

VACCINE COVERAGE IN CANADIAN CHILDREN

RESULTS FROM THE 2013 CHILDHOOD NATIONAL
IMMUNIZATION COVERAGE SURVEY (CNICS)



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BACKGROUND

The Public Health Agency of Canada (The Agency) routinely monitors immunization coverage in Canada through the childhood National Immunization Coverage Survey (cNICS). Since 1994, the cNICS has been conducted approximately every two years to estimate national uptake for all routine childhood immunizations recommended by the [National Advisory Committee on Immunization \(NACI\)](#) (1). The survey also includes questions on parental knowledge, attitudes and beliefs (KAB) to better understand the factors influencing decisions on immunization for their children. National immunization coverage estimates provide helpful information on the level of protection against disease in Canada and can identify general trends over time in uptake of and attitudes toward vaccines. The cNICS survey results are used to measure progress towards Canada's national immunization goals (2–4) and to provide estimates of coverage to the [World Health Organization](#) and the [Pan American Health Organization](#).

National standards for reporting immunization coverage in Canada specify that up-to-date coverage should be reported by the 2nd, 7th, and 17th birthday and by vaccine antigen. It is recommended that coverage data be reported on an annual basis when using electronic immunization registries or on a biennial basis when using survey data. At the time of publication of this report, [National Standards for Immunization Coverage Assessment: Recommendations from the Canadian Immunization Registry Network](#) are available and contain guidelines to facilitate the ongoing collection of aggregate immunization coverage data.

The methods used to estimate immunization coverage with the cNICS have improved over time. Until 2009, the cNICS surveys were conducted by polling firms using convenience samples or random digit dialing. In 2011 and 2013, cNICS was conducted by Statistics Canada using a representative sampling method, and a much larger sample size in 2013. The increased sample size provides reliable coverage estimates at the national, provincial and territorial levels for the first time. This summary report includes the national level results as well as the provincial and territorial results.

METHODS

Statistics Canada conducted the 2013 cNICS between September 2013 and March 2014. The questionnaire was developed by Statistics Canada and the Agency in consultation with immunization experts across Canada. It was also reviewed by Statistics Canada's Questionnaire Review Committees before being used in the study.

The childhood vaccines included in the cNICS were those that are routine and publicly-funded under provincial/territorial programs and appropriate for the selected age groups. Travel vaccines and vaccines for high-risk medical conditions were excluded. Human papillomavirus (HPV) vaccine coverage was measured only in girls because programs for boys started in 2012, making most boys in the study not yet eligible for the vaccine at the time the survey was conducted.

SAMPLING

The target population consisted of all Canadian children excluding on-reserve First Nations. The sampling frame was built using the June 2013 version of the Canadian Child Tax Benefit (CCTB) file, which includes all applicants to the CCTB. This roster is a representative sampling frame because it includes 96% of Canadian children across Canada (5). Households with children who were 2, 7 or 17 years of age and girls between 12 and 14 years of age as of March 1, 2013, were included in the study. Sampling was stratified by provinces and territories and by age group.

Parents or guardians (hereafter referred to as respondents) were selected from the sampling frame by Statistics Canada. The sampling method ensured that only one eligible child from each household was selected.

DATA COLLECTION PROCESS

Survey data was collected through a telephone interview with the respondent and a supplemental review of the child's healthcare record. The process is described below:

Mail-out notification:

Selected respondents were mailed a letter notifying them that Statistics Canada would be calling at a later date to collect immunization information on a specific child in the household. Participants were asked to locate that child's immunization booklet in advance of the telephone interview.

Telephone interview:

Using a telephone number (includes landline or cell phone) provided in the CCTB file, a trained Statistics Canada interviewer contacted the respondent on the date provided in the mail-out notification. The respondent was asked to retrieve the selected child's immunization booklet (or some other record of immunizations, such as a school record) for the interview.

If the respondent **was able to locate their child's immunization booklet** at the time of the first call, respondents were asked:

1. to read the booklet and provide the names of the vaccines and dates administered;
2. to report any other immunizations not listed in the booklet (e.g. a school record);
3. to recall by memory whether the child was ever vaccinated for: influenza (two year-olds only), hepatitis B (17 year-olds only) and HPV (12–14 and 17 year-old girls only) if it was not already reported;
4. to answer a series of questions related to immunization KAB, such as their perception of vaccine safety, the importance of vaccines in preventing disease and where they look for information on immunization;
5. to answer questions on the family/child demographics, such as education, income, and location of birth;

6. for permission for Statistics Canada to contact the child's healthcare provider(s) to supplement the immunization information provided during the interview. All age groups in the study were included in this step.

If the respondent was not able to locate their child's immunization booklet at the time of the call, they were only asked the questions that were based on memory recall, KAB questions and demographic questions, as described above.

To allow the respondent more time to locate the child's immunization booklet, three follow-up telephone attempts were made to complete the questionnaire. If the respondent was successful in locating the booklet in a subsequent telephone attempt, they were asked to provide immunization information from the booklet. If the booklet was still unavailable after three attempts, permission was asked to follow-up with the child's healthcare provider.

For 12% of respondents, only the KAB data and immunizations based on memory recall were collected. These respondents were never able to locate their booklets and information was never received from their healthcare provider.

COLLECTING IMMUNIZATION DATA FROM THE HEALTHCARE PROVIDER

All respondents who agreed to have their healthcare provider(s) contacted were mailed a consent form by Statistics Canada. The consent form requested for the name and contact information of all healthcare providers (e.g. physician, public health unit, clinic) that administered vaccine(s) to their child.

While over 90% of respondents agreed to have Statistics Canada follow up with their healthcare provider, only 45% of these parents returned their completed consent form.

Statistics Canada followed up with all the healthcare providers identified in the consent forms and offered them a \$25 stipend for their time needed to collect the data. Healthcare providers were asked to record all the immunizations given to the child and the corresponding dates of when vaccine was administered. Statistics Canada received a healthcare provider response for approximately one third of the overall participants in the study.

Upon receipt of the healthcare provider information, Statistics Canada supplemented this information with the parent/guardian information. In some cases, there were discrepancies between the healthcare provider data and the parent/guardian data.

DISCREPANCIES AND MISSING DATA

For immunization information which had responses from the telephone interview and from the healthcare provider, the two sources were combined to capture a more complete vaccination record. If information was missing from one of the two sources, the response with reported immunization was selected.

Missing immunization information can occur in both sources. For example, vaccines given at school may not have been captured in records held by parents or by healthcare providers.

Also, the parent or guardian may not have been able to read the information recorded in the booklet because it was illegible or blank. Vaccine questions dependent on recall (i.e. influenza, hepatitis B, HPV) are also prone to memory error.

In Canada and other countries, diphtheria, pertussis and tetanus antigens are given in a combination vaccine and are not available to children as a single-antigen vaccine. If two of the three antigens were reported in the child's immunization records at a given date, it was assumed that they received all three antigens on that day. This correction was not made for other combination vaccines because other antigens may have been administered as a single-antigen vaccine in Canada and/or other countries (e.g. *Haemophilus influenzae* type B, measles).

