VACCINE COVERAGE IN CANADIAN CHILDREN

RESULTS FROM THE 2017 CHILDHOOD NATIONAL IMMUNIZATION COVERAGE SURVEY (cNICS)

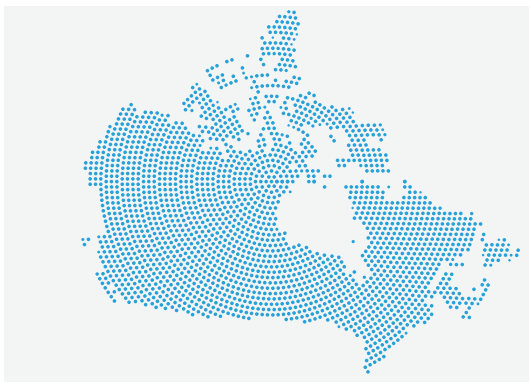

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TABLE OF CONTENTS

LIST OF TABLES

BACKGROUND

The Public Health Agency of Canada (PHAC) routinely monitors childhood vaccination coverage in Canada through the childhood National Immunization Coverage Survey (cNICS). Since 1994, cNICS has been conducted approximately every two years to estimate national uptake for all publicly funded routine childhood vaccinations that are recommended by the National Advisory Committee on Immunization (NACI).[1] Statistics Canada has conducted cNICS on behalf of PHAC since 2011. The survey also assesses knowledge, attitudes, and beliefs (KAB) among parents to better understand factors influencing decisions on vaccination for their children; however, these KAB results will be published in a separate report.

As part of the National Immunization Strategy objectives for 2016–2021, national vaccination coverage goals were developed in 2017 (to be achieved by 2025) for vaccines that are publicly funded in all provinces and territories.[2] While reflecting the Canadian context, the goals and targets are consistent with Canada's commitment to the World Health Organization (WHO) disease elimination targets and the Global Vaccine Action Plan.[3] This includes a vaccination coverage goal of 95% coverage for childhood vaccines (assessed at ages two and seven years) and 90% coverage for adolescent vaccines (assessed at age seventeen years).

Data from cNICS is used to report Canada's progress towards achieving the national vaccination coverage goals and to meet its international reporting obligations to the WHO and the Pan American Health Organization (PAHO).

METHODS

The 2017 cNICS questionnaire was developed by Statistics Canada and PHAC. The entire questionnaire was also reviewed and pre-tested by Statistics Canada's Questionnaire Design Resource Centre before being used in the study.

The childhood vaccines included in cNICS were those that are publicly funded under provincial/territorial programs. Vaccines recommended only for travel and some high-risk groups were excluded.

SAMPLING

The target population for this survey is children aged two, seven, fourteen and seventeen years, living in the 10 provinces and three territories, not residing on First Nations reserves and not institutionalized. The sampling frame was built using the list of children for whom the Canada Child Benefit (CCB) was claimed as of June 2017. This list is estimated to include 96% of Canadian children. Children aged two, seven, fourteen or seventeen years as of March 1, 2017, were eligible for inclusion in this survey. Children were randomly selected from the sampling frame by Statistics Canada. Only one eligible child from each household was selected. Depending on the age group, children were selected by strata defined by provinces, territories, sex and age. An oversample was conducted in order to produce provincial and territorial level vaccination coverage estimates in children two years of age only.

A more detailed description of data collection and processing methods is available on Statistics Canada's website.[4]

DATA COLLATION

Parents or Guardians

Survey data was collected through a telephone interview with selected children's parent or guardian (hereafter referred to as the respondent) between November 22, 2017, and February 24, 2018. This was followed by an assessment of the child's healthcare record from the child's immunization provider, when it was available. 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 vaccination information on a specific child in the household. Participants were asked to locate that child's vaccination card or booklet in advance of the telephone interview.

Telephone interview:

Using a telephone number (including landline or cell phone) provided in the CCB file, a trained Statistics Canada interviewer contacted the respondent. Interviews were conducted using computer-assisted telephone interview (CATI). The respondent was asked to retrieve the selected child's vaccination booklet for the interview. If the respondent was able to locate their child's vaccination 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 vaccinations not listed in the booklet;
3. To recall by memory whether the child was ever vaccinated for hepatitis B, HPV in fourteen year-old girls only, or had received the Tdap booster vaccine in seventeen year olds only, if not already reported;
4. To answer questions on the family/child demographics, such as education, income, and country of birth;
5. To give their permission for Statistics Canada to contact the child's healthcare provider(s) to supplement the vaccination 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 vaccination booklet at the time of the call, they were only asked the questions that were based on memory recall and demographic questions, as described above.

To allow the respondent more time to locate the child's vaccination 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 vaccination 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.

