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Do Regional Social and Material Characteristics Influence Human Papillomavirus (HPV) Vaccine Decision-Making? The Ontario Grade 8 HPV Vaccine Cohort Study

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Authors' contributions

This work was carried out in collaboration between all authors. Author OR was involved in the conception and design of this study, carried out the statistical analyses, interpreted the results and prepared the first draft of the manuscript. Author LMS participated in acquiring the data and funding for this study, contributed to the interpretation of the results, and critically reviewed the manuscript. Author BAL played a major role in the design, execution, and interpretation of the study, and critically reviewed the manuscript. Author LC supported author OR in the analysis and interpretation of the data and critically reviewed the manuscript. Author LEL was responsible for acquiring data and funding for the study, played a major role in the design, execution and interpretation of the study and critically reviewed the manuscript. All authors have given final approval of the manuscript and agree to be accountable for all aspects of the work.

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ABSTRACT

Aims: Although social and material characteristics are known determinants of health behaviours, there is no information on whether these factors influence human papillomavirus (HPV) vaccine decision-making. Moreover, few studies consider the potentially important influence of regional-level factors on HPV vaccine use. The objective

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of this study was to evaluate regional social and material characteristics as potential determinants of HPV vaccine refusal.

Study Design: Population-based retrospective cohort.

Methodology: Population-based administrative health and immunization databases were used to identify girls eligible for Ontario's Grade 8 HPV vaccination program during the 2007/08-2010/11 program years. A cohort member was classified as a 'refuser' if she received no doses of the vaccine. Regional-level (i.e., health unit-level) social and material characteristics potentially associated with HPV vaccine decision-making were derived from the 2006 Canadian Census. The association between a girl's environment and vaccine refusal was assessed using generalized estimating equations with a binomial distribution and a log link to estimate a population-average effect.

Results: We identified a cohort of 144,047 girls, almost half (49.3%) of whom refused HPV vaccination. Overall refusal ranged from 42-60% across health units. For the majority of health units, refusal was highest in the first program year. While most regional-level factors were not strongly associated with HPV vaccine use, high regional deprivation was associated with low vaccine refusal (OR=0.86, 95% CI: 0.83, 0.89).

Conclusions: Our findings of an association between high regional deprivation and low HPV vaccine refusal may be promising in terms of the health and economic benefits of this program. Future studies incorporating both individual- and regional-level determinants are needed to further elucidate the determinants of HPV vaccine refusal in the context of publicly funded, school-based programs.

Keywords: Human papillomavirus; HPV vaccine; determinants; vaccine refusal; epidemiologic determinants.

1. INTRODUCTION

The quadrivalent human papillomavirus (qHPV) vaccine (Gardasil[®]) is designed to protect against infection with four types of HPV that cause 70% of cases of cervical cancers (HPV types 16 and 18) and 90% of cases of anogenital warts (HPV types 6 and 11) [1-3]. In 2006, the Canadian government announced it was providing \$300 million to provinces and territories on a per-capita basis to fund the first three years of a national HPV immunization program for young girls. The Ontario government received \$117 million and, in September 2007, launched their Grade 8 HPV vaccination program [4]. Ontario offers all three doses of the vaccine, free of charge, to all Grade 8 girls; similar programs have been implemented across Canada [5]. Despite excitement over the HPV vaccine as one of the first cancer-preventing vaccines, levels of HPV vaccine receipt through the publicly funded programs have been much lower than anticipated in a number of provinces/territories.[5] For example, Ontario reported that only 53% of eligible girls received the first dose of the vaccine in the program's first year [4]. A number of factors were believed to have contributed to this low uptake, including health unit staff shortages and resource strains, logistical issues in delivering the vaccine to schools across the province, and delayed dissemination of promotional materials to schools [6]. Although these factors primarily affected the first year of the program, uptake has remained low in Ontario [7]. Given the negative public health and cost-effectiveness implications of low HPV vaccine uptake, it is important to identify the factors influencing HPV vaccine refusal.

