

## **Highlights**

- Preventing HPV-associated cancers through publicly funded vaccine programs is a priority
- Canadian provinces and territories design and implement vaccination programs
- It is difficult to gather current and reliable data on HPV vaccination in Canada
- This paper describes each jurisdiction's current HPV vaccine program and coverage rates
- Considerations for policy development are discussed

## Abstract

**Background:** The National Advisory Committee on Immunization in Canada recommends human papillomavirus (HPV) vaccination for females and males (ages 9-26). In Canada, the HPV vaccine is predominantly administered through publicly funded school-based programs in provinces and territories. This research provides an overview of Canadian provincial and territorial school-based HPV vaccination program administration and vaccination rates, and identifies foreseeable policy considerations. **Methods:** We searched the academic and grey literature and contacted administrators of provincial and territorial vaccination programs to compile information regarding HPV vaccine program administration and vaccination rates in Canada's 13 provincial and territorial jurisdictions. **Results:** As of October 2016, All 13 Canadian jurisdictions vaccinate girls, and six jurisdictions include boys in school-based publicly funded HPV vaccination programs. Eleven jurisdictions administer the HPV vaccine in a two-dose schedule. The quadrivalent vaccine (HPV4) has been the vaccine predominantly used in Canada; however, the majority of provinces will likely adopt the nonavalent vaccine in the future. According to available data, vaccination uptake among females ranged between 47%-93.9%, while vaccination uptake among males (in programs with available data to date) ranged between 77.9%-87.4%. **Conclusions:** Future research and innovation will beneficially inform Canadian jurisdictions when considering whether to administer the nonavalent vaccine, whether to implement a two or one-dose vaccination schedule, and how to improve uptake and rates of completion. The usefulness of standardizing methodologies for collecting and reporting HPV vaccination coverage and implementing a national registry were identified as important priorities.

## Canadian school-based HPV vaccine programs and policy considerations

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## Abstract

**Background:** The National Advisory Committee on Immunization in Canada recommends human papillomavirus (HPV) vaccination for females and males (ages 9-26). In Canada, the HPV vaccine is predominantly administered through publicly funded school-based programs in provinces and territories. This research provides an overview of Canadian provincial and territorial school-based HPV vaccination program administration and vaccination rates, and identifies foreseeable policy considerations. **Methods:** We searched the academic and grey literature and contacted administrators of provincial and territorial vaccination programs to compile information regarding HPV vaccine program administration and vaccination rates in Canada's 13 provincial and territorial jurisdictions. **Results:** As of October 2016, All 13 Canadian jurisdictions vaccinate girls, and six jurisdictions include boys in school-based publicly funded HPV vaccination programs. Eleven jurisdictions administer the HPV vaccine in a two-dose schedule. The quadrivalent vaccine (HPV4) has been the vaccine predominantly used in Canada; however, the majority of provinces will likely adopt the nonavalent vaccine in the future. According to available data, vaccination uptake among females ranged between 47%-93.9%, while vaccination uptake among males (in programs with available data to date) ranged between 77.9%-87.4%. **Conclusions:** Future research and innovation will beneficially inform Canadian jurisdictions when considering whether to administer the nonavalent vaccine, whether to implement a two or one-dose vaccination schedule, and how to improve uptake and rates of completion. The usefulness of standardizing methodologies for collecting and reporting HPV vaccination coverage and implementing a national registry were identified as important

24 priorities.

25 **Keywords**

26 Canada; cancer prevention; human papillomavirus; immunization policy; school-based

27 vaccination programs; vaccination coverage.

## 1. Introduction

28  
29  
30 Infection by the human papillomavirus (HPV) can result in morbidity and mortality  
31 because HPV is associated with multiple cancers and other health problems [1]. In Canada, the  
32 most common HPV-associated cancers are cervical, oropharyngeal, and anal cancers [2]. Over  
33 the past ten years, the safety and efficacy of the HPV vaccine has been established; the  
34 oncogenic protection offered by the HPV vaccine will ameliorate the health burden that HPV  
35 causes [1, 3-5]. Consequently, many countries have implemented HPV vaccine programs [1]. In  
36 Canada, the National Advisory Committee on Immunization (NACI) has recommended HPV  
37 vaccination for females (since 2007) and males (since 2012) [6]. The Public Health Agency of  
38 Canada advises that the HPV vaccine should be administered to school-aged children in order to  
39 provide the highest level of immunogenicity and to protect individuals before they become  
40 sexually active [7].

