

# Immunization coverage report for school pupils

2012-13 school year



Technical Report  
September 2014

## Public Health Ontario

Public Health Ontario is a Crown corporation dedicated to protecting and promoting the health of all Ontarians and reducing inequities in health. Public Health Ontario links public health practitioners, frontline health workers and researchers to the best scientific intelligence and knowledge from around the world.

Public Health Ontario provides expert scientific and technical support to government, local public health units and health care providers relating to the following:

- communicable and infectious diseases
- infection prevention and control
- environmental and occupational health
- emergency preparedness
- health promotion, chronic disease and injury prevention
- public health laboratory services

Public Health Ontario's work also includes surveillance, epidemiology, research, professional development and knowledge services. For more information, visit [www.publichealthontario.ca](http://www.publichealthontario.ca)

### **How to cite this document:**

Ontario Agency for Health Protection and Promotion (Public Health Ontario). Immunization coverage report for school pupils: 2012-13 school year. Toronto, ON: Queen's Printer for Ontario; 2014.

ISBN 978-1-4606-4410-2 [PDF]

Public Health Ontario acknowledges the financial support of the Ontario Government.

©Queen's Printer for Ontario, 2014

## Prepared by

Sarah E. Wilson, MD, MSc  
Medical Epidemiologist  
Immunization and Vaccine Preventable Diseases  
Public Health Ontario

Jill Fediurek, RN, BScN, MPH  
Manager  
Immunization and Vaccine Preventable Diseases  
Public Health Ontario

Chi Yon Seo, MSc  
Health Analyst  
Immunization and Vaccine Preventable Diseases  
Public Health Ontario

Shelley L. Deeks, MD, MHSc  
Medical Director  
Immunization and Vaccine Preventable Diseases  
Public Health Ontario

Gillian H. Lim, MSc  
Epidemiologist Lead  
Immunization and Vaccine Preventable Diseases  
Public Health Ontario

## Acknowledgements

The authors wish to express their sincere appreciation for the effort and dedication demonstrated by Ontario's 36 Public Health Units (PHUs) throughout the immunization coverage assessment process and our colleagues at the Ministry of Health and Long-Term Care (MOHLTC) in the Immunization Policy and Programs Section for their collaboration in the interpretation of the coverage estimates generated from the Immunization Records Information System (IRIS). We also thank Margaret McIntyre and Dr. Anne Wormsbecker for their earlier contributions to several sections of this document and to Dr. Natasha Crowcroft for her helpful feedback on the report. Finally, thank you to our colleagues in Communications at Public Health Ontario, including Keisha Mair, Steven Janovsky, and Cathy Mallove.

## Important Notice

This document was developed by Public Health Ontario (PHO). PHO provides scientific and technical advice to Ontario's government, public health organizations and health care providers. PHO's work is guided by the current best available evidence.

PHO assumes no responsibility for the results of the use of this document by anyone.

This document may be reproduced without permission for non-commercial purposes only and provided that appropriate credit is given to Public Health Ontario. No changes and/or modifications may be made to this document without explicit written permission from Public Health Ontario.

## Contents

<b>Executive Summary</b> .....	<b>1</b>
<b>Introduction</b> .....	<b>4</b>
<b>Methods</b> .....	<b>7</b>
Immunization Records Information System .....	7
Analysis .....	10
<b>Results</b> .....	<b>11</b>
Overall in 2012–13 .....	11
Temporal Trends .....	15
Age-specific trends.....	19
Exemptions.....	21
<b>Discussion</b> .....	<b>23</b>
Vaccines started in infancy and early childhood .....	23
Vaccines administered in school-based programs .....	27
Limitations and gaps .....	30
<b>Conclusion</b> .....	<b>32</b>
<b>References</b> .....	<b>33</b>

# Executive Summary

## Preamble

The immunization coverage data summarized within this report are provincial estimates and are subject to a number of limitations. It is important to emphasize that this is a report summarizing immunization coverage estimated at one point in time (June 2013) using data from the Immunization Records Information System (IRIS), rather than immunization coverage assessment calculated from a true population based immunization registry. True immunization coverage may be higher than what is reported within this report. More detailed information is provided in the “Limitation and Gaps” section of this report.

## Legislative, policy, and system context for student immunization coverage assessment in Ontario

The Ontario Public Health Standards require that public health units (PHUs) maintain immunization records for school pupils and conduct an assessment of immunization at least annually. At the time of the assessment of student immunization status for the production of this report, under the *Immunization of School Pupils Act (ISPA)*, students with incomplete immunizations against diphtheria, tetanus, polio, measles, mumps and rubella (referred to as ISPA-designated diseases) must be vaccinated or provide an exemption statement (religious/conscientious or medical) or risk school suspension. Effective July 2014, the ISPA will also include pertussis, varicella and invasive meningococcal disease. In this report, we present coverage and exemption data for Ontario’s school-aged population for the 2012-13 school year, and relate these estimates to recent provincial trends in coverage and to national coverage targets.

The Immunization Records Information System (IRIS) is the information technology application that has historically supported the implementation of the ISPA. The assessment of a student’s immunization status is based on the IRIS complete-for-age logic. A student is considered complete-for-age if the requisite number of doses of a vaccine for age has been received with the appropriate interval between doses. It is important to note that students who have an incomplete vaccine series but who are not yet overdue for their next dose are also considered complete-for-age using IRIS logic. Over the course of 2013 and 2014, all 36 PHUs will cease their use of IRIS and transition to its successor system, Panorama. Thus, this report marks the final provincial coverage report that will be derived from IRIS data.

## Data source and methodology

In June 2013, Public Health Ontario (PHO) requested immunization coverage reports from IRIS from Ontario’s 36 PHUs for students of relevant birth cohorts (those born during a specified year) or ages. Coverage reports were requested for the following vaccine-preventable diseases (VPDs): diphtheria, tetanus, polio, measles, mumps, rubella, pertussis, invasive meningococcal disease (toddler and

adolescent programs), invasive pneumococcal disease, varicella, *Haemophilus influenzae* type b (Hib), hepatitis B, and human papillomavirus (HPV). In addition, student immunization exemptions were obtained for the six ISPA-designated diseases.

PHU-level data were aggregated at the provincial level such that coverage was expressed as the proportion of enrolled students who were considered complete-for-age for each VPD and birth cohort, using IRIS logic parameters. Immunization exemptions were also analyzed and expressed as the proportion of enrolled students, by birth cohort, who had an immunization exemption recorded in IRIS.

## Immunization coverage among 4- to 7-year-old students

All 36 Ontario PHUs participated in this immunization coverage assessment. Among 7-year-olds, provincial vaccine coverage for diphtheria, tetanus, polio, and pertussis was 74.6%, 74.6%, 74.2%, and 72.6%, respectively. Measles and mumps (two doses) and rubella (at least one dose) coverage was 88.3%, 87.9% and 95.2%. Two-dose coverage for varicella was low at 10.3% among 7-year-olds whereas one-dose coverage for varicella among 5-year-olds was 77.8%. Coverage for one dose of meningococcal-C conjugate vaccine was 81.5% among 7-year-olds. This is the second birth cohort eligible for the publicly funded program since its introduction in September 2004.

Coverage for Hib and pneumococcal vaccines among 4-year-olds was 84.6% and 79.8%, respectively. This is the first coverage report that has examined coverage for these programs in age groups younger than seven years. IRIS logic assesses children who are older than 59 months as complete-for-age for both vaccines, even if no doses of vaccine have been previously received, as there is no routine vaccination against these diseases after the age of 5 years, unless the child has a medical condition that places them at higher risk.

## Immunization coverage among adolescents

Provincial coverage for diphtheria, tetanus, polio, and pertussis among 17-year-olds was 84.0%, 84.0%, 94.3%, and 69.9%, respectively. Measles and mumps (two doses) and rubella (at least one dose) coverage was 95.4%, 93.7% and 97.1%. These students were not eligible for publicly funded pneumococcal, meningococcal, or varicella vaccine programs, thus coverage for these diseases is not reported for this age group. With the exception of pertussis, coverage for all other VPDs among 17-year-olds was consistently higher than 7-year-olds.

Provincial coverage for Ontario's school-based immunization programs was 86.9%, 89.4% and 80.2% for the hepatitis B, meningococcal conjugate, and HPV vaccine programs, respectively.

## Immunization exemptions among 7-year-old students

Among the diseases set forth in the ISPA at the time of immunization coverage assessment, the proportion of 7-year-olds reporting a religious or conscientious exemption ranged from 1.3% (both mumps and rubella) to 2.0% (polio), at a provincial level. Although the overall proportion of students registering exemptions at the provincial level is relatively low, it obscures the geographic clustering of exemptions that is well-recognized.

## Limitations

Establishing accurate immunization coverage for Ontario school pupils is challenging. This report and previous coverage assessments have demonstrated that coverage estimates generated using the forecasting logic in IRIS provide an estimate of vaccine coverage subject to several limitations. In order to prepare this report, the age cohorts for coverage assessment were specifically selected in order to minimize the impact of these forecasting logic limitations. However, all estimates should still be regarded with some degree of caution. In addition, practice variation regarding the frequency of immunization coverage assessment activities by Ontario PHUs was not assessed as part of this report.

## Conclusions

Immunization coverage assessment in Ontario is supported by enabling provincial legislation and the dedication and commitment of a range of immunization stakeholders, in particular the staff of Ontario's 36 PHUs and dedicated health care providers who deliver immunizations throughout the province. This report documents that Ontario, with rare exceptions, is not meeting established benchmarks for immunization coverage. Across vaccine programs, coverage is higher among 17-year-old versus 7-year-old students. High immunization coverage is essential for preventing outbreaks and robust immunization information systems are required to ensure immunization coverage estimates are timely and accurate.

This and previous reports have also demonstrated the importance of strengthening the methodology supporting immunization coverage assessment in Ontario. As the implementation of Panorama continues, it is important not to lose sight of additional opportunities to strengthen the surveillance and delivery of immunization programs in Ontario, including efforts to increase immunization coverage.

# Preamble

The immunization coverage data summarized within this report are provincial estimates and are subject to a number of limitations. It is important to emphasize that this is a report summarizing immunization coverage estimated at one point in time (June 2013) using data from the Immunization Records Information System (IRIS), rather than immunization coverage assessment calculated from a true population based immunization registry. True immunization coverage may be higher than what is reported within this report. More detailed information is provided in the “Limitation and Gaps” section of this report.

# Introduction

Immunization coverage refers to the proportion of a specific population that is appropriately immunized for a specific vaccine-preventable disease (VPD). Maintaining high immunization coverage is essential for the effective prevention and control of VPDs, and accurate and timely information is required to predict population-level susceptibility. Routine immunization coverage assessment can establish coverage trends over time, facilitates the identification of sub-populations with inadequate coverage that may be at risk of outbreaks, and contributes to the evaluation of immunization programs.

Publicly funded immunization programs in Ontario include universal programs targeting infants, children, adolescents and adults, as well as high-risk programs targeting individuals with particular medical conditions, behavioural risk factors, or high-risk exposures (Table 1). In Ontario, vaccines administered in infancy and early childhood are predominantly delivered by health care providers (HCPs) while adolescent vaccines are largely delivered through school-based immunization programs. An exception is the adolescent booster of tetanus-diphtheria-acellular pertussis (Tdap) vaccine, which is delivered primarily by HCPs at 14 to 16 years of age. A variety of strategies are used for the delivery of yearly seasonal influenza vaccine. Ontario’s three school-based immunization programs are hepatitis B and quadrivalent meningococcal conjugate targeting grade 7 students, and human papillomavirus (HPV) which provides grade 8 females with quadrivalent HPV vaccine.

In Ontario, comprehensive immunization coverage assessment is conducted annually for students within each board of health jurisdiction.<sup>1</sup> Under the *Immunization of School Pupils Act (ISPA)*,<sup>2,3</sup> local medical officers of health (MOHs) maintain a record of immunization for each pupil attending school in their jurisdiction. Since 1992, all 36 public health units (PHUs) have used the Immunization Records Information System (IRIS), a provincially supported, decentralized database for this purpose. Select VPDs are referred to as “designated diseases” under the ISPA. When PHUs perform their annual review of students’ immunization records, those who are not appropriately immunized are notified and may be suspended if ISPA-designated immunizations are not completed by a certain date or if documentation of medical exemption or religious/conscientious objection is not provided. Unimmunized and under-immunized students can be excluded from school if there is an outbreak or an immediate risk of an outbreak of a designated disease.<sup>1-3</sup> In addition to its use in implementing the ISPA, IRIS has also been used to provide estimates of immunization coverage, although this is not its primary function.