A number of studies have identified individual-level determinants of HPV immunization uptake (e.g., family income, education, race, perceived risk for HPV-related disease, and

caregiver perceived benefits and harms of HPV vaccination), but few have been carried out in a Canadian context and only one has examined the role of regional level determinants [8-12]. The latter is especially surprising given that several studies have demonstrated the importance of considering the social and economic characteristics of one's environment when elucidating health behaviour patterns. For example, studies of the determinants of H1N1 vaccine uptake during the 2009 pandemic showed that regional socio-economic status, health service availability, and community policy regarding program financing were significant determinants of vaccine uptake [13,14]. Moreover, a recent study conducted in the Netherlands suggested that deprived areas with high regional percentages of anti-vaccine sentiments reported lower coverage of HPV vaccination in adolescent girls [15]. These findings demonstrate that the region in which a girl and her caregivers reside may be important determinants of vaccine acceptance, underscoring the need to investigate the role of regional-level characteristics on HPV vaccine decision-making.

To address this important gap in the literature and gain insight into the high HPV vaccine refusal in Ontario, we conducted a population-based, retrospective cohort study of girls eligible for Ontario's Grade 8 HPV vaccination program between the 2007/08 and 2010/11 program years. We aimed to describe the levels of refusal by health region (i.e., health unit) and identify the regional-level determinants of this refusal.

2. METHODOLOGY

2.1 Ontario's Grade 8 HPV Immunization Program

Ontario's HPV vaccination program was initiated in September 2007 and offers all three doses of the quadrivalent HPV (qHPV) vaccine to all Grade 8 girls in the province. While approximately 84,000 girls are eligible for this program each year, participation is optional and generally requires parental consent. The program structure is the same across the province; however, each of Ontario's 36 health units is responsible for administering and delivering the program in their jurisdiction. While the vast majority of doses received are administered through school-based immunization clinics, eligible girls may also receive the vaccine free of charge at their public health unit or in their physician's office. During the study period, girls had until the end of their Grade 8 academic year to initiate the vaccine series and until the end of their Grade 9 year to complete it [16]. All doses administered through the publicly funded program are documented in the Immunization Records Information System (IRIS) database, irrespective of whether it was administered at a school, health unit, or physician's office.

2.2 Data Sources and Record Linkage

This study used information from: (i) Ontario's Registered Persons Database (RPDB), (ii) the Immunization Records Information System (IRIS), and (iii) the 2006 Canadian Census.

The RPDB (described elsewhere in detail [17]) is a population registry of insured residents that is generated by Ontario's universal health insurance programs. It has been used extensively for health research as it provides individual-level information on the socio-demographics of the province's insured residents. This database is accessible through the Institute for Clinical Evaluative Sciences (ICES) where, to preserve confidentiality and anonymity, all individuals are represented by a unique encrypted number that permits complete individual-level record linkage across databases and over time [18].

The IRIS database was developed by the Ontario Ministry of Health and Long-Term Care to assist the province's 36 health units in tracking and recording mandatory vaccinations of school-aged children, as required by the Immunization of School Pupils Act, 1982 [19]. IRIS also provides detailed information on optional vaccines, especially those that are publicly funded. When a student transfers to a school in a different health unit, the legal guardians are required to provide the child's vaccination history to the local health unit so this information can be recorded in IRIS. The IRIS database has been shown to accurately capture information on HPV vaccination status with a sensitivity of 99.8% (95% confidence interval: 99.3, 99.9) and specificity of 97.7% (95% confidence interval: 96.3, 98.7) [20]. We transferred a copy of the IRIS database of each health unit to ICES to create a provincial immunization database that was record linked to the province's administrative health databases.

For information on regional-level (i.e., health unit-level) characteristics, we used data from the 2006 Canadian Census, a mandatory self-reported survey conducted every five years by Statistics Canada to provide a statistical portrait of the Canadian population [21,22]. The Census enumerates all citizens, landed immigrants, and non-permanent residents to obtain socio-demographic information for different levels of geography (e.g., census tract, postal code) and is used to plan public services, including health care, education, and transportation.