41 Three vaccines, the bivalent (HPV 2; protecting against two strains; Cervarix®,  
42 GlaxoSmithKline), quadrivalent (HPV 4; protecting against four strains; Gardasil®, Merck), and  
43 nonavalent (HPV 9; protecting against nine strains; Gardasil® 9, Merck) have been developed to  
44 protect against HPV infections and are approved for use [1, 6, 8-10]. In Canada, the quadrivalent  
45 and nonavalent vaccines have been licensed for females and males (aged 9-26), while the  
46 bivalent vaccine is licensed only for females (aged 9-45) [11]. The Canadian Immunization  
47 Committee originally set HPV vaccine coverage targets at 80% and 90% to vaccinate school-  
48 aged girls within two and five years of program introduction respectively [12]. The exact  
49 coverage necessary to achieve herd protection for HPV is not known, but a recent systematic  
50 review and meta-analysis of high-income countries suggested that female HPV vaccination

51 coverage of 50% would contribute to the presence of some herd effects [13]. However, for an  
52 individual to be protected, his or her partner must be among those vaccinated within the herd,  
53 which excludes certain groups (e.g. men who have sex with men in female-only vaccination  
54 programs) [14].

55 Canadian provinces and territories are responsible for providing health care to their  
56 people within their jurisdiction (with the exception of indigenous people living on reserves,  
57 whose vaccine programs are offered by the Federal Government) [15, 16].<sup>1</sup> The HPV vaccine is  
58 therefore administered predominantly through publicly funded school-based programs at the  
59 provincial or territorial level. There is substantial variation in the delivery and administration  
60 HPV vaccine programs among the provinces and territories, including whether boys are offered  
61 the HPV vaccine. Moreover, the HPV vaccine programs have been evolving in these  
62 jurisdictions, presenting a complicated picture. To understand the Canadian context better and to  
63 assist international comparison, it is important to describe the complexities of the thirteen school-  
64 based programs accurately. To date, such descriptions in the academic literature have been out-  
65 dated or incomplete because of the lack of reliable and current reports of Canadian HPV  
66 vaccination programs [2, 18-20]. Moreover, Canada's programs have been inaccurately  
67 portrayed (e.g. by the World Health Organization, in a recent academic international overview of  
68 HPV vaccination programs, in a report by the Institut Català d'Oncologia (ICO) Information  
69 Centre on HPV and Cancer, and in a report by the Canadian Cancer Society) [1, 2, 21-23].  
70 Because Canada does not have a national vaccination surveillance program, it is difficult to

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<sup>1</sup> Canada consists of thirteen jurisdictions known either as “provinces” or “territories”. Provinces are relatively populous and have elected provincial governments that exercise constitutional power in their own right [15]. Territories are situated primarily north of 60° latitude, have approximately only 3% of the Canadian population, and exercise power delegated to them by the Federal Government [17].

71 compare jurisdictions' vaccine rates as there is dissimilarity in data collection procedures,  
72 vaccination target age, years reported, and linking registries across the different provinces  
73 remains a challenge [24, 25]. Indeed, a recent report by the Canadian Partnership Against  
74 Cancer writes, "it is currently challenging to gather consistent, standardized data on HPV  
75 vaccination across Canada because provinces and territories collect and report data on uptake  
76 differently" (p.21) [20]. Accurate portrayal of uptake and completion of HPV vaccination in  
77 Canadian jurisdictions would enable program changes to be monitored, advance sound  
78 policymaking, and assist national and international comparison. Therefore, this research aimed  
79 to provide a current and comprehensive portrayal of school-based HPV vaccine programs in  
80 Canada, to compile recent vaccination rates (i.e. first dose 'uptake' and last dose 'completion'),  
81 and to identify foreseeable policy issues for Canadian HPV vaccine programs.

82

83

## 2. Methods

84

85 Between July and October, 2016, we sought to identify the most current details of school-  
86 based HPV vaccination programs (such as the eligible population, the type of vaccine, and the  
87 number of doses administered) and HPV vaccination rates in each Canadian jurisdiction (such as  
88 "uptake" or first dose and "completion" or final dose). First, we conducted a search of the  
89 academic and grey literature to obtain descriptions of HPV programs and vaccination rates in  
90 Canada, and to provide a historical context to current programs. We searched Pubmed and  
91 Google Scholar using "human papillomavirus AND vaccine AND Canada" as well as "human  
92 papillomavirus AND vaccine AND [for each jurisdiction; e.g. Ontario]". In total, 600 articles  
93 were detected in Pubmed, 259 of which were identified as duplicates, resulting in a total of 341



94 academic articles that were captured and their title and/or abstracts examined. In Google  
95 Scholar, the first and second page (up to 20 articles) were examined for reliable information  
96 about the HPV vaccine programs and their success. Second, we reviewed the references of the  
97 literature identified by the search. Additional articles were captured by reviewing relevant  
98 papers' references.