Ontario is in the midst of several changes with respect to immunization record documentation and the assessment of student immunization status under the ISPA. For the 2012–13 school year, diphtheria, tetanus, polio, measles, mumps, and rubella were the six designated diseases recognized by the ISPA. Effective July 2014, this list will have been expanded to also include pertussis, invasive meningococcal disease and varicella.<sup>2</sup> Furthermore, over the course of late 2013 and 2014, all Ontario PHUs are scheduled to implement the immunization module of Panorama, a public health information technology application that will replace IRIS. As a consequence, this will be the final immunization coverage report for school pupils in Ontario generated from IRIS data.

This report has several objectives:

- 1) To provide provincial immunization coverage estimates for students aged 7- and 17-years during the 2012–13 school year for vaccines started in infancy and early childhood. These vaccines are diphtheria, tetanus, polio, measles, mumps, rubella, pertussis, and varicella. Coverage estimates among 4- and/or 5-year-olds are presented for *Haemophilus influenzae* type b (Hib), meningococcal-C conjugate, pneumococcal conjugate, and varicella vaccines
- 2) To present provincial coverage estimates for Ontario’s school-based immunization programs: hepatitis B, quadrivalent meningococcal conjugate, and HPV
- 3) To describe temporal trends for provincial vaccine coverage, described in reference to national coverage targets
- 4) To present data on vaccine exemptions for the six VPDs designated under the ISPA for 7-year-old students.

**Table 1: Publicly funded immunization schedule for Ontario: Routine schedule for children beginning immunization in early infancy (starting at 2 months of age)<sup>1</sup>**

Age at vaccination: Completed months and years	DTaP-IPV- Hib	Pneu- C-13	Rot-1	Men- C-C	MMR	Var	MMRV	Men-C- ACYW	HB	HPV-4	Tdap	Inf
2 months	■ ■	■	■									
4 months	■ ■	■	■									
6 months	■ ■											
12 months		■		■	■							
15 months						■						
18 months	■ ■											
4-6 years	■						■					
Grade 7 students								■	■			
Grade 8 females										■		
14-16 years (10 years after 4-6 year old booster)											■	
Every year (in autumn)												■

1. Publicly funded immunization schedules for Ontario-August 2011 [Internet]: Ontario Ministry of Health and Long-Term Care; 2011. Available from: <http://www.health.gov.on.ca/en/public/programs/immunization/docs/schedule.pdf>.
2. Vaccine abbreviations used in Table 1: Diphtheria, Tetanus and Acellular Pertussis-Inactivated Polio (DTaP-IPV); *Haemophilus influenzae* type b (Hib); Pneumococcal Conjugate 13-valent (Pneu-C-13); Rotavirus (Rot-1); Meningococcal-C Conjugate (Men-C-C); Measles, Mumps, Rubella (MMR); Varicella (Var); Measles, Mumps, Rubella, Varicella (MMRV); Meningococcal Conjugate ACYW-135 (Men-C-ACYW); Hepatitis B (HB); Human Papillomavirus (HPV); Diphtheria, Tetanus and Acellular Pertussis (Tdap); Seasonal influenza (Inf).

# Methods

In June 2013, Public Health Ontario (PHO) issued a memorandum to all MOHs and VPD managers of Ontario's PHUs to request the provision of select immunization coverage reports from IRIS. To ensure consistency and comparability across jurisdictions, a detailed set of instructions outlining the process of preparing the IRIS reports accompanied the data request. These reports were submitted electronically to PHO's Immunization and Vaccine-Preventable Diseases team for compilation and analysis. A description of how immunization records and student enrolment data are captured within IRIS follows.

## Immunization Records Information System

### *Student enrolment data*

Each PHU receives student demographic information for schools located within its geographic boundaries from publicly funded school boards and independent schools, either electronically or manually. This student information is uploaded into the IRIS database to establish the denominator data used to assess immunization coverage of school pupils within each PHU's jurisdiction. However, the extent to which independent school and home-schooled students are fully represented in the denominator is variable.

### *Immunization records*

The numerator data present in IRIS to assess immunization coverage contains information on vaccines delivered by PHU staff and parental reporting of their child's immunization history. Student immunization records are collected at the time of school enrolment, although data entry may be delayed and completed at different times as convenient for each PHU. Additional data entry occurs when assessment activities are carried out, which should be completed at least annually as per the requirements of the ISPA. As part of this process, parents and guardians respond to an IRIS-generated "immunization questionnaire" that notifies families when students are identified as being overdue for immunizations according to IRIS complete-for-age vaccine forecasting logic. PHUs determine the timing of requests for immunization information based on their student population, staffing complement, and current public health priorities. Immunization information received by PHUs in response to the questionnaires is entered manually into IRIS. Variability in the timing of the receipt of updated immunization records can influence reported immunization coverage estimates.

For school-based immunization programs, PHU staff administers vaccines to eligible students at schools within their jurisdiction and manually update the students' immunization status in IRIS. Some PHUs update IRIS immediately following school-based clinics, while others do it at the conclusion of the school year and use alternative data systems to track doses delivered during the school year.

### *IRIS complete-for-age logic*

IRIS assesses a student's immunization status based on its complete-for-age vaccine forecasting logic, which uses a student's date of birth and a specified assessment date to capture all immunizations that have been administered on or before this date. Students' immunization records are assessed according to three different classifications: eligible, due, and overdue. An assessment of eligible or due indicates that the student is eligible to initiate the vaccine series or receive a subsequent dose. An assessment of overdue identifies students who have either exceeded the time interval recommended between doses or those who have yet to initiate the series by a specified age. A student is considered complete-for-age if he or she has received the requisite number of vaccine doses against a given disease, with an appropriate interval between doses, before reaching the age at which an immunization is considered overdue. The number of vaccine doses required to be assessed as complete-for-age varies by disease and age. However, IRIS also considers a student as complete-for-age if he or she has received an incomplete vaccine series but is not yet at the age or time interval at which an immunization is considered to be overdue. The implications of this approach for the accurate assessment of coverage are discussed in the limitations section.

Because IRIS coverage reports are based on forecasting logic, they identify the proportion of students who are not yet overdue for a particular immunization, rather than reporting on the proportion of students who have completed an age-appropriate number of doses (e.g., five doses of pertussis-containing vaccine by age 7 and six doses by age 17). The exception to this is the coverage report for measles-mumps-rubella (MMR) vaccine, which identifies the proportion of students who have received one or two doses of MMR vaccine by vaccine component. This latter approach is considered the gold standard methodology for immunization coverage assessment.

### *Requested coverage reports*

The immunization coverage estimates presented in this report reflect immunizations received by students as of June 30, 2013 that were recorded in IRIS at the time of data extraction.

The following IRIS coverage reports were requested from each PHU for the 2012–13 school year:

#### Diseases designated under the ISPA

- Diphtheria
- Tetanus
- Poliomyelitis (polio)
- Measles
- Mumps
- Rubella

#### Diseases not designated under the ISPA

- Pertussis
- *Haemophilus influenzae* type b (Hib)
- Varicella
- Invasive pneumococcal disease
- Invasive meningococcal disease
- Hepatitis B
- Human papillomavirus (HPV)

Immunization coverage for students 7 and 17 years of age was requested as per the *National Standards for Immunization Coverage Assessment* with exceptions noted below.<sup>4</sup> Only students under the age of 18 years were included as the ISPA is not applicable to those who are older.<sup>2</sup> Within each report, the number of students enrolled, as well as the number of students noted to be complete-for-age for each VPD, is provided by birth cohort or age. Students who were between 7 and 17 years of age in the 2012-13 school year are represented by the birth cohorts of 1995 to 2005. Complete-for-age coverage for Ontario's three school-based programs was assessed among students in grade 7 (2000 birth cohort) and grade 8 females (1999 birth cohort), depending on program. Although Ontario's school-based programs are delivered by grade rather than age, coverage reports by grade cannot be completed using IRIS; instead, birth cohorts approximating the typical age of grade 7 and 8 students are used for assessment. Furthermore, because IRIS coverage reports cannot distinguish between monovalent meningococcal-C conjugate vaccine (Men-C-C) and quadrivalent conjugate vaccine (Men-C-ACYW-135 vaccine, hereafter referred to as MCV4), it is assumed that assessment at 12 years of age represents MCV4 coverage among grade 7 students.

In April 2012, changes were made in the IRIS forecasting logic for varicella to reflect the provincial schedule, with children assessed at age seven as overdue for their second dose of varicella-containing vaccine. Consequently, only two-dose varicella coverage is available for children at age seven. An estimate of one-dose varicella coverage is presented for 5-year-olds to supplement this information. A further change in age of reporting has been made for Hib and pneumococcal coverage estimates. This report provides estimates for these diseases among 4-year-old students. This change was adopted to address significant limitations in the ability to use IRIS forecasting logic to assess coverage for these two VPDs as children who are older than 59 months are assessed as complete-for-age, regardless of immunization history.

Historical immunization coverage and exemption data from previously collected IRIS coverage reports were used to describe temporal trends over the period of 2008–09 to 2012–13 among 7-year-olds. Exemptions data related to measles was documented in IRIS as an exemption to MMR vaccine prior to 2010–11, and by measles from 2010–11 to present. Temporal trends for exemptions due to religious belief and conscientious objection are presented for measles, tetanus, and polio among 7-year-olds.

## Analysis

PHU coverage reports generated in IRIS were received as text files and the statistical software program SAS (version 9.2) was used to import and compile these data to derive provincial estimates of coverage.

Using data from IRIS, immunization coverage was calculated as the proportion of enrolled students who were considered to be complete-for-age for each VPD and birth cohort. In addition, students who provided documentation demonstrating prior immunity were included in the numerator data for diphtheria, tetanus, polio, pertussis, varicella, and meningococcal diseases. Excluded from the numerator were students who were considered to be overdue for immunization using IRIS logic and those with exemptions based on medical reasons and religious or conscientious beliefs.

Coverage for VPDs where protection is provided through the use of combination vaccines were analyzed by single vaccine component, rather than grouped in combination. This change was made as of the 2007–08 school year to improve the quality of data and to enhance understanding of the level of population protection against specific VPDs. Two-dose coverage of measles and mumps, and at least one-dose coverage of rubella vaccine are presented to be consistent with the recommendations of the National Advisory Committee on Immunization;<sup>5,6</sup> however, the ISPA required only one dose of mumps-containing vaccine at the time of this assessment.<sup>3</sup>

Student exemptions were expressed as the proportion of enrolled students who were exempted on the grounds of prior immunity, medical reasons, and religious or conscientious beliefs and reported at the provincial level for the six ISPA-designated diseases in place at the time of the report's preparation. The affidavit used to collect non-medical exemptions in Ontario does not differentiate between exemptions due to religious belief versus conscientious objection; thus, there is no way to discriminate between these exemptions within our analysis and reporting.

To ensure the accuracy of data used in this report, PHU-level data were compiled and provided to PHUs for review and validation in November 2013.

# Results

All 36 PHUs provided coverage and exemptions data for this report and all used IRIS as the data source.

## Overall in 2012–13

Provincial estimates of coverage for vaccines started in infancy and early childhood are presented in Table 2 and Figures 1a, 1b, and 1c. For diseases designated under the ISPA, provincial coverage ranged between 74.2% (polio) and 95.2% (rubella) among 7-year-olds and between 84.0% (diphtheria and tetanus) and 97.1% (rubella) among 17-year-olds. Among diseases not designated under the ISPA at the time of this report, coverage was lowest for two doses of varicella-containing vaccine, which was 10.3% among 7-year-olds. In contrast, one-dose coverage for varicella among 5-year-olds was 77.8%.