Healthcare Providers

A consent form was mailed to all respondents who had agreed over the phone to have their healthcare provider(s) contacted. The consent form asked for the names and contact information of all healthcare providers (e.g. physician, public health unit, health clinic) that vaccinated the child selected for the survey.

While 95% of respondents verbally agreed to have Statistics Canada follow up with their healthcare provider, only 55% of parents or guardians returned the completed consent form. Statistics Canada followed up with all the healthcare providers identified in the consent forms and offered them a $25 stipend for completing the immunization request form. Healthcare providers were asked to record all the vaccinations given to the child and the corresponding dates of when each vaccine was administered. Approximately 92% of healthcare providers who were sent these forms completed and returned them. Ultimately, information from vaccinators was available for 49.5% and 41.9% of two and seven-year-old children, respectively.

DATA PROCESSING

Following data collection, the survey responses were run through a series of validity and consistency checks designed to help ensure its usefulness for analysis. For vaccination information which had responses from the telephone interview and from the healthcare provider, the two sources were combined to provide a more complete vaccination record.

For two and seven-year-old Canadian born children, imputation was done for diphtheria, pertussis and tetanus (DTaP) to account for the fact that in Canada, these antigens are given as part of a combination vaccine and are not available to children as single-antigen vaccines. If a dose date was reported for any one of diphtheria, pertussis or tetanus, it was assumed that the child received all of diphtheria, tetanus, pertussis and polio on that given date. Polio was included as this antigen is given in combination with DTaP at those age milestones; however, a dose date for polio was not used as a donor for imputation as there is a polio vaccine licensed for use in Canada (i.e. children can receive a single-antigen polio vaccine without also receiving DTaP). These imputations were not made for any other combination vaccines, as some of the other antigens may have been administered as single-antigen vaccines in Canada and/or other countries.

Children were considered to be vaccinated for specific antigens if they had received the recommended number of doses by two, seven, fourteen, and seventeen years of age. Variation in provincial or territorial vaccination programs were considered in calculating the required number of doses; however, certain vaccination requirements were standardized across all jurisdictions (i.e. one dose of measles, mumps, rubella, varicella by two years of age). Minimum ages and appropriate dose intervals were not always considered when estimating coverage. However, two doses of the same antigen had to be at least 28 days apart to be considered as distinct.

As cNICS is a probabilistic survey, survey weights are assigned to respondents in order for estimates to be representative of the target population. These weights are calculated to take into account the sampling strategy as well as nonresponse, and are adjusted to align with known population totals (estimated by Statistics Canada) by province/territory, age groups and sex. Bootstrap weights were created to be used when estimating variances.[5]

DATA ANALYSIS

Analysis was completed using SAS 9.3. Based on parental and healthcare provider records, vaccination coverage rates were calculated as the proportion of the eligible children who were vaccinated according to their jurisdictions recommended schedules.[6] Coefficients of variation were calculated to assess the quality level of the estimates. A coefficient of variation from 16.6–33.3% indicated higher sampling error, so estimates are to be interpreted with caution. A coefficient of variation greater than 33.3% were considered unreliable and therefore an estimate could not be reported. In this report, this situation occurred only for the proportion of children not vaccinated at all in some jurisdictions.

RESULTS

PARTICIPATION AND RESPONSE RATES

The participation rates recorded in our analysis of cNICS 2017 was 61.7% for those answering whether or not their child had ever been vaccinated, and 49.0% for the coverage assessment (Table 1).

TABLE 1: Sampling and participation, by age group — childhood National Immunization Coverage Survey, Canada, 2017

AGE GROUP	2 YEARS		7 YEARS		14 YEARS		17 YEARS		TOTAL	
	n	%	n	%	n	%	n	%	n	%
Children sampled from frame	10,545	–	964	–	1,957	–	1,242	–	14,708	–
Children whose parents were contacted	6,919	65.6	658	68.3	1,403	71.7	862	69.4	9,842	66.9
Children whose parents agreed to participate	6,616	62.7	630	65.4	1,352	69.1	825	66.4	9,423	64.1
Children included in the 'ever vaccinated' assessment	6,519	61.8	466	48.3	1,335	68.2	752	60.5	9,072	61.7
Children included in vaccination coverage assessment	4,702	44.6	466	48.3	1,295	66.2	752	60.5	7,215	49.0

n = non-weighted count

CHILDREN AGED TWO YEARS

The national vaccination goal of 95% was not met for any vaccine in two-year-old children (Table 2).

The vaccination coverage estimate for at least four doses of DTaP by two years of age was 75.8%. Coverage was higher for polio (90.7%), despite this antigen being always administered in a combination vaccine with DTaP, as children require only three doses of polio to be considered vaccinated. The lower coverage for *Haemophilus influenzae* type B (Hib) (despite the fact that all vaccine programs in Canada use DTaP-IPV-Hib), suggests that there may be under-reporting for antigens included in combination vaccines.

