TITLE: Comparing cervical cancer stage of diagnosis at presentation in immigrant women and long-term residents: a retrospective cohort study

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ABSTRACT

Background: Globally, cervical cancer is the fourth most common cancer in women and seventh most common cancer overall. Cervical cancer is highly preventable with screening. Previous work has shown that immigrants are less likely to be screened than non-immigrants in Ontario, Canada. We examined whether immigrant women are more likely to present with later stage cervical cancer than long-term residents of the province.

Methods: We conducted a retrospective matched cohort study of women with cervical cancer diagnosed from 2010 to 2014 using provincial administrative health data, comparing the odds of late stage diagnosis between immigrants and long-term residents, adjusting for socioeconomic measures, comorbidities and healthcare utilization. The outcome of interest was stage of cervical cancer diagnosis, defined as early (stage I) or late (stage II-IV). We confirmed results with a cohort from 2007-2012.

Results: Complete staging data was available for 218 immigrants and 1348 non-immigrants. We found no association between immigrant status and stage at diagnosis (adjusted OR: 0.935, p value=0.739). Factors that did show significant association with late stage diagnosis were physician characteristics, whether a woman had been previously screened, and having visited a gynecologist in the past 3 years. These results were echoed in the 2007-2012 cohort (immigrants vs. long-term residents OR: 0.942, adjusted p value=0.6773).

Interpretation: Our results show that being an immigrant is not associated with late stage diagnosis of cervical cancer in Ontario. Programs broadly aimed at immigrants may require a targeted approach to address higher-risk subgroups.

INTRODUCTION

Globally, cervical cancer is the fourth most common cancer in women and seventh most common cancer overall, with age-standardized incidence rates (ASIR) and death rates (ASDR) nearly twice as high in developing countries as developed countries (ASIR 15.70 vs. 9.58; ASDR 8.32 vs. 3.96)(1, 2). Differences in incidence rates can be attributed to the widespread implementation of screening programs in developed countries, which make use of the Papanicolaou (Pap) test to detect the presence of pre-cancerous changes or cancer(3). If pre-invasive and early-stage disease is detected, close monitoring and treatment can prevent the progression to invasive cancer(3). In Canada, it is estimated that 1500 new cases will be diagnosed in 2015 with nearly half of incident cases occurring in Ontario(4).

In developed countries, such as Canada, where screening programs exist, it is concerning that immigrant women are less likely to be screened than non-immigrants(5, 6). Moreso, previous research has shown that diagnosis of advanced stage cervical cancer has been found to be associated with low socioeconomic status(7). While marginalized populations are known to have poorer access to healthcare resources, recent studies comparing stage at diagnosis among foreign-born vs. US-born women have yielded contrasting findings, with one study finding no difference in diagnosis of late stage cervical cancer between foreign-born women and non-immigrant women, and another finding that foreign-born women were more likely to be diagnosed with late stage cancer(8, 9). However, we have found no studies exploring this question in the Canadian setting.

Given these conflicting results and evidence that immigrants are less likely to be screened for cervical cancer in Ontario, further exploration is warranted of the relationship between immigrant status and stage at diagnosis. The aim of this study was to examine the association between cervical cancer stage at diagnosis among immigrant women compared to Ontario's long-term residents.

METHODS

Setting

Ontario is Canada's most populous province, with a population of 13.8 million people as of 2015(10). Census data from 2011 indicated that 28.5% of Ontarians are immigrants, and the most common regions of origin are South Asia (18.5% of immigrants) and China (12.3%)(11). In Ontario, coverage of medically necessary services is provided through a government-funded, single-payer system. Physician services are covered by the Ontario Health Insurance Program and hospital services are provided for by the Ministry of Health and Long Term Care.

Study design and patient population

We conducted a retrospective matched cohort study using population-level administrative data that are de-identified and linked through a comprehensive research agreement between the Institute for Clinical Evaluative Sciences (ICES) and the Ontario Ministry of Health and Long Term Care. The cohort consisted of women, aged 25 years and over, residing in Ontario with cervical cancer (ICD 10-CA code C53.X) diagnosed on or after January 1, 2010 until October 2014 and who were eligible for health coverage throughout the study period.

