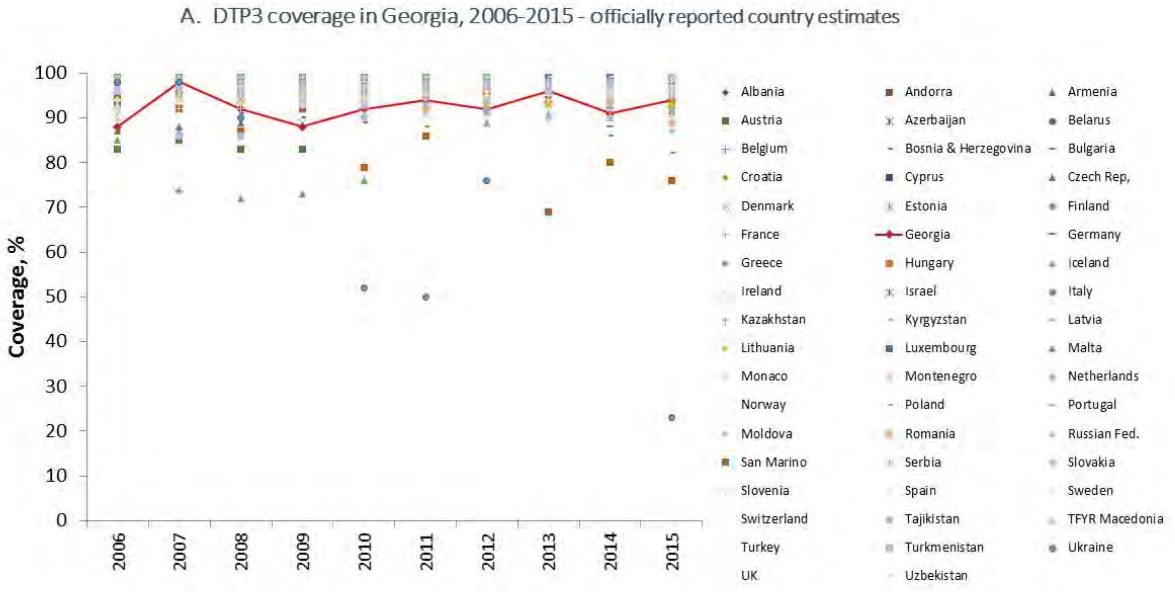
| Vaccine dose | Georgia | | Tbilisi | | Batumi | | Kutaisi | | Rest of Georgia | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coverage level | 95% target achieved | Coverage level | 95% target achieved | Coverage level | 95% target achieved | Coverage level | 95% target achieved | Coverage level | 95% target achieved |
| **2014 cohort** | | | | | | | | | | |
| BCG | Moderate | No | High | No | High | No | Moderate | No | Moderate | No |
| HepB0 | Moderate | No | Moderate | No | High | No | Moderate | No | Moderate | No |
| Penta1 | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** | Moderate | No | **High** | **Yes** |
| Penta3 | Moderate | No | Moderate | No | Moderate | No | Low | No | High | No |
| Pol1 | **High** | **Yes** | **High** | **Almost*** | **High** | **Almost*** | Moderate | No | **High** | **Yes** |
| Pol3 | Moderate | No | Moderate | No | Moderate | No | Low | No | High | No |
| **2013 cohort** | | | | | | | | | | |
| BCG | Moderate | No | Moderate | No | Moderate | No | Moderate | No | Moderate | No |
| HepB0 | Low | No | Low | No | Low | No | Low | No | Low | No |
| Penta1 | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** | High | No | **High** | **Yes** |
| Penta3 | High | No | High | No | **High** | **Almost*** | Moderate | No | **High** | **Almost*** |
| DTP4 | Moderate | No | Low | No | Low | No | Low | No | Moderate | No |
| Pol1 | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** | High | No | **High** | **Yes** |
| Pol3 | High | No | Moderate | No | **High** | **Almost*** | Moderate | No | **High** | **Almost*** |
| Pol4 | Low | No | Low | No | Low | No | Low | No | Moderate | No |
| MMR1 | Moderate | No | Moderate | No | Moderate | No | Low | No | High | No |
| **2009 cohort** | | | | | | | | | | |
| BCG | Moderate | No | Moderate | No | High | No | Moderate | No | Low | No |
| HepB0 | Low | No | Low | No | Low | No | Low | No | Low | No |
| DTP1 | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** |
| DTP3 | High | No | High | No | **High** | **Yes** | Moderate | No | Moderate | No |
| DTP4 | Moderate | No | Moderate | No | **High** | **Yes** | Moderate | No | Moderate | No |
| DT5 | Low | No | Low | No | Moderate | No | Low | No | Low | No |
| Pol1 | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** | **High** | **Yes** |
| Pol3 | High | No | Moderate | No | **High** | **Yes** | Moderate | No | High | No |
| Pol4 | Moderate | No | Moderate | No | **High** | **Almost*** | Moderate | No | Moderate | No |
| Pol5 | Low | No | Low | No | Moderate | No | Low | No | Low | No |
| MMR1 | High | No | **High** | **Almost*** | **High** | **Yes** | High | No | High | No |
| MMR2 | Low | No | Low | No | Moderate | No | Low | No | Low | No |

Note. High – ≥90%; Moderate – 80%-89%; Low – <80%.

* Upper 95% confidence interval of an estimate is ≥95.0%. Vaccine doses with national target achieved or almost achieved are shaded in blue.

## 11. Figures

**Figure 1. Official country estimates of immunization coverage with DTP3, Pol3, MMR1 and MMR2, reported to WHO — Georgia, 2006-2015 (http://apps.who.int/immunization_monitoring/globalsummary/coverages?c=GEO Accessed Jan 28, 2017)**