2.3 Study Design and Population

A population-based, retrospective cohort of girls eligible for Ontario's Grade 8 HPV vaccination program in the 2007/08 to 2010/11 program years was identified using the province's insured persons database (RPDB) and immunization database (IRIS). As school grade was not available in the databases, birth cohorts were used to identify the eligible population. In particular, since individuals are typically thirteen by December 31 of their Grade 8 year, girls born in 1994, 1995, 1996 and 1997 would have been in Grade 8 in September 2007, 2008, 2009, and 2010, respectively; hence, they would be eligible for the corresponding year's vaccination program. Although this approach could miss girls who are advanced or held back a year, a re-abstraction study of a medium-sized health unit demonstrated that the birth cohort definition correctly identified 96.4% of eligible girls [23]. Grade 8 girls whose immunization records were not available at the time of the analysis (i.e., data not yet transferred to ICES and/or record linked) were excluded. Cohort members were followed from September 1 of their Grade 8 academic year (cohort entry) until the earliest of their date of death or March 31, 2011 (study end).

2.4 HPV Vaccination Status

In this study, refusal of the HPV vaccine was the outcome of interest; it was ascertained using the IRIS database. A girl's outcome status was classified as 'refused' if she received no doses of the HPV vaccine during study follow-up and 'accepted' if she received at least one dose. Receipt of at least one dose (rather than three) was used to indicate vaccine acceptance since the goal of the study was to investigate regional-level factors that influenced the decision to vaccinate (rather than HPV immunization/adherence).

2.5 Regional-level Characteristics

The ecologic (i.e., regional) level of interest for this study was the health unit within which a cohort member resided at cohort entry. We chose the health unit as the regional level of interest since Ontario's vaccination program is administered and delivered at this level and because it is believed that HPV vaccine acceptance varies across health units. The social and economic characteristics of the health unit within which a girl resided at the time of vaccine decision-making (i.e., cohort entry) were extracted from the 2006 Canadian Census using postal codes. We used information from the 2006 Census because this represented the most recent data available at the time of our analysis and because 2006 corresponded with a time period preceding the decision to vaccinate.

We initially considered 19 census variables as potential regional-level determinants of HPV vaccine refusal (Appendix A). These variables were chosen based on a review of the literature on the determinants of HPV vaccine uptake. The census variables included a number of social characteristics (e.g., percentage of single-parent families; percentage of residents who are separated, divorced, or widowed; percentage of residents living alone) and material characteristics (e.g., percentage of residents with no high school diploma, representing a low level of education; average income of residents; the employment/population ratio). We also included the percentage of residents belonging to a visible minority group and who were of Aboriginal status as these may also be important determinants of HPV vaccine acceptance [24,25]. For categorical variables (e.g., single parenthood), we obtained the percentage of residents in each health unit with the characteristic; for continuous variables (e.g., income), we obtained the average regional value.

2.6 Statistical Analyses

2.6.1 Descriptive analyses

To describe the patterns of HPV vaccine refusal, the percentage of cohort members who did not receive any doses of the HPV vaccine was determined for the first four program years (2007/08 to 2010/11). Vaccine refusal was then stratified by health unit and by program year, and chi-square tests were used to determine whether vaccine refusal varied significantly by region and over time.

Initially, we considered all 19 variables previously described as potential regional-level determinants of HPV vaccine refusal. However, our descriptive analyses revealed that only eight of these characteristics demonstrated sufficient variability across health units to be included in the primary analysis (Appendix A).

2.6.2 Primary analyses

An index of area deprivation was created for our regional-level (i.e., health unit-level) measures of social and material deprivation using principal component analysis (PCA), which is the preferred method for developing such indexes [26,27]. The index was derived in a similar way as the Pampalon index of deprivation. The primary advantage of using this index for our study was that it acted as a data reduction technique. Therefore, it allowed us to assess the influence of a number of potentially important characteristics with fewer variables, which was particularly important given the limited number of health units

contributing to the analysis. In addition, this approach enabled us to assess the influence of potentially highly correlated regional characteristics on HPV vaccine refusal.