Outcome

The primary outcome was stage of cervical cancer stratified into late stage (stage II-IV) and early stage (I). We excluded cases of pre-cancerous carcinoma in situ and cases of recurrent cancer. Staging is captured in the Ontario Cancer Registry using best available stage through collaborative staging. Collaborative staging is a novel process for assigning stage which employs an algorithm to reconcile stage from clinical and pathological stage data acquired from patient health records in community hospitals and regional cancer centers. Collaborative stage recording practices began in 2007 and capture of cervical cancer stage with this novel staging methodology became available in 2011/2012. Data on subcategories within each stage was not available (ie Stage IIA vs. IIB).

Data sources

For this study, several sources were accessed for data on the primary outcome, exposure, and covariates. The exposure of interest, immigrant status, was identified from the Citizenship and Immigration Canada (CIC) database which contains demographic and language information on Ontario permanent residents with a landing visa by date of issue arriving from 1985-2014. The CIC also captures place of origin (i.e. country/region of birth) and immigrant class (i.e. economic, family, refugee). Cervical cancer stage data was obtained from the Ontario Cancer Registry, a passive surveillance patient registry which links data from hospitals, cancer centers and pathology labs(12). The Ontario Health Insurance Program (OHIP) and Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD) provided information on measures of healthcare utilization and comorbidity (using the Johns Hopkins Case-Mix Aggregated Diagnosis Group (ADG) and Resource Utilization Bands (RUB)). Data on socioeconomic status defined by neighbourhood income quintile and residence type (large urban/small urban/rural), measured with the Rurality Index of Ontario (RIO) score, were derived from the Registered Persons Database (RPDB), Postal Code Conversion File (PCCF) and Statistics Canada 2006 Census data. As family physicians are typically the first point of access to the healthcare system, physician characteristics were obtained from the ICES Physicians Database (IPDB) and Corporate Physicians Database (CPDB). These were family physician sex, whether they are an international medical graduate, and whether patients are rostered with the primary care provider as part of a patient enrolment model. HIV status was obtained from the Ontario HIV database. Linkage of data sources was done using a secure encrypted ICES number (IKN) performed on premises.

This study received ethics approval from the Research Ethics Board of Sunnybrook Health Sciences Centre in Toronto, Ontario.

Variable Definitions and Operationalization

We defined immigrants as those who were identified in the CIC, which refers to a person who had a landed immigrant/permanent resident status at any time from 1985 to 2014. Long-term residents were defined as those not identified in the CIC, i.e. women who were Canadian-born, or who arrived before 1985. In Canada, immigrants are admitted under one of three categories: economic class (skilled workers), family class (relatives of Canadian residents), refugees and other (typically accepted for compassionate reasons)(13). We looked at whether an individual had been screened before and up to one year prior to the date of diagnosis (the pre-diagnostic interval, during which screening tests are likely diagnostic in nature). We limited the cohort to women over age 25 as women under 25 years would have likely received HPV

vaccination in schools due to a relatively recent school-based vaccination program in Ontario. Healthcare utilization was measured as any visit to a healthcare provider in the 3 years prior to the pre-diagnostic interval, and also as any visit to a gynecologist in the 3 years prior to the pre-diagnostic interval. This period of time was felt to sufficiently represent active use of the healthcare system prior to diagnosis. We excluded cases with a recorded hysterectomy prior to diagnosis. ADGs, captured up to one year before the date of diagnosis, were stratified into groupings of 0, 1-5, 6-10, 10+, with higher levels indicating greater comorbidity.

Statistical Analysis

Immigrants were matched 1:4 to long-term residents +/- 5 years of age at date of diagnosis, and on census tract. Bivariate and multivariate conditional logistic regressions were used to determine odds ratios for late stage cervical cancer for immigrants vs. long-term matched residents. We report p-values for odds ratios less than 0.05 as significant. SAS 9.3 was used to conduct the analyses. All cell sizes of less than 5 women were suppressed.

