

Population-level sexual behaviours in adolescent girls before and after introduction of the human papillomavirus vaccine (2003–2013)

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ABSTRACT

BACKGROUND: The human papillomavirus (HPV) vaccine is delivered widely through school-based immunization programs. Some groups have expressed concern that HPV vaccination programs will result in an increase in sexual risk-taking behaviours among adolescents. We aimed to evaluate population-level changes in sexual behaviours before and after implementation of the school-based HPV vaccination program in British Columbia.

METHODS: In 2008, a school-based HPV vaccination program for girls was introduced in British Columbia. Using data from the BC Adolescent Health Survey —

a longitudinal provincial survey administered in schools to capture adolescent physical and emotional health indicators, we conducted a linear trend analysis on sexual health behaviours and risk factors in adolescent girls before and after the implementation of vaccination for HPV (2003, 2008 and 2013).

RESULTS: We analyzed data for 298 265 girls who self-identified as heterosexual. The proportion of girls reporting ever having sexual intercourse decreased from 21.3% (2003) to 18.3% (2013; adjusted odds ratio [OR] 0.79). Self-report of sexual intercourse before the age of 14 years decreased significantly from 2008 to 2013

(adjusted OR 0.76), as did reported substance use before intercourse (adjusted OR for 2003–2013 0.69). There was no significant change in the number of sexual partners reported (2003–2013). Between 2003 and 2013, girls' reported use of contraception and condoms increased, while pregnancy rates decreased.

INTERPRETATION: Since the implementation of school-based HPV vaccination program in BC, sexual risk behaviours reported by adolescent girls either reduced or stayed the same. These findings contribute evidence against any association between HPV vaccination and risky sexual behaviours.

Human papillomavirus (HPV) is the most commonly diagnosed sexually transmitted infection in the world.¹ While the majority of HPV infections are transient and resolve naturally without intervention, persistent infection with high-risk types of HPV can cause precancerous lesions that may progress to cervical, anal, oropharyngeal or other reproductive tract cancers, or anogenital warts if left untreated.² There is evidence that vaccination programs for HPV effectively reduce rates of high-risk types of HPV at the population and clinical level.^{3,4} Cervarix (GlaxoSmithKline), Gardasil and Gardasil-9 (Merck) are the 3 vaccines approved by Health Canada⁵ and recommended for use by the Canadian National Advisory Committee on Immunization.⁶ All 3 vaccines protect against HPV types 16 and 18, which are responsible for 70% of all cervical cancers.² Gardasil and Gardasil-9

reduce the risk of additional types of HPV that are associated with genital warts and other cancers.

Many countries have implemented national publicly funded immunization programs for HPV. These programs are offered typically in school to adolescent girls aged 9–13 years and, in recent years, to boys.⁷ School-based programs for HPV vaccination have shown broad coverage among adolescent populations compared with other approaches.⁸ However, negative beliefs about HPV vaccination may present barriers to uptake. Parents of adolescent girls have expressed concern that HPV vaccination at a young age would encourage risky sexual behaviours such as early sexual debut, more sexual partners or unprotected intercourse,^{9–11} and that by consenting to having their child receive the HPV vaccine that they would be condoning sexual activity at younger ages.¹²

Some evidence from clinic-based populations, billings by physicians and cross-sectional studies of existing cohorts suggests no association between HPV vaccination and increased sexual risk behaviours after vaccination.¹³⁻¹⁵ However, few studies have examined population-level sexual behaviours over time. In this study, we used an established provincial adolescent health survey to evaluate population-level changes in sexual health and risky behaviours over a decade, before and after the implementation of the school-based HPV vaccination program, in British Columbia, Canada.¹¹