The traditional Pampalon deprivation index includes two dimensions of deprivation, each of which is composed of three characteristics: (i) social deprivation, which is composed of single parenthood, being single/divorced, and living alone and (ii) material deprivation, which is composed of education, income, and employment (Appendix B). Our PCA, however, did not result in a separate dimension for social and material deprivation. Instead, it yielded two factors, one of which was comprised of five social *and* material characteristics - average income, level of education, employment/population ratio, marital status, and living alone (Appendix B). An area deprivation score for each health unit was estimated based on the factor loadings of each of these five characteristics. These scores were subsequently categorized into quartiles. The second factor yielded by the PCA was the percentage of single-parent families, which was considered as an independent regional-level characteristic (i.e., was not considered as part of the area deprivation index). Next, we examined the distribution of our three independent regional-level characteristics – the percentage of single parent families, Aboriginal status, and visible minority status. Because the distribution of each of these characteristics was skewed, they were dichotomized based on the median.

To assess whether the characteristics of the health unit within which a girl and her parents/guardians resided might have influenced the decision to refuse the HPV vaccine, the values of the corresponding health unit's characteristics were attributed to the girl (the unit of analysis). To estimate the population-averaged effects of these health unit-level characteristics on HPV vaccine refusal while accounting for the possible correlation introduced by the clustering of girls within health units, we used generalized estimating equations (GEE) with a logit link and an exchangeable correlation structure. A multivariable model was constructed containing the quartiles of the area deprivation index and the three independent characteristics previously described. Determinants of HPV vaccine refusal were identified using a backward selection approach. Variables with the largest non-significant *p*-value were removed in successive iterations using a significance threshold of 0.1 for variable retention. Model fit was assessed using the QIC (quasi-likelihood under independence model criterion) goodness of fit statistic for GEE proposed by Pan et al [28].

3. RESULTS

We identified 144,047 girls eligible for Ontario's free HPV vaccination program between 2007/08 and 2010/11 whose vaccination records were available at the time of the analysis (i.e., from 21 of the 36 health regions). At cohort entry, girls were between 12.7 and 13.7 years of age (mean of 13.2 years). Almost half (49.3%, *n*=71,048) of girls eligible in the first four years of the program did not receive any doses of the HPV vaccine. During that time period, refusal between health units varied from a low of 41.8% to a high of 60.3% (Fig. 1). In 8 of the 21 health units, more than 50% of the girls refused HPV vaccination.

Overall, refusal was not independent of health region for each of the first four years of the HPV vaccination program (Table 1). Furthermore, there was a significant linear trend between refusal and program year for 12 health units (*p*<0.05). The majority of health units experienced a downward trend in refusal over time (i.e., increased acceptance), with vaccine refusal being highest in the first year of the program for 13 (61.9%) health units. The largest change in refusal within a given health unit was a decline from 55.4% to 39.0%, indicating that 16.4% more girls were vaccinated in Year 4 compared with Year 1 (Health Unit 16).