DATA ANALYSIS

Analysis was completed using SAS 9.3 and SUDAAN 11.0.1. Based on parental and healthcare provider reports, coverage was calculated as the proportion of the eligible sample that was immunized. Coverage was weighted to be nationally representative of the Canadian population as of March 2013 and adjusted for non-response. Children were considered to be up-to-date for specific antigens if they received the full number of required vaccine doses by the recommended age (6). Minimum ages and minimum intervals were not considered when counting doses. Variances and weighted 95% confidence intervals were estimated using the bootstrap method. The quality level of an estimate is determined by the coefficient of variation. Estimates with a coefficient of variation from 16.6% to 33.3% indicated higher sampling error and were for users to interpret with caution. Estimates were considered unreliable if the coefficient of variation was greater than 33.3%; however, none of the national estimates from cNICS 2013 exceeded that threshold.

2013 CNICS SURVEY RESULTS

The overall participation rate in cNICS 2013 was 61% (Table 1).

TABLE 1: Sampling and participation, by age group—childhood National Immunization Coverage Survey, 2013

AGE GROUP	2 YEARS		7 YEARS		12-14 YEARS*		17 YEARS		TOTAL	
	N	%	N	%	N	%	N	%	N	%
Sampled	8,686	-	9,301	-	10,042	-	12,109	-	40,138	-
Contacted	6,744	77.6	7,228	77.7	7,874	78.4	9,512	78.6	31,358	78.1
Agreed to participate	5,512	63.5	5,678	61.0	6,039	60.1	7,422	61.3	24,651	61.4

* Girls only. Only HPV coverage was assessed in this age group.

DEMOGRAPHICS

Overall, 6% of children in this study were born outside Canada. The proportion increased with age, from 3% in the two year-old group to 13% in the 17 year-old group. Among all respondents (parents and guardians), 37% had secondary education or less, 36% had post-secondary education and 27% were university graduates. More than half (52%) of the respondents had annual household incomes of at least \$80,000.

NEVER VACCINATED CHILDREN

The proportion of children whose parents or guardians reported they had never received a vaccine was 1.5% (Table 2). Across age groups, children two years of age had the largest proportion (2.7%) of those who had never been vaccinated.

TABLE 2: Proportion of children never vaccinated, by age group—childhood National Immunization Coverage Survey, 2013

AGE GROUP	SAMPLE SIZE	% NEVER VACCINATED (95% CI)
2 years	5,476	2.7 (2.1, 3.4)
7 years	3,754	1.1 (0.8, 1.6)*
12–14 years (girls only)	5,720	1.0 (0.7, 1.5)*
17 years	6,990	0.8 (0.5, 1.3)*
Total	21,940	1.5 (1.3, 1.7)

* Coefficient of variation between 16.5% and 33%; interpret with caution

COVERAGE ESTIMATES BY VACCINE ANTIGEN AND AGE

The 2013 cNICS national estimates for diphtheria, pertussis, tetanus, polio, *Haemophilus influenzae* type B (Hib), measles, mumps, rubella, hepatitis B, influenza, varicella, meningococcal C, and pneumococcal by age two, seven and 17 years are detailed in Table 3. Provincial and territorial coverage diphtheria, pertussis, tetanus, polio and Hib are presented in Tables 4–6; measles, mumps and rubella in Tables 7–9; meningococcal C, pneumococcal conjugate and varicella in Table 10; hepatitis B in Table 11; influenza in Table 12; and HPV in Table 13. Due to differences in routine childhood immunization schedules, comparisons across jurisdictions may not be appropriate.

TABLE 3: Estimated national vaccination coverage of routine immunizations by two, seven, and 17 years of age—childhood National Immunization Coverage Survey, 2013

ANTIGEN	2 YEARS OF AGE		7 YEARS OF AGE		17 YEARS OF AGE	
	NUMBER OF DOSES*	COVERAGE % (95% CI)†	NUMBER OF DOSES‡	COVERAGE % (95% CI)†	NUMBER OF DOSES§	COVERAGE % (95% CI)†
Diphtheria	≥ 4	77.4 (75.3, 79.4)	≥ 5	72.2 (70.0, 74.2)	≥ 6	55.3 (52.9, 57.7)
Pertussis	≥ 4	77.0 (74.9, 79.0)	≥ 5	71.5 (69.3, 73.6)	≥ 6	52.6 (50.2, 55.0)
Tetanus	≥ 4	77.0 (74.8, 79.0)	≥ 5	71.5 (69.2, 73.6)	≥ 6	55.3 (52.9, 57.7)
Polio	≥ 3	91.1 (89.6, 92.3)	≥ 4	89.6 (88.2, 90.9)	≥ 4	85.4 (83.6, 87.0)
<i>Haemophilus influenzae</i> type B (Hib)	≥ 4	72.7 (70.6, 74.8)	≥ 4	81.3 (79.4, 83.1)	≥ 4	72.1 (69.9, 74.2)
Measles	≥ 1	89.6 (88.1, 90.9)	≥ 2	85.5 (83.8, 87.1)	≥ 2	83.6 (81.7, 85.3)
Mumps	≥ 1	89.2 (87.7, 90.6)	≥ 2	84.9 (83.1, 86.5)	≥ 2	82.2 (80.3, 84.0)
Rubella	≥ 1	89.2 (87.8, 90.6)	≥ 1	84.9 (83.1, 86.5)	≥ 1	94.5 (93.5, 95.6)
Hepatitis B	-	55.3 (50.9, 59.6)	-	68.9 (65.1, 72.5)	≥ 1	87.9 (86.6, 89.1)
Influenza	≥ 1	38.9 (37.0, 40.9)	-	-	-	-
Varicella	≥ 1	73.1 (71.0, 75.1)	-	-	-	-
Meningococcal type C conjugate	≥ 1	88.6 (86.9, 90.0)	-	-	-	-
Pneumococcal conjugate [¶]	≥ 3–4	79.3 (77.2, 81.2)	-	-	-	-

n: Non-weighted sample size

* Number of doses by 2nd birthday

† Weighted coverage estimates based on parent-reported and/or healthcare provider records

‡ Number of doses by 7th birthday

§ Number of doses by 7th birthday for polio, Hib, measles, mumps, and rubella; and by 17th birthday for diphtheria, pertussis and tetanus

¶ Coverage for 2 and 7 year-old groups were limited to jurisdictions where a 3-dose program for infants was in place (British Columbia, New Brunswick, Prince Edward Island, Yukon, Northwest Territories and Nunavut). Child was considered vaccinated if they received the number of doses recommended by the child's province/territory of residence. The 17 year-old age group includes all jurisdictions and is based on at least one dose of hepatitis B vaccine.

¶¶ Coverage indicated by 4 doses for Northwest Territories and Nunavut; 3 doses in other provinces/territories

95% CI: 95% Confidence interval (weighted)

DIPHTHERIA, PERTUSSIS, TETANUS, POLIO, AND HIB

The national coverage for four or more doses of diphtheria, pertussis and tetanus antigens by two years of age was 77% (Table 3), which is below the national immunization coverage targets at two years of age of 95% for pertussis and 97% for diphtheria and tetanus (2). In the same age group, Newfoundland and Labrador and New Brunswick were the only two provinces that had coverage over 80% for the three antigens. Meanwhile, coverage in Manitoba and the three territories was under 70% (Table 4).

Up-to-date coverage for the three antigens declined with older age groups (72% by 7 years; 53–55% by 17 years) (Table 3). Lower immunization coverage in the older age groups may reflect reporting errors by parental or healthcare provider records (i.e. school based immunizations not captured). Also, for some antigens (e.g. diphtheria, pertussis, tetanus), additional booster shots are required for older age groups where receipt of the vaccine may be delayed or not received at all.