Methods

Survey design and methods

The BC Adolescent Health Survey has been conducted every 5 or 6 years since 1992 and represents more than 1.4 million students enrolled in public schools in the province.¹⁶ It is a cluster-stratified randomized survey of classrooms in grades 7 through 12 in public schools across BC, administered between January and June of the relevant year. Students complete the questionnaire (comprising about 140 items) by hand, facilitated by public health nurses and nursing students.¹⁶ Questions included those about demographic information, health, risky behaviours, health protective factors and respondents' experiences concerning health and other risk exposures. The survey is anonymous and does not capture identifiable data. Survey items were derived from existing surveys in Canada and the United States¹⁷ or pilot-tested based on community consultation and testing.¹⁶ Only items that were the same across all 3 survey years were included in this analysis. The overall participation rate in the survey is about 75% each year. Additional descriptions of survey methods have been published previously.¹⁶

School program for human papillomavirus vaccination

In September 2008, BC launched a publicly funded, school-based routine program for HPV vaccination.¹⁸ During the first 3 years of the program, girls in grades 6 and 9 (born in 1994 to 1997) were offered vaccination for HPV. After 2011, the program was available for girls in grade 6 only, reaching those born in 1997 and later. Between 2008 and 2014, girls were offered a 3-dose vaccination schedule, which changed to a 2-dose schedule after 2014 for girls under the age of 15 years who were starting the series.

The school-based HPV vaccine program was not available for girls who completed the survey in 2003 and 2008. For 2013, all survey participants would have had the opportunity to receive HPV vaccination if they attended a BC school in grade 6 or 9. We obtained uptake rates for HPV vaccination from the immunization coverage reports provided by the BC Centre for Disease Control, which capture all HPV vaccinations in the province. Coverage rates were defined as the proportion of female students enrolled in the relevant grade (6 or 9) in the specified year who were up to date with HPV vaccination by June 30.^{19,20}

Sampling

We analyzed data from the 2003, 2008 and 2013 BC Adolescent Health Surveys. We stratified by grade and health service delivery

area (there are 16 areas within the 5 regional health authorities in BC) to obtain a representative sample at provincial and regional levels. The sample size was adjusted within each grade and health service delivery area stratum to ensure standard errors of 3.5% or lower. In school districts that required signed parental consent, the response rate was lower than in school districts that required parental notification and student consent. Therefore, we over-sampled these districts (about 25%–30% of participating school districts). We included only the school districts that had participated in all 3 survey rounds; 46 of the 59 school districts (77.9%) met this criterion.

We weighted data after survey completion to adjust for differential probability of sampling and differential response rates and scaled to provincial enrolment by consultants at Statistics Canada. For this analysis, we included only adolescent girls who indicated that they were heterosexual, unsure, questioning or without attractions in the final weighted sample. Girls who identified as lesbian or bisexual (who represented < 5% of the total sample) will be examined in a separate analysis, because there may be differences in sexual decision-making among girls who identify as lesbian or bisexual and, therefore, it is unclear whether the HPV vaccine would have comparable effect.

Measures

Measures included demographic information (age, urban or rural residence and whether born in Canada) and selected sexual health behaviours (ever having sexual intercourse, age at first intercourse, number of sexual partners within the past year, substance use before last intercourse, use of condoms for last intercourse, use of birth control pills at last intercourse and pregnancy involvement). Additional descriptions of study measures and definitions have been published previously.¹⁶

Statistical analysis

We used SPSS Complex Samples version 22.0 (IBM) to adjust for complex cluster-stratified sampling and weighted data. We reported the prevalence of self-reported sexual behaviours among heterosexual girls for each year. To test the linear trend of sexual behaviours, contraception use and pregnancy involvement across years, we used age-adjusted logistic regression models (reference year 2013). Adjusted odds ratios (ORs) less than 1 indicated that the trend (or odds) of the given sexual behaviour in the earlier survey year was greater than in 2013, and adjusted ORs greater than 1 indicated that the odds of the behaviour in the earlier survey were less than in 2013.

Ethics approval

The study was approved by the Behavioural Research Ethics Board at The University of British Columbia (H12-02630).