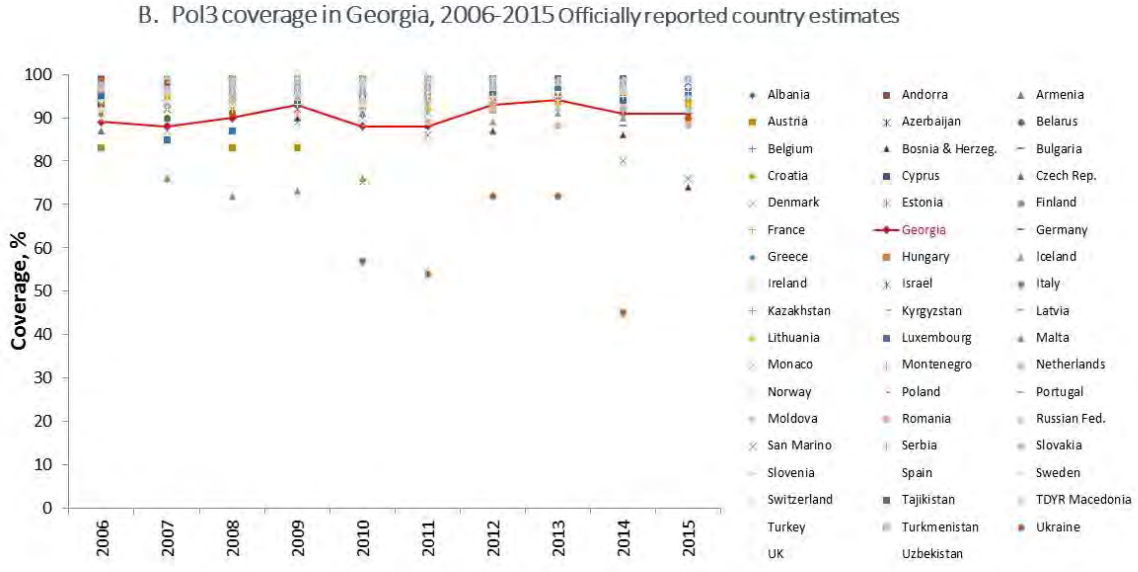
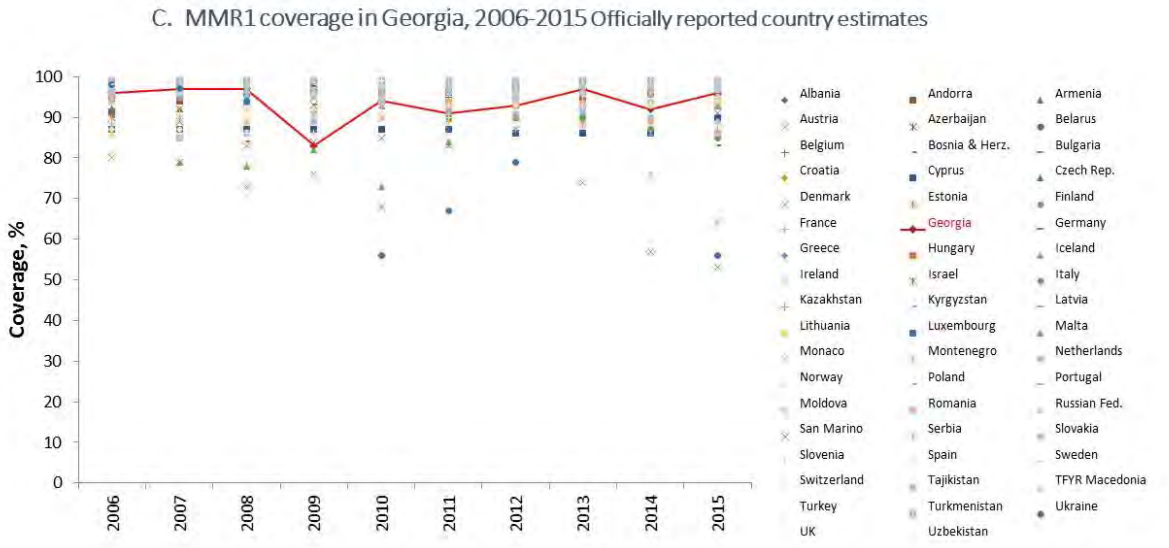



Figure 1 - continued



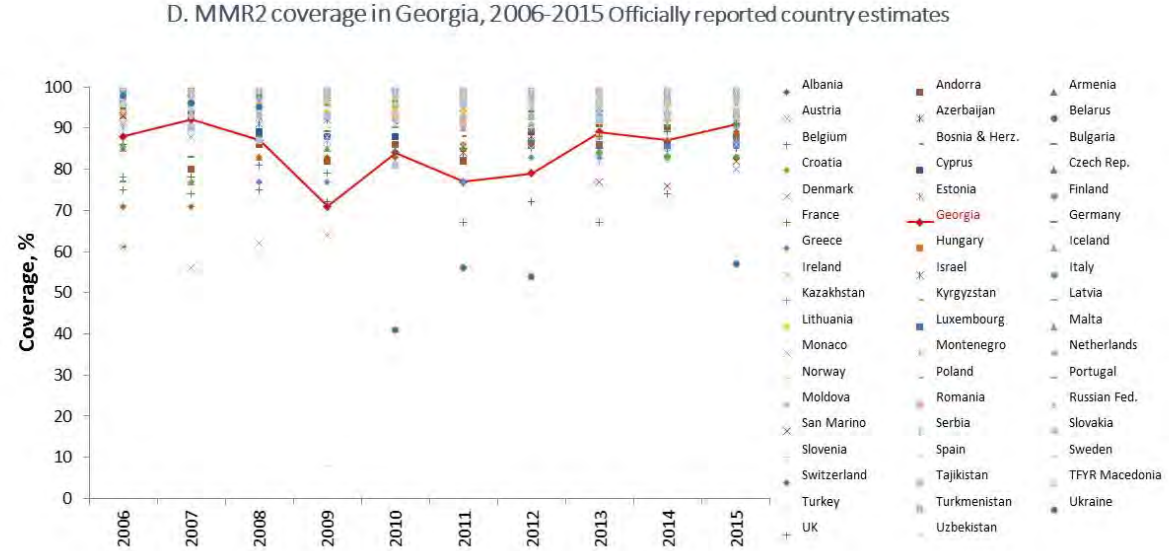
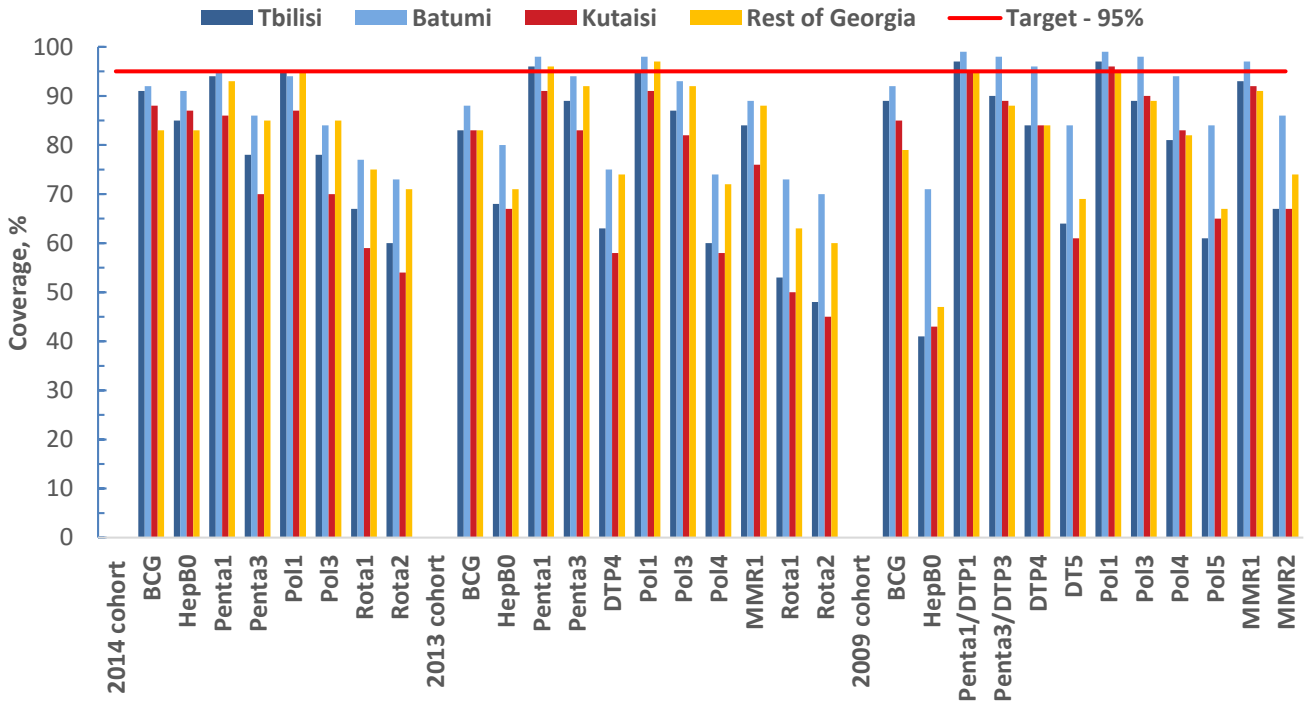
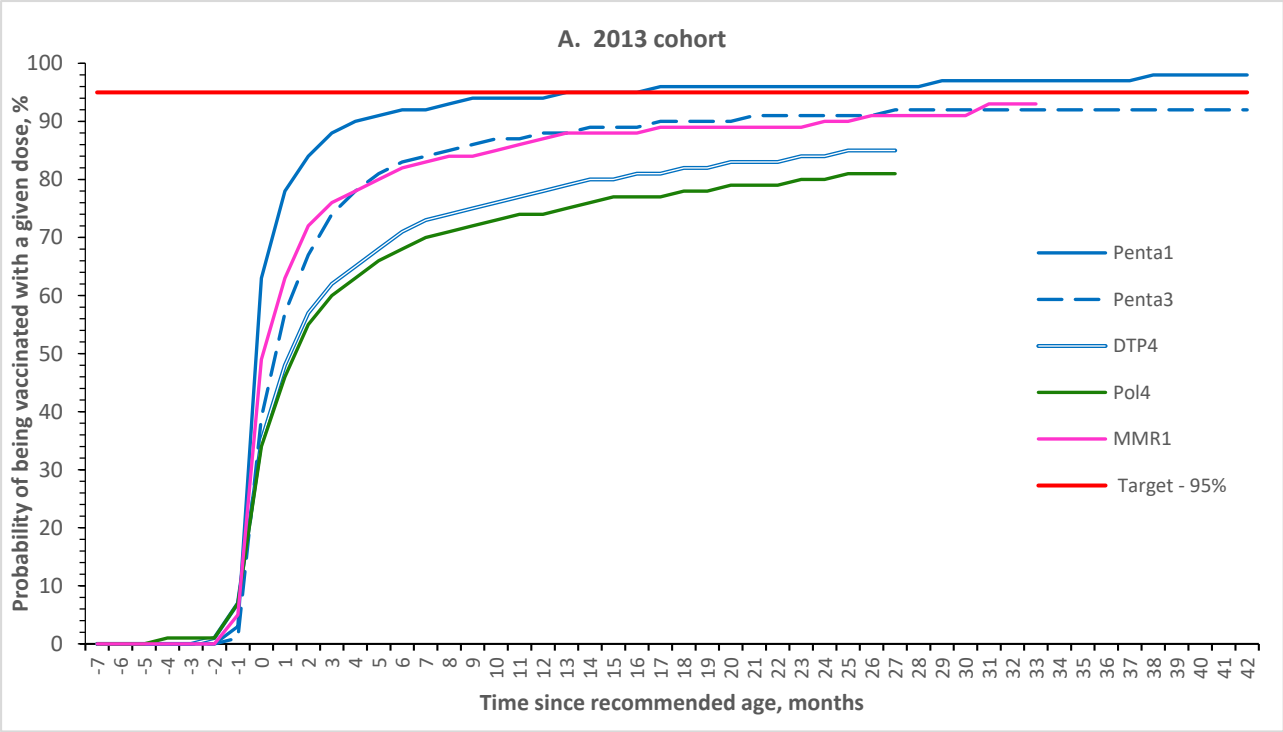