99 Third, we continually examined Canadian publications including the Canadian  
100 Immunization Guide (last updated for HPV September 2016) [26], and the most recent  
101 information provided by the provincial and territorial health ministries. Finally, we sent email  
102 messages to all jurisdictions' ministries and/or vaccination program coordinators to confirm that  
103 published program information was accurate, and to seek more recent coverage rates; we sent  
104 reminders two and four weeks after first contact. We asked informants about the details of their  
105 jurisdiction's programs (e.g. gender targeted, grade, dose schedule, catch up program...etc.), as  
106 well as the most recent uptake (first dose) and completion (two or three doses) rates for the HPV  
107 vaccine school-based program. We also asked them whether there are any publicly available  
108 reports on the jurisdictions' program and coverage rates. Informants in ten jurisdictions  
109 responded with information, while informants in three jurisdictions did not.

110

### 111 3. Results

112

113 We provide an overview of the administration of Canadian school-based HPV vaccination  
114 programs (2016-2017) in Table 1. We have clarified the population vaccinated, grade, and  
115 vaccine dose schedule for each jurisdiction. Between 2007 -2010, all Canadian jurisdictions  
116 initiated a school-based HPV vaccine program for females within their publicly funded

117 vaccination programs. From 2013 -2016 , six Canadian provinces expanded their programs to  
118 include boys, thus achieving a gender-neutral HPV vaccination program [ 27]. For all  
119 jurisdictions in 2016-2017, school-based programs were offered in grades four to seven, and  
120 administered generally in a two-dose schedule. In 2016-2017, catch-up programs were directed  
121 to males in grades 8 and 9 in three provinces (i .e. Alberta, Manitoba, and Prince Edward Island  
122 (P.E.I.)) for varying lengths of time (Table 1). For both sexes, HPV vaccination programs in  
123 Canada are primarily school-based; the target age group in 2016 -2017 ranges from grades four to  
124 seven (approximately ages nine to 13 years). This year, Ontario changed the target age of its  
125 vaccination program from grade eight to seven in recognition of evidence that the vaccine is  
126 more effective at a younger age [28].

127 We present the most recent reported vaccination rates, where possible, in Table 2 and  
128 Figure 1. “Uptake” refers to the administration of the first dose whereas “completion” refers to  
129 administration of the final dose (we specify the dose, 2 or 3 depending upon the jurisdiction’s  
130 requirements). Available data for female HPV vaccination uptake (i .e. first dose) ranged  
131 between 46.7% in the Northwest Territories (2013/2014) and 93.9% in Newfoundland and  
132 Labrador (2014/2015). Available data for female completion rates (i.e. two or three doses  
133 depending on jurisdiction) ranged between 39.3% in the Northwest Territories (2013/2014; three  
134 doses) and 89.2% in Newfoundland and Labrador (2014/ 2015; three doses). Vaccination uptake  
135 among males (in programs with available data to date) ranged between 75.0% in Alberta to  
136 87.4% in P.E.I, while vaccination completion ranged from 66.0% in Alberta to 81.4% in P.E.I.  
137 Data for males are available from only Alberta and P.E.I because the remaining four gender-  
138 neutral provincial programs were initiated in 2015 or 2016. Available data suggest that  
139 vaccination rates in some provinces are rising [ 29], while other jurisdictions’ vaccination rates

140 appear to be falling slightly (Table 2). Overall, these rates indicate that the HPV vaccine  
141 program remains under-used in Canada.

142

143

## 4. Discussion

144

### 4.1. HPV vaccination programs

146 Given that healthcare in Canada is the jurisdiction of the provinces and territories, there  
147 is substantial variation in the delivery and administration of the HPV vaccine across the 13  
148 different programs. This study has tracked the substantial evolution of the programs (e.g.  
149 regarding type of vaccine, dose, and population vaccination), providing a comprehensive  
150 portrayal of school-based HPV vaccine programs in Canada. The details and overview offered  
151 here may lead to clarity in international comparison and present varying policy options for other  
152 countries to pursue.

153 In 2016-2017, both HPV4 and HPV9 were used in different programs throughout  
154 Canada. A number of Canadian programs do not clearly specify which vaccine is offered to  
155 children. Nevertheless, given the efficacy and greater protection of HPV9 and its cost-  
156 effectiveness [11, 30], Canadian jurisdictions are likely to move towards administering HPV9,  
157 phasing out HPV4.

158 Canada is a global leader in offering two (rather than three) doses [1, 31]. British  
159 Columbia has provided two doses since 2010, and Quebec has offered a two-dose schedule since  
160 2013 [32, 33]. Outside Canada, two-dose vaccination was introduced in Switzerland in 2012  
161 [31]. In 2014, a number of other countries (including the United Kingdom, South Africa, France,  
162 Spain, The Netherlands, and Chile) began providing only two doses [31]. This dosing change

163 coincided with the WHO's 2014 approval of the use of two-dose schedules in females (who are  
164 younger than 15 and immunocompetent). As of April 2017, few countries (e.g. Australia)  
165 continue to provide three doses of the HPV vaccine [34]. In a two dose regime, a minimum  
166 spacing of five [35] or six [11] months between doses is necessary.