Measles vaccination coverage by two years of age was 90.2%; however, when doses administered to those under twelve months of age (the recommended age for measles vaccination) were excluded, coverage dropped to 87.6%. Vaccination coverage estimates were 81.4% for pneumococcal, 87.6% for meningococcal C, 82.9% for varicella, 78.8% for rotavirus, and 74.1% for hepatitis B among two-year-old children.

No significant differences were observed between male and female coverage in two-year-old children.

TABLE 2: Estimated national vaccination coverage of routine childhood vaccines by two years of age, by sex — childhood National Immunization Coverage Survey, Canada, 2017

TWO-YEAR-OLD VACCINATION COVERAGE, % (95% CI)*					
ANTIGEN	NUMBER OF DOSES‡	ALL CHILDREN	MALE	FEMALE	P
Diphtheria	≥ 4	75.8 (73.1–78.5)	74.1 (71.2–77.1)	77.5 (73.7–81.3)	0.116
Pertussis	≥ 4	75.8 (73.1–78.5)	74.1 (71.2–77.1)	77.5 (73.7–81.3)	0.116
Tetanus	≥ 4	75.8 (73.1–78.5)	74.1 (71.2–77.1)	77.5 (73.7–81.3)	0.116
Polio	≥ 3	90.7 (89.3–92.2)	90.0 (88.1–91.9)	91.4 (89.2–93.7)	0.341
Haemophilus influenzae type B (Hib)	≥ 4	73.4 (70.7–76.0)	72.1 (69.2–75.0)	74.7 (70.9–78.5)	0.227
Measles	≥ 1	90.2 (88.3–92.1)	88.9 (86.7–91.1)	91.6 (89.0–94.1)	0.083
Mumps	≥ 1	89.9 (88.0–91.9)	88.8 (86.5–91.0)	91.1 (88.5–93.7)	0.135
Rubella	≥ 1	90.0 (88.0–91.9)	88.8 (86.5–91.0)	91.1 (88.5–93.7)	0.132
Hepatitis B[a]	≥ 3	74.1 (71.3–77.0)	72.5 (68.4–76.5)	75.8 (71.6–79.9)	0.276
Varicella	≥ 1	82.9 (80.4–85.4)	82.1 (79.3–84.9)	83.8 (80.4–87.2)	0.358
Meningococcal type C[b]	≥ 1–2	87.6 (85.8–89.4)	87.1 (84.7–89.4)	88.3 (85.9–90.7)	0.438
Pneumococcal[c]	≥ 3–4	81.4 (79.2–83.6)	80.1 (77.5–82.7)	82.6 (79.4–85.8)	0.219
Rotavirus[d]	≥ 2	78.8 (76.6–81.0)	78.3 (75.1–81.4)	79.3 (76.1–82.4)	0.664

Note: Children whose sex was not disclosed by their parent or guardian (n = 12) were included in the combined coverage estimates.

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

‡ Number of doses by 2nd birthday.

[a] Coverage estimates were limited to jurisdictions where a 3-dose program for infants was in place (British Columbia, Quebec, New Brunswick, Prince Edward Island, Yukon, Northwest Territories, and Nunavut). Children were considered vaccinated if they received the number of doses recommended by the child's province/territory of residence.

[b] Coverage estimated by a two-dose program in British Columbia, Alberta, Yukon, and Northwest Territories; one-dose program in all other provinces/territories.

[c] Coverage estimated by a four-dose program in Northwest Territories and Nunavut; 3-dose program in other provinces/territories.

[d] Coverage estimated by a two-dose program in British Columbia, Manitoba, Saskatchewan, Quebec, Prince Edward Island, Yukon, and Northwest Territories.

Coverage estimates for multi-dose vaccines, such as DTaP, can be displayed by dose at varying age milestones (Table 3). The majority of hospitalizations due to pertussis occur in infants under one year of age, highlighting the importance of on-time vaccination with the first three doses, scheduled at two, four, and six months of age.[7] The DTaP series initiation by 3 months of age is higher at 87.4% and lower at seven months (73.2% for 3 doses) and two years (75.8% for 4 doses). This suggests that on-time vaccination may be an issue for parents with young infants. These coverage rates do not meet the national coverage goal of 95% for the first three doses of pertussis by three, seven, and twelve months of age.