RESULTS

Before matching, our study sample consisted of 2508 women, 345 of which (13.7%) were immigrants. In comparison, 25-26% of women aged 25 and over in Ontario are foreign-born(11, 14). Figure 1 shows the process of cohort selection. Among the cohort, immigrants were matched on age at diagnosis (median age=50) and census tract with 1380 long-term residents (median age=53). Characteristics of the study cohort are presented in Table 1. Immigrant women with cervical cancer were more likely to live in a lower-income neighbourhood and to live in a major urban area. Nearly all immigrants had a family physician while 4.6% of long-term residents did not. Compared with 18.1% of long-term residents, 44.6% of immigrants had a family physician who was a graduate of a non-Canadian/American medical school.

Table 2a and 2b describe the characteristics of the 345 immigrant women in the study cohort. More than 40% spoke neither English nor French, Canada's two official languages. 13.9% of immigrants were refugees, 39% were economic class immigrants and 47.1% were family class immigrants. In our sample, the majority of immigrants with diagnosis of cervical cancer immigrated from East Asia (34.2%), Western Europe and USA (27.2%), and South Asia (13.9%). Table 2b presents immigrant characteristics by stage at diagnosis. Women of East Asian or Western European/American origin had a higher incidence of early stage cancer, while South Asian women had a higher incidence of late stage cancer.

Participant demographics stratified by early vs. late stage are present in Table 3. Regarding stage at diagnosis, 34.2% of immigrants were diagnosed with stage I, 12.4% with stage II, 9.8% with stage III and 6.7% with stage IV cervical cancer. Stage data was not available for 36.8% of immigrants. Among long-term residents 33.5% were diagnosed with stage I, 10.2% with stage II, 11.8% with stage III and 7.7% with stage IV disease. There was no stage data available for 36.7% of long-term residents. A confirmatory analysis was performed with data using a sample cohort from 2007-2012 where the availability of stage data was greater; stage data was not available for 13.5% of immigrants and 14.4% of long-term residents (results not shown). Between cohorts, results were comparable.

We did not observe a difference in screening history between immigrants and long-term residents: 33.3% of immigrants and 32.2% of long-term residents were screened within the three years before the pre-diagnostic interval, and 51.8% of immigrants and 51.1% long-term residents had never been screened. We also did not see an income gradient, difference in comorbidity or

residence type between immigrants or long-term residents diagnosed with cervical cancer. In the recent cohort, among both groups, 51% of women had no record of screening in available data.

The unadjusted and adjusted odds ratios for the outcome of late vs. early stage cervical cancer at the time of diagnosis are presented in Table 4. No significant difference in diagnosis of late stage cancer was observed between immigrants and long-term residents (unadjusted OR: 0.99 p=0.9529; adjusted OR: 0.935 p=0.739). In bivariate analyses, significant associations were seen with comorbidity, screening status, gynecologist visit, sex of family physician and number of healthcare contacts in past 3 years, but only history of visit to a gynecologist in the pre-diagnostic interval remained significant in the adjusted model. HIV was excluded as a variable from the model as there were too few cases and screening status was excluded as lack of screening could be on the causal pathway.

INTERPRETATION

Using population-level administrative data, the results from our study show no association between immigrant status and stage of diagnosis of cervical cancer among women diagnosed with cervical cancer in Ontario from 2010 to 2014. These results were replicated with data from a 2007-2012 cohort, to confirm that the observed lack of association was not due to data unavailability.

The findings in this study present a thought-provoking query as to why, despite being screened for cervical cancer less than long-term residents(15), immigrant women in Ontario do not present with more advanced disease. Risk factors for cervical cancer include HPV infection (which is sexually transmitted) and smoking, and it is reasonable to suggest that Ontario's immigrant population may have a lower prevalence of these risk factors. We observed variations in stage at diagnosis by region of origin, including a higher incidence of later stage cancer in South Asian women. This may reflect findings from previous research where South Asian women showed the lowest rates of screening among immigrant women in Ontario(5). This could indicate causes related to sociocultural determinants of health associated with place of origin, including religious and cultural beliefs influencing how and when healthcare is accessed(16-18), however, numbers were too small to draw any firm conclusions. One possible interpretation of these results may be the healthy immigrant effect: that those who are able to immigrate are selected for and have better health immediately after migration than long-term residents(8, 19).