For children seven years of age, New Brunswick had the highest up-to-date coverage (> 80%) for diphtheria, pertussis, and tetanus (DPT) (Table 5). In the same age group, DPT estimates for Nova Scotia and Nunavut were more than 10% below the national coverage. Estimates at age seven years ranged from 64% (Nunavut) to 89% (Northwest Territories) for Hib (≥ 5 doses), and 64% (Nunavut) to 95% (Newfoundland and Labrador) for polio (≥ 4 doses).

Saskatchewan had the highest percentage of children 17 years of age vaccinated with at least six doses containing DPT (68–69%) (Table 6). Five jurisdictions (Newfoundland and Labrador, Prince Edward Island, Nova Scotia, British Columbia and Nunavut) had DPT coverage under 50% for the same age group.

In Canada, the polio antigen is given in combination vaccines with diphtheria, pertussis, tetanus (i.e. DTaP-IPV or Tdap-IPV) and in most cases Hib (i.e. DTaP-IPV-Hib). Some jurisdictions use a hexavalent vaccine containing the hepatitis B antigen (DTaP-HB-IPV-Hib). By the second birthday, only 73% of children were reported to have had at least four doses of Hib-containing vaccine (Table 3).

Of all these antigens, polio had the highest up-to-date coverage by two years of age with 91% of children receiving at least three doses of polio-containing vaccine (Table 3). Provincial and territorial estimates ranged from 77% in Nunavut to 95% in Newfoundland and Labrador (Table 4). Due to differences in the number of doses required for up-to-date coverage, polio coverage is not comparable with the other antigens given in the same combination vaccine.

TABLE 4: Estimated vaccination coverage for diphtheria, pertussis, tetanus, polio and Haemophilus influenzae type B by two years of age across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/ TERRITORY	2 YEARS OF AGE – COVERAGE % (95% CI)*				
	DIPHTHERIA (≥ 4 DOSES)	PERTUSSIS (≥ 4 DOSES)	TETANUS (≥ 4 DOSES)	POLIO (≥ 3 DOSES)	HIB (≥ 4 DOSES)
Newfoundland and Labrador	84.5 (80.2, 87.9)	84.2 (79.9, 87.7)	83.9 (79.7, 87.4)	95.3 (92.3, 97.1)	83.2 (78.8, 86.9)
Prince Edward Island	75.8 (71.3, 79.8)	74.7 (70.2, 78.8)	74.3 (69.8, 78.4)	90.3 (87.1, 92.8)	68.8 (64.0, 73.2)
Nova Scotia	72.8 (67.0, 77.9)	72.8 (67.1, 77.8)	72.8 (67.1, 77.8)	90.6 (86.3, 93.6)	67.2 (61.2, 72.6)
New Brunswick	81.2 (76.7, 85.0)	80.7 (76.2, 84.5)	81.3 (76.8, 85.1)	93.5 (90.4, 95.6)	75.4 (70.6, 79.6)
Québec	79.3 (75.7, 82.5)	79.5 (75.9, 82.7)	79.3 (75.7, 82.5)	91.8 (89.2, 93.9)	72.3 (68.3, 76.0)
Ontario	79.9 (75.3, 83.7)	79.7 (75.1, 83.6)	79.7 (75.1, 83.6)	93.4 (90.3, 95.5)	75.9 (71.3, 79.9)
Manitoba	68.7 (62.4, 74.4)	67.5 (61.2, 73.3)	67.8 (61.5, 73.5)	82.8 (76.3, 87.8)	65.8 (59.5, 71.6)
Saskatchewan	77.9 (72.6, 82.5)	77.4 (72.0, 82.0)	78.0 (72.7, 82.5)	93.0 (88.8, 95.7)	71.6 (65.9, 76.6)
Alberta	71.7 (67.0, 75.9)	70.9 (66.2, 75.1)	70.9 (66.1, 75.2)	86.7 (82.9, 89.7)	69.6 (64.9, 73.9)
British Columbia	72.9 (67.6, 77.6)	71.0 (65.7, 75.8)	71.0 (65.7, 75.8)	87.7 (83.5, 90.9)	68.9 (63.6, 73.7)
Yukon	69.9 (66.2, 73.3)	68.0 (64.3, 71.5)	68.0 (64.3, 71.5)	87.3 (84.0, 90.0)	65.7 (61.9, 69.4)
Northwest Territories	64.6 (58.5, 70.2)	64.0 (57.8, 69.7)	65.2 (59.1, 70.9)	85.7 (80.6, 89.6)	61.0 (54.9, 66.8)
Nunavut	64.0 (53.8, 73.1)	60.9 (50.7, 70.2)	60.9 (50.7, 70.2)	77.1 (67.2, 84.7)	57.6 (47.2, 67.4)
Canada	77.4 (75.3, 79.4)	77.0 (74.9, 79.0)	77.0 (74.8, 79.0)	91.1 (89.6, 92.3)	72.7 (70.6, 74.8)

* Weighted coverage estimates based on parental records and/or healthcare provider records

95% CI: 95% Confidence interval (weighted)

TABLE 5: Estimated vaccination coverage for diphtheria, pertussis, tetanus, polio and Haemophilus influenzae type B by seven years of age across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/ TERRITORY	5 YEARS OF AGE – COVERAGE % (95% CI)*				
	DIPHTHERIA (≥ 5 DOSES)	PERTUSSIS (≥ 5 DOSES)	TETANUS (≥ 5 DOSES)	POLIO (≥ 4 DOSES)	HIB (≥ 4 DOSES)
Newfoundland and Labrador	77.2 (72.4, 81.4)	77.0 (72.2, 81.2)	75.7 (70.9, 80.0)	95.3 (92.3, 97.2)	86.7 (82.3, 90.1)
Prince Edward Island	69.7 (63.1, 75.7)	68.8 (62.1, 74.7)	68.8 (62.1, 74.7)	89.9 (82.4, 94.5)	83.1 (75.9, 88.4)
Nova Scotia	61.6 (55.7, 67.2)	61.3 (55.4, 66.9)	61.3 (55.4, 67.0)	80.9 (75.8, 85.2)	72.8 (67.2, 77.7)
New Brunswick	82.9 (78.3, 86.8)	82.6 (78.0, 86.5)	82.8 (78.2, 86.6)	93.0 (89.0, 95.6)	85.3 (81.0, 88.8)
Québec	75.0 (71.2, 78.4)	73.8 (70.0, 77.3)	74.7 (70.9, 78.2)	90.3 (87.4, 92.7)	84.4 (81.0, 87.3)
Ontario	69.7 (65.1, 73.9)	69.8 (65.2, 74.0)	69.4 (64.8, 73.6)	93.3 (90.3, 95.4)	83.4 (79.3, 86.8)
Manitoba	71.9 (66.3, 76.9)	71.3 (65.6, 76.3)	71.7 (66.0, 76.7)	84.7 (80.2, 88.4)	78.4 (73.2, 82.8)
Saskatchewan	67.5 (61.8, 72.7)	65.8 (60.1, 71.1)	66.1 (60.4, 71.4)	81.4 (76.0, 85.9)	74.0 (68.3, 79.0)
Alberta	75.1 (70.1, 79.4)	73.9 (68.8, 78.4)	73.4 (68.3, 77.9)	86.0 (81.7, 89.4)	77.6 (72.8, 81.8)
British Columbia	74.1 (69.1, 78.5)	72.3 (67.3, 76.9)	72.1 (67.0, 76.7)	84.8 (80.5, 88.3)	76.1 (71.3, 80.4)
Yukon	64.7 (60.4, 68.7)	64.7 (60.4, 68.7)	64.7 (60.4, 68.7)	76.3 (72.3, 79.9)	72.2 (67.9, 76.0)
Northwest Territories	70.7 (65.5, 75.4)	69.9 (64.7, 74.6)	69.9 (64.7, 74.6)	91.7 (87.5, 94.5)	88.9 (84.7, 92.1)
Nunavut	45.8 (37.0, 54.8)	44.5 (35.7, 53.7)	51.3 (42.1, 60.3)	64.1 (54.9, 72.5)	64.1 (54.9, 72.5)
Canada	72.2 (70.0, 74.2)	71.5 (69.3, 73.6)	71.5 (69.2, 73.6)	89.6 (88.2, 90.9)	81.3 (79.4, 83.1)