With the exception of pertussis, coverage estimates were consistently higher among 17-year-olds compared to 7-year-olds. Coverage for polio had the greatest difference between the two age groups (20.1%), followed by a difference of 9.4% noted for diphtheria and tetanus. This large difference observed for polio is possibly due to the fact that receipt of all polio-containing vaccines should have been completed by seven years of age in Ontario as students become overdue for polio at this age. In contrast, 17-year-olds students have had a decade to update their polio immunization status. The magnitude of difference between 7- and 17-year-olds was smallest for rubella (at least one dose) at 1.9%. For pertussis-containing vaccines, 72.6% of 7-year-olds were considered complete-for-age in contrast to only 69.9% of 17-year-olds. Among all vaccines started in infancy and early childhood, only the provincial coverage estimate for rubella among 17-year-olds met the national coverage target.

**Table 2: Immunization coverage (%) in Ontario for vaccines started in infancy and early childhood among children 7 and 17 years of age, 2012–13 school year**

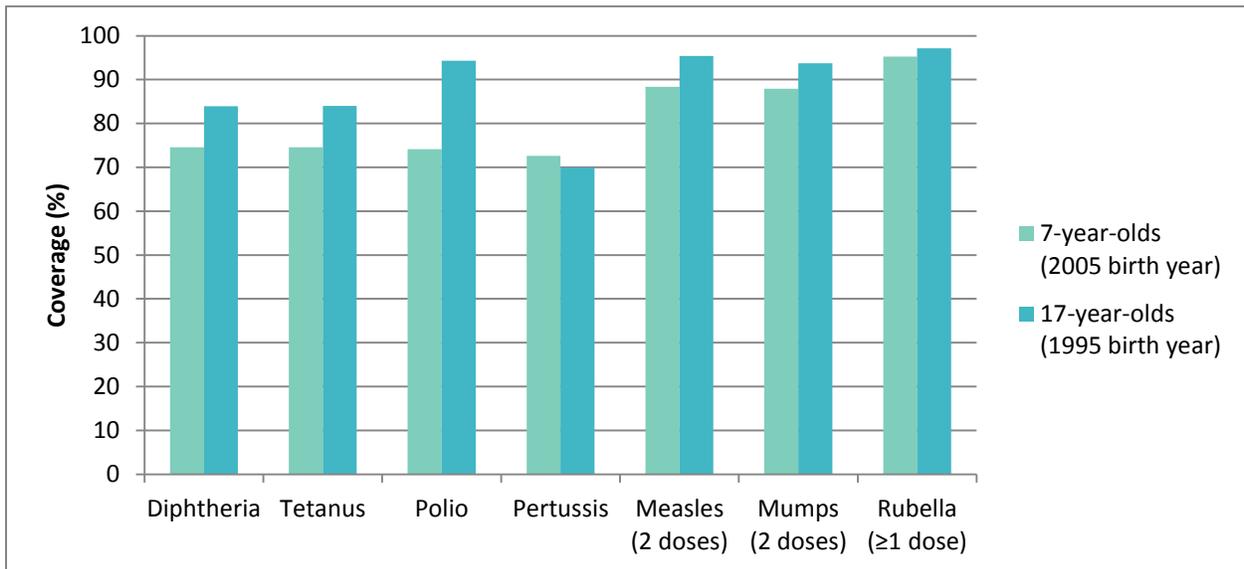
Vaccine-preventable disease		4- and 5-year-olds (2008 and 2007 birth years)	7-year-olds (2005 birth year)	17-year-olds (1995 birth year)	Target coverage
<b>Diseases designated under the ISPA</b>	Diphtheria	-	74.6	84.0	99 <sup>1</sup>
	Tetanus	-	74.6	84.0	99 <sup>1</sup>
	Polio	-	74.2	94.3	99 <sup>1</sup>
	Measles <sup>3</sup>	-	88.3	95.4	99 <sup>1</sup>
	Mumps <sup>3</sup>	-	87.9	93.7	99 <sup>1</sup>
	Rubella <sup>3</sup>	-	95.2	97.1	97 <sup>2</sup>
<b>Diseases not designated under the ISPA</b>	Pertussis	-	72.6	69.9	85-95 <sup>2</sup>
	Meningococcal	-	81.5	n/a <sup>4</sup>	97 <sup>2</sup>
	Varicella (age 5)	77.8 <sup>5</sup>	-	n/a <sup>4</sup>	85 <sup>2</sup>
	Hib (age 4)	84.6 <sup>6</sup>	-	n/a <sup>4</sup>	97 <sup>1</sup>
	Pneumococcal (age 4)	79.8 <sup>6</sup>	-	n/a <sup>4</sup>	90 <sup>2</sup>

**Notes:**

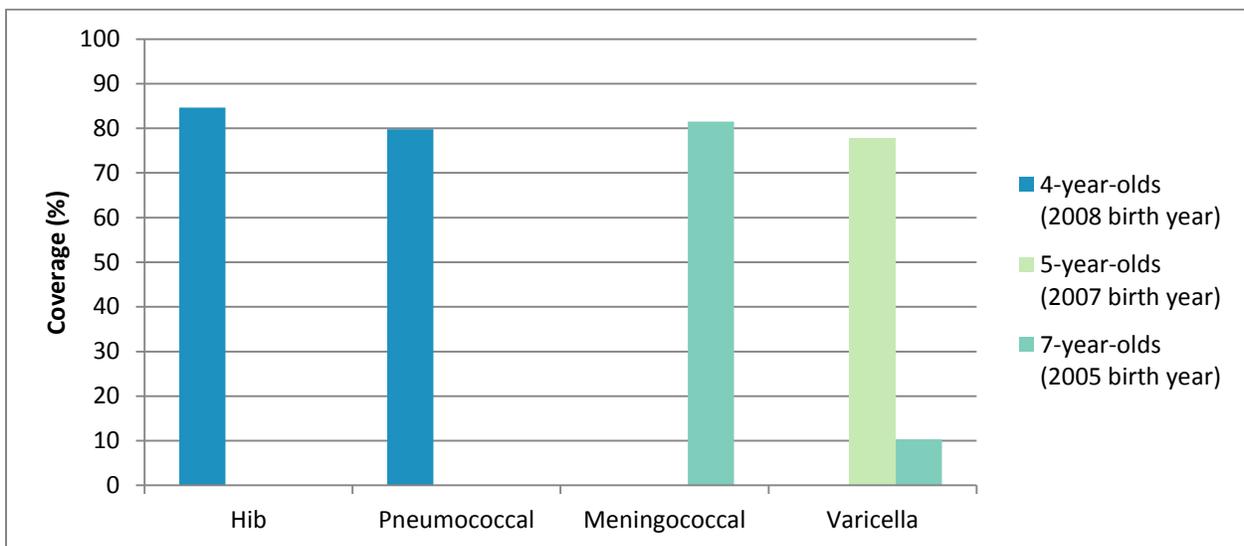
1. Canadian national report on immunization, 1996. Can Comm Dis Report. 1997;23(S4).
2. Final report on outcomes from the National Consensus Conference for Vaccine-Preventable Diseases in Canada, June 12-14, 2005 - Quebec City, Quebec. Can Comm Dis Report. 2008;34 Suppl 2:1-56.
3. Coverage for two doses of measles and mumps-containing vaccines and at least one dose of rubella-containing vaccine are presented as per the recommendations of the National Advisory Committee on Immunization<sup>5</sup> and the Canadian Immunization Guide.<sup>6</sup>
4. Meningococcal, varicella, Hib and pneumococcal coverage for 17-year-olds are not presented as they were not eligible for the publicly funded program.
5. IRIS logic was updated to reflect the implementation of the two-dose varicella program for 4- to 6-year-olds in August 2011. Thus, 7-year-old varicella coverage reflects two-dose coverage and is low since most of these children did not have the opportunity to receive a second dose through the routine program. Instead, one-dose coverage for 5-year-olds is presented.
6. IRIS logic assesses children who are older than 59 months as complete-for-age even if no doses of Hib or pneumococcal vaccines have been previously received. Thus, coverage estimates for 4-year-olds are presented.

**Figure 1: Immunization coverage (%) in Ontario for vaccines started in infancy and early childhood, 2012–13 school year**

(a) Diphtheria, tetanus, polio, pertussis, measles (2 doses), mumps (2 doses) and rubella ( $\geq 1$  dose)



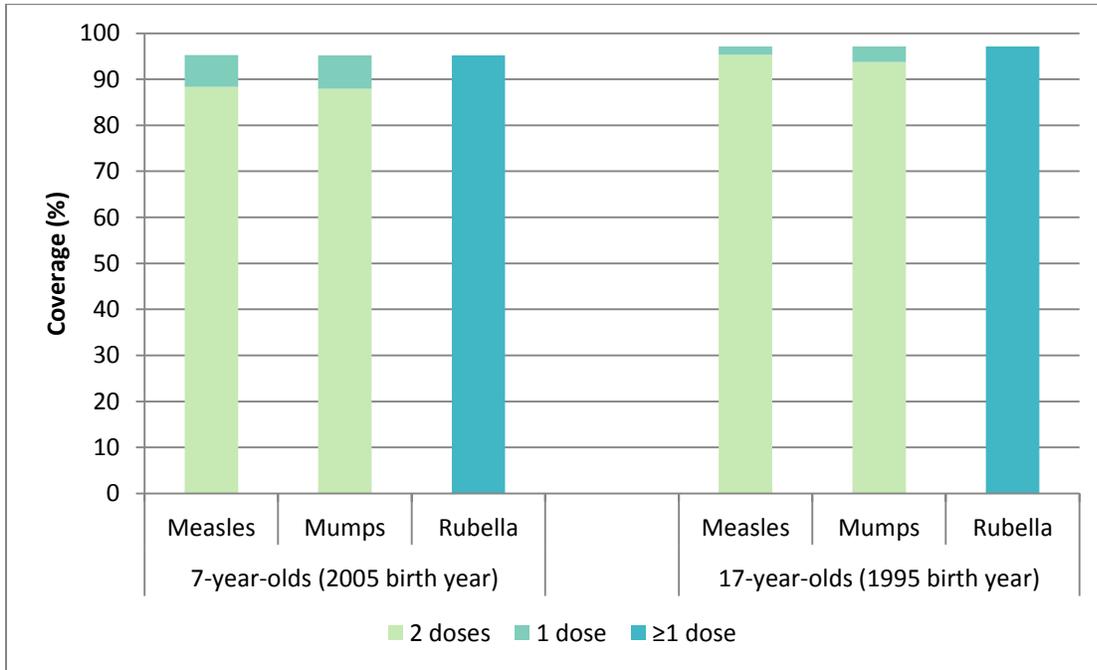
(b) Hib, pneumococcal, meningococcal and varicella<sup>1,2,3</sup>



**Notes:**

1. Meningococcal, varicella, Hib and pneumococcal coverage for 17-year-olds are not presented as they were not eligible for the publicly funded program.
2. IRIS logic was updated to reflect the implementation of the two-dose varicella program for 4- to 6-year-olds in August 2011. Thus, 7-year-old varicella coverage reflects two-dose coverage and is low because of limited opportunity to receive the second dose between the program's implementation and the assessment of coverage.
3. Varicella coverage among 5-year-olds reflects one-dose coverage whereas varicella coverage among 7-year-olds reflects two-dose coverage.

(c) Measles, mumps and rubella by dose<sup>1</sup>



Notes:

1. Coverage for two doses of measles and mumps-containing vaccines and at least one dose of rubella-containing vaccine are presented as per the recommendations of the National Advisory Committee on Immunization<sup>5</sup> and the Canadian Immunization Guide.<sup>6</sup>

Table 3 presents provincial estimates of coverage for vaccines administered through Ontario’s school-based immunization programs. At the provincial level, the school-based program with the lowest coverage was the HPV vaccine program at 80.2%. The highest school-based coverage estimate was noted for MCV4 (89.4%), followed by hepatitis B (86.9%). School-based immunization coverage estimates for 2012–13 school year did not include doses administered as part of extended eligibility and eligibility in perpetuity program components. National vaccine coverage targets were not met for HPV and Hepatitis B vaccines, while MCV4 vaccine approached the target.