TABLE 3: Estimated national vaccination coverage of DTaP at varying age milestones, by sex — childhood National Immunization Coverage Survey, Canada, 2017

DTAP VACCINATION COVERAGE AT VARYING AGE MILESTONES, % (95% CI)*					
AGE (MONTHS)	NUMBER OF DOSES	ALL CHILDREN	MALE	FEMALE	P
3	≥ 1	87.4 (85.7–89.0)	86.0 (83.8–88.1)	88.7 (86.1–91.2)	0.118
7	≥ 3	73.2 (71.0–75.5)	72.1 (69.2–75.1)	74.3 (71.2–77.3)	0.289
12	≥ 3	85.7 (83.8–87.6)	85.3 (83.0–87.5)	86.1 (83.4–88.8)	0.621
24	≥ 4	75.8 (73.1–78.5)	74.1 (71.2–77.1)	77.5 (73.7–81.3)	0.116

Note: Children whose sex was not disclosed by their parent or guardian (n = 12) were included in the combined coverage estimates.

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

Provincial and Territorial Vaccination Coverage Estimates

The national goal of 95% vaccination coverage for four or more doses of diphtheria, pertussis and tetanus antigens by two years of age remains unmet among all provinces and territories. Newfoundland and Labrador and Prince Edward Island were the only two provinces to have coverage over 80%, while Manitoba and Nunavut were below 70% (Table 4.1).

Canadian infants and toddlers are vaccinated for polio using a combination vaccine with diphtheria, tetanus, pertussis, and Hib (i.e. DTaP-IPV-Hib). Some jurisdictions use a hexavalent vaccine containing the hepatitis B antigen (i.e. DTaP-HB-IPV-Hib). Newfoundland and Labrador was the only province to reach the 95% vaccination coverage goal for three or more doses of polio by two years of age. However, many other provinces and territories including PEI (93.9%), Nova Scotia (93.5%) and the Yukon (93.7%) are very close to meeting the coverage goal. Meanwhile, British Columbia (87.5%), Manitoba (85.6%), and Nunavut (82.1%) had polio vaccination coverage below 90%. Vaccination coverage for four or more doses of Hib by two years of age was much lower. Vaccination coverage estimates across all provinces and territories ranged from 57.2% in Nunavut to 87.7% in Newfoundland and Labrador.

Measles, mumps, and rubella antigens are administered in a combination vaccine (MMR), often with varicella as well (MMR-V). Newfoundland and Labrador is the only province to meet the 95% national coverage goal for at least one dose of measles, mumps, and rubella by age two, while British Columbia and Manitoba had the lowest estimated coverage. The minor discrepancies between measles vaccination coverage compared to mumps and rubella among two year old children can be due to the availability of monovalent measles vaccines in many developing countries that may be administered before a child has migrated to Canada, as well as transcription errors in and from the child's vaccination booklet,. Varicella vaccination coverage estimates were lower than measles, mumps, and rubella estimates across all provinces and territories. Newfoundland and Labrador (95.1%), Prince Edward Island (92.0%), and New Brunswick (90.9%) had varicella vaccination coverage over 90%, while approximately only three in four children received at least one dose of the varicella vaccine by their second birthday in Quebec (76.1%).

Depending on the province or territory, hepatitis B is either administered as part of the routine infant vaccination schedule or as part of a school-based program. For provinces and territories with a three-dose infant program, Prince Edward Island had the highest estimated coverage at 86.7% while Yukon was the lowest at 62.8% (Table 4.2).

The meningococcal-C and pneumococcal vaccines are available through different programs across provinces and territories. Meningococcal-C vaccine is administered in a two-dose program in British Columbia, Alberta, Yukon and Northwest Territories, while all other provinces and territories are a one-dose program. Similarly, the pneumococcal vaccine is available as a four-dose program in Northwest Territories and Nunavut while it is administered as a three-dose program in all other provinces and territories. The 95% national coverage goal for one or more doses of meningococcal-C vaccine by a child's second birthday was met in Northwest Territories, while Nunavut had the lowest coverage at 80.1%. For the pneumococcal vaccine, no province or territory met the 95% coverage goal for three or four doses by a child's second birthday. Newfoundland and Labrador have the highest coverage while Manitoba (74.6%), Northwest Territories (63.8%) and Nunavut (62.4%) remain below 80%.

Lastly, rotavirus vaccination coverage was estimated among provinces and territories that had a two-dose program. There is no specified national coverage goal for rotavirus and vaccination coverage remains low, partly due to the vaccine being relatively new in provincial and territorial schedules. In addition, unlike other routine vaccinations during infancy, there is a maximum recommended age for vaccination (must be less than 15 weeks of age).[8] Prince Edward Island, the first province to implement a publicly funded rotavirus program in Canada (2010), had the highest rotavirus vaccination coverage at 85.6% while Manitoba (68.4%) and Northwest Territories (66.3%) were below 70%.