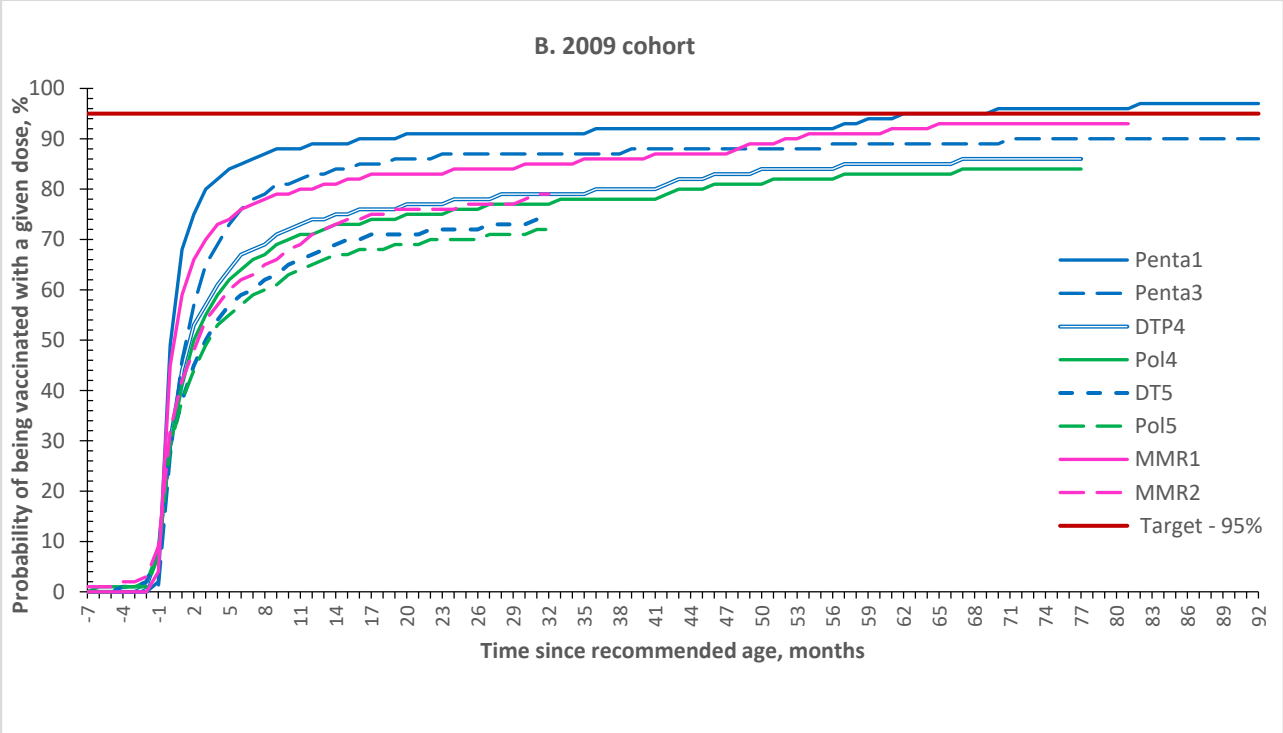
**Figure 2. Immunization coverage by survey site and birth cohort as of September 1, 2015 — Georgia***




* To account for sequential implementation of the survey , for the purpose of direct comparisons across survey sites the coverage estimates were adjusted to reflect situation as of September 1 2015, the time of the survey implementation in Batumi, the city surveyed first.

**Figure 3. Probability of vaccination by time since recommended age for the given vaccine — Georgia, 2015-2016***




*The data for Pol1 and Pol3 are omitted in the chart because of substantial overlap of the curves with those for Penta1/DTP1 and Penta3/DTP3.

**Figure 4. Timing of vaccination for DTP and polio-containing vaccines, nationwide, by birth cohort — Georgia, 2015-2016**