167 As of September 2016, 11 (of 13) jurisdictions administered the HPV vaccine in a two-  
168 dose schedule (Table 1). Nevertheless, NACI recommended that while HPV 2 and HPV 4 may be  
169 administered in two doses (prior to age 15 or 14, respectively); HPV 9 should be administered in  
170 three doses (as of July 2016) [11]. In November 2016, Iversen *et al.* reported evidence that, like  
171 HPV 4 [35, 36], two doses of HPV 9 in females and males aged 9-14 was found to be noninferior  
172 to three doses of HPV 9 [37, 38]. As more data about the persistence of antibody responses  
173 become available, NACI's recommendation might change to a two (or even one [36]) dose  
174 schedule. In the meantime, however, NACI does not deem two doses of HPV 9 sufficient based  
175 on the available evidence; a booster shot may be necessary. The duration of immunity for the  
176 HPV 9 vaccine has not yet been determined, but existing data suggest long-lasting (up to 10  
177 years) protection after HPV 4 vaccination [39].

178 In Canada, the HPV vaccine is predominantly administered through publicly funded  
179 school-based programs in provinces and territories (often in conjunction with another vaccine  
180 such as Hepatitis B). As Table 1 illustrates, all provinces and territories developed female  
181 vaccination programs between 2007 and 2010. From 2013 to 2016, six provinces funded HPV  
182 vaccination for boys [27]. In recent announcements, four provinces (i.e. British Columbia, New  
183 Brunswick, Newfoundland and Labrador, and Saskatchewan) have stated that they will  
184 commence funding HPV vaccination for boys in September 2017 [40-42]. The HPV vaccination  
185 programs are voluntary; nurses must receive the consent of parents or guardians before

186 administering the HPV vaccine to children. In publicly funded programs, public health nurses  
187 typically administer the HPV vaccine in schools [28]. If children miss one or more dose of the  
188 HPV vaccine at school, then the next time that the nurse is in the school, the nurse typically finds  
189 the child for vaccination. Additionally the child may obtain the missed dose outside of school  
190 (from a public health nurse, doctor, pharmacist, or nurse practitioner) [6]. It would be helpful to  
191 determine how many Canadian children miss HPV vaccine doses offered in schools and how  
192 likely they are to obtain missed doses outside of school; across Canada these data is not  
193 systematically collected and reported to the public health nurses [43]. Research has shown that  
194 providing opportunities to receive missed doses in schools through catch-up programs is  
195 important in optimizing coverage [44, 45].

196 Even though HPV vaccine programs in Canada are school-based, it is worth noting that  
197 certain groups may receive the HPV vaccine outside of school. These include children with  
198 significant fear of needles who may be vaccinated apart from their peers in a public health clinic.  
199 More notably, since September 2015, British Columbia has funded and made the HPV vaccine  
200 available in clinics for a subset of males including males aged 9-26 who have (or plan to have)  
201 sex with men, are infected with human immunodeficiency virus (HIV), or are street-involved;  
202 males aged 9-18 in the care of the Ministry of Children and Family Development; and males  
203 aged 12-17 in youth custody services centres [46]. This approach was directed to males in  
204 greatest need of HPV vaccination, but has received criticism for being inequitable and difficult to  
205 implement [14]. The number of British Columbia males vaccinated in this way will diminish  
206 because all males will be invited to receive the vaccine in Grade 6 beginning in September 2017.  
207 Quebec has an enhanced HPV vaccine program; in addition to its school-based program for girls  
208 and boys (Table 1), Quebec offers publicly funded school HPV vaccination to females aged 9 to

209 17, all individuals aged 26 or under who are infected with HIV or who have a weakened immune  
210 system, and to males aged 26 or under who have, or plan to have, sex with men (since 2016)  
211 [47]. Ontario also offers the HPV vaccine to men who have sex with men, aged 26 or younger  
212 (since 2016) [48]. Saskatchewan provides the HPV vaccine to males 9-17 who are HIV infected  
213 [49]. For all non-eligible individuals, the HPV vaccine can be purchased privately  
214 (approximately \$540 CAD for all three doses); some private insurance policies partially cover  
215 this cost [50].

216

#### 217 4.2. HPV vaccine uptake

218 A comprehensive and current depiction of HPV vaccine uptake rates across Canada is  
219 necessary for comparison of Canada's HPV vaccine rates compare with that of other countries.  
220 This information can be used also to assist in identifying which regions may benefit from a  
221 psychosocial or economic intervention and emerging issues for policy makers. Furthermore,  
222 standardization in how vaccine uptake is measured across Canadian jurisdictions may assist in  
223 improving our understanding of how evolving vaccine policy may affect HPV vaccine rates as  
224 well as important areas for further research.