* Weighted coverage estimates based on parental records and/or healthcare provider records

95% CI: 95% Confidence interval (weighted)

TABLE 6: Estimated vaccination coverage for diphtheria, pertussis, tetanus, polio and Haemophilus influenzae type B by seventeen years of age across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/ TERRITORY	17 YEARS OF AGE – COVERAGE % (95% CI)*				
	DIPHTHERIA (≥ 6 DOSES)	PERTUSSIS (≥ 6 DOSES)	TETANUS (≥ 6 DOSES)	POLIO (≥ 4 DOSES)	HIB (≥ 4 DOSES)
Newfoundland and Labrador	40.8 (35.9, 45.8)	39.4 (34.6, 44.4)	40.6 (35.7, 45.6)	92.7 (89.4, 94.9)	78.9 (74.5, 82.8)
Prince Edward Island	27.0 (22.5, 32.0)	25.2 (20.8, 30.2)	26.4 (22.0, 31.4)	88.6 (84.4, 91.8)	67.8 (62.7, 72.6)
Nova Scotia	40.7 (34.4, 47.3)	38.9 (32.7, 45.3)	39.8 (33.6, 46.3)	80.4 (75.3, 84.6)	71.2 (65.3, 76.4)
New Brunswick	53.0 (48.1, 57.9)	52.7 (47.7, 57.5)	53.5 (48.6, 58.3)	88.9 (85.3, 91.7)	76.7 (72.3, 80.6)
Québec	60.4 (56.6, 64.1)	58.8 (54.9, 62.5)	60.3 (56.5, 64.0)	82.9 (79.6, 85.7)	67.7 (63.9, 71.2)
Ontario	55.7 (51.2, 60.2)	52.0 (47.5, 56.5)	56.0 (51.5, 60.5)	88.1 (84.7, 90.8)	73.5 (69.2, 77.3)
Manitoba	56.2 (50.9, 61.3)	52.6 (47.3, 57.9)	56.4 (51.1, 61.6)	80.4 (75.8, 84.3)	75.7 (71.0, 79.9)
Saskatchewan	68.1 (63.1, 72.7)	67.9 (62.9, 72.5)	69.0 (63.9, 73.6)	86.5 (82.5, 89.8)	78.1 (73.4, 82.2)
Alberta	51.3 (46.1, 56.5)	49.3 (44.2, 54.6)	51.0 (45.7, 56.3)	85.0 (80.6, 88.5)	77.4 (72.8, 81.4)
British Columbia	45.2 (39.6, 50.8)	42.1 (36.6, 47.8)	44.0 (38.5, 49.7)	81.0 (76.2, 85.0)	69.1 (63.7, 74.0)
Yukon	60.1 (54.9, 65.0)	56.3 (51.2, 61.4)	60.1 (54.9, 65.0)	78.7 (73.8, 82.8)	66.3 (61.2, 71.0)
Northwest Territories	54.3 (50.2, 58.5)	51.0 (46.7, 55.2)	56.9 (52.7, 61.1)	85.2 (81.3, 88.4)	72.9 (68.7, 76.7)
Nunavut	30.5 (23.0, 39.2)	24.8 (18.0, 33.1) [†]	36.4 (28.1, 45.5)	51.1 (42.2, 60.0)	54.2 (44.9, 63.2)
Canada	55.3 (52.9, 57.7)	52.6 (50.2, 55.0)	55.3 (52.9, 57.7)	85.4 (83.6, 87.0)	72.1 (69.9, 74.2)

* Weighted coverage estimates based on parental records and/or healthcare provider records

[†] Coefficient of variation between 16.5% and 33%; interpret with caution

95% CI: 95% Confidence interval (weighted)

MEASLES, MUMPS, AND RUBELLA

In Canada, measles, mumps and rubella are given as a combination vaccine (i.e. MMR) and, in some cases, with varicella as well (i.e. MMR-V). By two years of age, the national coverage was 90% for at least one dose of measles-containing vaccine and 89% for mumps- and rubella-containing vaccine (Table 7). This is below the national immunization target of 97% at two years of age for all three antigens (3).

Up-to-date coverage by the second birthday across jurisdictions ranged from 78% (Nunavut) to 95% (Newfoundland and Labrador) for measles and 75% (Nunavut) to 95% (Newfoundland and Labrador) for mumps and rubella (Table 7).

There was greater variation across jurisdictions among older age groups (Table 8). At the national level, 86% of 7-year old children had received two dose of measles-containing vaccine. The reported coverage for mumps was slightly lower, with 85% of children having received two doses of vaccines. Among jurisdictions, New Brunswick had the highest coverage, 92%, while Nova Scotia and Nunavut had coverage under 70% for the two antigens. Rubella coverage was much higher, as children are considered as vaccinated with only one dose of vaccine. The national coverage was 95%, and provincial/territorial rates ranged from 73% (Nunavut) to 98% (Newfoundland and Labrador).

TABLE 7: Estimated vaccination coverage for measles, mumps, and rubella by two years of age across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/ TERRITORY	2 YEARS OF AGE - COVERAGE % (95% CI)*		
	MEASLES (≥ 1 DOSE)	MUMPS (≥ 1 DOSE)	RUBELLA (≥ 1 DOSE)
Newfoundland and Labrador	95.1 (92.2, 97.0)	95.1 (92.2, 97.0)	95.1 (92.2, 97.0)
Prince Edward Island	90.2 (87.3, 92.5)	90.2 (87.3, 92.5)	90.2 (87.3, 92.5)
Nova Scotia	85.8 (81.0, 89.5)	85.5 (80.6, 89.3)	85.5 (80.6, 89.3)
New Brunswick	92.3 (89.1, 94.7)	92.3 (89.1, 94.7)	92.3 (89.1, 94.7)
Québec	90.6 (88.0, 92.7)	90.6 (88.0, 92.7)	90.6 (88.0, 92.7)
Ontario	92.6 (89.5, 94.8)	92.0 (88.9, 94.3)	92.0 (88.9, 94.3)
Manitoba	82.8 (76.3, 87.9)	82.8 (76.3, 87.9)	82.8 (76.3, 87.9)
Saskatchewan	90.1 (85.6, 93.3)	89.6 (85.0, 92.9)	89.1 (84.5, 92.5)
Alberta	82.0 (77.8, 85.5)	81.1 (76.9, 84.8)	81.1 (76.9, 84.8)
British Columbia	86.9 (82.7, 90.2)	86.9 (82.7, 90.2)	87.1 (82.9, 90.4)
Yukon	85.2 (82.1, 87.9)	85.2 (82.1, 87.9)	85.2 (82.1, 87.9)
Northwest Territories	84.0 (79.0, 88.0)	80.8 (75.5, 85.2)	80.8 (75.5, 85.2)
Nunavut	78.2 (68.2, 85.7)	75.1 (65.2, 82.9)	75.1 (65.2, 82.9)
Canada	89.6 (88.1, 90.9)	89.2 (87.7, 90.6)	89.2 (87.8, 90.6)