Results

The weighted and scaled population estimate for adolescent girls who identified as heterosexual or were unsure was 302 626 (Table 1), of whom 123 166 (40.7%) participated in 2003, 99 925 (33.0%) in 2008 (prevaccination group) and 79 535

Table 1: Characteristics of female participants in the BC Adolescent Health Survey, by years 2003, 2008 and 2013

Characteristic	% (95% CI) of participants who identified as heterosexual* n = 302 626		
	2003†	2008†	2013‡
Total population weighted estimate,§ n (%)	123 166 (40.7)	99 925 (33.0)	79 535 (26.3)
Age, mean ± SD; yr	14.87 (14.80–14.93)	14.98 (14.94–15.03)	14.89 (14.85–14.93)
School grade, mean ± SD	9.45 (9.39–9.51)	9.66 (9.60–9.73)	9.62 (9.58–9.66)
Residence area			
Urban	86.9 (85.6–88.1)	86.6 (85.0–88.1)	88.0 (86.3–89.6)
Rural	13.1 (11.9–14.4)	13.4 (11.9–15.0)	12.0 (10.4–13.7)
Born in Canada			
Yes	82.0 (80.1–83.7)	81.5 (80.3–82.6)	81.3 (80.1–82.4)
No	18.0 (16.3–19.9)	18.5 (17.4–19.7)	18.7 (17.6–19.9)

Note: CI = confidence interval, HPV = human papillomavirus, SD = standard deviation.
 *Unless stated otherwise.
 †Survey years before implementation of the school-based HPV vaccination program in British Columbia.
 ‡Survey year after implementation of the school-based HPV vaccination program in BC. All girls surveyed would have had the opportunity to receive the HPV vaccine.
 §Weighted and scaled sample represents this population of adolescent girls in BC who were heterosexual.

(26.3%) in 2013 (postvaccination group). Demographic factors are presented in Table 1. The age range was 12–18 years for girls in all years. Most girls lived in urban areas (between 86.6% and 88.0% for all years), and most were born in Canada (81.3%–82% for all years). In the first year of the BC school-based HPV vaccination program (2008/09), uptake rates were 61.8% among female students in grade 6. Rates decreased slightly the following year but then increased over time to 68.8% in 2013.¹⁹ Among female students in grade 9, 62.1% of eligible girls were vaccinated in 2008/09, and rates decreased slightly to 61.7% in 2011 (Table 2).²⁰

Participants were asked whether they had had sex in their lifetime, and only those with valid responses were included in the analysis (population estimate 298 265; 1.5% of responses were missing from the demographic population). Only girls who responded yes to this question answered subsequent questions related to sexual behaviours. Prevalence and adjusted OR between time points among girls who identified as heterosexual are presented in Table 3. The prevalence of girls reporting ever having sexual intercourse decreased steadily between survey years, from 21.3% in 2003 to 20.6% in 2008 to 18.3% in 2013. When comparing prevaccination years (2003 and 2008) with the postvaccination year (2013), the adjusted ORs for ever having sexual intercourse were 0.79 (95% confidence interval [CI] 0.71–0.88) and 0.89 (95% CI 0.82–0.98), respectively, which indicates that girls were significantly less likely to report ever having sex after introduction of the HPV vaccination program.

Among those who have ever had intercourse, the proportion having intercourse before the age of 14 years also decreased over time, with a significant change observed between 2008 and 2013 (adjusted OR 0.76, 95% CI 0.61–0.96). There was no

significant change in the prevalence of having 3 or more sexual partners over time (adjusted OR for 2003–2013 1.02, 95% CI 0.83–1.26; adjusted OR for 2008–2013 0.90, 95% CI 0.75–1.09). The percentage of girls who used substances such as alcohol or drugs before their last intercourse increased slightly between 2003 (26.0%) and 2008 (28.3%), and then decreased in 2013 (19.3%). The trend analyses showed that prevalence of substance use before last intercourse decreased after implementation of the HPV vaccination program (adjusted OR for 2003–2013 0.69, 95% CI 0.58–0.82).