**Table 3: Immunization coverage (%) in Ontario for school-based immunization programs among grade 7 and 8 students, 2012–13 school year**

Program	Target grade <sup>1</sup>	2012-13 school year	Target coverage
Hepatitis B	Grade 7	86.9	95 <sup>2,3</sup>
MCV4	Grade 7	89.4	90 <sup>4,5</sup>
HPV	Grade 8	80.2	90 <sup>6,7</sup>

**Notes:**

1. The target grade refers to the primary target population for school-based delivery.
2. Canadian national report on immunization, 1996. Can Comm Dis Report. 1997;23(S4).
3. This coverage target was identified for all populations targeted by universal hepatitis B immunization programs.
4. Final report on outcomes from the National Consensus Conference for Vaccine-Preventable Diseases in Canada, June 12-14, 2005 - Quebec City, Quebec. Can Comm Dis Report. 2008;34 Suppl 2:1-56.
5. This coverage target was identified for Men-C-C vaccine for 17-year-olds. A MCV4 target has not been specified.
6. The coverage target of 90% applies only to the 2011–12 school year, Ontario’s fifth year of HPV vaccine program implementation.
7. Canadian Immunization Committee. Recommendations on a human papillomavirus immunization program. Her Majesty the Queen in Right of Canada, represented by the Minister of Health; 2008.

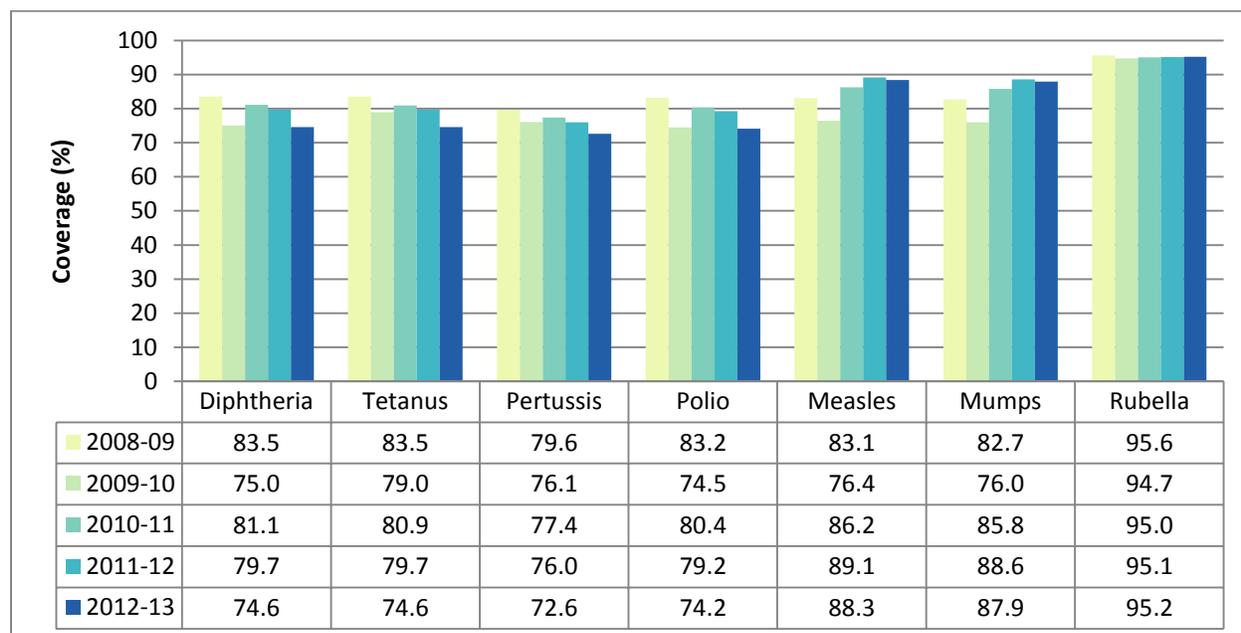
## Temporal Trends

Figures 2a and 2b present the change in provincial coverage between 2008–09 and 2012–13 for 7- and 17-year-olds, respectively. Trends for pneumococcal, meningococcal, and varicella coverage are not presented as there were three or fewer years to present. Temporal trends for Hib are also excluded due to lack of comparability, as coverage was reported for 4-year-olds in 2012-13 and for 7-year-olds in previous years.

As discussed in previous reports, among 7-year-olds, a decrease in provincial coverage was observed between 2008–09 and 2009–10 for all VPDs assessed, with an increase in coverage observed from 2009–10 to 2010–11 with those gains maintained between 2010–11 and 2011–12. Between 2011–12 and 2012–13, coverage decreased for all VPDs except rubella, with the magnitude of decline ranging from 0.7% (two doses of mumps) to 5.1% (diphtheria and tetanus).

Among 17-year-olds, coverage estimates for most diseases remained relatively unchanged between 2008-09 and 2012-13. Compared to the previous year, coverage for all VPDs assessed increased in 2012–13 with the magnitude of increase ranging from 0.3% (at least one dose of rubella) to 2.2% (pertussis). As has been previously described, two-dose mumps coverage was exceptionally low in 2008–09 (41.0%).<sup>7,8</sup> This is explained by the use of monovalent measles vaccine (as opposed to mumps-containing MMR vaccine) during Ontario’s measles catch-up campaign in 1996.

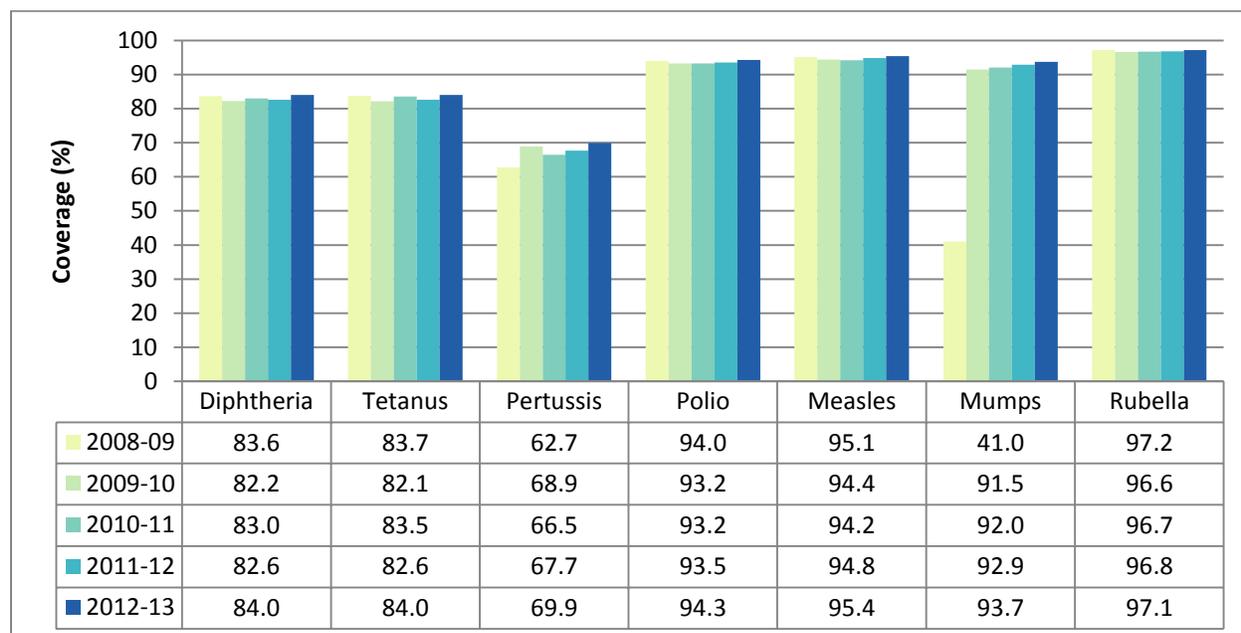
**Figure 2a: Immunization coverage (%) in Ontario for vaccines started in infancy and early childhood among children 7 years old, 2008–09 to 2012–13 school year<sup>1</sup>**



**Notes:**

1. Coverage for two doses of measles and mumps-containing vaccines and at least one dose of rubella-containing vaccine are presented as per the recommendations of the National Advisory Committee on Immunization<sup>5</sup> and the Canadian Immunization Guide.<sup>6</sup>

**Figure 2b: Immunization coverage (%) in Ontario for vaccines started in infancy and early childhood among children 17 years old, 2008–09 to 2012–13 school year<sup>1,2,3</sup>**

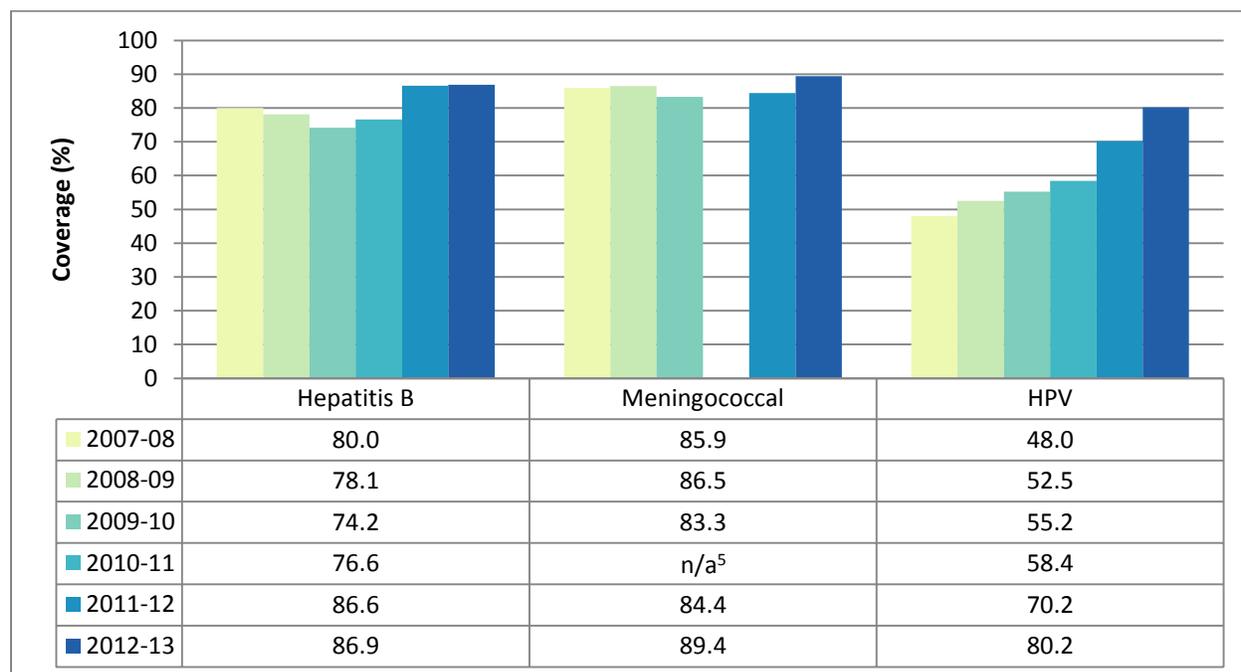


**Notes:**

1. 35 out of 36 PHUs provided coverage estimates for pertussis and tetanus for 17-year-olds in the 2009–10 school year.
2. 32 of out 36 PHUs provided coverage estimates for 17-year-olds in the 2010–11 school year.
3. Coverage for two doses of measles and mumps-containing vaccines and at least one dose of rubella-containing vaccine are presented as per the recommendations of the National Advisory Committee on Immunization<sup>5</sup> and the Canadian Immunization Guide.<sup>6</sup>

Temporal trends in provincial coverage for Ontario’s three school-based immunization programs are presented in Figure 2c. Coverage for hepatitis B vaccine declined between 2007–08 and 2009–10, but has since increased in each successive year with the greatest magnitude of increase observed between 2010–11 and 2011–12. Provincial hepatitis B coverage was 86.9% in 2012–13, representing an increase of 12.7% from 2009–10. Despite the change from Men-C-C to MCV4 vaccine in the 2009–10 school year, meningococcal conjugate vaccine coverage among grade 7 students remained relatively stable between 2007-08 and 2011–12 before increasing by 5.0% to 89.4% in 2012–13. MCV4 coverage was not assessed at the provincial level in 2010–11. Provincial coverage for HPV has increased steadily since program inception in 2007–08, with the largest annual increase of 11.8% observed between 2010–11 and 2011–12. The HPV coverage estimate for 2012–13 was 80.2%, representing an increase of 10.0% compared to the previous year, and a remarkable 32.2% increase since the start of the program.