* Weighted coverage estimates based on parental records and/or healthcare provider records

95% CI: 95% Confidence interval (weighted)

TABLE 8: Estimated vaccination coverage for measles, mumps, and rubella by seven years of age across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/ TERRITORY	7 YEARS OF AGE - COVERAGE % (95% CI)*		
	MEASLES (≥ 2 DOSES)	MUMPS (≥ 2 DOSES)	RUBELLA (≥ 1 DOSE)
Newfoundland and Labrador	84.3 (79.8-87.9)	84.3 (79.8-87.9)	97.8 (96.1-99.4)
Prince Edward Island	83.7 (77-88.7)	82.9 (76.1-88)	95.9 (93.7-98.2)
Nova Scotia	69.7 (64.1-74.9)	69.7 (64-74.8)	91.9 (88.5-95.2)
New Brunswick	92.2 (88.3-94.9)	92.2 (88.3-94.9)	96.4 (93.9-98.9)
Québec	90.9 (88-93.1)	90.4 (87.5-92.7)	96.0 (94.3-97.8)
Ontario	88.5 (84.8-91.4)	88.1 (84.3-91)	95.9 (93.8-98.0)
Manitoba	76.4 (71.1-81)	75.1 (69.8-79.8)	92.8 (89.9-95.8)
Saskatchewan	79.3 (73.7-84)	78.6 (73-83.3)	90.7 (87.0-94.4)
Alberta	75.4 (70.3-79.8)	74.3 (69.2-78.9)	90.6 (87.6-93.7)
British Columbia	83.4 (79.1-87)	82.4 (78. 86)	92.7 (89.9-95.5)
Yukon	77.5 (73.7-81)	73.4 (69.4-77.1)	86.7 (83.6-89.7)
Northwest Territories	87.2 (82.3-90.8)	88.4 (83.9-91.7)	95.6 (93.1-98.1)
Nunavut	62.3 (53.4-70.5)	61.1 (52-69.4)	72.7 (64.2-81.3)
Canada	85.5 (83.8-87.1)	84.9 (83.1-86.5)	94.5 (93.5-95.6)

* Weighted coverage estimates based on parental records and/or healthcare provider records

95% CI: 95% Confidence interval (weighted)

TABLE 9: Estimated vaccination coverage for measles, mumps and rubella by 17 years of age across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/ TERRITORY	17 YEARS OF AGE - COVERAGE % (95% CI)*		
	MEASLES (≥ 2 DOSES)	MUMPS (≥ 2 DOSES)	RUBELLA (≥ 2 DOSES)
Newfoundland and Labrador	87.5 (83.6, 90.5)	87.5 (83.6, 90.5)	95.2 (93.0-97.5)
Prince Edward Island	79.4 (75.1, 83.1)	79.0 (74.7, 82.7)	93.6 (91.0-96.3)
Nova Scotia	67.6 (58.7, 75.4)	66.7 (58.0, 74.5)	90.6 (87.4-93.8)
New Brunswick	73.4 (68.6, 77.6)	73.1 (68.4, 77.3)	95.8 (93.7-97.9)
Québec	88.3 (85.5, 90.6)	86.0 (83.1, 88.4)	94.1 (92.3-95.9)
Ontario	84.4 (80.7, 87.6)	83.7 (79.9, 86.9)	95.5 (93.4-97.5)
Manitoba	84.9 (80.6, 88.3)	83.4 (79.0, 87.0)	93.5 (90.8-96.1)
Saskatchewan	89.0 (85.3, 91.8)	82.7 (78.2, 86.3)	95.4 (93.1-97.6)
Alberta	78.9 (74.2, 82.9)	78.1 (73.4, 82.2)	89.4 (86.1-92.7)
British Columbia	74.1 (68.7, 78.8)	72.6 (67.3, 77.4)	89.2 (85.5-92.9)
Yukon	80.2 (75.4, 84.2)	78.4 (73.6, 82.5)	90.0 (86.4-93.5)
Northwest Territories	92.0 (89.1, 94.2)	90.8 (87.8, 93.1)	97.1 (95.6-98.7)
Nunavut	65.2 (55.7, 73.6)	58.8 (49.3, 67.8)	71.7 (62.9-80.5)
Canada	83.6 (81.7, 85.3)	82.2 (80.3, 84.0)	93.8 (92.7-94.9)

* Weighted coverage estimates based on parental records and/or healthcare provider records

95% CI: 95% Confidence interval (weighted)

VARICELLA, MENINGOCOCCAL-C CONJUGATE, AND PNEUMOCOCCAL CONJUGATE

The introduction of public immunization programs for varicella (2000–2007), meningococcal-C conjugate (2002–2005) and pneumococcal conjugate (2002–2005) vaccines was staggered across provinces and territories (7–9). Because a proportion of children aged seven years or older were not eligible for those vaccines, only estimates by the age of two years were reported.

By two years of age, 87% of children received at least one dose of the meningococcal C conjugate vaccine (Table 10). Across jurisdictions, coverage ranged from 78% (Manitoba/Nunavut) to 93% (British Columbia).

For the pneumococcal conjugate vaccine, the national coverage at two years of age was 79%. Estimates were lowest (53%–59%) in jurisdictions requiring at least four or more doses by age two years as compared with immunization programs where three doses were recommended (72%–90%).

The reported national coverage for at least one dose of the varicella vaccine by the second birthday was 73% (Table 3), and provincial/territorial results are shown in Table 10. These results are to be interpreted with caution given the large differences between varicella and measles, mumps and rubella coverage estimates from provinces that have been administering all these antigens in combination (as MMRV) in or before 2011 (Newfoundland and Labrador, Prince Edward Island, New Brunswick, Quebec, Saskatchewan and Alberta). In these jurisdictions, children surveyed in 2013 should have had their varicella vaccine as MMRV and, therefore, their varicella coverage should be very close to their coverage for measles, mumps and rubella. Possible causes of under-reporting are discussed in the limitations section of this report.

TABLE 10: Estimated vaccination coverage for meningococcal C, pneumococcal conjugate and varicella by two years of age, across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/ TERRITORY	2 YEARS OF AGE – COVERAGE % (95% CI)*		
	MENINGOCOCCAL C (≥ 1 DOSE)	PNEUMOCOCCAL (≥ 3–4 DOSES) [†]	VARICELLA (≥ 1 DOSE)
Newfoundland and Labrador	91.6 (88.1, 94.2)	90.1 (86.5, 92.8)	89.7 (86.2, 92.4)
Prince Edward Island	88.5 (85.1, 91.2)	83.8 (79.9, 87.1)	66.1 (61.2, 70.7)
Nova Scotia	84.7 (79.9, 88.5)	81.9 (76.6, 86.2)	78.6 (73.2, 83.2)
New Brunswick	88.2 (84.5, 91.0)	82.2 (77.8, 85.8)	80.1 (75.9, 83.8)
Québec	89.1 (86.2, 91.4)	82.0 (78.5, 85.0)	53.9 (49.7, 58.0)
Ontario	88.7 (85.0, 91.6)	79.5 (75.0, 83.4)	81.9 (77.5, 85.6)
Manitoba	78.3 (71.6, 83.7)	76.9 (70.4, 82.3)	78.6 (72.1, 83.9)
Saskatchewan	89.7 (85.2, 92.9)	88.7 (83.8, 92.3)	71.0 (65.3, 76.2)
Alberta	85.8 (81.9, 89.0)	72.2 (67.5, 76.5)	74.8 (70.2, 79.0)
British Columbia	93.1 (89.5, 95.5)	76.3 (71.4, 80.6)	84.6 (80.2, 88.1)
Yukon	89.9 (86.6, 92.5)	81.3 (77.4, 84.7)	73.2 (69.4, 76.7)
Northwest Territories	90.4 (86.1, 93.5)	52.7 (46.6, 58.8)	81.5 (76.1, 85.9)
Nunavut	78.2 (68.1, 85.7)	59.4 (48.9, 69.1)	74.9 (64.6, 82.9)
Canada	88.6 (86.9, 90.0)	79.3 (77.2, 81.2)	73.1 (71.0, 75.1)