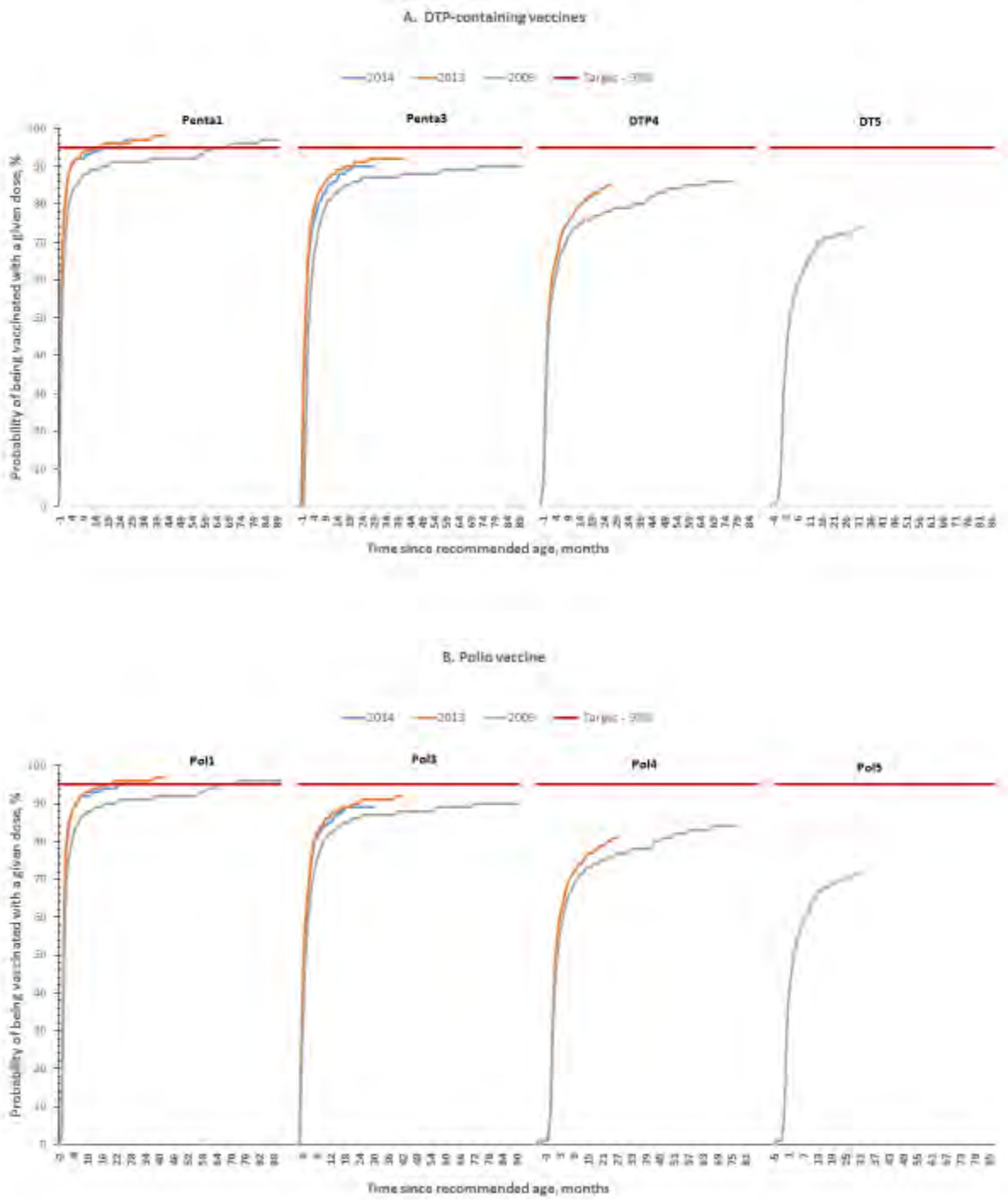
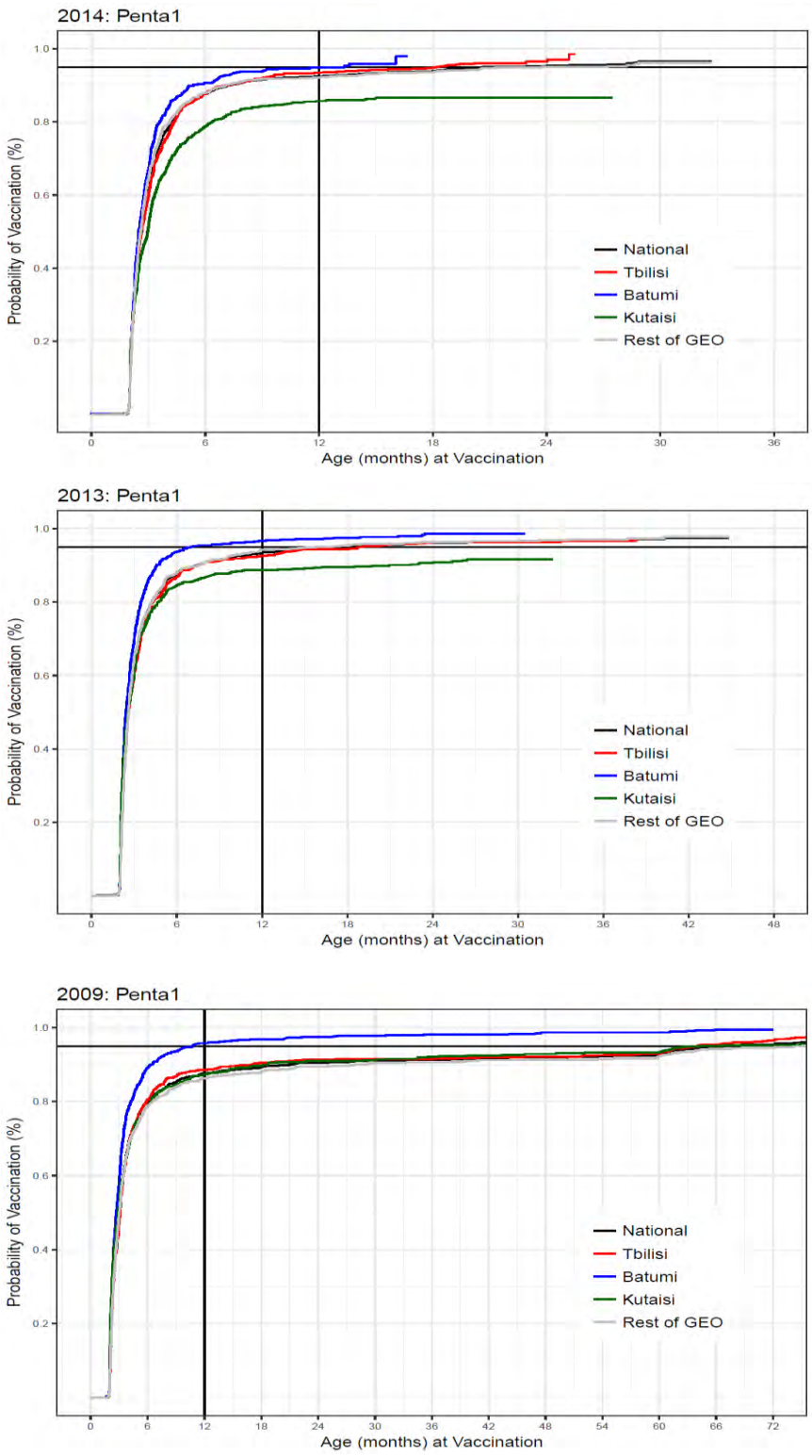
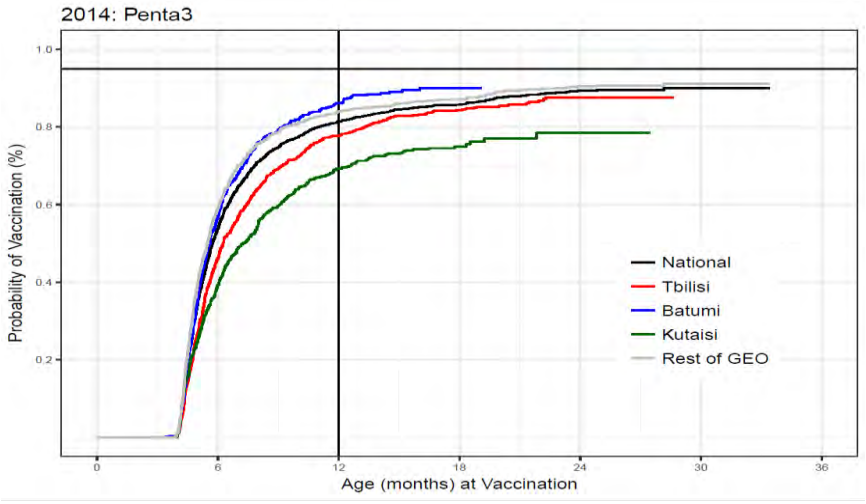