TABLE 4.1: Estimated vaccination coverage of routine childhood vaccines by two years of age across provinces and territories — childhood National Immunization Coverage Survey, Canada, 2017

	2-YEAR-OLD VACCINATION COVERAGE, % (95% CI)*					
PROVINCE/ TERRITORY	DIPHTHERIA, PERTUSSIS, AND TETANUS (≥ 4 DOSES)	POLIO (≥ 3 DOSES)	HAEMOPHILUS INFLUENZAE TYPE B (HIB) (≥ 4 DOSES)	MEASLES (≥ 1 DOSE)	MUMPS (≥ 1 DOSE)	RUBELLA (≥ 1 DOSE)
Newfoundland and Labrador	88.9 (83.2–94.6)	96.9‡ (94.8–99.1)	87.7 (82.6–92.9)	96.9‡ (94.5–99.2)	96.9‡ (94.5–99.2)	96.9‡ (94.5–99.2)
Prince Edward Island	81.2 (71.0–91.4)	93.9 (88.1–99.6)	79.8 (69.4–90.3)	93.2 (88.3–98.0)	92.6 (88.1–97.2)	92.6 (88.1–97.2)
Nova Scotia	73.8 (67.2–80.5)	93.5 (89.2–97.8)	68.5 (61.9–75.1)	87.1 (80.4–93.8)	86.8 (80.2–93.5)	86.8 (80.2–93.5)
New Brunswick	75.5 (68.0–83.0)	90.1 (85.8–94.3)	74.7 (67.1–82.4)	92.0 (88.1–95.8)	92.0 (88.1–95.8)	92.0 (88.1–95.8)
Quebec	73.7 (69.4–77.9)	90.9 (88.3–93.6)	71.3 (66.6–76.0)	91.0 (88.3–93.6)	90.5 (87.7–93.3)	90.5 (87.7–93.3)
Ontario	75.7 (71.8–79.6)	91.0 (88.2–93.8)	72.9 (68.9–77.0)	90.9 (87.7–94.1)	90.5 (87.3–93.8)	90.5 (87.3–93.8)
Manitoba	67.5 (61.6–73.3)	85.6 (81.6–89.5)	62.2 (56.6–67.7)	86.1 (81.4–90.8)	85.9 (81.3–90.6)	86.2 (81.7–90.7)
Saskatchewan	78.6 (73.4–83.7)	90.0 (86.5–93.5)	75.1 (69.9–80.4)	89.5 (85.9–93.1)	89.5 (85.9–93.1)	89.5 (85.9–93.1)
Alberta	79.9 (72.8–86.1)	93.0 (90.1–96.0)	79.0 (73.1–85.1)	91.7 (88.1–95.2)	91.4 (87.8–95.0)	91.4 (87.8–95.0)
British Columbia	76.6 (71.5–81.6)	87.5 (84.0–91.1)	74.4 (69.4–79.5)	86.1 (82.0–90.1)	86.1 (82.0–90.1)	86.1 (82.0–90.1)
Yukon	70.7 (62.5–78.8)	93.7 (89.0–98.5)	69.3 (61.2–77.3)	91.0 (86.4–95.5)	91.0 (86.4–95.5)	91.0 (86.4–95.5)
Northwest Territories	76.7 (63.9–89.5)	91.1 (84.7–97.6)	75.5 (62.7–88.3)	91.8 (85.3–98.3)	91.8 (85.3–98.3)	91.8 (85.3–98.3)
Nunavut	63.8 (51.3–76.3)	82.1 (71.7–92.5)	57.2 (44.5–70.0)	88.7 (79.7–97.6)	88.7 (79.7–97.6)	88.7 (79.7–97.6)
Canada	75.8 (73.1–78.5)	90.7 (89.3–92.2)	73.4 (70.7–76.0)	90.2 (88.3–92.1)	89.9 (88.0–91.9)	90.0 (88.0–91.9)

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

‡ National vaccination coverage goal of 95% achieved.

TABLE 4.2: Estimated vaccination coverage of routine childhood vaccines by two years of age across provinces and territories — childhood National Immunization Coverage Survey, Canada, 2017