Reported use of condoms and birth control pills increased from previous years to 2013. Condom use was 65.6% in 2003, which decreased to 63.3% in 2008 and increased to 68.9% in 2013. Condom use significantly increased from previous years to 2013 after implementation of the HPV vaccination program (adjusted OR for 2003–2013 1.19, 95% CI 1.02–1.39). Oral contraceptive use

Table 2: Coverage rates of the school-based vaccination program for human papillomavirus among female participants in grades 6 and 9 in British Columbia, 2008–2013

Grade in school	% of participants who completed the series (by year of grade completion)				
	2009	2010	2011	2012	2013
6	61.8	59.9	68.2	68.7	68.8
9	62.1	58.1	61.7	*	*

Note: HPV = human papillomavirus.
 *Coverage rates for girls who were in grade 9 in 2011/12 and 2012/13 were not assessed because these girls had been offered 3 doses of the HPV vaccine in grade 6 in 2008/09 and 2009/10, respectively. Therefore, their coverage rates can be observed in the grade 6 results.

Table 3: Sexual behaviours in female participants between 2003 and 2013, based on the BC Adolescent Health Survey

Behaviour	% (95% CI) of participants*			Age-adjusted OR (95% CI)	
	2003†	2008†	2013‡	Trend 2003–2013	Trend 2008–2013
Total population weighted estimate§, <i>n</i>	121 355	98 588	78 322		
Sexual risk behaviour					
Ever had sexual intercourse	21.3 (20.0–22.5)	20.6 (19.7–21.5)	18.3 (17.4–19.3)	0.79 (0.71–0.88)	0.89 (0.82–0.98)
Early first intercourse (before age 14 yr)	14.3 (12.7–16.2)	13.0 (11.6–14.7)	10.2 (8.7–11.8)	0.82 (0.65–1.03)	0.76 (0.61–0.96)
Three or more sexual partners within the past year	15.5 (13.4–17.8)	17.1 (15.4–18.9)	15.7 (14.0–17.6)	1.02 (0.83–1.26)	0.90 (0.75–1.09)
Used substances before last intercourse	26.0 (23.7–28.5)	28.3 (26.2–30.6)	19.3 (17.4–21.3)	0.69 (0.58–0.82)	0.60 (0.51–0.71)
Contraceptive use					
Used condoms at last intercourse	65.6 (63.2–68.1)	63.3 (60.9–65.7)	68.9 (66.4–71.3)	1.19 (1.02–1.39)	1.28 (1.10–1.49)
Used birth control pills at last intercourse	45.1 (42.2–48.0)	48.1 (45.7–50.5)	54.5 (52.0–57.0)	1.43 (1.21–1.67)	1.26 (1.10–1.45)
Pregnancy involvement					
Ever been pregnant	5.9 (4.6–7.3)	5.0 (4.1–6.1)	3.4 (2.6–4.5)	0.56 (0.40–0.80)	0.69 (0.49–0.98)

Note: CI = confidence interval, HPV = human papillomavirus, OR = odds ratio.
 *Unless specified otherwise.
 †Survey years before the implementation of the school-based HPV vaccination program in British Columbia.
 ‡Survey year after the implementation of the school-based HPV vaccination program in BC. All girls surveyed would have had the opportunity to receive the HPV vaccine.
 §Weighted and scaled sample represents this population of adolescent heterosexual girls in BC who responded to the question on sexual intercourse.

increased by 9.4% between 2003 and 2013 (adjusted OR 1.43, 95% CI 1.21–1.67). The prevalence of girls who reported pregnancy decreased by 42% from 2003 to 2013 (adjusted OR for 2003–2013 0.56, 95% CI 0.40–0.80).

Interpretation

After implementation of the publicly funded school-based vaccination program for HPV in September 2008 in BC, sexual behaviours and sexual health indicators among adolescent girls either improved toward safer sexual health practices or did not change significantly. Our analysis of data from the BC Adolescent Health Survey suggests that the implementation of a school-based program for HPV vaccination was not associated with an increase in risky sexual behaviours among adolescent girls at the population level.