**Figure 2c: Immunization coverage (%) in Ontario for school-based immunization programs among grades 7 and 8 students, 2007–08 to 2012–13 school year<sup>1,2,3,4</sup>**



**Notes:**

1. The 2011–12 school year coverage estimates are derived from the “Survey to assess vaccine coverage for Ontario’s school-based immunization programs” distributed by PHO on October 3, 2012.
2. Between 2007–08 and 2008–09 school years, Men-C-C- vaccine was used in the school-based meningococcal vaccine program. Since 2009–10, MCV4 vaccine has replaced Men-C-C vaccine.
3. 35 out of 36 PHUs provided school-based coverage estimates in the 2007–08 school year.
4. 34 out of 36 PHUs provided school-based coverage estimates in the 2008–09 school year.
5. Meningococcal vaccine coverage was not assessed in the 2010–11 school year.

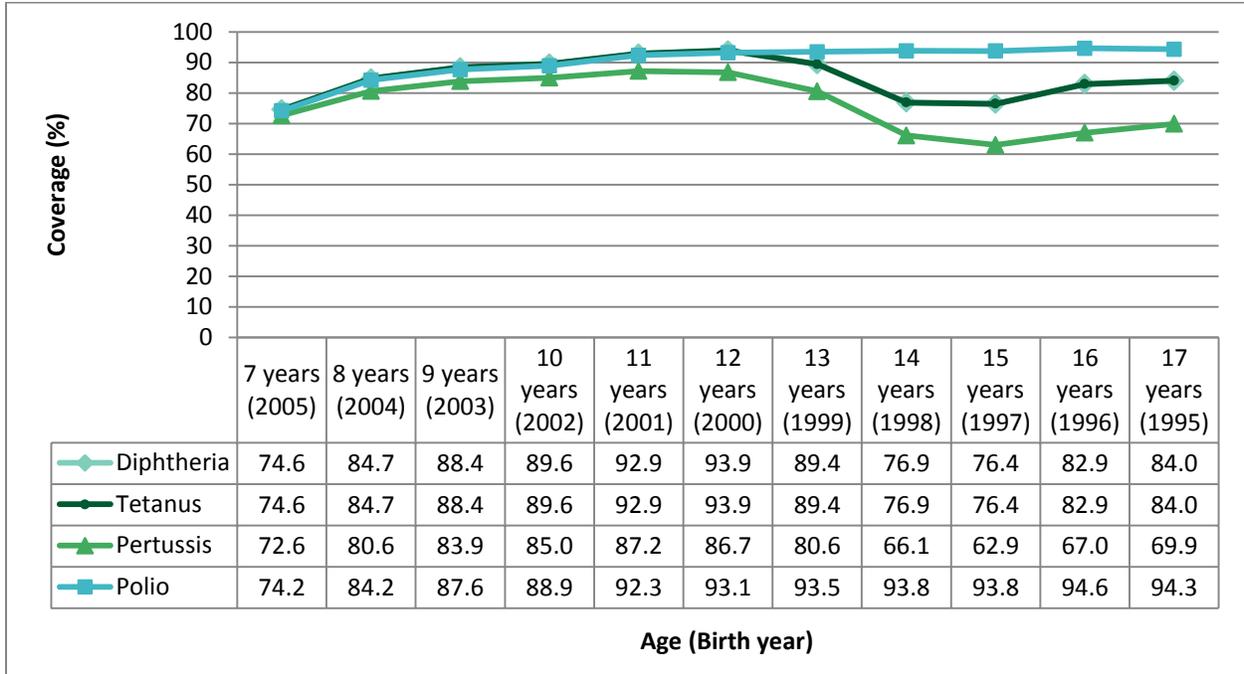
## Age-specific trends

Age-specific immunization coverage for vaccines started in infancy and early childhood for the 2012–13 school year is shown in Figures 3a and 3b. Figure 3a presents coverage by age, from 7-year-olds (2005 birth cohort) to 17-year-olds (1995 birth cohort), for diphtheria, tetanus, pertussis and polio. Of the four VPDs, coverage for pertussis remained lowest across all ages. Pertussis coverage was highest among 11-year-olds (87.2%) and lowest among 15-year-olds (62.9%). Coverage for pertussis, along with coverage for diphtheria and tetanus, fluctuated with increasing age; a slight increase was observed from 7- to 12-year-olds, followed by a pronounced decline among 13- to 15-year olds and an increase among the 16- and 17-year-olds. The drop in coverage noted between the ages of 14 and 16 likely reflects the overdue logic of IRIS as students become overdue for Tdap vaccine ten years following their receipt of the 4- to 6-year-old booster dose. In terms of polio-containing vaccines, coverage increased with age from 74.2% among 7-year-olds to 94.3% among 17-year-olds. Children should have received all doses of polio-containing vaccine by age seven, indicating that the increase in coverage represents a ten-year time period over which students could potentially be caught up.

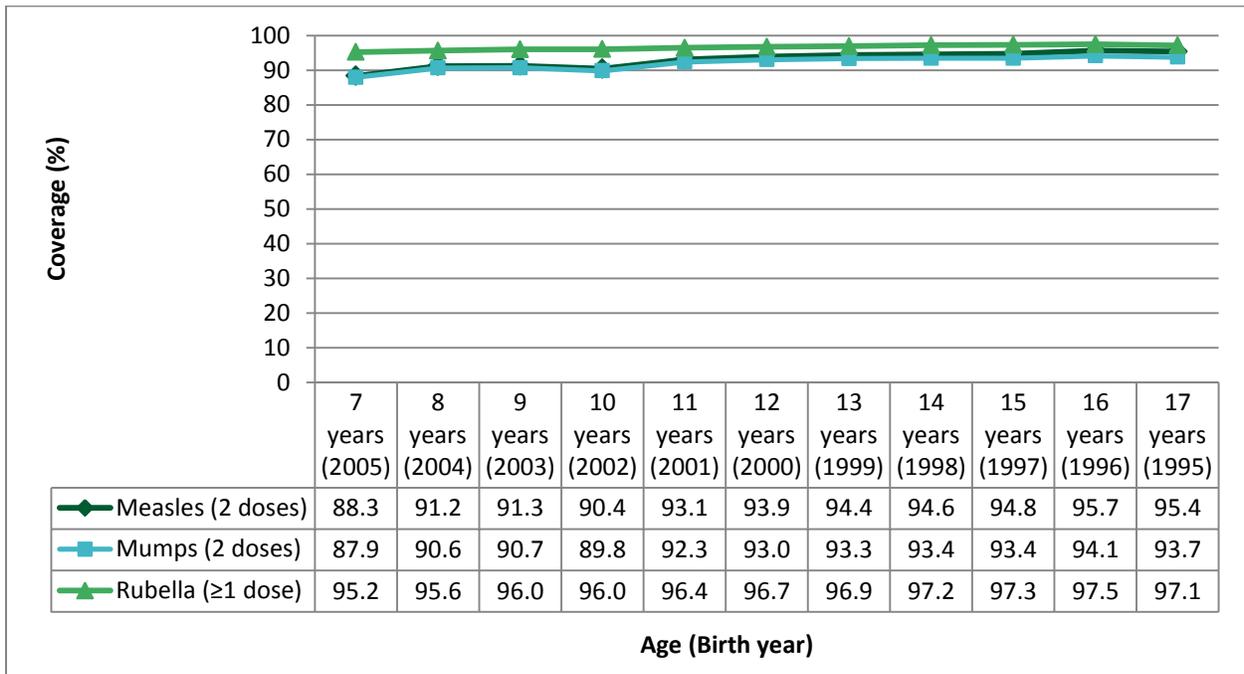
In general, the proportion of students who received two doses of combination MMR vaccine increased with increasing age (Figure 3b). All children should have received both doses of MMR vaccine by age seven. Two-dose measles coverage ranged between 88.3% (7-year-olds) and 95.7% (16-year-olds), while two-dose mumps coverage ranged between 87.9% (7-year-olds) and 94.1% (16-year-olds). Coverage for at least one dose of rubella-containing vaccine was high across all ages, ranging between 95.2% (7-year-olds) and 97.5% (16-year-olds).

**Figure 3: Age-specific immunization coverage (%) in Ontario for vaccines started in infancy and early childhood, 2012–13 school year**