	2-YEAR-OLD VACCINATION COVERAGE, % (95% CI)*				
PROVINCE/ TERRITORY	VARICELLA (≥ 1 DOSE)	MENINGOCOCCAL TYPE C (≥ 1-2 DOSES)[a]	PNEUMOCOCCAL (≥ 3-4 DOSES)[b]	ROTAVIRUS (≥ 2 DOSES)[c]	HEPATITIS B (≥ 3 DOSE)[d]
Newfoundland and Labrador	95.1‡ (92.3–98.0)	93.2 (89.2–97.2)	90.2 (86.0–94.4)	–	–
Prince Edward Island	92.0 (87.1–96.9)	92.7 (87.6–97.8)	89.5 (84.2–94.9)	85.6 (80.1–91.6)	86.7 (79.0–94.4)
Nova Scotia	84.8 (78.1–91.4)	81.8 (75.2–88.5)	80.4 (73.7–87.1)	–	–
New Brunswick	90.9 (87.0–94.9)	88.3 (83.5–93.0)	82.2 (76.4–87.9)	–	81.0 (76.1–86.0)
Quebec	76.1 (72.1–80.1)	89.9 (87.0–92.9)	83.3 (80.0–86.6)	81.0 (77.6–84.4)	75.7 (71.9–79.4)
Ontario	84.3 (80.3–88.3)	85.7 (82.2–89.3)	80.5 (76.7–84.2)	77.7 (73.8–81.6)	–
Manitoba	81.6 (76.4–86.8)	82.2 (78.0–86.4)	74.6 (69.7–79.4)	68.4 (63.5–73.2)	–
Saskatchewan	84.8 (80.0–89.6)	81.1 (76.4–85.8)	83.7 (79.4–88.0)	84.0 (79.4–88.6)	–
Alberta	86.7 (82.2–91.2)	91.0 (87.8–94.3)	82.6 (77.0–88.3)	–	–
British Columbia	83.7 (79.1–88.4)	89.3 (85.7–92.9)	80.3 (75.6–84.9)	80.2 (76.0–84.3)	69.7 (64.8–74.6)
Yukon	85.5 (79.8–91.2)	93.7 (88.8–98.5)	83.2 (76.1–90.3)	76.6 (69.7–83.6)	62.8 (55.0–70.7)
Northwest Territories	88.9 (81.4–96.4)	95.2 (91.0–99.4)	63.8 (49.2–78.4)	66.3 (58.5–74.0)	80.5 (74.0–87.0)
Nunavut	82.1 (71.5–92.7)	80.1 (69.1–91.1)	62.4 (50.0–74.7)	–	70.8 (59.4–82.3)
Canada	82.9 (80.4–85.4)	87.6 (85.8–89.4)	81.4 (79.2–83.6)	78.8 (76.6–81.0)	74.1 (71.3–77.0)

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

‡ National vaccination coverage goal of 95% achieved.

[a] Coverage estimated by a two-dose program in British Columbia, Alberta, Yukon, and Northwest Territories; one-dose program in all other provinces/territories.

[b] Coverage estimated by a four-dose program in Northwest Territories and Nunavut; 3-dose program in other provinces/territories.

[c] Coverage estimated by a two-dose program in British Columbia, Manitoba, Saskatchewan, Quebec, Prince Edward Island, Yukon, and Northwest Territories.

[d] Coverage estimates were limited to jurisdictions where a 3-dose program for infants was in place (British Columbia, Quebec, New Brunswick, Prince Edward Island, Yukon, Northwest Territories and Nunavut). Children were considered vaccinated if they received the number of doses recommended by the child's province/territory of residence.

Parents of two-year-olds, regardless of vaccination booklet availability, were asked whether their child had ever been vaccinated with any vaccine (Table 5). Nationally, 2.4% of Canadian children at two years of age are estimated to be unvaccinated. At the regional level, Atlantic Canada had the lowest unvaccinated rate (1.3%), while British Columbia had the highest (3.9%). The coefficient of variation for all individual regions are between 16.6–33.3%, and should be interpreted with caution.

TABLE 5: Proportion of children with no history of vaccination by two years of age across provinces and territories — childhood National Immunization Coverage Survey, Canada, 2017

REGION	UNVACCINATED, % (95% CI)*
Newfoundland and Labrador, Prince Edward Island, Nova Scotia, and New Brunswick[a]	1.34 (0.78–1.91)‡
Quebec	2.97 (1.64–4.30)‡
Ontario	1.64 (0.65–2.63)‡
Manitoba	3.28 (1.86–4.72)‡
Saskatchewan	2.88 (1.40–4.36)‡
Alberta	2.01 (0.86–3.17)‡
British Columbia	3.89 (2.24–5.55)‡
Yukon, Northwest Territories, and Nunavut[a]	1.76 (0.71–2.80)‡
Canada	**2.35 (1.76–2.93)**

* Weighted estimates based on parental report (vaccination record not required)

‡ Coefficient of variation between 16.6–33.3%. Interpret with caution.

[a] Estimates from maritime provinces and territories had to be combined as their individual results had coefficients of variation too high to be reported.

CHILDREN AGED SEVEN YEARS

The national coverage goal of 95% for all routine vaccinations by seven years of age has not yet been reached, except for rubella for females (Table 6). The highest vaccination coverage by seven years of age was 94.5% for one or more doses of rubella, which requires only one dose for immunity compared to the two doses necessary for measles and mumps protection.[9] Diphtheria, pertussis, and tetanus vaccination coverage for five doses or more by age seven was the lowest at 80.5%. A significant difference (p = 0.014) between male and female vaccination coverage was observed for diphtheria, pertussis, and tetanus. The sample size did not allow for the estimation of coverage at the provincial/territorial level.