Our finding that physician characteristics were related to stage at diagnosis may be due to the notion that female patients feel more comfortable with female healthcare providers, especially when first arriving in a new country; this has been reportedly previously(20). Having a male family physician, not being in a patient enrolment model, and not visiting a gynecologist were associated significantly with late stage at diagnosis. Of concern is that women are at an increased risk *at all* based on who their physician is. We observed that women with fewer comorbidities were more likely to have late stage cancer at diagnosis, which is consistent with the postulate that women with fewer health system contacts are less likely to be caught early. A large proportion of immigrant women in this cohort also did not speak either of Canada's official languages which would be a barrier to accessing screening and treatment services.

Interestingly, similar overall findings between immigrants and native-born women were shown by Gomez et al. in a population-based study using the California Cancer Registry comparing foreign-born and native Hispanic women, on the odds of late stage cervical cancer (stage II-IV), and controlling for possible ethnicity-related confounding (OR=1.04, 95% CI=0.94-1.15). In this study, the authors did find that lower socioeconomic status was associated

with late stage disease (OR=1.29; 95% CI=1.03-1.63)(8). Montealegre et al. however, examined this question using data from the Surveillance, Epidemiology, and End Results program, and found that foreign-born Hispanic women were slightly more likely to have a late stage diagnosis than US-born women (OR=1.09; 95% CI= 1.05-1.15), although the outcome was defined differently using summary staging than was done in the present study (9). Although costs of screening for cervical cancer may be relatively low, in the United States, accessing healthcare services typically requires proof of insurance coverage, which may deter immigrants from being screened routinely and from seeking care when symptoms emerge. In Canada, routine screening is covered under a government-funded health insurance system, though comparable barriers to access may exist for newcomers who have yet to be registered and for whom indirect costs (e.g. transportation) may still be an issue.

This study is the first we know of to examine the association between immigrant status and stage of diagnosis in a general population. Previous studies focused on particular ethnic groups (e.g. Hispanics), but with the use of population-level data, we are reporting findings based on the entire population of the province of Ontario. Given Ontario's diverse population, our study is unique in having data on a broad ethnic mix of immigrants, enabling observation of patterns by region of origin. We also make use of collaborative staging, a relatively new method of capturing stage that makes use of multiple sources to allow for more complete stage data(21). However, our study has several limitations. First, despite being population-based, our study is limited by small sample size, which could partly be influenced by the increasing use of preventive practices reducing the number of incident cases of cervical cancer in Ontario. Furthermore, our data set was not sufficiently large to allow for meaningful comparison of more recent and less recent immigrants. Second, the transition to new staging methods resulted in a sizeable proportion (36%) of unavailable stage data in the 2010-2014 cohort though the comparable proportion of missing data between immigrants and long-term residents makes it unlikely to be an issue of differential reporting between groups. We confirmed our results with data from 2007-2012, for which the proportion of missing data was less (14%). Third, the CIC database may not capture all immigrants, whereby control patients whose birthdate differed from their date of OHIP eligibility could be misclassified as controls instead of cases. Lastly, not all relevant variables are captured in administrative data, including those such as educational achievement and religion, and variables such as country of origin may not accurately reflect sociocultural influences on disease risk factors at an individual level. Though our results are representative of the population of Ontario, they may not be generalizable to other regions with different population demographics.