225 As Table 2 demonstrates, vaccination uptake among females ranged between 46.7%-  
226 93.9%, while vaccination uptake among males (in programs with data available to date) ranged  
227 between 77.9%-87.4%. Data for males are available from only P.E.I and Alberta because the  
228 remaining four gender-neutral provincial programs were initiated in 2015 or 2016, with four  
229 more commencing in 2017. Although McClure *et al.* (2015) found that a significantly greater  
230 proportion of girls completed three doses of the HPV vaccine compared to boys (2013/2014) in  
231 P.E.I. [51], it appears that more recently there has been little difference in coverage between girls

232 and boys in P.E.I and Alberta (2014 /2015 , Table 2). Where governments fund in-school HPV  
233 vaccine programs, males are more likely to be vaccinated than where the program does not exist.  
234 Specifically, in contrast to uptake for males in P.E.I. and Alberta (77.9% and 87.4% respectively  
235 in 2014/ 2015) , a national survey conducted before any male vaccination programs (except P.E.I.)  
236 found that only approximately 1% of parents reported their sons received the HPV vaccine [52].  
237 Interestingly, since males have been included in HPV vaccine programs in Australia (2013) ,  
238 female uptake has also increased [53]. Future research is required to evaluate whether there is a  
239 similar rise in female HPV vaccine uptake when males are offered the vaccine in Canada and, if  
240 so, then to identify the underlying reasons for this phenomenon [ 54].

241 The coverage rates presented in Table 2 obscure the variation within each jurisdiction. As  
242 an example of such variation, coverage rates in different British Columbia health service delivery  
243 areas ranged from 46.5% to 75.4% [ 32]. Manitoba also reported that, “a significantly higher  
244 proportion of vaccinated than non-vaccinated females lived in urban areas and in areas of higher  
245 income...” [ 55]. By contrast, an Ontario evaluation found HPV vaccine refusal was highest in  
246 regions with both the lowest and highest income levels (2007 -2011 data) [ 56]. Further research  
247 is required to identify and to understand the disparities in HPV vaccination coverage within  
248 different Canadian jurisdictions (e.g. by gender, household income, ethnicity, and region)  
249 because such disparities might foreshadow future inequalities in cancer burden [57].

250 It is important to assess how coverage rates reported by Canadian jurisdictions (Table 2)  
251 compare with self-report data from Canadian parents. A recent Statistics Canada survey of  
252 Canadian parents of 12-13 year-old girls (N =5720 ) found that, overall , an estimated 72.3%  
253 reported their daughter had received one dose of the HPV vaccine [ 58]. Moreover, parents of  
254 girls residing in Nunavut, the Northwest Territories, and Yukon reported the lowest uptake while

255 New foundland and Labrador and P.E.I reported the highest [ 58]. Parental survey data might be  
256 inaccurate because parents may not know or remember whether their child received the HPV  
257 vaccine and may confuse the HPV vaccine with another vaccine. Encouragingly, these data from  
258 a Statistics Canada parent survey are similar to the proportion and distribution of uptake as  
259 reported by the programs (Table 2); however, further and continued evaluation is required.

260 Canadian HPV vaccination uptake rates compare poorly with other developed countries.  
261 Although HPV uptake rates in Canadian jurisdictions are perhaps slightly better than the United  
262 States (63% in females; 2015 survey data) [ 59], they are worse than Australia (85.6% in girls and  
263 77% in boys; 2015 vaccination data) [ 60, 61] and the United Kingdom (89.5% in females; 2015  
264 vaccination data) [ 62]. Like Canada, both Australia and the United Kingdom offer the HPV  
265 vaccine at no cost to parents in school-based vaccination programs. Canada's comparably lower  
266 HPV uptake is similar to its uptake with respect to other childhood vaccinations; in 2013,  
267 Canada's coverage was ranked below most affluent countries (28<sup>th</sup> of 29 countries, above  
268 Austria) according to a UNICEF evaluation [ 63]. To increase vaccine coverage rates in  
269 adolescents, the existing research has indicated that important interventions include: making  
270 national recommendations, implementing school-based vaccine administration, sending  
271 reminders (e.g. for parents to sign consent forms), offering opportunities to receive missed doses  
272 (e.g. through schools or by automatically notifying physicians), and creating vaccination  
273 information systems (or registries) [ 44, 45, 64-66]. Other crucial strategies include: educational  
274 interventions to increase awareness and knowledge, doctors' recommendation, and management  
275 of concerns and misconceptions of parents and adolescents [ 27, 44, 67]. Greater high quality  
276 research is necessary to evaluate which interventions are most effective in increasing HPV



277 vaccine coverage [ 44, 68, 69]. Case studies evaluating the successful programs of  
278 New foundland and L abrador or P.E.I. may be particularly fruitful in this regard.