* Weighted coverage estimates based on parental records and/or healthcare provider records

† Coverage indicates 4 doses for Northwest Territories and Nunavut; 3 doses for other provinces/territories

95% CI: 95% Confidence interval (weighted)

HEPATITIS B

Depending on the province or territory, the hepatitis B vaccine is administered as part of routine infant immunization or through school-based programs. For jurisdictions with a three-dose hepatitis B infant immunization program, the coverage estimates by two and seven years of age were 68% and 75%, respectively (Table 11). There was wide variation in coverage estimates for two- and seven-year-olds across provinces and territories (Table 11). Up-to-date coverage by the second birthday was highest in Prince Edward Island and British Columbia (> 70%) and lowest in New Brunswick and Nunavut (< 40%).

By 17 years of age, 88% of Canadian children had at least one dose of the hepatitis B vaccine. Across jurisdictions, estimates ranged from 78% (Yukon) to 94% (Quebec).

TABLE 11: Estimated vaccination coverage for hepatitis B by two, seven and 17 years of age, across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/ TERRITORY	2 YEARS OF AGE [†] (≥ 3 DOSES)	7 YEARS OF AGE [†] (≥ 3 DOSES)	17 YEARS OF AGE [‡] (≥ 1 DOSE)
Newfoundland and Labrador	-	-	84.9 (82.2, 87.3)
Prince Edward Island	74.7 (69.8, 79.0)	85.0 (78.0, 90.1)	84.2 (81.1, 86.8)
Nova Scotia	-	-	86.9 (84.1, 89.3)
New Brunswick	39.7 (34.8, 44.9)	37.7 (32.9, 42.7)	91.4 (88.8, 93.5)
Québec	-	-	93.5 (91.5, 95.1)
Ontario	-	-	86.3 (83.4, 88.8)
Manitoba	-	-	79.2 (75.9, 82.2)
Saskatchewan	-	-	85.3 (82.2, 88.0)
Alberta	-	-	89.1 (86.4, 91.3)
British Columbia	72.6 (67.4, 77.3)	80.9 (76.3, 84.8)	85.5 (82.4, 88.2)
Yukon	68.1 (64.1, 71.9)	72.4 (68.2, 76.3)	77.9 (74.4, 81.1)
Northwest Territories	49.1 (43.0, 55.1)	42.6 (37.6, 47.8)	82.8 (80.2, 85.1)
Nunavut	36.4 (26.9, 47.1)	43.0 (34.5, 52.0)	84.9 (82.2, 87.3)
Canada	67.6 (63.3, 71.6)	74.5 (70.8, 77.9)	87.9 (86.6, 89.1)

* Weighted coverage estimates based on parental records and/or healthcare provider records and/or parental recall.

† Coverage for 2 and 7 year-old age groups were limited to jurisdictions where a 3-dose program for infants was in place (British Columbia, New Brunswick, Prince Edward Island, Yukon, Northwest Territories and Nunavut). Child was considered vaccinated if they received the number of doses recommended by the child's province/territory of residence.

‡ Coverage for the 17 year-old age group is based on parental recall only and includes all jurisdictions.

95% CI: 95% Confidence interval (weighted)

INFLUENZA

While the influenza vaccine is recommended for all individuals six months of age or older across Canada, children between six to 59 months of age are considered at high risk for influenza-related complications. Influenza coverage was the lowest among all antigens by the second birthday, with only 39% of children having received at least one dose of the influenza vaccine (Table 12). Provincial and territorial estimates ranged from 32% in Newfoundland and Labrador and Ontario to 58% in Nova Scotia. Six jurisdictions (Nova Scotia, New Brunswick, Saskatchewan, Alberta, Yukon, Nunavut) had coverage greater than 50%.

TABLE 12: Estimated vaccination coverage for influenza by two years of age, across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/TERRITORY	2 YEARS OF AGE ≥ 1 DOSE INFLUENZA COVERAGE % (95% CI)*
Newfoundland and Labrador	31.8 (27.3, 36.6)
Prince Edward Island	49.8 (45.5, 54.1)
Nova Scotia	58.3 (53.6, 63.0)
New Brunswick	50.5 (45.8, 55.2)
Québec	35.5 (31.8, 39.4)
Ontario	32.1 (28.2, 36.3)
Manitoba	38.9 (34.3, 43.6)
Saskatchewan	56.8 (52.1, 61.5)
Alberta	54.7 (50.4, 59.0)
British Columbia	38.2 (33.8, 42.8)
Yukon	54.0 (50.5, 57.4)
Northwest Territories	46.3 (41.6, 51.0)
Nunavut	50.5 (45.3, 55.7)
Canada	38.9 (37.0, 40.9)

* Weighted coverage estimates based on parental recall

95% CI: 95% Confidence interval (weighted)

Influenza vaccine coverage for seven and 17 year-olds were excluded from the report because they are not considered as high-risk for influenza-related complications.

HPV

Publicly funded HPV vaccine programs have been gradually introduced across Canada since 2007. By 2010, all provinces and territories had implemented an HPV immunization program for pre-adolescent/adolescent girls (10). Among girls 12 to 14 years of age, 72% had at least one dose of the HPV vaccine (Table 13). Girls 12 years of age in Ontario were excluded from the HPV coverage calculation because many were not eligible for the province's public HPV vaccine program that starts in Grade 8.

Newfoundland and Labrador, Prince Edward Island and New Brunswick were the only three provinces that had coverage over 80%. Meanwhile, estimates from the three territories were more than 10% lower than the national coverage.

TABLE 13: Estimated vaccination coverage for human papillomavirus (≥ 1 dose) among females 12–14 years of age, across provinces and territories—childhood National Immunization Coverage Survey, 2013

PROVINCE/TERRITORY	FEMALES–12-14 YEARS OF AGE ≥ 1 DOSE HPV COVERAGE % (95% CI)*
Newfoundland and Labrador	89.3 (86.4, 91.7)
Prince Edward Island	84.1 (80.5, 87.2)
Nova Scotia	78.9 (75.3, 82.1)
New Brunswick	81.5 (77.7, 84.8)
Québec	79.7 (76.4, 82.6)
Ontario [†]	67.6 (62.7, 72.2)
Manitoba	65.2 (60.9, 69.3)
Saskatchewan	76.1 (72.0, 79.8)
Alberta	70.8 (67.0, 74.4)
British Columbia	67.6 (63.2, 71.7)
Yukon	64.3 (61.2, 67.3)
Northwest Territories	52.4 (48.4, 56.3)
Nunavut	52.6 (47.0, 58.0)
Canada	72.3 (70.3, 74.1)

* Weighted coverage estimates based on parental recall

[†] Girls 12 years of age in Ontario were excluded from the HPV coverage calculation because many were not eligible for province's public HPV vaccine program that starts in Grade 8.