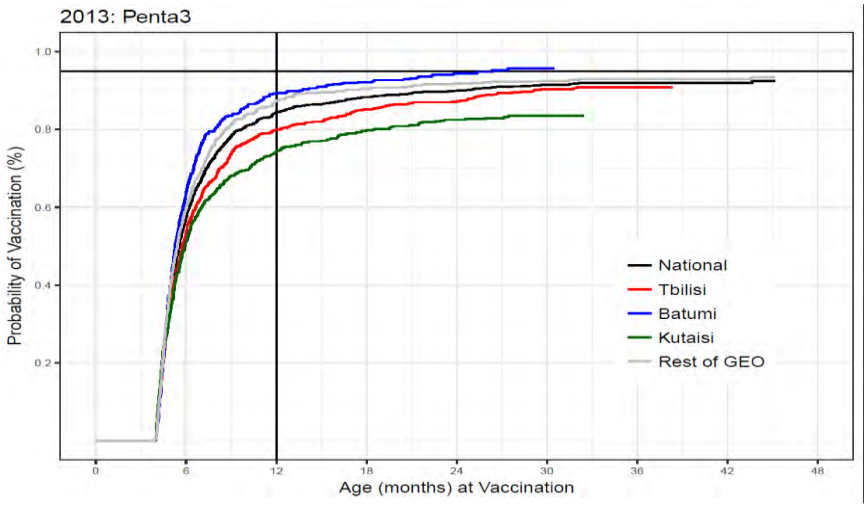
**Figure 5. Timeliness of receipt of Penta1/DTP1 by birth cohort – nationwide and for survey sites — Georgia, 2015-2016**

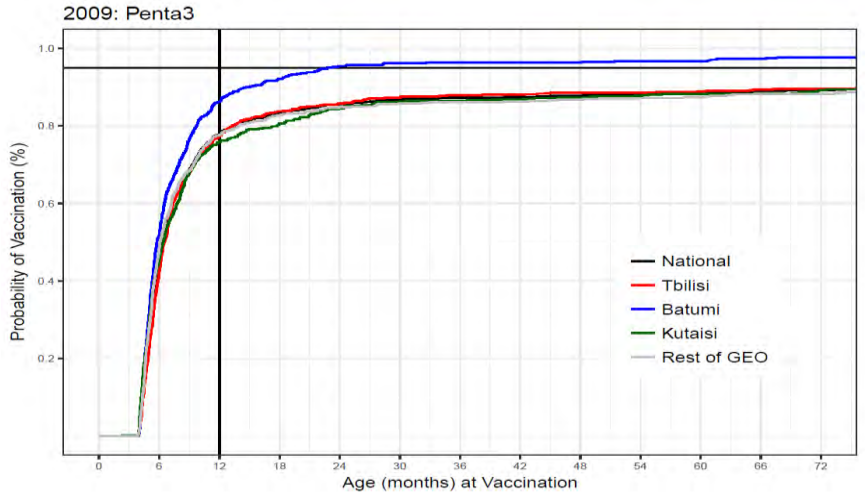



Note. Penta1 on the chart includes doses of any DTP-containing vaccine (Penta, DTP, DT, Hexa or other combination vaccines)

**Figure 6. Timeliness of receipt of Penta3/DTP3 by birth cohort – nationwide and for survey sites — Georgia, 2015-2016**




Note. Penta3 on the chart includes doses of any DTP-containing vaccine (Penta, DTP, DT, Hexa or other combination vaccines)

**Figure 7. Timeliness of receipt of MMR1 by birth cohort – nationwide and for survey sites — Georgia, 2015-2016**

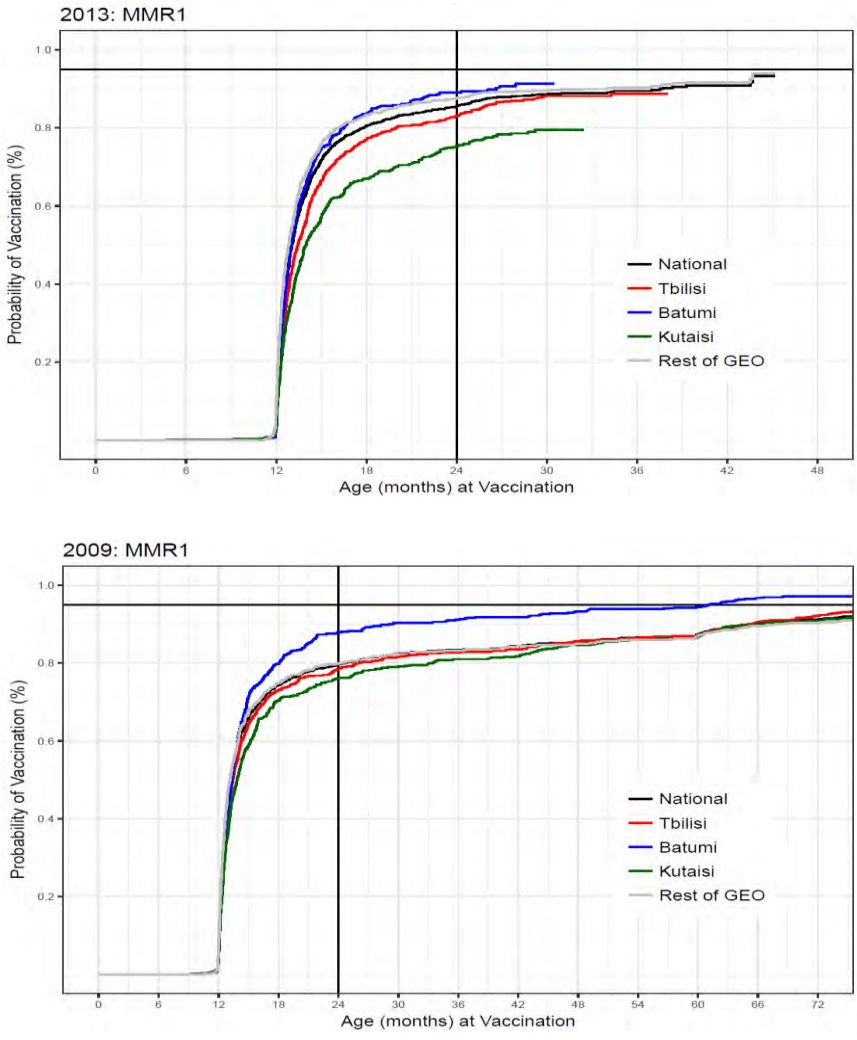
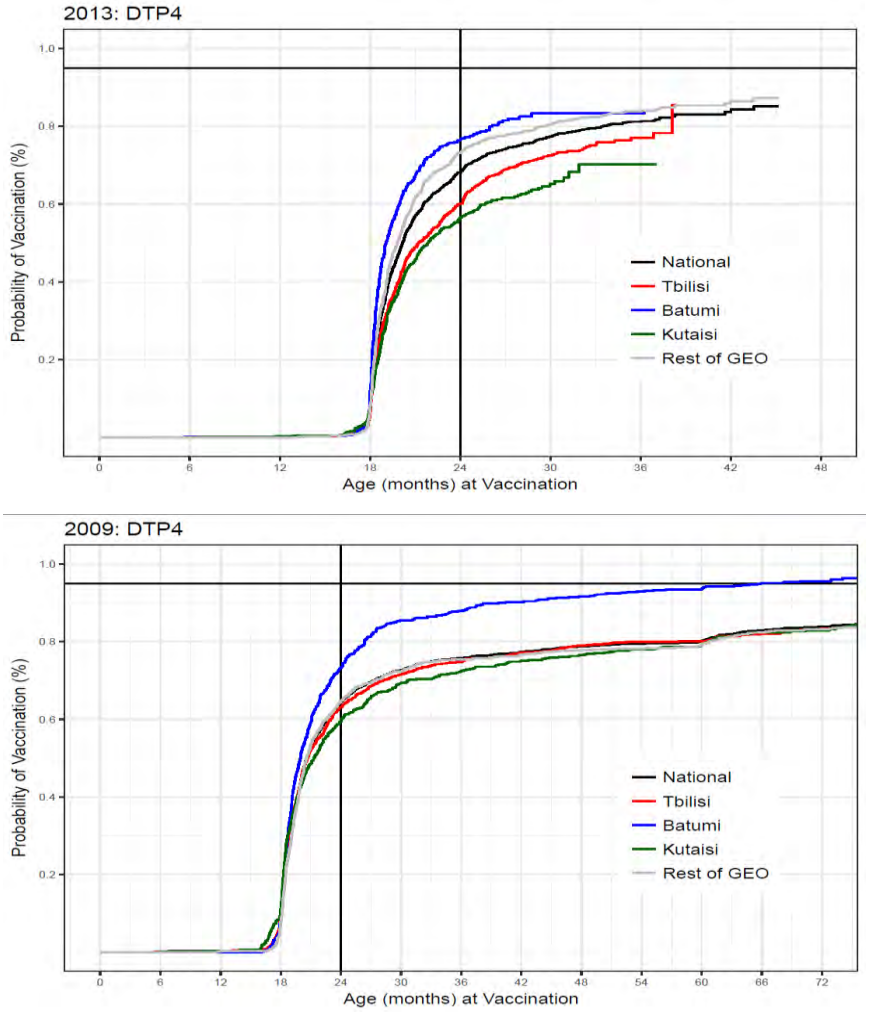
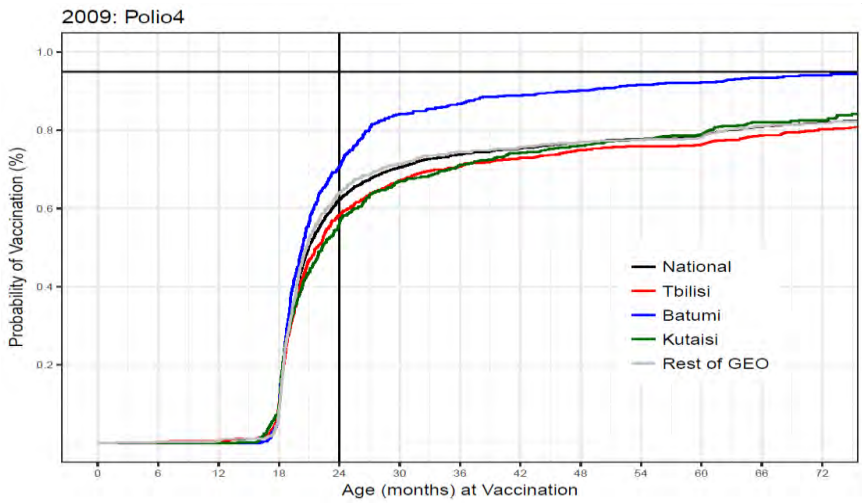