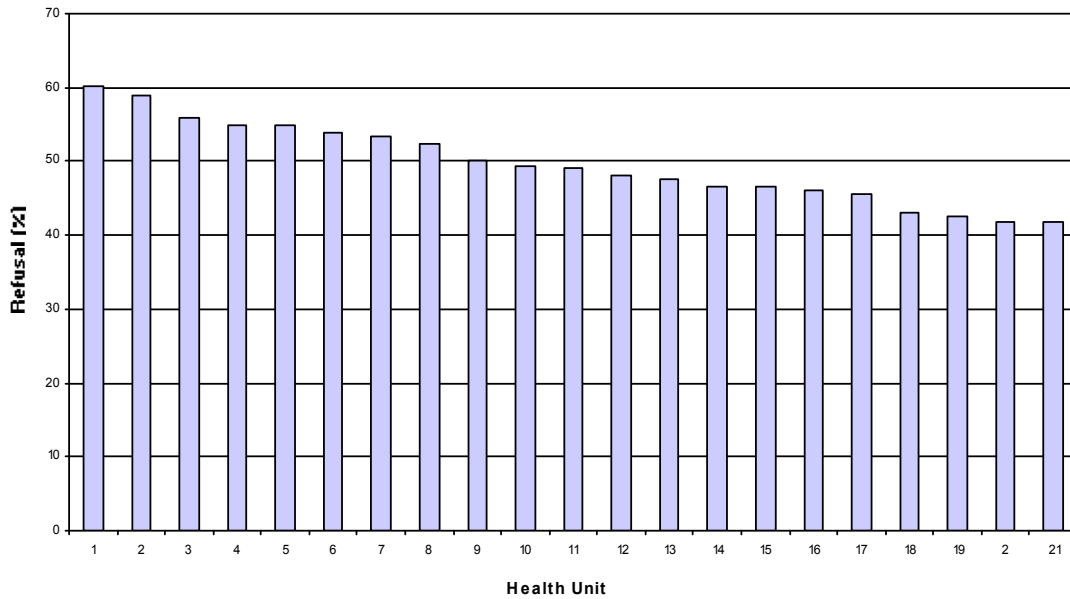


Fig. 1. Percentage of HPV vaccine refusal by health unit* during the first four years of Ontario's vaccination program

*To protect the confidentiality of participating health units, names are not provided. Instead, each health unit was assigned a number that reflected their ranking for HPV vaccine refusal

Table 1. Patterns of HPV vaccine refusal across health units and program year

Health Unit	Refusal (%) 2007/08	Refusal (%) 2008/09	Refusal (%) 2009/10	Refusal (%) 2010/11	P-value*
1	60.4	57.1	61.3	62.5	0.0076
2	54.6	59.4	62.2	59.5	<0.0001
3	58.1	50.8	56.7	58.1	0.4700
4	57.9	51.2	57.2	53.3	0.3606
5	58.9	51.9	54.7	53.7	0.2199
6	51.2	56.7	NA	NA	0.0153
7	52.5	52.1	53.0	55.9	0.2683
8	54.7	55.7	47.2	51.4	0.0042
9	55.1	48.0	51.7	43.8	0.0021
10	56.3	41.9	47.2	51.5	0.0784
11	53.9	45.7	48.5	47.8	0.0010
12	50.2	47.3	50.1	44.2	0.0842
13	54.6	42.6	44.7	49.0	<0.0001
14	51.9	43.8	41.3	49.6	0.1526
15	46.1	45.5	46.2	48.8	0.1863
16	55.4	42.5	46.3	39.0	0.0009
17	49.0	46.1	44.0	42.1	0.0048
18	48.0	39.8	45.1	38.4	0.0015
19	44.2	38.7	42.0	46.1	0.2105
20	47.4	40.1	41.1	38.6	<0.0001
21	48.6	40.5	38.8	38.6	<0.0001
<i>P-value†</i>	<0.0001	<0.0001	<0.0001	<0.0001	

NA = Not available* Based on chi-square trend test of association between refusal and program year for each health unit. †Based on chi-square test of association between refusal and health unit for each program year

Our assessment of collinearity revealed that the area deprivation index was highly collinear with Aboriginal status and visible minority status. As a result, two separate models were used to assess the association of interest—one included the deprivation index and single parenthood, and the other included single parenthood, Aboriginal status, and visible minority status. Results from the first model revealed that girls living in regions with a higher proportion of single parents had a 5% lower odd of refusing the HPV vaccine – odds ratio (OR) =0.95; 95% confidence interval (CI) 0.93,0.97 (Table 2). In that model, lower levels of material deprivation were not significantly associated with HPV vaccine refusal, but high deprivation was (OR=0.86; 95% CI 0.83, 0.89).