In conclusion, we observed no difference in stage at diagnosis between immigrants and long-term residents with cervical cancer in Ontario, Canada. Placed in the context of previous research showing that immigrant women were screened less for cervical cancer than long-term residents, our results pose an interesting and unexpected finding indicating that previously broad notions regarding immigrant health may require a refined approach that factors in differing innate health risks per ethnic group as well as health habits. In our cohort, nearly all immigrants lived in a major urban center, and comorbidities, screening status (especially being never screened), and physician characteristics were associated risk factors for late stage disease. Addressing those at risk by targeting potentially higher-risk ethnic groups, such as South Asians, those who have never been screened, and better understanding the reasons for the findings based on physician characteristics may facilitate the improvement of modifiable health outcomes.

Future work into the characteristics of those patients who are never screened will better elucidate how programs may be directed to address an otherwise preventable disease.

Table 1: Characteristics of women in the study cohort diagnosed with cervical cancer in Ontario in 2010-2014. Cases (immigrant women) were matched 1:4 with controls (long-term residents).

Characteristic, n (%)	**Immigrants (n=345)**	**Long-Term Residents (n=1380)**
Age (median)	50	53
Neighbourhood income quintile		
1 (low)	96 (27.8)	304 (22.0)
2	93 (27.0)	271 (19.6)
3	47 (13.6)	278 (20.1)
4	64 (18.6)	271 (19.6)
5 (high)	44 (12.8)	247 (17.9)
Missing data	<5 (n/a)	<5 (n/a)
Rurality index		
Major urban	332 (96.0)	937 (67.9)
Non-major urban	<5 (n/a)	324 (23.5)
Rural	<5 (n/a)	108 (7.8)
Missing data	<5 (n/a)	8 (0.6)
Aggregated diagnosis group		
0 (no comorbidity)	23 (6.7)	108 (7.8)
1-5	163 (47.2)	655 (47.4)
6-9	105 (30.4)	445 (32.2)
10+ (high comorbidity)	54 (15.7)	172 (12.5)
Screening status		
Within past 3 years	126 (36.5)	465 (33.7)
3-5 years	32 (9.3)	162 (11.7)
>5 years ago	11 (3.2)	38 (2.8)
Never screened	174 (50.4)	715 (51.8)
Had a visit to gynecologist in the past three years		
Yes	204 (59.1)	788 (57.1)
No	141 (40.9)	592 (42.9)
Missing data	-	-
Median # of health contacts in past three years	23.5	21
Diagnosis of HIV	<5 (n/a)	<5 (n/a)
Family physician sex		
Female	118 (34.2)	507 (36.7)
Male	222 (64.3)	798 (57.8)
Missing data	6 (1.7)	64 (4.6)
Family physician is an International Medical Graduate		
Yes	154 (44.6)	250 (18.1)
No	186 (53.9)	1066 (77.2)
Missing data	6 (1.7)	64 (4.6)
Family physician in a patient enrolment model		
Yes	296 (85.8)	1207 (87.5)
No	45 (13.0)	112 (8.1)
Missing data	<5 (n/a)	61 (4.4)

Table 2a: Characteristics of 345 immigrant women with diagnosis of cervical cancer in Ontario

Characteristic, n (%)	**Immigrants (n=345)**
Immigrant class	
Economic	134 (38.8)
Family	162 (46.96)
Refugee with landing visa	48 (13.9)
Other	<5 (n/a)
Language ability	
English or French	195 (56.5)
Other	150 (43.5)
Region of origin	
Africa	8 (2.3)
Caribbean	26 (7.5)
East Asia	118 (34.2)
Hispanic America	29 (8.4)
Middle East	20 (5.8)
South Asia	48 (13.9)
Western Europe and USA	94 (27.2)

Table 2b: Immigrant characteristics by stage

Characteristic, n (%)	**Immigrants (n=345)**		
Immigrant class	No known stage	Early Stage	Late Stage
Economic	43 (33.9)	55 (46.6)	36 (36.0)
Family	64 (50.4)	43 (38.1)	53 (53.0)
Refugee with landing visa	19 (15.0)	18 (15.3)	11 (11.0)
Other	<5 (n/a)	-	-
Language ability			
English/French	75 (59.1)	71 (60.2)	49 (49.0)
Other	52 (40.9)	47 (39.8)	51 (51.0)
Region of origin			
Africa	<5 (n/a)	6 (5.1)	<5 (n/a)
Caribbean	11 (8.7)	9 (7.6)	6 (6.0)
East Asia	40 (31.5)	46 (39.0)	31 (31.0)
Hispanic America	10 (7.9)	11 (9.3)	8 (8.0)
Middle East	12 (9.4)	<5 (n/a)	<5 (n/a)
South Asia	22 (17.3)	<5 (n/a)	22 (22.0)
Western Europe and USA	30 (23.6)	36 (30.5)	28 (28.0)