Concerns that the HPV vaccine could lead to increasingly risky sexual behaviours originate from the perception that by participating in an intervention that reduces risk, one may engage in higher-risk behaviours (also called risk compensation²¹ or risk homeostasis).²² Studies on risk perception after HPV vaccination suggest that related adolescent beliefs are not aligned with risk compensation theory. Two 2012 studies reported that, although adolescent girls who had received the HPV vaccine perceived themselves to be at lower risk of acquiring HPV, they did not perceive a lower risk for other sexually transmitted infections, and most reported the continued need for safer sexual practices.^{23,24} It is worth noting that a comprehensive vaccine education program was paired with the implementation of the HPV vaccination program in BC.²⁵ This could

have provided participants with a better understanding of the limits of the HPV vaccine for protection against other sexually transmitted infections.

A prospective cohort study that used clinical indicators to measure sexual behaviours among 11- to 12-year-old girls enrolled in a managed care organization in the US, who were exposed and not exposed to the HPV vaccine, found no differences between groups in incidence of pregnancy, testing for sexually transmitted diseases or contraceptive counselling.¹⁵ Another study found no increased risk in composite outcomes of pregnancy and sexually transmitted infection among adolescent girls after implementation of Ontario's grade 8 HPV vaccination program.¹³ These studies examined clinical outcomes related to risky sexual behaviours as a proxy for direct measures of such behaviours, such as age at first intercourse or number of sexual partners. Studies of self-reported direct measures of risky behaviours similarly reported no association between measures of sexual debut and HPV vaccination.^{26,27} Other research has also found no relationship between HPV vaccination and the number of sexual partners,^{26,27} which is consistent with the results of our study. In other research, use of condoms and contraceptives was consistently higher among young women who had received the vaccine than those who had not.^{4,26,27} We did not find other studies that examined the association between HPV vaccination and substance use before intercourse.

The main strength of our study is that it is representative of the BC population because of its large sample size and complex sampling technique using an established provincial adolescent health survey, accompanied by a high response

rate. Previous research has focused mainly on clinic-based populations, retrospective cohorts and smaller cross-sectional study samples.

Limitations

Our analysis has some limitations. We did not examine the direct relationship between individual HPV vaccination status and sexual behaviours, and we cannot infer individual-level or causal relationships because the Adolescent Health Survey does not capture identifiable data that can be linked to public health vaccination records. However, a self-reported question on HPV vaccination status is being included for future survey cycles. For this ecological study, we used time as an indicator to separate the prevaccination program population (2003 and 2008) from the postvaccination population (2013). We do not suggest that the observed sexual behaviours over time are attributable to the implementation of HPV vaccination in BC. Previous evidence from the survey has shown a downward trend in risky sexual behaviours since before 2003.¹⁶ Sexual and reproductive health behaviours are influenced by a complex interplay of contextual factors including the legal and political environment, as well as sociocultural and economic factors.²⁸ There is evidence of a global trend toward safer sex practices since before the HPV vaccine was available.^{29,30} In sub-Saharan Africa where HPV vaccination is mostly absent, a multicountry study using data from 2000 to 2010 observed trends toward older age of sexual debut and increasing use of contraception over time.³¹ Population data in the US for 1976–2016 showed that fewer adolescents have been engaging in behaviours such as dating, alcohol consumption and sex, with a sharp decline since 2000.³⁰ Sexual behaviour data are self-reported and may be subject to recall and social desirability bias. However, this bias was likely present in all survey years.

Conclusion

Our finding that self-reported risky sexual behaviours reduced or stayed the same among adolescent girls in BC after introduction of a school HPV vaccination program with uptake of about 68% can help mitigate concerns based on risk compensation theory.

Future analyses should explore differences between girls who identify with other sexual orientations such as homosexuality and evaluate sexual behaviour among girls who received the HPV vaccine and those who did not. Additional studies could be conducted to explore national trends or examine differences between different provincial vaccination programs.

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Data sharing: The BC Adolescent Health Survey is conducted by the McCreary Centre Society; they give approval for data access to established health and social science researchers whose proposed research aligns

with the original purposes of the survey. Data are available for analysis only on site at the McCreary Centre Society in Vancouver, BC, on its secure computers, after approval of the proposed analyses, a signed Memorandum of Understanding and payment of data access fees to provide computer access and technical support. Further information on accessing the BC Adolescent Health Surveys is available at www.mcs.bc.ca/research_partnerships.

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