HPV: Human papillomavirus

95% CI: 95% Confidence interval (weighted)

PARENTAL KNOWLEDGE, ATTITUDES AND BELIEFS (KAB)

A series of questions were asked pertaining to respondents' knowledge, attitudes and beliefs (KAB) related to vaccines and vaccination. The total sample size for the KAB portion of the cNICS 2013 is higher (n=24,650) than the portion of the 2013 cNICS measuring immunization coverage (n=21,944) because parents who could not locate their child's immunization record were still asked KAB questions.

An excerpt of the KAB questions and results are included in Table 14. Further analysis of the entire collection of KAB data will be conducted by the Agency at a later date.

In summary, the majority of respondents strongly agreed or somewhat agreed that childhood vaccines are safe (95%), effective (97%) and are important for children's health (97%) (Table 4). On the other hand, respondents strongly agreed (34%) or somewhat agreed (36%) that they were concerned about potential side effects from vaccines.

Most Canadian parents strongly agreed or somewhat agreed that they understood how vaccines work (96%). Some parents strongly agreed (12%) or somewhat agreed (25%) that a vaccine can cause the same disease it was meant to prevent. Inactivated vaccines (e.g. Hepatitis B) contain killed bacteria or viruses that cannot cause disease. In extremely rare circumstances, live attenuated vaccines (i.e. derived from weakened bacteria or virus) can cause disease, such as the live oral polio vaccine which has not been used in Canada since 1996 (11, 12). A small proportion of respondents strongly agreed (5%) that alternative practices, such as homeopathy or chiropractics, can eliminate the need for vaccines. These results show there is still room for improvement in increasing knowledge about immunization given that homeopathic alternatives, such as nosodes, are not a substitute for vaccines.

TABLE 14: Level of agreement with the selected statements about vaccines, childhood National Immunization Coverage Survey, 2013

STATEMENT	RESPONSE % (95% CI)*				
	STRONGLY AGREE	SOMEWHAT AGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE	DO NOT KNOW†
In general, childhood vaccines are safe	59.9 (59.0, 60.9)	34.9 (33.9, 35.8)	3.9 (3.5, 4.3)	1.3 (1.1, 1.6)	-
In general, childhood vaccines are effective	67.1 (66.2, 68.0)	30.0 (29.1, 30.9)	2.2 (1.9, 2.5)	0.7 (0.5, 0.9)	-
In general childhood vaccines are important to child's health	74.0 (73.1, 74.9)	22.6 (21.8, 23.4)	2.4 (2.1, 2.7)	1.0 (0.8, 1.2)	-
In general, understand how vaccines work	64.6 (63.7, 65.6)	31.3 (30.5, 32.2)	2.9 (2.6, 3.3)	1.1 (0.9, 1.4)	-
In general concerned about the potential side effects from vaccines	33.5 (32.5, 34.6)	36.2 (35.3, 37.2)	15.8 (15.0, 16.5)	14.5 (13.8, 15.2)	-
In general, a vaccine can give you a serious case of the very same disease it was meant to prevent	12.2 (11.5, 12.9)	25.4 (24.5, 26.3)	27.5 (26.6, 28.4)	27.9 (27.0, 28.8)	7.1 (6.6, 7.6)
In general, the use of alternative practices, such as homeopathy or chiropractics, can eliminate the need for vaccination	4.7 (4.2, 5.2)	12.4 (11.7, 13.1)	25.0 (24.1, 25.8)	48.7 (47.7, 49.7)	9.3 (8.7, 9.9)

* Weighted response estimates

† For items where a large number of respondents answered "Do not know", the results were also presented with this response category. For questions where 1% or fewer respondents answering "Do not know", this response category was excluded from the analysis.

95% CI: 95% Confidence interval (weighted)

LIMITATIONS OF THE 2013 CNICS

As with any large scale survey, the cNICS has some limitations that must be considered when interpreting the results. The limitations are summarized below.

SELECTION BIAS

Surveys can be affected by selection bias, as those who agree to participate may be different from those who decline with respect to some variables collected in the survey. The potential for selection bias increases with decreasing response rate. In the case of cNICS, it is possible that parents who had their children immunized may have been more eager to participate than those who did not have their children immunized.

INCOMPLETE INFORMATION IN RECORDS

In some cases, there was missing information in the immunization booklet held by respondents and/or the healthcare provider if immunizations were not recorded or captured correctly. A combined parent/guardian and healthcare provider report was considered the most complete record. However, only one-third of all respondents had a healthcare provider return immunization information.

Missing information may partly explain the variations of coverage estimates for antigens that are given together in a 'combination' vaccine, such as measles, mumps and rubella. As well, booster vaccines administered through school programs (e.g. Tdap—a combined vaccine with tetanus, diphtheria and pertussis) may not have been reported in records held by parents, which may contribute to the lower immunization rates seen in older age groups.

For vaccines that are always administered in combination in all jurisdiction, such as measles, mumps, and rubella, parents who reported that their child received one antigen but not the other were told that these antigen are normally administered in combination, and asked to confirm that the child received one but not the other. However, this confirmation was not made for vaccines that are administered in combination in only some jurisdictions, such as varicella with MMR. This could explain the lower rates observed in two-year-old children in some jurisdictions.

DIFFERENCES IN IMMUNIZATIONS PROGRAM DELIVERY AND COVERAGE ASSESSMENT IN CANADA

In some jurisdictions, immunizations are administered primarily by public health and in others, by physicians. Some jurisdictions have also introduced pharmacist-administered vaccination programs (13). For the cNICS 2013 sample, healthcare provider records were, for the most part, given by a child's physician(s), local health unit(s) or *Centre local de services communautaires* (CLSC) in Quebec. Only in some cases was provincial public health contacted. Records kept through electronic immunization registries may be more complete than paper-based records. The healthcare provider was not asked for their source of data (e.g. paper-based chart, provincial electronic immunization registry, public health record).

As well, the existence of a robust provincial/territorial electronic immunization registry may negate the need (or perceived need) for a parent or guardian to maintain an up-to-date hand-held record at home. As a result, in jurisdictions with electronic registries, parents may be less inclined to keep accurate records of their child's immunizations, which can lead to higher reporting error.

VACCINES ADMINISTERED TO ADOLESCENTS

For some vaccines administered at school (e.g. hepatitis B at 17 years of age and HPV), data collection relied to a large extent on parental recall. As parents were asked whether or not their child had ever received the vaccine, rather than the exact number of doses received, the coverage estimates presented are the proportion of children having received at least one dose of the vaccine. We were therefore unable to calculate the proportion of children vaccinated with all doses required to be up-to-date for specific antigens. Therefore, these proportions do not represent vaccine coverage as they will overestimate it.

AT-RISK POPULATIONS

The socio-demographic information collected in cNICS 2013 was minimal, thus limiting our ability to identify specific at-risk populations. Further analyses of the associations between the variables included in cNICS 2013 (e.g. country of origin) and immunization practices are currently underway. Coverage analysis at the community level to identify under-immunized groups is not possible using cNICS data.