Table 3: Participant demographics by stage

Characteristic, n (%)	**Immigrants (n=345)**			**Long-Term Residents (n=1380)**		
Immigrant status	No known stage	Early Stage	Late Stage	No known stage	Early Stage	Late Stage
	127 (36.8)	118 (34.2)	100 (29.0)	506 (36.7)	463 (35.6)	411 (29.8)
Income quintile						
1 (low)	31 (24.4)	37 (31.4)	28 (28.0)	114 (22.5)	101 (21.8)	89 (21.7)
2	42 (33.1)	24 (20.3)	27 (27.0)	98 (19.4)	86 (18.6)	87 (21.2)
3	19 (15.0)	15 (12.7)	13 (13.0)	97 (19.2)	104 (22.5)	77 (18.7)
4	24 (18.9)	21 (17.8)	19 (19.0)	99 (19.6)	92 (19.9)	80 (19.5)
5 (high)	10 (7.9)	21 (17.8)	13 (13.0)	95 (18.8)	76 (16.4)	76 (18.5)
Missing data	<5 (n/a)	-	-	<5 (n/a)	<5 (n/a)	<5 (n/a)
Rurality index						
Rural	<5 (n/a)	<5 (n/a)	-	38 (7.5)	35 (7.6)	35 (8.5)
Non-major urban	<5 (n/a)	<5 (n/a)	<5 (n/a)	99 (19.6)	118 (25.5)	107 (26.0)
Major urban	121 (95.3)	113 (95.8)	98 (98.0)	366 (72.3)	308 (66.5)	263 (64.0)
Missing data	<5 (n/a)	-	-	<5 (n/a)	<5 (n/a)	6 (1.5)
Aggregated diagnosis group						
0 (no comorbidity)	9 (7.1)	6 (5.1)	8 (8.0)	39 (7.7)	20 (4.3)	49 (11.9)
1-5	53 (41.7)	65 (55.1)	45 (45.0)	218 (43.1)	223 (48.2)	214 (52.1)
6-9	43 (33.9)	27 (22.9)	35 (35.0)	181 (35.8)	165 (35.6)	99 (24.1)
10+ (high comorbidity)	22 (17.3)	20 (16.9)	12 (12.0)	68 (13.4)	55 (11.9)	49 (11.9)
Screening status						
Within past 3 years	51 (40.2)	52 (44.1)	23 (23.0)	181 (35.8)	197 (42.5)	87 (21.2)
3-5 years	15 (11.8)	11 (9.3)	6 (6.0)	69 (13.6)	57 (12.3)	36 (8.8)
>5 years ago	<5 (n/a)	<5 (n/a)	6 (6.0)	27 (5.3)	<5 (n/a)	6 (1.5)
Never screened	57 (44.9)	52 (44.1)	65 (65.0)	229 (45.3)	204 (44.1)	282 (68.6)
Had a visit to gynecologist in the past three years						
No	56 (44.0)	38 (68.0)	47 (47.0)	226 (45.0)	132 (29.0)	234 (57.0)
Yes	71 (55.9)	80 (67.8)	53 (53.0)	280 (55.3)	331 (71.5)	177 (43.1)
Family physician sex						
Female	48 (37.8)	41 (34.7)	29 (29.0)	207 (40.9)	188 (40.6)	123 (29.9)
Male	77 (60.6)	77 (65.3)	68 (68.0)	281 (55.5)	262 (56.6)	255 (62.0)
Missing data	<5 (n/a)	-	<5 (n/a)	18 (3.6)	13 (2.8)	33 (8.0)
Family physician in a patient enrolment model						
No	11 (8.7)	18 (15.3)	16 (16)	48 (9.5)	24 (5.2)	40 (9.7)
Yes	114 (89.8)	100 (84.7)	82 (82)	441 (87.2)	426 (92.0)	340 (82.7)
Missing data	<5 (n/a)	-	<5 (n/a)	17 (3.4)	13 (2.8)	31 (7.5)
Median number of healthcare contacts in past three years	30	23.5	23	23.5	18	21