**Figure 8. Timeliness of receipt of DTP4 by birth cohort – nationwide and for survey sites — Georgia, 2015-2016**




Note. DTP4 on the chart includes doses of any DTP-containing vaccine (Penta, DTP, DT, Hexa or other combination vaccines)

**Figure 9. Timeliness of receipt of Pol4 by birth cohort – nationwide and for survey sites — Georgia, 2015-2016**




Note. Pol4 on the chart includes doses of any polio-containing vaccine (OPV or IPV as part of combination vaccines)

**Figure 10. Timeliness of receipt of MMR2 in 2009 birth cohort – nationwide and for survey sites — Georgia, 2015-2016**

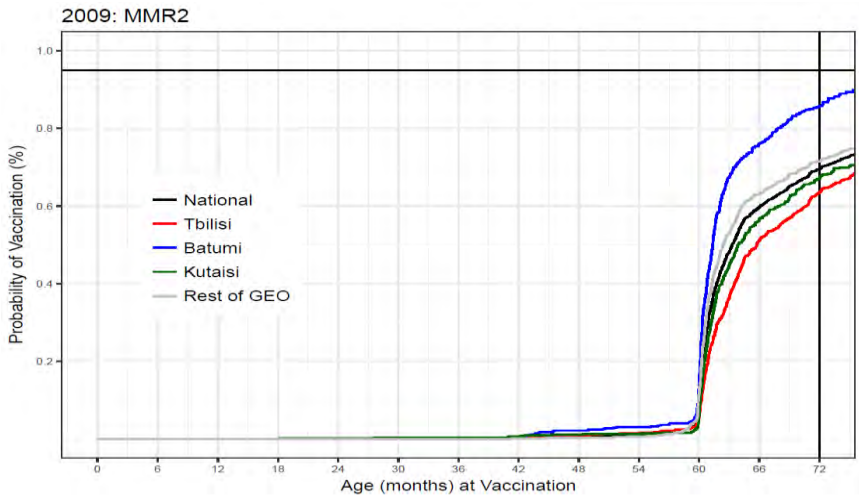


**Figure 11. Timeliness of receipt of DT5 in 2009 birth cohort – nationwide and for survey sites — Georgia, 2015-2016**

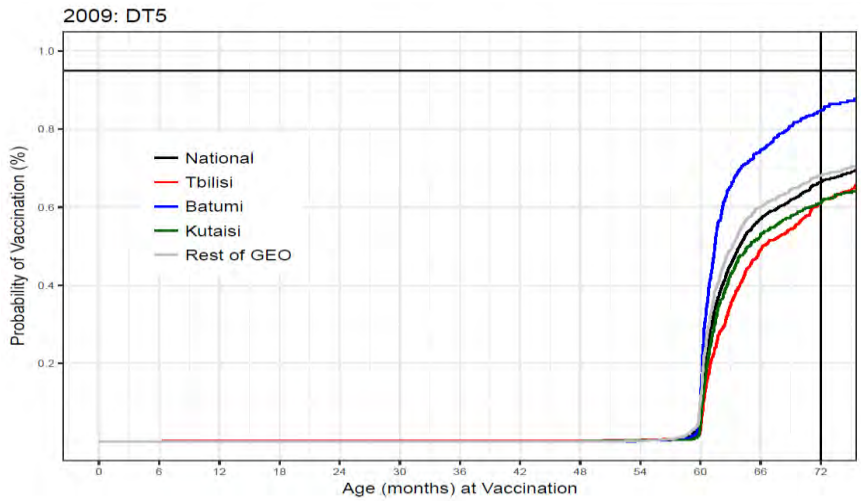
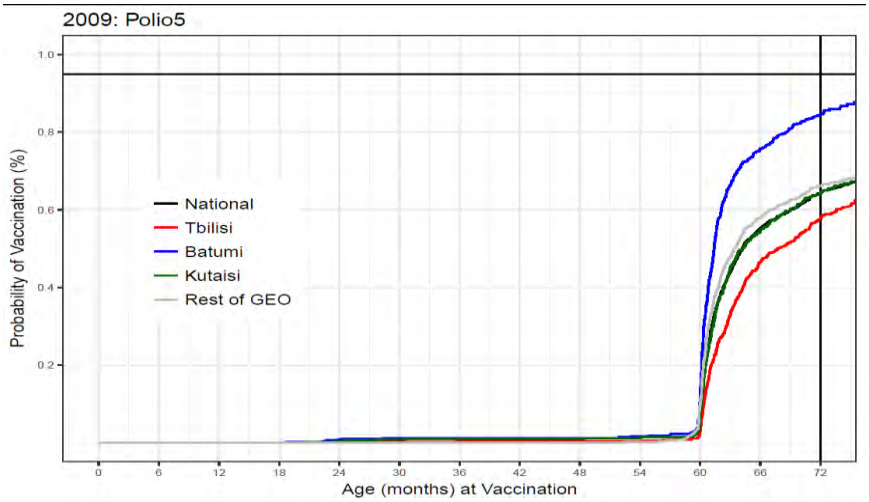