279

#### 280 4.3. *Strengths and Limitations*

281 This study's principle strength is compiling specific details of each Canadian jurisdiction's  
282 school-based HPV vaccine program and providing the most recent coverage rates. The principle  
283 limitations arise because some jurisdictions did not respond to inquiries, or report information  
284 differently or inconsistently. The HPV vaccine coverage rates of the different jurisdictions  
285 (reported in Table 2) are difficult to compare because jurisdictions have important differences in  
286 data collection procedures, vaccination target age, and years reported. In particular, we aimed to  
287 report which vaccine is administered in each jurisdiction (i.e. HPV 2, 4 or 9), but could not do so  
288 because we received conflicting information.

289

#### 290 4.4. *Future Policy Considerations*

291 Canada's HPV vaccine programs face key challenges. First, the well-identified need in  
292 Canada for implementation of national standards for immunization registries and methods for  
293 coverage assessments has not yet been met [ 43, 70-72]. Consequently, it is difficult to report  
294 national data regarding HPV vaccination rates even though there continues to be demand for  
295 such data. A recent report by the Canadian Partnership Against Cancer explains that  
296 "standardized data collection and reporting on HPV vaccination could result in more comparable  
297 uptake rates and the ability to more accurately assess prevention and health promotion efforts  
298 and the impact of vaccination on subsequent cancer outcomes" (p.21) [20]. The Canadian  
299 Immunization Committee has also called for harmonization of data in a national registry as an

300 important element in evaluating HPV vaccination programs and preventing HPV-associated  
301 cancer: “The evaluation of the immunization program will require specific tools. The  
302 availability of a registry of HPV immunization coverage and a registry of cervical cancer, as well  
303 as a national HPV sentinel surveillance system, will be important components in this evaluation.  
304 Effective linkage between the latter databases will be needed” (p.33) [73].

305 All provinces and territories with one exception (Nunavut) have systems to assess vaccine  
306 coverage [70]. Efforts are underway to implement a new national communicable disease and  
307 surveillance and case management system called “Panorama” that permits jurisdictions to input  
308 and access immunization data [70, 74]. If Canada had a national HPV registry as countries such  
309 as Australia do, then cross-jurisdiction and international comparisons could be made accurately.  
310 Such a registry will be helpful as a basis when investigating the determinants of vaccination  
311 rates, identifying whether differences exist among specific groups, monitoring program success,  
312 and facilitating the sharing of strategies that contribute to high vaccine rates.

313 Second, greater transparency is needed to inform parents, researchers, and policy-makers  
314 nationally and internationally about Canada’s HPV vaccine programs. Tulsieram *et al.* (2016 )  
315 examined the readability and coherence of HPV information on seven provincial  
316 departments/ministries of health websites and found that information is not comprehensible to a  
317 sizeable group of the population [75]. Organizations and academics should be able to report  
318 Canada’s experience accurately and easily, yet the conclusions of recent publications  
319 demonstrate that such reporting remains a challenge [1, 2, 20, 21, 76]. This paper found that no  
320 coverage data have ever been reported for HPV vaccination (or any other vaccine) in one  
321 jurisdiction—Nunavut, a territory founded in 1999—and that the most recent available coverage  
322 data for some jurisdictions were dated (i.e. up to five years old) (Table 2). How coverage data

323 were collected, and who was included and excluded from coverage data reports is information  
324 that is essential to monitoring and evaluating HPV vaccination programs. Provinces and  
325 territories should annually enter into the database, Panorama, important information about  
326 vaccine uptake and completion rates.

327 A final issue related to both transparency and consistency across Canada is the importance  
328 of reporting adverse risks and events. Steenbeek *et al.* (2012) found major discrepancies and  
329 dissimilarities in the list of HPV vaccine-related physical risks that were reported by Canadian  
330 jurisdictions, and by organizations such as Merck Frosst Canada, NACI, and the Society of  
331 Obstetricians and Gynecologists of Canada [77]. Standardized content and format for consent  
332 forms and physical risks reports would increase reporting consistency across Canada.  
333 Furthermore, employing Panorama's system of surveillance for monitoring adverse events would  
334 also likely increase confidence in the safety of the HPV vaccine program.