TABLE 6: Estimated national vaccination coverage of routine childhood vaccines by seven years of age, by sex — childhood National Immunization Coverage Survey, Canada, 2017

		SEVEN-YEAR-OLD VACCINATION COVERAGE, % (95% CI)*			
ANTIGEN	NUMBER OF DOSES‡	ALL CHILDREN	MALE	FEMALE	P
Diphtheria	≥ 5	80.5 (76.6–84.3)	76.4 (71.1–81.7)	85.5 (80.5–90.5)	0.014
Pertussis	≥ 5	80.5 (76.6–84.3)	76.4 (71.1–81.7)	85.5 (80.5–90.5)	0.014
Tetanus	≥ 5	80.5 (76.6–84.3)	76.4 (71.1–81.7)	85.5 (80.5–90.5)	0.014
Polio	≥ 4	92.3 (89.8–94.8)	91.7 (88.3–95.0)	93.0 (89.5–96.5)	0.585
***Haemophilus influenzae* type B (Hib)**	≥ 4	83.9 (80.3–87.6)	83.8 (79.2–88.3)	84.1 (78.6–89.6)	0.917
Measles	≥ 2	87.0 (83.6–90.4)	86.5 (82.3–90.7)	87.9 (83.0–92.8)	0.649
Mumps	≥ 2	86.4 (82.9–90.0)	86.5 (82.3–90.7)	86.7 (81.4–91.9)	0.955
Rubella	≥ 1	94.5 (92.4–96.7)	93.8 (91.0–96.6)	95.8 (93.2–98.5)	0.285

Note: Children whose sex was not disclosed by their parent or guardian (n < 5) were included in the combined coverage estimates.

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

‡ Number of doses by seventh birthday.

ADOLESCENTS AGED FOURTEEN AND SEVENTEEN YEARS

Three routine vaccinations are offered in school-based vaccination programs in Canada. Depending on the jurisdiction, hepatitis B is offered either in infancy or between grades four and seven. Human papillomavirus (HPV) vaccine is offered between grades four and seven, with catch-up programs available in later years in some provinces. Although HPV vaccine has been offered to boys and girls in all provinces and territories since 2015, fourteen-year-old boys surveyed in 2017 would not have had the opportunity to get the vaccine in many jurisdictions. Therefore, HPV vaccine coverage was measured in girls only. Finally, the tetanus-diphtheria-acellular pertussis vaccine booster (Tdap) is offered between grades six and nine in most jurisdictions. The national coverage goal for at least one dose of hepatitis B, HPV and a Tdap booster is 90% by seventeen years of age.

None of the three routine vaccines assessed in adolescence met the national coverage goal, however the Tdap booster came very close at 89.3% (Table 7). Vaccination coverage for at least one dose of HPV vaccine for females and hepatitis B for both sexes at fourteen years of age were similar at 83.1% and 83.0%, respectively. HPV vaccination coverage was only measured among females, as the male vaccination program was not implemented consistently across provinces and territories, nor had there been enough time elapsed for those with programs at the time of data collection.

TABLE 7: Estimated national vaccination coverage of vaccines offered in school-based programs for fourteen and seventeen-year-old adolescents, by sex — childhood National Immunization Coverage Survey, Canada, 2017

AGE GROUP (YEARS)	VACCINE	NUMBER OF DOSES	VACCINATION COVERAGE, % (95% CI)*			
			ALL CHILDREN	MALE	FEMALE	P
14	**Hepatitis B**[a]	≥ 1	83.1 (81.0–85.3)	82.1 (79.1–85.2)	84.1 (81.1–87.1)	0.369
	Human Papillomavirus	≥ 1	–	–	83.0 (79.7–86.2)	–
17	**Diphtheria, Tetanus, acellular Pertussis (Tdap) booster**	≥ 1	89.3 (87.0–91.6)	87.9 (84.6–91.1)	90.7 (87.5–93.9)	0.232

Note: Children whose sex was not disclosed by their parent or guardian (n < 5) were included in the combined coverage estimates.

Coverage was determined for at least one dose of HPV and Hep B vaccines because parental knowledge was used. As some provinces and territories request parental consent only once for the entire vaccine series, parents may be unable to specify the number of doses received.

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

[a] Hepatitis B coverage estimates include all jurisdictions unlike coverage estimates for two and seven-year-old children.