(a) Diphtheria, tetanus, polio and pertussis



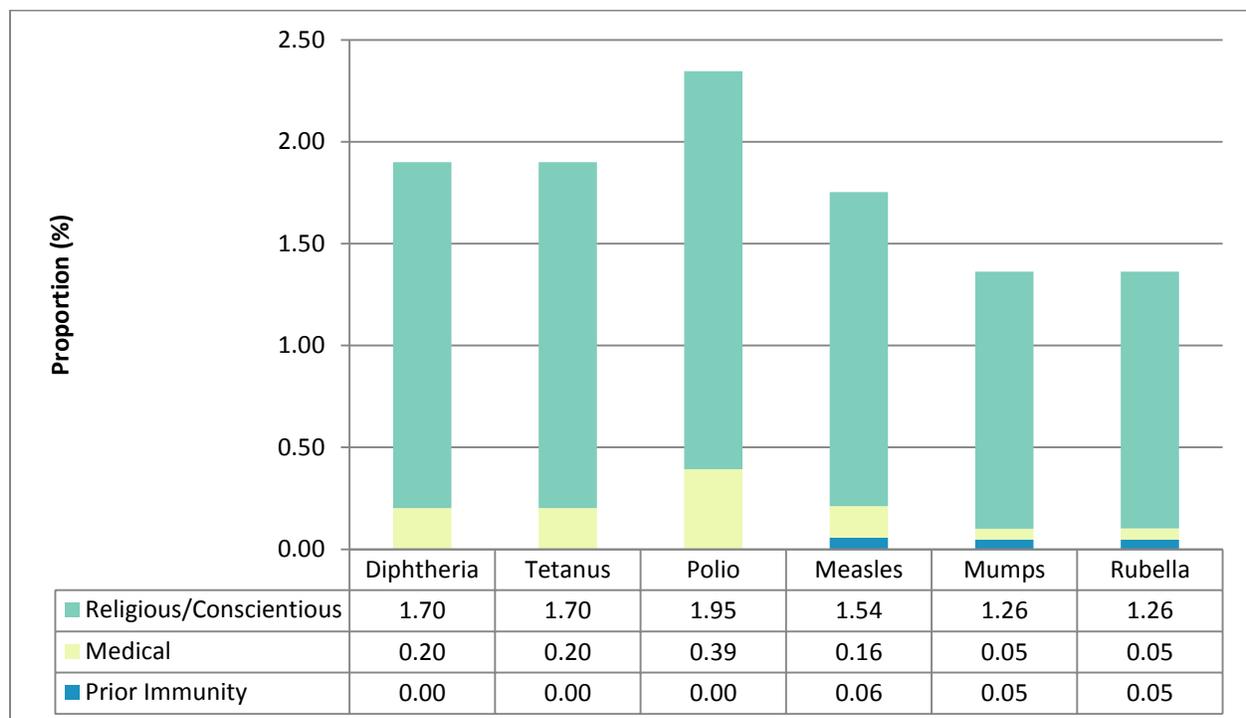
(b) Measles, mumps and rubella



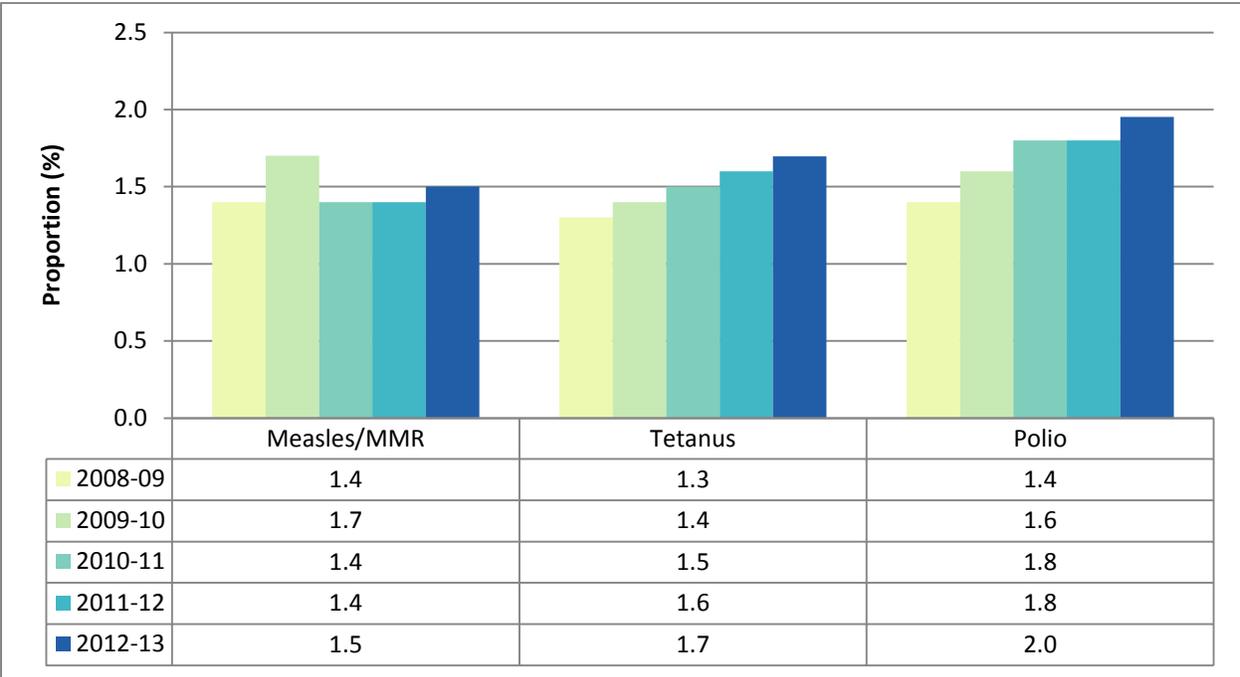
## Exemptions

Figure 4 shows the distribution of categories of exemption among 7-year-olds in Ontario for diseases designated under the ISPA at the time of the report’s preparation. In 2012–13, total exemptions were highest against polio-containing vaccine (2.3%) and lowest against mumps and rubella (1.4%). Of the three categories of exemptions captured in IRIS, religious beliefs or conscientious objections accounted for the greatest proportion of exemptions (1.3–2.0%, depending on disease) relative to prior immunity (0–0.1%) and medical reasons (0.1–0.4%). Although the overall proportion of 7-year-old students with this category of exemption remains low at 2.0% or less for any ISPA-designated disease, a small temporal increase in the proportion of students with religious or conscientious objection exemptions against tetanus- and polio-containing vaccines was observed between 2008–09 and 2012–13 (Figure 5). Interestingly, this category of exemptions appears to have been more stable for MMR/measles-containing vaccine.

**Figure 4: Reasons for exemptions among children 7 years old in Ontario for diseases designated under the ISPA, 2012–13 school year**



**Figure 5: Temporal trends in exemptions due to religious beliefs and conscientious objections against measles/MMR, tetanus- and polio-containing vaccines among children 7 years old in Ontario, 2008–09 to 2012–13**



# Discussion

Similar to previous years, this immunization coverage assessment of the 2012–13 school year demonstrates that immunization coverage among school pupils varied greatly by vaccine and age groups. Although the limitations of IRIS are associated with a number of challenges described below, the wide range in reported coverage suggests that some communities and age groups within Ontario may be at increased risk of certain VPDs.

## Vaccines started in infancy and early childhood

Immunization coverage among 7-year-olds in the 2012–13 school year decreased by approximately 3.4–5.1%, depending on VPD, for diphtheria, tetanus, polio and pertussis, relative to the 2011–12 school year. In contrast, coverage for measles, mumps, and rubella were all within 1% of estimates as compared to the previous school year. Coverage among 17-year-olds demonstrated a small increase across all diseases relative to the 2011–12 school year, with the largest coverage increase observed for pertussis at 2.2%.

### *Diphtheria, tetanus and pertussis*

Protection against diphtheria, tetanus and pertussis is provided through the administration of multi-component vaccines (i.e., DTaP-IPV, DTaP-IPV-Hib, Tdap-IPV and Tdap vaccines). Although these vaccines provide protection against these three VPDs, only diphtheria and tetanus were specified within the ISPA at the time of this assessment.<sup>3</sup> Immunization coverage estimates for diphtheria and tetanus are approximately 10% higher among 17-year-olds compared to 7-year-olds, despite the older students requiring one extra dose. This is likely because IRIS assesses students as overdue for diphtheria, tetanus and pertussis if ten years and one month have elapsed since the date of the booster dose administered between the ages of four and six years. In contrast, all students are assessed for their receipt of the four-to-six-year booster at age seven.

As in previous years, this report identifies suboptimal coverage for pertussis, and perhaps of greater concern, what appears to be a trend towards declining coverage among 7-year-olds with 72.6% coverage in 2012–13, relative to 79.6% in 2008–09. In contrast, pertussis coverage among 17-year-olds has increased as compared to recent years; 69.9% in 2012-13 compared to 62.7% in 2008-9. As demonstrated in previous reports, a drop in coverage was noted after the age of 14 years for diphtheria, tetanus, and pertussis, which likely reflects low uptake or a lack of timely administration of the adolescent booster recommended between 14 and 16 years of age. Previous coverage reports have also raised questions about whether pertussis coverage is underestimated because it is not required for school attendance. The change in the ISPA to include pertussis as a designated disease effective July 2014 provides an opportunity to evaluate this in future assessments of vaccine coverage.

Pertussis is a highly communicable disease which requires high vaccine coverage (92% or greater) to eliminate transmission and prevent outbreaks.<sup>9</sup> Immunization coverage targets for pertussis-containing vaccines have been defined in Canada. The National Consensus Conference for Vaccine-Preventable Diseases has identified targets of 95% coverage for five doses among 7-year-olds and a coverage target of 85% for the receipt of the Tdap booster among 18-year-olds.<sup>10</sup>

## **Polio**

Vaccines that include the inactivated polio antigen include DTaP-IPV-Hib and DTaP-IPV vaccines for children who begin their immunization series before seven years of age. Due to the use of combination vaccines, children typically receive up to five doses of polio to complete the series. Polio coverage in Ontario is much greater among 17-year-olds than 7-year-olds, possibly due to increased opportunities to be vaccinated over time and the need for fewer doses if immunization is initiated after the age of seven.

In 1994, the World Health Organization declared Canada free of wild poliovirus.<sup>11</sup> Continuing to maintain high coverage for polio is essential in upholding Canada's polio elimination status and to minimize the risk of disease transmission should polio virus importation occur. The WHO 2010 Polio Position Paper considers a country to have a low potential for transmission of imported polio if the country is of high socioeconomic status, has tertiary water treatment and has three-dose inactivated polio vaccine (IPV) coverage between 90% and 95%.<sup>12</sup> However, the recent detection of asymptomatic transmission of wild poliovirus in Israel in 2013, despite national polio vaccine coverage being greater than 90%,<sup>13</sup> serves as an important reminder that Canada must remain vigilant with regards to the uptake of polio-containing vaccines.

The Canadian benchmarks for polio immunization coverage were to achieve and maintain 97% immunization with three doses of polio vaccine by two years of age by 1997, and to achieve and maintain this target by the seventh birthday in 99% of children, also by 1997.<sup>14</sup> These benchmarks are still applicable and higher than those set recommended by WHO. As noted, Ontario children typically receive more than three doses of polio-containing vaccine. Due to the limitations inherent in using IRIS complete-for-age logic to assess coverage, it is not possible to determine what proportion of Ontario students meet the three-dose IPV national and international coverage targets.

## **Hib and pneumococcal conjugate vaccines**

Protection against Hib is included within the pentavalent DTaP-IPV-Hib vaccine for children less than five years of age. According to Ontario's publicly funded immunization schedule, Hib vaccine is not routinely recommended for children five years of age and older, unless they have one of a number of predefined medical conditions that places them at higher risk of infection.<sup>15</sup> In Ontario, children are immunized against invasive pneumococcal disease using a 13-valent pneumococcal conjugate vaccine (PCV-13) that was introduced into the schedule in November 2010. Prior to this, 10-valent and 7-valent vaccines were used. Ontario's immunization schedule recommends three doses of PCV-13 for all low risk children

under the age of two years, with unimmunized children remaining eligible until five years of age; children at higher risk of disease are recommended to complete the series with publicly funded vaccine even after the age of five years.<sup>15</sup>

Due to the functionality of the IRIS forecaster and the immunization schedule noted above, all children five years of age or older will be assessed as complete-for-age for these diseases, regardless of their true immunization status.<sup>16</sup> Because of this limitation, we assessed Hib and pneumococcal conjugate vaccine coverage among 4-year-olds. Provincial vaccine coverage was estimated to be 84.6% for Hib and 79.8% for pneumococcal. To our knowledge, this is the first time that coverage estimates have been generated for these two programs for ages less than 5 years at a provincial level. Some caveats still apply to the interpretation of these estimates. Immunization data completeness among 4-year-olds is unknown as some children may yet to have entered licensed elementary schools at this age and even among those attending school, time delays associated with PHU-receipt of immunization records for this age group may also influence data quality and completeness. This could result in either an under- or overestimation of coverage depending on whether those not enrolled in school are more or less likely to be immunized, respectively.

### *Measles, mumps, and rubella*

Measles is the most communicable of vaccine-preventable diseases, requiring very high vaccine coverage for effective control and ultimately elimination. Endemic measles virus transmission was declared eliminated from the WHO Region of the Americas in 2002,<sup>17</sup> the last case of endemic measles occurred in Canada in 1997.<sup>18</sup> Measles elimination does not require zero incidence, as cases will still occur due to travel (importations) and some imported cases may also result in limited local transmission (import-related cases).

Immunization against measles, mumps and rubella is administered in Ontario through two doses involving trivalent MMR vaccine and quadrivalent measles-mumps-rubella-varicella (MMRV) vaccine, with the first dose administered using MMR at 12 months of age. Between 1996 and 2004, the second dose was given between four and six years of age. In January 2005, the recommended age for the second dose was changed to 18 months. In August 2011, the recommended product for the second dose was changed to MMRV, to be administered between four and six years of age. Based on the present coverage report, most students between 7- and 17-years of age have had two doses of vaccines containing measles, mumps, and rubella. The level at which measles vaccine coverage is adequate to prevent transmission of the highly communicable measles virus is between 96% and 99%.<sup>19</sup> The provincial measles coverage estimates observed (88.3% at age 7, 95.4% at age 17) among Ontario students in 2012–13 are still below the national goal of 99%<sup>14</sup> and the level required to prevent transmission.<sup>17,19</sup> The Pan American Health Organization has recommended a two-dose mumps target coverage of 95% or greater<sup>17</sup> whereas Ontario's two-dose mumps coverage is 87.9% for 7-year-olds and 93.7% for 17-year-olds. Measles importations and mumps outbreaks continue to occur in Canada and efforts should be made to improve Ontario's measles and mumps coverage in order to best protect the population. In contrast, Ontario's coverage for rubella is high, likely because only one dose is required to

be considered complete and to meet national targets. In 2012-13, Ontario met the national coverage target for rubella of 97% for 17-year-olds (97.1%) and closely approached the target among 7-year-olds (95.2%).<sup>10</sup>

### **Varicella**

In September 2004, Ontario introduced a publicly funded single-dose varicella vaccine. Under the routine schedule, children born as of September 1, 2003, were eligible to be immunized between 12 and 15 months of age. Eligibility also included high-risk individuals of all ages, and children born as of January 1, 2000, if susceptible to chickenpox. In August 2011, a two-dose varicella program was introduced with the second dose administered in the form of MMRV between the ages of four and six years. Children who were born on or after January 1, 2000, are eligible for two doses of varicella vaccine.