335

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337

## 5. Conclusion

338

339 The prevention of HPV-associated cancers is an important public health priority.  
340 Measuring and reporting on HPV vaccination programs and coverage rates is crucial to  
341 informing future cancer prevention activities [20]. Canada has been an international leader in  
342 implementing gender neutral vaccination programs for both girls and boys and a two-dose HPV  
343 vaccine schedule [1, 31, 78]; however, specific details of Canada's HPV vaccination programs  
344 and coverage rates are often incomplete, not current, or unavailable. This paper offers a current  
345 portrayal of HPV vaccine programs in Canada and has compiled recent coverage rates for use in

346 national and international comparison and in policy development. The research has also  
347 identified policy issues that Canadian HPV vaccine programs will likely soon face. Indeed,  
348 Canadian jurisdictions variously must consider whether to administer the nonavalent vaccine, to  
349 offer possible booster shots, to establish a one-dose vaccination schedule, and to begin HPV  
350 vaccine programs for boys. The jurisdictions must also consider how to improve uptake and  
351 completion rates. To make future evidence-based policy decisions, Canadian HPV vaccination  
352 programs should offer transparent data about HPV vaccine coverage, detail the specifics of their  
353 HPV vaccine programs clearly, and employ standard methods for collecting HPV vaccination  
354 rates. In order to evaluate program success, to make accurate comparisons, and to improve HPV  
355 prevention efforts on a national basis, it is critical for jurisdictions to employ the existing  
356 national system, Panorama, to monitor HPV vaccination.

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
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**Table 1. Publicly Funded School-Based HPV Vaccination Programs, by Canadian Jurisdiction for 2016 -2017**

Jurisdiction	Population Vaccinated	Grade Vaccinated	Vaccine Dose Schedule*	Catch-up Program	Sources
Alberta	Females (since 2008); Males (since 2014)	5	3	Male catch-up (3 doses) 2014-2018 in grade 9	[26, 79]
British Columbia	Females (since 2008)	6	2	°	[26, 46]
Manitoba	Females (since 2008); Males (since 2016)	6	2	Male catch-up (2 doses) 2016-2019 in grade 8 or 9 (depending on health region)	[26, 80]
New Brunswick	Females (since 2008)	7	2	°	[26, 81]
Newfoundland and Labrador	Females (since 2007)	6	2	°	[26, 82]
Nova Scotia	Females (since 2007); Males (since 2015)	7	2	No male catch-up program	[26, 83]
Northwest Territories	Females (since 2009)	4-6	2 (9-14 y); 3 (>15 y)	°	[26, 84]
Nunavut	Females (since 2010)	6	3	°	[26, 85]
Ontario	Females (since 2007); Males (since 2016)	7	2	No male catch-up program	[26, 28, 48]
Prince Edward Island	Females (since 2007); Males (since 2013)	6	2	Male catch-up (2 doses; unless 15 years of age at dose 1 in which case 3 doses) 2015-2016 in grade 9	[26, 86, 87]
Quebec	Females (since 2008); Males (since 2016)	4	2	No male catch-up program	[26, 47]
Saskatchewan	Females (since 2008)	6	2	°	[26, 88]
Yukon	Females (since 2009)	6	2	°	[26, 89, 90]

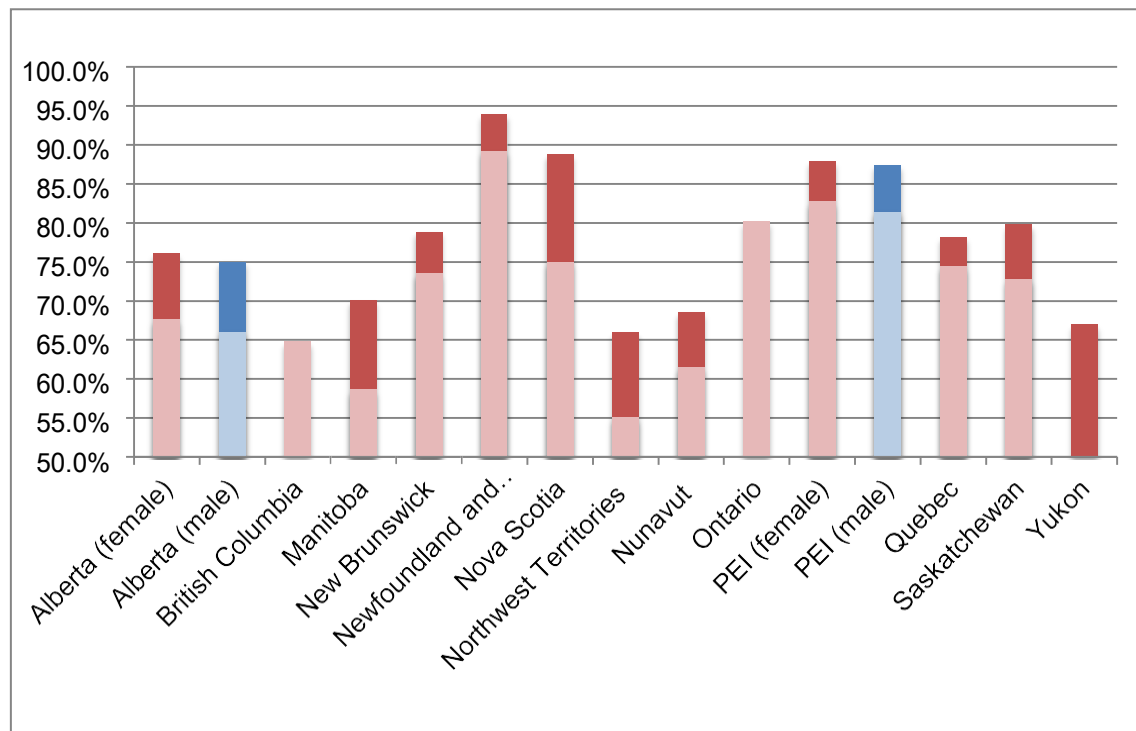
Note. \* Two doses are administered in a 0/6 month schedule while 3 doses are administered in a 0/2/6 month regimen. ° No male HPV vaccine program.