The age for a student to consent to receiving a vaccine varies across Canada, and is often based on whether or not the student is assessed to be a mature minor. For a student to be deemed a mature minor they must be assessed by a health care professional. The student must understand the risks and benefits of the medical treatment (vaccination) they are consenting to. If the student is deemed a mature minor and provides informed consent for vaccination, their medical records would be kept confidential. Parents of students who are deemed a mature minor may not be aware their child was vaccinated, as the information cannot be shared unless the minor provides their permission. This could affect the cNICS study results, as parents of school-age children are asked if their child is vaccinated.

HPV vaccination is administered in Grades 6 and 7 in most provinces and territories; based on local consent requirements, it would be possible in half of the provinces or territories for students to consent for the HPV vaccine without a parent's knowledge. Tdap vaccination is generally administered between Grades 7 and 9; based on local consent requirements, it would be possible for students to consent to the Tdap vaccine in eight out of ten jurisdictions. Hepatitis B vaccine is provided in either the jurisdictions' infant or school-age program. This survey does not differentiate between those students who were given the hepatitis B vaccine during their infant primary series (less than two years of age) and those who were given it as students at school. Thus, it is not possible to fully determine how student consent affected hepatitis B vaccination in the survey results.

STRENGTHS AND LIMITATIONS

The cNICS has several strengths and limitations that must be considered when interpreting the results of the survey.

Strengths

- cNICS used random sampling from a comprehensive sampling frame which is believed to include 96% of Canadian children, allowing for a representative sample to be collected on a national and provincial/territorial level.
- Oversampling of two year old children enabled the calculation of provincial/territorial vaccination coverage estimates.
- cNICS estimated vaccination coverage at the national and provincial/territorial level in a consistent manner despite differences in provincial/territorial vaccination schedules and program delivery.
- The sufficiently large sample size used in this comprehensive survey allows the analysis of under-vaccinated populations and to inform vaccination programs.

Limitations

- The response rate for the vaccination coverage portion of cNICS 2017 was 49.0%. Although not optimal, the response rate was higher than comparable surveys conducted by the United States Centres for Disease Control and Prevention, which were 26.1% for the 2017 National Immunization Survey (NIS) — Child, conducted among children aged 19–35 months, and 25.7% for NIS — Teen, conducted among adolescents aged 13–17 years.[10,11]
- Interviews were conducted in English or French, excluding children with parents that are not fluent in either official language. This subpopulation of children may have differences in vaccination coverage and access or utilization of healthcare services from that of other Canadian children.
- cNICS data was collected from parent-held vaccination records, in which some information may be incomplete, erroneous, or missing altogether. This may lead to an underestimation in vaccination coverage, especially among vaccines delivered in schools such as Tdap, HPV, and hepatitis B. In most cases, a child who does not bring their vaccination record to school on vaccination day will still be vaccinated, but the dose received will not be directly recorded in their card or booklet. This may not be recorded in their healthcare record either. Moreover, there may have been some errors in collecting data from vaccination cards or booklets.
- Some changes have been made to the methodology to mitigate the systematic under-reporting of vaccine doses observed in cNICS 2011, 2013 and 2015. Therefore, most coverage estimates from cNICS 2017 cannot be compared with those from previous iterations of cNICS, as apparent differences in estimates are likely to reflect changes in methodology rather than true changes in vaccination coverage.
- Similar to many other Statistics Canada surveys, cNICS excluded First Nations on-reserve communities and institutionalized children.

CONCLUSION

None of the national vaccination coverage estimates reported in cNICS 2017 met the corresponding national vaccination coverage goals. Among children aged two and seven years old, vaccination coverage has not changed significantly from past cycles of this survey. In fourteen year olds, HPV coverage in females has increased from 74.6% to 83.0%, likely due to increased availability and awareness of this relatively new vaccine.

Vaccination coverage estimates were analysed by sex throughout all age groups. Although coverage point estimates in females were higher for all vaccines, they were not significantly (statistically) different than males, with the exception of diphtheria, tetanus and pertussis in seven year old children. Statistically significant vaccination coverage differences between male and female children have not been observed in past cycles of cNICS.[12] It is not expected that parents would make different vaccination decisions based on the sex of their child; however, continued monitoring of this matter may be warranted, as it could provide additional targets for vaccination campaigns and policy.

Known methodological limitations of cNICS may have contributed to an underestimation of coverage. Therefore, it is possible that vaccination coverage in Canada is higher than the estimates presented in this report for all age groups. Statistics Canada continues to work alongside the Public Health Agency of Canada to improve the collection methods of cNICS.

Data from the cNICS surveys are essential for monitoring vaccination coverage at the national level in Canada. Results from cNICS 2017 suggest that there continues to be a need for improvement in vaccination coverage in order to attain sufficient community protection within the population to prevent disease and outbreaks. A separate report will be published presenting the knowledge, attitudes, and beliefs of Canadian parents regarding vaccination in childhood.

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