Table 2. Crude and adjusted odds ratios of HPV vaccine refusal – Model 1

Characteristic	Refusal (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Percentage of single-parent families			
Low (reference)	49.6	1.00	1.00
High [†]	48.7	0.97 (0.95, 0.99)	0.95 (0.93, 0.97)
Deprivation index (low to high)			
Quartile 1 (reference)	49.8	1.00	1.00
Quartile 2	48.9	0.96 (0.94, 0.99)	0.97 (0.94, 1.00)
Quartile 3	49.2	0.98 (0.95, 1.01)	0.98 (0.95, 1.01)
Quartile 4	46.4	0.87 (0.84, 0.91)	0.86 (0.83, 0.89)

OR: odds ratio; CI: confidence interval; *Adjusted for all other factors listed in the table. [†]Above the median value of 15% for the percentage of residents living in single-parent families

Model 2 suggested that neither regional Aboriginal status nor single parenthood influenced a girl's odds of refusing HPV vaccination (OR=1.03; 95% CI 1.00, 1.06 and OR=0.98; 95% CI 0.95, 1.00, respectively); however, living in an area with a higher percentage of visible minorities was associated with lower odds of refusal (OR=0.92; 95% CI 0.90, 0.94; Table 3).

Table 3. Crude and adjusted odds ratios of HPV vaccine refusal – Model 2

Characteristic	Refusal (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Percentage of aboriginals			
Low (reference)	48.7	1.00	1.00
High [†]	50.3	1.06 (1.04, 1.09)	1.03 (1.00, 1.06)
Percentage of single-parent families			
Low (reference)	49.6	1.00	1.00
High [‡]	48.7	0.97 (0.95, 0.99)	0.98 (0.95, 1.00)
Percentage of visible minorities			
Low (reference)	50.6	1.00	1.00
High [§]	48.0	0.90 (0.88, 0.92)	0.92 (0.90, 0.94)

OR = odds ratio; CI: confidence interval; *Adjusted for all other factors listed in the table. [†]Above the median value of 3% for the percentage of residents identifying as Aboriginals. [‡] Above the median value of 15% for the percentage of residents living in single-parent families. [§] Above the median value of 13% for the percentage of residents identifying as visible minorities

4. DISCUSSION

We found that HPV vaccine refusal varied between health regions during the first four years of Ontario's Grade 8 HPV vaccination program. Despite this, regional-level factors did not

appear to exert a strong influence on HPV vaccine decision-making, with the exception of area deprivation. In particular, compared with a low level of area deprivation, a high level of deprivation was associated with low vaccine refusal. Also, there was a significant linear trend between refusal and program years for the majority of health units, with the highest levels of vaccine refusal reported during Year 1.

This study is the first to assess the potential influence of regional-level factors on HPV vaccine acceptance in the context of a publicly funded, school-based program. Indeed, we report a 20% range in HPV vaccine refusal across health units, suggesting the region within which a girl resides may influence whether or not she receives the vaccine. Our findings showed that, while most characteristics under consideration were not associated with HPV vaccination, a composite measure representing high area social and material deprivation was associated with higher HPV vaccine acceptance. These findings are of public health importance given that measures of deprivation (including low income, low education, unemployment, and marital status) are also determinants of low cervical cancer screening and are risk factors for cervical cancer [29-32]. Therefore, these results are promising because immunizing girls most vulnerable to HPV-related conditions will help optimize the health and economic benefits of this public health program.

A study from British Columbia (BC), Canada, on individual-level determinants of HPV vaccine acceptance reported that parents with a higher socio-economic status (SES) were more informed about the harms and benefits of HPV vaccination, but were ultimately less likely to accept the vaccine for their daughters [10]. If area deprivation is a proxy for individual-level deprivation, then our findings are consistent with the results from BC, indicating that factors like high education can be a predictor of vaccine refusal. In contrast, our findings on deprivation are not consistent with those found outside of the Canadian context. Specifically, studies in the United States (US) report low income (an individual-level measure of deprivation) as one of the most important determinants of vaccine refusal.[12] This discrepancy is not surprising given that, in the US, the HPV vaccination series is only available through private means at a cost of approximately \$400. Undoubtedly, this high cost greatly limits access for low-income individuals. Indeed, the difference in results seems to highlight the benefit of Canada's publicly funded, school-based program, which minimizes the financial and accessibility barriers to HPV vaccination that are commonly encountered in private systems. Taken together, these results suggest that, while income can be a primary predictor of HPV vaccine use (as is the case in the US), when this barrier is removed (as is the case in Canada), factors like education drive HPV vaccine decision-making. Certainly, this would help explain our findings that individuals in areas of low deprivation (e.g., high education) were more likely to refuse the HPV vaccine.