**Table 2. HPV Vaccine Coverage Rates, by Canadian Jurisdiction**

Jurisdiction	Female Uptake	Female Completion	Male Uptake	Male Completion	Sources
Alberta	74.2% (2013/2014) 76.1% (2014/2015)	64.9% (3 doses) 67.6% (3 doses)	75.0% (2014-2015) -- 77.9% (2014-2015)	66.0% (3 doses) -- 67.2% (3 doses) □	[91]
British Columbia	N ot A vail able N ot A vail able	65.8% (2013/2014; 2 doses) 64.8% (2014/2015; 2 doses)	---	---	[32]
Manitoba	68.8% (2013/2014) □ 70.1% (2014/2015)	58.2% (3 doses) 58.6% (3 doses)	---	---	[19, 20]
New Brunswick	80.1% (2012/2013) 80.1% (2013/2014) 78.9% (2014/2015)	75.1% (3 doses) 73.1% (3 doses) 73.5% (3 doses)	---	---	[92]
Newfoundland and Labrador	96.6% (2012/2013) 92.8% (2013/2014) 93.9% (2014/2015)	94.3% (3 doses) 88.7% (3 doses) 89.2% (3 doses)	---	---	[93, 94]
Nova Scotia	88.8% (2013/2014)	75.0% (3 doses)	N ot A vail able	N ot A vail able	[19]
Northwest Territories *	46.7% (2013/2014) 62% (2014/2015) 66% (2015/2016)	39.3% (3 doses) 48% (2/3 doses) 55% (2/3 doses)	---	---	[20, 95]
Nunavut †	87.8% (2013-2014) 68.6% (2014-2015)	61.9% (3 doses) 61.5% (3 doses)	---	---	[96]
Ontario °	Not Available	70.2% (2011/2012; 3 doses) 80.2% (2012/2013; 3 doses) □	---	---	[97]
Prince Edward Island	90.7% (2012/2013) 90.6% (2013/2014) 87.9% (2014/2015)	87.3% (3 doses) 84.9% (3 doses) 82.7% (3 doses)	85.4% (2013/2014) 87.4% (2014/2015)	79.0% (3 doses) 81.4% (3 doses)	[98]
Quebec	81% (2013/2014) 78.2% (2014/2015)	77% (2 doses) 74.4% (2 doses)	---	---	[19, 20]
Saskatchewan	79.5% (2011/2012) 80.2% (2012/2013) 79.8% (2013/2014)	72.7% (3 doses) 73.5% (3 doses) 72.8% (3 doses)	---	---	[88]

Yukon	67% (2011/2012) □	Not Available □	---	---	[99]
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Note. The year provided for completion rates are the same as for uptake rates. Grade 4 is the target vaccination for Quebec; grade 5 for Alberta; grade 6 for British Columbia, Manitoba, Newfoundland and Labrador, Nunavut, Prince Edward Island, Saskatchewan, and Yukon; grade 7 for New Brunswick, Nova Scotia, and Northwest Territories; and, grade 8 for Ontario. † Nunavut does not have a vaccination registry for any vaccine; data reported here is for the Qikiqtalik (Baffin) region only. □ More recent rates not available. (Ontario plans to release more recent rates in a forthcoming report). ° Although Ontario children were vaccinated in grade 7 in 2016-2017, the most recent coverage rates are provided for the period when the children were vaccinated in grade 8. \* Although Northwest Territories vaccinates girls in grades 4 to 6, coverage estimates are conducted in grade 7. □ Rates of grade 9 males in Alberta's catch-up program.



**Figure 1. Available data reporting most recent HPV vaccine coverage rates, by Canadian jurisdiction**

Note. Comparisons across jurisdictions should consider variation in data collection procedures, vaccination target age, and most recent year reported. Darker shade represents uptake rates and lighter shade represents completion rates. Nunavut data reported here is for the Qikiqtaaluk (Baffin) region only.