DISCUSSION

This is by far the largest immunization coverage survey ever carried out in Canada. The large sample size resulted in precise coverage estimates with small margins of error. This survey allowed for the estimation of immunization coverage across provinces and territories for the first time.

As we are not meeting the target rates outlined in the national goals and objectives (Table 15), more effort is needed to achieve higher coverage levels. For this we need to better understand of factors affecting vaccine acceptance and uptake, and to better identify sub-populations at risk of under-immunization. At the same time, we need to improve our methods to estimate immunization coverage.

TABLE 15: Comparison of 2013 cNICS results with national immunization coverage goals

ANTIGEN	AGE GROUP (YEARS)	DEFINITION (DOSES)	NATIONAL COVERAGE GOAL ^A (%)	COVERAGE BASED ON CNICS 2013 (%)
Diphtheria ¹	2	≥ 4	97	77
	7	≥ 5	99	72
Tetanus ¹	2	≥ 4	97	77
	7	≥ 5	99	72
Pertussis	2	≥ 4	95	77
	7	≥ 5	95	72
Haemophilus influenzae type B ¹	7	≥ 4	97	73
Polio ¹	2	≥ 3	97	91
Measles ¹	2	≥ 1	97	90
	7	≥ 2	99	86
Mumps ¹	2	≥ 1	97	89
	7	≥ 2	99	85
Rubella ²	2	≥ 1	97	89
	7	≥ 1	97	95
	14–16	Not specified	97	94
Varicella ²	2	≥ 1	85	73
Meningococcal C conjugate ²	2	Not specified	97	87
Pneumococcal conjugate ²	2	Not specified	90	79

There are coverage goals for influenza, but not for the age groups included in cNICS 2013

^a National immunization coverage goals were set in 1992, 1994 and 2005.

For most antigens, immunization coverage for children 17 years of age was lowest as compared with younger age groups. This may be a result of missing and incomplete records but could also reflect a delay in receiving additional booster shots recommended for adolescents.

It is, however, encouraging to see that the recent imported measles cases resulted only in pockets of disease where larger outbreaks were restricted to non-immunizing communities (i.e. outbreaks did not spread outside these communities) (14). This could indicate adequate coverage in the general population. The very low proportion (1.5%) of children reported to be not vaccinated at all is also encouraging, especially considering that this overall rate (unlike the vaccine-specific coverage rates) is not affected by incomplete records.

Polio and MMR coverage by two years of age were similar to estimates reported in the United States (15), Australia (16) and England (4). International comparisons are not possible for some vaccines where up-to-date definitions and vaccine schedules are different from Canada. Because of public vaccination programs and vigilant surveillance, there has been no endemic transmission of polio, measles and rubella cases in Canada since 1977, 1998, and 2005, respectively. With on-going disease activity in other regions of the world, imported cases of disease can occur and can lead to large outbreaks. As such, high vaccination coverage is

required to maintain disease elimination in Canada and contribute to international efforts in disease eradication.

Because of varying routine childhood immunization schedules across jurisdictions, coverage estimates between provinces and territories may not be comparable and need to be interpreted with caution. As well, due to changes in immunization programs over time, the eligibility for certain vaccines were different across the age groups of interest. The [routine immunization schedule for infants and children](#) contains current information on programs across provinces and territories and is updated quarterly. In addition, even with rigorous survey methodology, reported coverage estimates are an underestimate of the true coverage due to the limitations in measurement as described in the *Limitations of the 2013 cNICS* section above.

The cNICS 2013 results are not comparable with estimates reported by provinces and territories because of differences in methods used to determine coverage. Provinces and territories monitor coverage by immunization registries/repository and/or periodic surveys. Electronic registries do not rely on parental records/recall and cover a larger proportion of the population within the jurisdiction where the registry is implemented. Also, the age groups used to estimate coverage may be different from the sample used in cNICS 2013. Differences in coverage assessment are described, with the example of measles vaccine by second birthday, in Appendix 1.

Electronic registries are being implemented in provinces and territories across Canada. A fully functional immunization registry, as defined by the Canadian Immunization Registry Network, is one that complies with the national functional and data standards, allows for exchange of information across jurisdictions and includes all children 17 years of age or younger (17). A fully functional immunization registry will provide precise and real-time coverage estimates within a jurisdiction. The cNICS will continue to be used to estimate national coverage while the Agency continues to support provinces and territories in establishing a robust network of immunization registries.

Finally, the results on knowledge, attitudes and beliefs indicate that overall, Canadian parents trust the effectiveness of recommended vaccines and believe they are useful. Although 95% believe that vaccines are safe, more than two thirds are concerned about vaccine side effects and more than one third believe that vaccines can cause the diseases they are meant to prevent. This finding requires further investigation and shows that there is still room for improvement in increasing public knowledge about immunization.

This report is only a snapshot in time of national coverage estimates by age group. Further analyses on the factors determining why people are under or non-immunized are underway and will be published in the future. Socio-economic determinants to be investigated may include parental education, household income, country of origin and immigrant status. In addition, associations between knowledge, attitudes and beliefs, and non-vaccination or refusal of specific antigens will be investigated. These analyses will allow the Agency to further explore populations at risk and to assess the need for special surveys.

Future cNICS surveys will explore the feasibility of collecting more information from healthcare providers and from a broader range of immunization providers. Future surveys will also request the source of data used by the healthcare provider (e.g. patient paper record, immunization

registry in healthcare facility, jurisdictional immunization registry, public health record) to ensure the most complete record is being referenced. In partnership with Statistics Canada, the Agency carried out the 2015 cNICS. Once the 2015 results are available, the Agency will analyze the national coverage estimate trends from 2011–2015. The three cNICS surveys (2011, 2013 and 2015) used consistent methodology and the data processing will be consistently applied across all three national-level surveys. This will enable the Agency to monitor trends over time in immunization.

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APPENDIX 1

Comparison of vaccination coverage reported by provinces and territories, and cNICS 2013 results for measles-containing vaccine by two years of age

PROVINCE OR TERRITORY	DATA SOURCE	COVERAGE DEFINITION	AGE GROUP (YEARS)	YEAR	COVERAGE REPORTED BY P/T (%)	CNICS 2013 RESULTS ^a (%)
Newfoundland and Labrador	Registry	MMRV, 1 dose	2	2011–2012	95.5	95.1
Prince Edward Island	No publicly available data					
Nova Scotia	Registry	MMR, 1 dose	2	2008	85.9	85.8
New Brunswick	No comparable publicly available data					
Québec	Survey	Measles, 1 dose	2	2014	96.7	90.6
Ontario	Registry	Measles, 2 doses	7	2012–2013	88.3	88.5
Manitoba	Registry	MMR, 1 dose	2	2013	81.2	82.8
Saskatchewan	Registry	MMR, 1 dose	2	2010–2011	71	90.1
Alberta	Registry	MMR, 1 dose	2	2013	88.3	82.0
British Columbia	Registry	MMR, 1 dose	2	2014	85	86.9
Yukon	Registry	MMR, 1 dose	2	2011	75	85.2
Northwest Territories	Registry	MMR, 1 dose	2	2009	77.4	84.0
Nunavut	No publicly available data					

MMR: Measles, mumps, rubella

MMRV: Measles, mumps, rubella and varicella

Publicly available provincial/territorial data closest in time from cNICS 2013 (i.e., not necessarily the most recent) were reported here

^a Percentage of children having received one dose of measles-containing vaccine by their second birthday (2 years) or two doses by 7th birthday (7 years)