Apart from the association found between vaccine refusal and health region, we also identified a significant linear trend between refusal and program years. Importantly, overall HPV vaccine refusal decreased over time in the majority of health regions, suggesting that the vaccine has become increasingly accepted. Nevertheless, the absolute decrease in refusal is low, indicating we still need more information on factors influencing HPV vaccine refusal in order to better address this issue.

Our study has a number of strengths, including the fact that it is based on a large, population-based cohort (minimizing the possibility of selection bias) and that it benefits from validated exposure data. Nevertheless, there are also some limitations. For one, given the high prevalence of the outcome (vaccine refusal), the odds ratios over-estimate the risk ratios. Therefore, caution must be taken when interpreting the risk estimates presented in

this study. Also, it is important to consider the possibility that there may be regional-level determinants of refusal that we were not able to capture through our data sources. For example, we did not have information on strategies employed by individual health units to maximize HPV vaccine acceptance in their area (e.g., promotional tools, education campaigns). Similarly, we did not take into account individual-level determinants of HPV vaccine refusal. While this is understandable given that the focus of this study was on explaining regional variation, future studies should consider both individual-level and regional-level measures to discern the independent contributions of each. Finally, our results may not be generalizable to other jurisdictions.

5. CONCLUSION

Our study showed that, despite a significant association between HPV vaccine refusal and health region, health unit-level characteristics generally did not have an important influence on HPV vaccine decision-making. However, high area deprivation was associated with lower rates of HPV vaccine refusal, a finding that may have positive implications in terms of the health benefits and cost-effectiveness of this public health program. Future studies incorporating both individual- and regional-level potential determinants of HPV vaccination are needed to further elucidate HPV vaccine refusal in the context of publicly funded, school-based programs.

CONSENT

Not applicable.

ETHICAL APPROVAL

This study was approved by the Health Sciences Research Ethics Board of Queen's University.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Appendix A. 2006 Canada Census variables considered as potential regional-level determinants of HPV vaccine refusal

Variable	Variable type	Included in determinants analysis
Lone parent families	Categorical	Yes
Average income of people ≥ 15 year	Continuous	Yes
North American Aboriginal *	Categorical	Yes
Registered Indian Status *	Categorical	Yes
Non-family persons living alone	Categorical	Yes
Employment – by labour force activity	Categorical	Yes
Visible minority status	Categorical	Yes
Education level – no certificate, diploma, or degree	Categorical	Yes
Marital status – divorced, separated, widowed	Categorical	Yes
Rented dwellings	Categorical	No
Arabic ethnicity	Categorical	No
West Asian ethnicity	Categorical	No
South Asian ethnicity	Categorical	No
East and South-East Asian ethnicity	Categorical	No
Females 10 to 14 years	Categorical	No
Non-English mother tongue	Categorical	No
Non-French mother tongue	Categorical	No
Arabic mother tongue	Categorical	No
Chinese mother tongue	Categorical	No

* Combined to create one variable capturing the percentage of residents in a health unit identifying as being of Aboriginal descent

Appendix B. Health unit characteristics comprising the Pampalon index

Health unit characteristic	Definition (Statistics Canada Census)	Type of Characteristic	In Pampalon index?	In area deprivation index?
(Low) education level	Proportion of people aged 15 years and older with no high school diploma, certificate or degree	Material	Yes	Yes
Employment /population ratio	Ratio of individuals 15 years of age and older who are employed	Material	Yes	Yes
Average income	Average personal (before tax) income of individuals 15 years of age and older	Material	Yes	Yes
Living alone	Proportion of individuals 15 years of age and older living alone	Social	Yes	Yes
Separated /divorced /widowed	Proportion of individuals 15 years of age and older who are separated, divorced or widowed	Social	Yes	Yes
Single parents	Proportion of lone-parent families	Social	Yes	No

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