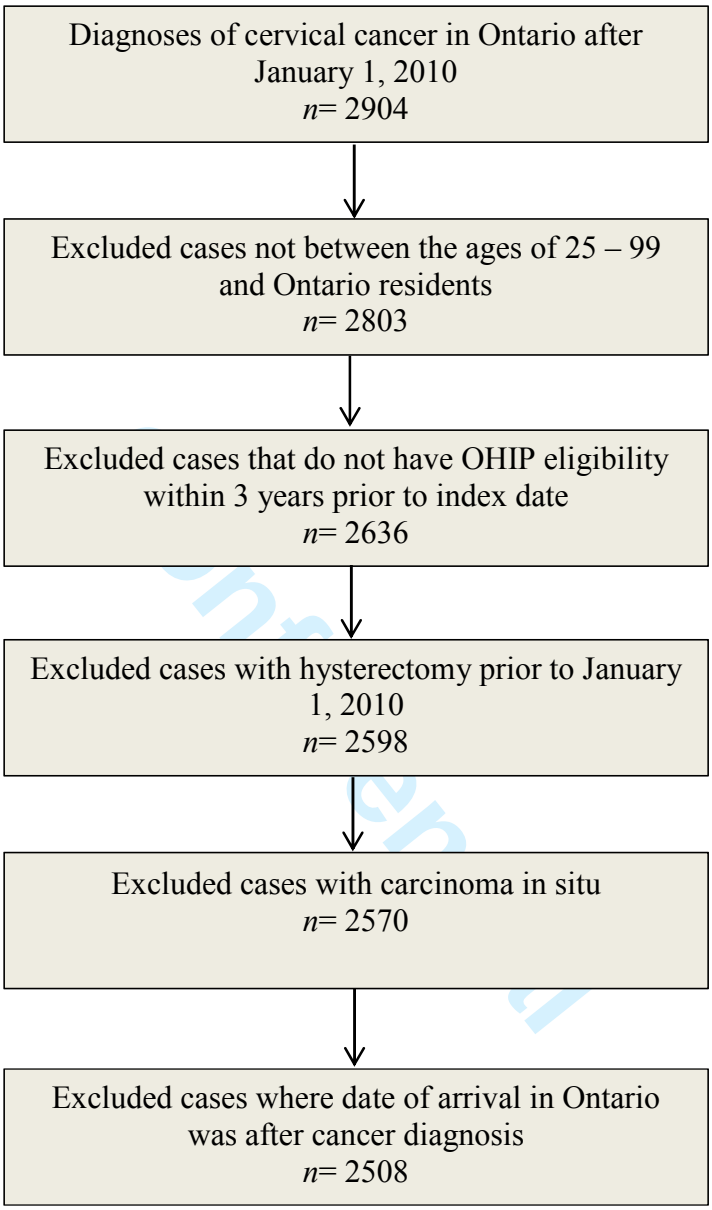
Table 4: Bivariate and multivariate analysis showing unadjusted and adjusted odds ratios with respect to the probability of late stage vs. early stage for the study cohort