In April 2012, a number of changes were made to IRIS to reflect the publicly funded schedule that was introduced in August 2011. One consequence of this was a change in the logic used to assess immunization coverage for varicella among 7-year-olds, requiring students to have received two doses of varicella to be considered complete-for-age, and a subsequent inability to report on one-dose coverage for varicella in this age group. Complete-for-age immunization coverage among 7-year-olds was low for varicella at 10.3% in 2012–13, although this represents a doubling from the 5.3% in the same age group in the 2011–12 school year. Most children in these two birth cohorts would have received their two doses of MMR at 12 and 18 months of age as per the previous schedule, and therefore would have no indication to receive MMRV. The two-dose coverage presented here likely reflects the delivery of monovalent varicella vaccine by HCPs who are knowledgeable about the change to a two-dose varicella program and students who have documented immunity against varicella. To gain a better appreciation for one-dose varicella coverage, we examined 5-year-olds, who would not yet be considered overdue for a second dose of varicella according to IRIS logic. We found a provincial coverage of 77.8% for one dose of varicella, slightly higher than the 2011–12 school year (75.0%), and substantially higher than the coverage found in 2010–11 of 47% among 7-year-old students.<sup>7,20</sup> However, this is another example of the constraints that forecasting logic places on immunization coverage surveillance.

### **Meningococcal disease**

This report marks the second time vaccine coverage associated with Ontario's toddler meningococcal C program has been assessed and reported. The program was first implemented in September 2004, targeting toddlers at 12 months of age; children born on or after September 2003 were eligible. Complete-for-age immunization coverage for the second full birth cohort eligible for this program, who were seven years of age in the 2012–13 school year, was 81.5%, a nearly 10% increase from 2011–12. Given that the program requires only one dose and the future inclusion of invasive meningococcal disease among the list of ISPA-designated diseases effective September 2014, we anticipate that meningococcal-C vaccine coverage will continue to increase in future assessments.

## Immunization exemptions

The proportion of 7-year-old students in Ontario with a religious or conscientious exemption to immunization to any ISPA-designated disease was relatively low at less than 2.5%, for the 2012–13 school year. It is not possible to compare these exemption estimates to other Canadian provinces and territories, as only New Brunswick (NB) has legislation similar to the ISPA. Since 1982, NB has required immunization against measles, mumps, rubella, diphtheria, tetanus, and polio prior to school entry.<sup>21</sup> In 2009, the enabling provincial legislation was amended to also include immunization against pertussis, varicella and invasive meningococcal disease,<sup>21</sup> similar to Ontario's recently amended ISPA. Like Ontario, NB permits both medical and philosophical exemptions, but these estimates are not publicly available for comparison.

Although the overall provincial picture of total exemptions is relatively low at less than 2.5%, this obscures the geographic clustering of immunization exemptions that is well-recognized.<sup>22,23</sup> These overall proportions conceal important variations in immunization exemptions across communities within Ontario. A limitation to this assessment is an inability to examine exemptions across the range of ISPA designated diseases, in order to document the proportion of Ontario students with an immunization exemption to at least one disease. This is how exemptions data is typically examined in immunization literature, which makes it challenging to compare Ontario's estimates and trends to other jurisdictions. Despite these limitations, it appears that religious or philosophical exemptions may be increasing over time in Ontario as evidenced by an increasing proportion of 7-year-old students reporting religious and conscientious objections to tetanus and polio over the period of 2008–09 to 2012–13. However, the time frame examined in this report is too brief to draw any firm conclusions and immunization exemptions due to religious belief and conscientious objection for MMR/measles-containing vaccine have been relatively stable. PHO has concluded a more detailed temporal analysis of immunization exemptions in Ontario over the last ten years, which will be disseminated outside of this report.

## Vaccines administered in school-based programs

School-based vaccine delivery serves as an important platform to achieve high immunization coverage among adolescents who tend to have a low frequency of HCP visits for preventive care.<sup>24,25</sup> School-based immunization programs seek to reduce socioeconomic barriers to accessing immunization delivery, which may improve health equity in immunization coverage. In addition, these programs aim to minimize the burden of VPDs by immunizing adolescents before the onset of risk behaviours and offer the benefit of peer support at the time of immunization. Several studies in the United States, Canada, and United Kingdom have found that school-based delivery, versus HCP-based delivery, is more cost-effective for hepatitis B and meningococcal conjugate vaccine programs targeting adolescents.<sup>26-28</sup>

Ontario's school-based programs continued to achieve high coverage in 2012–13 with continued gains in uptake for HPV and for the quadrivalent meningococcal program. Temporal trends which include

provincial immunization coverage between 2007–08 and 2010–11 should be made with caution, because different large PHUs did not report coverage data in 2007–08 and 2008–09.

### ***Hepatitis B***

The hepatitis B vaccine program was first implemented in September 1994 for grade 7 students and includes two doses of the vaccine given four to six months apart, depending on the vaccine product. The extended eligibility component of the program allows any grade 7 student who missed one or both doses of the vaccine to remain eligible until the end of their grade 8 year.

In 2012–13, Ontario maintained a 10% increase in coverage that was noted between 2010–11 and 2011–12. A decline in coverage for the hepatitis B vaccine was observed between 2007–08 and 2009–10. This decline may have been due in part to the shortage of hepatitis vaccines from April–June 2010 in Ontario. Many PHUs were not able to complete their two-dose hepatitis B immunization program for the 2009–10 school year and delayed the program until the next school year. The impact of the pandemic H1N1 virus on PHU activities, including school-based immunization programs, in 2009–10 may also partly explain lower coverage during the 2009–10.

With a provincial coverage estimate of 86.9% in 2012–13, Ontario continues to make progress towards the national coverage target of 95% identified for universal hepatitis B programs.<sup>14</sup> A more appropriate measure of Ontario's hepatitis B coverage would include doses delivered as part of extended eligibility, as the estimate presented here does not include these doses.

### ***Quadrivalent meningococcal conjugate vaccine***

In January 2005, a school-based immunization program against invasive meningococcal disease, also targeting grade 7 students, was introduced using Men-C-C vaccine. In September 2009, MCV4 replaced the Men-C-C vaccine for the provincial grade 7 program. Once they become eligible in grade 7, students remain eligible until the vaccine is received (i.e., eligibility in perpetuity). The coverage target for Men-C-C vaccine for 17-year olds was set at 90% to be achieved by 2012;<sup>10</sup> a target specific to MCV4 vaccine has not been expressed as many provinces and territories continue to use Men-C-C vaccine for their adolescent programs.

Ontario's coverage estimate for this program (89.4%) increased by 5% between 2011–12 and 2012–13. Immunization coverage is highest for this vaccine among school-based immunization programs. This is likely explained by the fact that the vaccine series requires only one dose and the high acceptability for this vaccine as invasive meningococcal disease is associated with a high degree of public concern. An additional explanation to account for the high vaccine coverage observed in 2012–13 relates to a limitation of IRIS. The IRIS coverage report for the meningococcal conjugate vaccine program cannot differentiate between meningococcal vaccine products. This is important as Ontario has two meningococcal programs: one targeting toddlers at the age of 12 months with Men-C-C vaccine and the grade 7 program which administers MCV4. Although the toddler program was introduced in September 2004, many parents opted to purchase this vaccine for their children before it became publicly funded.

Parents in birth cohorts including those who were in grade 7 in the 2012–13 school year (born in 2000) may have opted to privately purchase the vaccine. If Men-C-C vaccine was recorded in IRIS, and no MCV4 vaccine was administered in grade 7, this dose would be inappropriately attributed to vaccine coverage for the MCV4 program. It is difficult to quantify how common this event may be but this underscores the need to delineate vaccine coverage for these two programs once the transition to Panorama occurs.

## HPV

Ontario's most recently introduced school-based immunization is the HPV vaccine program that began in September 2007. This program involves the administration of three doses of HPV vaccine to grade 8 females. The extended eligibility component of this program has historically been decided on an annual basis by the Ontario Ministry of Health and Long-Term Care (MOHLTC) Currently, female students who did not receive or complete the three-dose HPV vaccine series in grade 8 are eligible to initiate or complete the series with publicly funded vaccine until the end of their grade 12 year.<sup>29</sup>

HPV vaccine coverage continues to increase in Ontario, increasing 11.8% between 2010–11 and 2011–12, rising a further 10% between 2011–12 and 2012–13 to 80.2%. This estimate does not include doses administered as part of the extended eligibility program. Detailed work conducted in collaboration with MOHLTC and several PHUs involved generating HPV coverage reports for the same birth cohort in multiple versions of IRIS to ensure that the dramatic increase in coverage observed between 2010–11 and 2011–12 was not explained by an IRIS performance issue.<sup>30</sup> Identical coverage estimates were obtained across the various versions suggesting that a true increase in coverage was observed.

The continued increase in HPV coverage since the program's implementation in 2007–08 suggests an impact from the education, communications and outreach activities that have conducted over the last six years by PHUs and may also be reflective of public acceptance. If recent trends in vaccine coverage for the HPV vaccine are maintained, coverage in 2013–14 may reach the coverage target of 90% established by the Canadian Immunization Committee's (CIC). The original CIC coverage targets for HPV vaccine were set at 80% and 90% to be achieved within two and five years of program introduction, respectively.<sup>31</sup> The school year of 2012–13 is the sixth year of the HPV vaccine program in Ontario.

## Limitations and gaps

Establishing accurate immunization coverage for Ontario school pupils has several limitations, a number of which are related to the IRIS application, including in some cases the parameters used to establish immunization coverage. As previously noted, all PHUs will cease use of IRIS and transition to Panorama, a centralized provincial immunization repository, over the period of 2013 to 2014. However, there are other limitations to coverage assessment in Ontario that relate to gaps in the system at large.

### *IRIS application*

IRIS was introduced more than two decades ago in 1992. The aging IT infrastructure of the application poses many challenges, including system instability and slow processing time. This also makes revisions to the application, as new immunizations are introduced into the publicly-funded schedule, time-intensive and complex. Furthermore, IRIS is a decentralized database, which means that it does not allow for the integration of student immunization information across the 36 PHUs in Ontario. The consequences of this include student immunization information that is collected and housed in different PHUs when a student moves. The cumbersome nature of the system and the lack of a routinely collected unique identifier make it challenging and very resource-intensive to ensure duplicate (or multiple) records are managed appropriately and this likely results in an underestimate of true immunization coverage in Ontario for most VPDs. As previously noted, with the implementation of Panorama underway, this report will be the final immunization coverage report produced with data derived from IRIS.

### *Lack of system integration with HCP-delivered immunizations*

As previously noted, with the exception of PHU-immunization delivery, parents and guardians must provide immunization information to local PHU staff, who then enter this information into IRIS. It is possible that many students who are described as being under-immunized within this report have been appropriately immunized, but have not supplied the information to their local PHU. Alternatively, the family may have provided the information, but data entry into IRIS may not have occurred in time to be reflected in the coverage estimates presented within this report. Both would result in underestimating provincial coverage. The lack of system integration for the documentation of immunizations and their inclusion within the provincial immunization repository challenges the timeliness and accuracy of immunization coverage assessment. Furthermore, practice variation regarding the frequency of immunization coverage assessment activities by Ontario PHUs was not assessed as part of this report.

### *Timing of data entry and creation of IRIS coverage reports*

PHU-specific immunization coverage data contained within an IRIS report reflect coverage at one particular point in time, which is subject to change as soon as the next day. For example, coverage will be highest immediately following a PHU's ISPA-related assessment of complete-for-age, as students will have been given an opportunity to complete immunization to avoid suspension from school. If PHU coverage is assessed prior to this opportunity or the updating of records, a smaller proportion of students will be complete-for-age. Based on the survey of PHUs completed for the 2010–11 coverage report, there was wide variability of timing of data entry into IRIS.<sup>7</sup> While the majority of PHUs stated they enter immunization data on an ongoing basis as it is received, others noted that they complete data entry at specific times throughout the year.

### *Representativeness*

The immunization coverage assessment process in Ontario is school-based and underpinned by the ISPA. PHUs must assess and maintain records, as well as report on the immunization status of all children attending both public and private schools in the province. Children who are home-schooled may not be fully represented in the numerator or denominator for this report. Students who have dropped out of school are also not captured in this assessment of immunization coverage. Previous work has also suggested that the extent to which independent schools are included in PHU denominators may be variable across the province.<sup>7</sup>

### *Complex and dynamic nature of Ontario's immunization schedule*

Errors made by immunization providers may also result in unexpected immunization coverage estimates. These errors include incorrect vaccine administered or documented, incorrect interval between immunizations, lack of provider knowledge of updates to the schedule, and incorrect medical assessment of client status in relation to opportunity to vaccinate. Ontario has a complex and dynamic immunization schedule and if immunizers do not practice according to the current schedule, children may miss opportunities for immunization.