**Figure 12. Timeliness of receipt of Pol5 in 2009 birth cohort – nationwide and for survey sites — Georgia, 2015-2016**




Note. Pol5 on the chart includes doses of any polio-containing vaccine (OPV or IPV as part of combination vaccines)

## 12. Appendices

### Appendix 1. Immunization schedules applicable to birth cohorts included in the coverage survey and vaccines used — Georgia, 2015-2016

| Age | | 0-12 hrs | 0-5 days | 2 mos | 3 mos | 4 mos | 12 mos | 18 mos | 5 Yrs | 14 yrs |
|---|---|---|---|---|---|---|---|---|---|---|
| **Diseases** | **Vaccines - recommended** */also used* | | | | | | | | | |
| **For the 2014 birth cohort:** | | | | | | | | | | |
| Hepatitis B | **Hep B** | X | | | | | | | | |
| Tuberculosis | **BCG** | | X | | | | | | | |
| Diphtheria, tetanus, pertussis, Hib, hepatitis B | **Penta (DTwPHibHepB) /** DTwP, DT, Hexa (DTaPHibHepBIPV) | | | X | X | X | | | | |
| Diphtheria, tetanus, pertussis | **DTwP /** DT, Hexa | | | | | | | X | | |
| Poliomyelitis | **OPV /** Hexa (for doses 1-4) | | | X | X | X | | X | X | |
| Rotavirus | **Rotarix** | | | X | X | | | | | |
| Pneumococcal infection | **10-valent PCV** | | | X | X | | X | | | |
| Measles, mumps, rubella | **MMR** | | | | | | X | | X | |
| Diphtheria, tetanus | **DT** | | | | | | | | X | |
| Tetanus, diphtheria | **Td** | | | | | | | | | X |
| **For the 2013 birth cohort:** | | | | | | | | | | |
| Hepatitis B | **Hep B** | X | | | | | | | | |
| Tuberculosis | **BCG** | | X | | | | | | | |
| Diphtheria, tetanus, pertussis, Hib, hepatitis B | **Penta (DTwPHibHepB) /** DTwP, DT, Hexa (DTaPHibHepBIPV) | | | X | X | X | | | | |
| Diphtheria, tetanus, pertussis | **DTwP /** DT, Hexa | | | | | | | X | | |
| Poliomyelitis | **OPV /** Hexa (for doses 1-4) | | | X | X | X | | X | X | |
| Rotavirus | **Rotarix** | | | X | X | | | | | |
| Measles, mumps, rubella | **MMR** | | | | | | X | | X | |
| Diphtheria, tetanus | **DT** | | | | | | | | X | |
| Tetanus, diphtheria | **Td** | | | | | | | | | X |
| **For the 2009 birth cohort:** | | | | | | | | | | |
| Hepatitis B | **Hep B** | X | | X | X | | | | | |
| Tuberculosis | **BCG** | | X | | | | | | | |
| Diphtheria, tetanus, | **DTwP /** DT, Hexa | | | X | X | X | | X | | |
| Poliomyelitis | **OPV /** Hexa (for doses 1-3) | | | X | X | X | | X | X | |
| Measles, mumps, rubella | **MMR** | | | | | | X | | X | |
| Diphtheria, tetanus | **DT** | | | | | | | | X | |
| Tetanus, diphtheria | **Td** | | | | | | | | | X |

**Appendix 2. Information sheet about the survey for parents/guardians of the children who did not have health care facility indicated — Georgia, 2015-2016**

**National Center for Disease Control and Public Health**

**Assessment of immunization coverage in Georgia**

**Information sheet**

The National Center for Disease Control and Public Health of Georgia is conducting the assessment to find out how well children in Georgia are receiving vaccinations. The assessment is done in collaboration with the Georgia Office of the United States Centers for Disease Control and Prevention. To obtain the most accurate information, we need to review immunization records of randomly selected children.

Your child was selected for this assessment randomly. We would like to ask the child's mother or other closest caregiver, if the child has been vaccinated and which vaccines he or she has received.

If you have the immunization card at home, we will review it now. If you do not have it at home, we will ask you at which health care facility does your child receive vaccinations and obtain the records there. Only the information on children's immunizations to which public health officials have routine access for the purpose of program monitoring will be obtained for this assessment.

You are free to decline your child being part of this survey. There will be no direct benefits to you or your child from being part of this assessment, but having your child's immunization data will help us to more accurately assess the situation with immunization in Georgia and help us to better target our activities to reduce diseases that can be prevented by vaccines. To avoid potential minimal risk of the loss of confidentiality of the collected information, we will protect the data as much as possible: only investigators directly involved in the assessment will have access to your child's information, the files containing personal information will be password-protected and the your child's name and address will not be entered into the survey data base.

If you would like to have more information about this assessment, please contact _____ (name) - the Survey Coordinator at NCDC at _____ (phone number).

Thank you for your help with this assessment.

**Appendix 3. The interview form for parents/guardians of the children who did not have health care facility indicated — Georgia, 2015-2016**

**National Center for Disease Control and Public Health**

**Assessment of immunization coverage in Georgia**

**Parent/Guardian interview form**

**Survey ID number _____**

**Child's Name _____ Date of birth ___ / ___ /____ (dd /mm / yyyy)**

**Residence: City /district /village _____ Region _____**

***IF child not found, mark with "X" and stop:*** Not found [ ]

***IF child found, provide the parent/guardian with the Survey Information Sheet and ask for their participation.***

***IF parent/guardian refused to provide information mark with "X" and stop:*** Refusal [ ]

1. Since birth, has this child received at least one vaccination? Yes [ ] [ ] Only in maternity hospital
   No [ ] Unknown [ ]