Characteristic	**Unadjusted Odds Ratio (95% CI)**	***P*-value**	**Adjusted Odds Ratio (95% CI)**	***P*-value**
Immigrant status				
Long-Term Resident	0.99 (0.70-1.4)	0.9529	0.94 (0.63-1.4)	0.7390
Immigrant	1.00		1.00	
Income quintile				
1	0.85 (0.54-1.4)	0.8506	0.87 (0.53-1.43)	0.5608
2	1.02 (0.62-1.7)		0.99 (0.58-1.70)	
3	0.86 (0.53-1.4)		0.92 (0.54-1.58)	
4	1.05 (0.64-1.7)		1.33 (0.78-2.27)	
5	1.00		1.00	
Rurality index				
Rural	0.98 (0.53-1.8)	0.9684	0.94 (0.45-1.9)	0.7509
Non-major urban	0.95 (0.67-1.4)		0.85 (0.55-1.3)	
Major urban	1.00		1.00	
Aggregated diagnosis group				
0 (no comorbidity)	3.29 (1.51-7.15)	0.0006	1.66 (0.60-4.59)	0.1798
1-5	1.50 (0.93-2.43)		1.18 (0.61-2.27)	
6-9	0.88 (0.52-1.48)		0.78 (0.42-1.45)	
10+ (high comorbidity)	1.00		1.00	
Screening status*				
Within past 3 years	0.41 (0.29-0.59)	<0.0001	---	---
3-5 years	0.48 (0.28-0.81)			
>5 years ago	1.88 (0.54-6.54)			
Never screened	1.00			
Visit to gynecologist in the past three years				
No	2.73 (2.00-3.73)	<0.0001	2.47 (1.8-3.5)	<0.0001
Yes	1.00		1.00	
Family physician sex				
Female	0.69 (0.50-0.95)	0.0230	0.71 (0.50-1.0)	0.0560
Male	1.00		1.00	
Family physician in a patient enrolment model				
No	1.65 (0.99-2.8)	0.0573	1.72 (0.98-3.0)	0.0586
Yes	1.00		1.00	
Number of healthcare contacts in past three years	0.992 (0.986-0.998)	0.0128	0.999 (0.991-1.01)	0.8583

* Screening was excluded from multivariate analysis as lack of screening could be on the causal pathway

**HIV diagnosis was excluded because of small cell sizes

Figure 1- Study cohort selection flow diagram of immigrant women and long-term residents with diagnosis of cervical cancers



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CONTRIBUTIONS

R. T. V. conceived of the study, contributed to the design of the study and analysis, and wrote the first draft of the article. R. M. contributed to the design and analysis of the study and provided feedback on the manuscript. N. J. performed the analysis of the study and provided feedback on the manuscript. L. E. helped conceive the study, contributed to writing the manuscript and provided feedback. E. G. helped conceive the study, contributed to writing the manuscript and provided feedback. A. K. L. helped conceive the study, contributed to the design and analysis of the study, and provided feedback on the manuscript. All authors gave final approval of the version to be published and are willing to act as guarantors of this work.

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STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract: ☑
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found ☑
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported ☑
Objectives	3	State specific objectives, including any prespecified hypotheses ☑
Methods		
Study design	4	Present key elements of study design early in the paper ☑
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection ☑
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up ☑
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed ☑
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable ☑
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group ☑
Bias	9	Describe any efforts to address potential sources of bias ☑
Study size	10	Explain how the study size was arrived at ☑
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why ☑
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding ☑
		(*b*) Describe any methods used to examine subgroups and interactions ☑
		(*c*) Explain how missing data were addressed ☑
		(*d*) If applicable, explain how loss to follow-up was addressed ☑
		(*e*) Describe any sensitivity analyses ☑

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed ☑
		(b) Give reasons for non-participation at each stage ☑
		(c) Consider use of a flow diagram ☑
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders ☑
		(b) Indicate number of participants with missing data for each variable of interest ☑
		(c) Summarise follow-up time (eg, average and total amount) ☑
Outcome data	15*	Report numbers of outcome events or summary measures over time ☑
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included ☑
		(*b*) Report category boundaries when continuous variables were categorized ☑
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period ☑
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses ☑
Discussion		
Key results	18	Summarise key results with reference to study objectives ☑
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias ☑
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence ☑
Generalisability	21	Discuss the generalisability (external validity) of the study results ☑
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based ☑

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.