### *Use of forecasting logic to assess immunization coverage*

Both this report and previous coverage assessments have demonstrated that the use of forecasting logic is problematic for assessing immunization coverage.<sup>20,30</sup> Because it considers students who have initiated a vaccine series, but who are not yet overdue for their next dose as complete-for-age, it does not report on what proportion of students have received an age-appropriate number of doses, based on the schedule (up-to-date). Previous reports have also identified that because forecasting logic parameters are based on eligibility criteria listed in the publicly funded schedule, that for VPDs such as Hib and pneumococcal, there is an inability to report on coverage on and after the age of five years.

## Gaps

The implementation of Panorama, as IRIS's replacement, may address some of the limitations in immunization coverage assessment noted here if forecasting logic is not used to assess coverage. However, important gaps in immunization information are likely to persist. The focus of Ontario's enabling legislation and infrastructure is on immunization coverage among school-aged students, with either no or limited information on coverage in other groups, including infants, pre-school children, adults, and individuals with high risk medical conditions. Although the *Day Nurseries Act*<sup>32</sup> sets out the requirement for PHUs to collect and review the immunization records of children enrolled in licensed children care programs as defined in the Act, not all young children in Ontario attend such a child care facility. Pre-school aged children (including infants and toddlers) are an important group to monitor, because most VPDs have an age-dependent risk of complications with younger age groups, especially infants, being particularly vulnerable. Furthermore, the age of two years is defined as an international benchmark for the assessment of immunization coverage. At present, Ontario does not have the surveillance infrastructure to assess immunization coverage in this important age group.

Until the time at which there is a true population-based immunization registry in Ontario, including the ability to receive information from electronic medical records held by HCPs who deliver the vast majority of immunizations in Ontario, there will continue to be limited information on immunization coverage among populations outside of school pupils. Additional strategies to address this gap are needed such as immunization surveys, administrative health services research using vaccine-specific billing codes, and population-level sero-epidemiology studies.

## Conclusion

Immunization coverage assessment in Ontario is supported by enabling provincial legislation and the dedication and commitment of a range of immunization stakeholders, in particular the staff of Ontario's 36 PHUs and dedicated health care providers who deliver immunizations throughout the province. This report documents that Ontario, with rare exceptions, is not meeting established benchmarks for immunization coverage. In general, across vaccine programs, coverage is higher among 17-year-old versus 7-year-old students. High immunization coverage is essential for preventing outbreaks and robust immunization information systems are required to ensure immunization coverage estimates are timely and accurate. This and previous reports have also demonstrated the importance of strengthening the methodology supporting immunization coverage assessment in Ontario to move away from an approach that relies exclusively upon forecasting logic. As the implementation of Panorama continues, it is important not to lose sight of additional opportunities to strengthen the surveillance and delivery of immunization programs in Ontario, including efforts to increase immunization coverage.

# References

1. Ontario. Ministry of Health and Long-Term Care. Immunization management protocol. Toronto, ON: Queen's Printer for Ontario; 2013. Available from: [http://www.health.gov.on.ca/en/pro/programs/publichealth/oph\\_standards/docs/immunization\\_management.pdf](http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/immunization_management.pdf)
2. *Immunization of School Pupils Act*, R.R.O. 1990, Reg. 645. Available from: [http://www.e-laws.gov.on.ca/html/regs/english/elaws\\_regs\\_900645\\_e.htm](http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_900645_e.htm)
3. *Immunization of School Pupils Act*, R.S.O. 1990, c.1.1. Available from: [https://www.e-laws.gov.on.ca/html/statutes/english/elaws\\_statutes\\_90i01\\_e.htm](https://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90i01_e.htm)
4. National standards for immunization coverage assessment: recommendations from the Canadian Immunization Registry Network. *Can Comm Dis Report*. 2005;31(9):93-7. Available from: <http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/05vol31/dr3109a-eng.php>
5. National Advisory Committee on Immunization. Statement on mumps vaccine. *Can Comm Dis Report*. 2007;33(ACS-8):1-10. Available from: <http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/07vol33/acs-08/index-eng.php>
6. National Advisory Committee on Immunization; Public Health Agency of Canada. Canadian immunization guide [Internet]. Evergreen ed. Ottawa, ON: Her Majesty the Queen in Right of Canada; [cited 2014 Feb 6]. Available from: <http://www.phac-aspc.gc.ca/publicat/cig-gci/index-eng.php>
7. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Immunization coverage report for school pupils: 2010/11 school year. Toronto, ON: Queen's Printer for Ontario; 2012.
8. Ontario. Ministry of Health and Long-Term Care, Public Health Division. Immunization coverage report for school pupils: school years 2007/08 and 2008/09. Toronto, ON: Queen's Printer for Ontario; 2011.
9. Anderson RM, May RM. Immunisation and herd immunity. *Lancet*. 1990;335(8690):641-5.
10. Final report on outcomes from the National Consensus Conference for Vaccine-Preventable Diseases in Canada, June 12-14, 2005 - Quebec City, Quebec. *Can Comm Dis Report*. 2008;34 Suppl 2:1-56. Available from: <http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/08vol34/34s2/index-eng.php>
11. National Advisory Committee on Immunization; Public Health Agency of Canada. Canadian immunization guide [Internet]. Evergreen ed. Ottawa, ON: Her Majesty the Queen in Right of Canada; [cited 2012 Nov 30]. Part 4: active vaccines: poliomyelitis vaccine. Available from: <http://www.phac-aspc.gc.ca/publicat/cig-gci/p04-poli-eng.php>
12. Polio vaccines and polio immunization in the pre-eradication era: WHO position paper. *Wkly Epidemiol Rec*. 2010;85(23):213-28. Available from: <http://www.who.int/wer/2010/wer8523.pdf>
13. Shulman L, Gavrilin E, Jorba J, Martin J, Burns C, Manor Y, et al. Molecular epidemiology of silent introduction and sustained transmission of wild poliovirus type 1, Israel, 2013. *Euro Surveill*. 2014;19(7):20709. Available from: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20709>

14. Canadian national report on immunization, 1996. Can Comm Dis Report. 1997;23(S4). Available from: <http://www.collectionscanada.gc.ca/webarchives/20071124031904/http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/97vol23/23s4/index.html>
15. Ontario. Ministry of Health and Long-Term Care. Publicly funded immunization schedules for Ontario - August 2011 [Internet]: Toronto, ON: Queen's Printer for Ontario; 2011 [cited 2014 Jun 17]. Available from: <http://www.health.gov.on.ca/en/public/programs/immunization/docs/schedule.pdf>
16. Ontario. Ministry of Health and Long-Term Care, Public Health Division, Public Health Policy & Programs Branch, Immunization Policy & Programs Section. IRIS immunization logic: eligible, due and overdue guidelines. Toronto, ON: Queen's Printer for Ontario; 2012.
17. Pan-American Health Organization, Technical Advisory Group on Vaccine-Preventable Diseases. Technical Advisory Group on Vaccine-Preventable Diseases: final report [Internet]. Buenos Aires: Pan-American Health Organization; 2011 [cited 2014 Jun 17]. Available from: [http://www.who.int/immunization/sage/5\\_PAHO-TAG2011\\_nov11.pdf](http://www.who.int/immunization/sage/5_PAHO-TAG2011_nov11.pdf)
18. Public Health Agency of Canada. Elimination of measles, rubella and congenital rubella syndrome in Canada: documentation and verification report: executive summary [Internet]. Ottawa, ON: Public Health Agency of Canada; 2011 [cited 2014 Jun 17]. Available from: <http://www.phac-aspc.gc.ca/im/vpd-mev/measles-rougeole-mrer-eng.php>
19. Plans-Rubió P. Evaluation of the establishment of herd immunity in the population by means of serological surveys and vaccination coverage. Hum Vaccin Immunother. 2012;8(2):184-8.
20. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Immunization coverage report for school pupils. 2011-12 school year. Toronto, ON: Queen's Printer for Ontario; 2013.
21. New Brunswick. Office of the Chief Medical Officer of Health (Public Health). Immunization program guide: policy 2.19 - required immunization of school children [Internet]. Fredericton, NB: Government of New Brunswick; 2012 [cited 2014 Jun 17]. Available from: <http://www2.gnb.ca/content/dam/gnb/Departments/h-s/pdf/en/CDC/HealthProfessionals/NBIPG-policy2-9-e.pdf>
22. Hull B, Dey A, Mahajan D, Menzies R, McIntyre P. Immunisation coverage annual report, 2009. Commun Dis Intell Q Rep. 2011;35(2):132-48. Available from: [http://www.health.gov.au/internet/main/publishing.nsf/Content/cda-cdi3502-pdf-cnt.htm/\\$FILE/cdi3502b.pdf](http://www.health.gov.au/internet/main/publishing.nsf/Content/cda-cdi3502-pdf-cnt.htm/$FILE/cdi3502b.pdf)
23. Omer S, Enger K, Moulton L, Halsey N, Stokley S, Salmon D. Geographic clustering of nonmedical exemptions to school immunization requirements and associations with geographic clustering of pertussis. Am J Epidemiol. 2008;168(12):1389-96. Available from: <http://aje.oxfordjournals.org/content/168/12/1389.long>
24. Dempsey AF, Freed GL. Health care utilization by adolescents on Medicaid: implications for delivering vaccines. Pediatrics. 2010;125(1):43-9. Available from: <http://pediatrics.aappublications.org/content/125/1/43.long>
25. Rand CM, Szilagyi PG, Albertin C, Auinger P. Additional health care visits needed among adolescents for human papillomavirus vaccine delivery within medical homes: a national study. Pediatrics. 2007;120(3):461-6. Available from: <http://pediatrics.aappublications.org/content/120/3/461.long>

26. Guay M, Clouâtre A, Blackburn M, Baron G, DE WALS P, ROY C, et al. Effectiveness and cost comparison of two strategies for hepatitis B vaccination of schoolchildren. *Can J Pub Health*. 2003;94(1):64-7. Available from: <http://journal.cpha.ca/index.php/cjph/article/view/367/367>
27. Deuson RR, Hoekstra EJ, Sedjo R, Bakker G, Melinkovich P, Daeke D, et al. The Denver school-based adolescent hepatitis B vaccination program: a cost analysis with risk simulation. *Am J Public Health*. 1999;89(11):1722-7. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1508974/>
28. Trotter C, Edmunds W. Modelling cost effectiveness of meningococcal serogroup C conjugate vaccination campaign in England and Wales. *BMJ*. 2002;324(7341):809. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC100788/>
29. Ontario. Ministry for Health and Long-Term Care. Ontario's HPV vaccination program [Internet]. Toronto, ON: Queen's Printer for Ontario; 2012 [cited 2013 Mar 14]. Available from: <http://www.health.gov.on.ca/en/ms/hpv/immunize.aspx>
30. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Immunization coverage for Ontario's school-based programs: 2011-12 school year and exploring the impact of expanded eligibility programs on immunization coverage (2007-08 to 2010-11 school years). Toronto, ON: Queen's Printer for Ontario; 2013.
31. Canadian Immunization Committee. Recommendations on a human papillomavirus immunization program. Her Majesty the Queen in Right of Canada, represented by the Minister of Health; 2008. Available from: <http://www.phac-aspc.gc.ca/publicat/2008/papillomavirus-papillome/papillomavirus-papillome-index-eng.php>
32. *Day Nurseries Act*, R.S.O. 1990, c D2. Available from: [http://www.e-laws.gov.on.ca/html/statutes/english/elaws\\_statutes\\_90d02\\_e.htm](http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90d02_e.htm)

**Public Health Ontario**

480 University Avenue, Suite 300

Toronto, Ontario

M5G 1V2

647.260.7100

[communications@oahpp.ca](mailto:communications@oahpp.ca)

[www.publichealthontario.ca](http://www.publichealthontario.ca)