   ***IF "No", mark with "X" and go to Question 3:*** Unvaccinated child [ ]

   ***IF "Yes" or***
   ***Only in maternity hospital", or "Unknown",*** **continue**.

2. Do you have this child's immunization records at home? Yes [ ] No [ ]

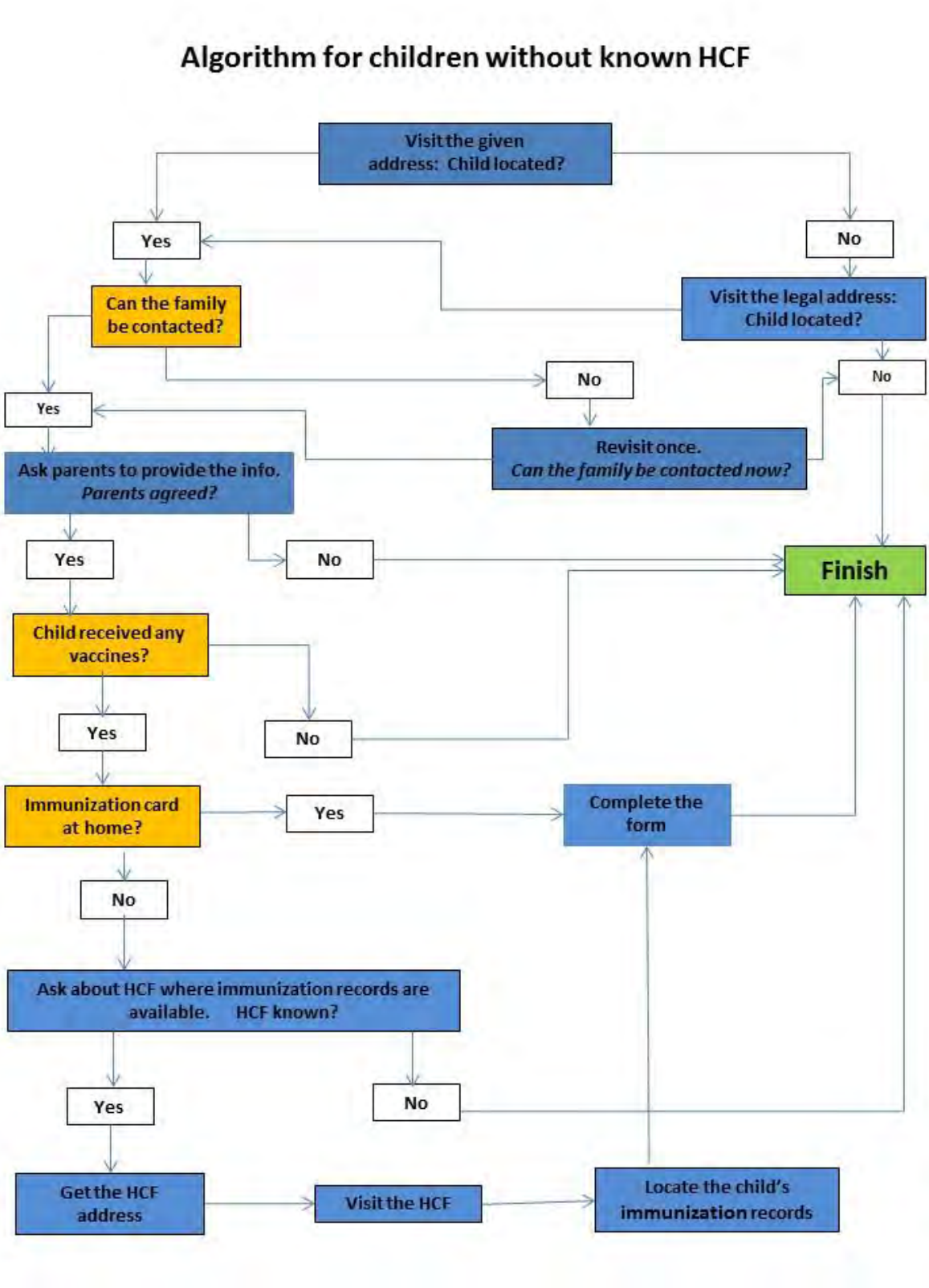
   ***IF" Yes", fill in the Survey Data Collection Form.***

3. At which health care facility does this child receive health services?
   a. Facility name _____
   b. Address _____

***IF the child is not registered with any health care facility, mark with "X":*** Not registered [ ]

***IF the child's health care facility is unknown, mark with "X"*** Health care facility unknown [ ]

**Appendix 4. Survey algorithm for children who did not have HCF indicated — Georgia, 2015-2016**



**Appendix 5. Survey data collection form — Georgia, 2015-2016**

## Survey Data Collection Form

| **Assessment of immunization coverage in Georgia**<br>**National Center for Disease Control and Public Health** | |
|---|---|
| **Location and Date** | |
| 1. Survey ID number *(# from the list of selected children)* | _____ |
| 2. Date completed | ___ / ___ / _____ (dd / mm / yyyy) |
| 3. Field team # | 4. Birth cohort: a. 2014 [ ]; b. 2013 [ ]; **c.** 2009 [ ] |
| 5. Survey site | a. Batumi [ ] c. Kutaisi [ ]<br>b. Tbilisi [ ] d. Rest of Georgia [ ] |
| *If the answer was "d. Rest of Georgia"* | 6. Cluster No. ____ / Sampling Unit No. _____ |
| 7. Location of health care facility (HCF) | a. City _____<br>b. District/Village _____ / _____ |
| 8. Name of HCF | |
| 9. HCF address | |

| **Demographic data** | |
|---|---|
| 10. Child's name | _____ _____<br>*First name* *Last name* |
| 11. Child's date of birth | ___ / ___ / _____ (dd / mm / yyyy) |
| 12. Sex | **a.** Male [ ] b. Female [ ] |
| Child's address (actual) | a. Region _____<br>b. City/District _____<br>c. Village _____<br>d. Address _____ |

| **Immunization data** | | |
|---|---|---|
| 13. Immunization status | a. Unvaccinated [ ]<br>**b.** Received ≥1 vaccine dose (after vaccines given at maternity hospital) [ ]<br>**c.** Only at maternity hospital (BCG/HepB0) [ ] | |
| 14. Source of immunization information *(mark all)* | HCF records [ ] | |
| | Immunization card at home [ ] | |
| | Immunization module [ ] | |
| 15. Any "commercial" vaccine received | If a child received any "commercial" vaccine, mark **"X"** [ ] | |

| Immunizations received | | | | | |
|---|---|---|---|---|---|
| **Diseases** | Vaccine | **Sequential # of doses** | **Vaccination date** (dd / mm / yyyy) | Lot No. | Brand name *(if indicated)* |
| TB | **BCG** | **[ ]** | | | |
| **Hepatitis B** *(Monovaccine for Hepatitis B is used for birth dose and was in use for other doses before 2010)* | | | | | |
| | **Hep B 0** | **0 [ ]** | | | |
| *Only if monovaccine was given* | **Hep B** | **1 [ ]** | | | |
| *Only if monovaccine was given* | **Hep B** | **2 [ ]** | | | |
| *Only if monovaccine was given* | **Hep B** | **3 [ ]** | | | |
| **Penta (DTwPHibHepB) / Hexa / DTP / DT** *(Penta since 2010; DTP before 2010; DT may be used if pertussis component is contraindicated; Hexa – "commercial" only)* | | | | | |
| *Mark one* | **Penta [ ]**<br>**Hexa [ ]**<br>**DTP [ ]**<br>**DT [ ]** | **1 [ ]** | | | |
| *Mark one* | **Penta [ ]**<br>**Hexa [ ]**<br>**DTP [ ]**<br>**DT [ ]** | **2 [ ]** | | | |
| *Mark one* | **Penta [ ]**<br>**Hexa [ ]**<br>**DTP [ ]**<br>**DT [ ]** | **3 [ ]** | | | |
| **DTP / DT** *(DT may be used if pertussis component is contraindicated)* | | | | | |
| *Mark one* | **DTP [ ]**<br>**DT [ ]** | **4 [ ]** | | | |
| DT | | | | | |
| | **DT [ ]** | **5 [ ]** | | | |
| **Rotavirus** *(since 2013)* | | | | | |
| | **Rota** | **1 [ ]** | | | |
| | **Rota** | **2 [ ]** | | | |
| **Poliomyelitis** | | | | | |
| | **OPV** | **1 [ ]** | | | |
| | **OPV** | **2 [ ]** | | | |
| | **OPV** | **3 [ ]** | | | |
| | **OPV** | **4 [ ]** | | | |
| | **OPV** | **5 [ ]** | | | |
| MMR | | | | | |
| | **MMR** | **1 [ ]** | | | |
| | **MMR** | **2 [ ]** | | | |
| **Other** (Include if child is vaccinated with any other vaccine, e.g. PCV, chickenpox) *Please complete all fields* | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Comments: | | | | | |

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