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A population-based study of breast cancer screening among women with HIV in Ontario, Canada

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Abstract:	Background: As women with HIV live longer, the need for age-appropriate breast cancer screening will increase. We compared rates of screening mammography among women with and without HIV. Methods: We used administrative health databases to identify all women in Ontario, Canada, who were eligible for screening mammography (aged 50 to 74 years and no history of breast cancer) as of April 1, 2011. We used multivariable log-binomial regression to compare the two-year period prevalence of screening mammography in 2011 to 2013 among women living with and without HIV and to examine the correlates of screening among women with HIV.

Results: We identified 1,447,015 screen-eligible women, among whom 623 (0.04%) were women with HIV. Women with HIV were less likely to undergo screening than HIV-negative women (50.1% vs. 63.4%, p<0.001). Following multivariable adjustment, HIV-positive status was associated with significantly lower odds of receiving mammography (adjusted prevalence ratio (aPR) 0.83; 95% confidence interval (CI) 0.77 to 0.89). Compared with women with HIV receiving regular care from both a family physician and HIV specialist, women with HIV receiving neither kind of care (aPR 0.64; 95% CI 0.50 to 0.83) or predominantly specialist care (aPR 0.77; 95% CI 0.60 to 0.97) were less likely to receive screening mammography.

Interpretation: Women with HIV are less likely to receive breast cancer screening mammography than HIV-negative women. Addressing this disparity requires optimizing care delivery to ensure adequate provision of comprehensive primary care to people with HIV.

Title: A population-based study of breast cancer screening among women with HIV in Ontario, Canada

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A population-based study of breast cancer screening among women with HIV in Ontario, Canada from 2011 to 2013

Abstract

Background: As women with HIV live longer, the need for age-appropriate breast cancer screening will increase. We compared rates of screening mammography among women with and without HIV.

Methods: We used administrative health databases to identify all women in Ontario, Canada, who were eligible for screening mammography (aged 50 to 74 years and no history of breast cancer) as of April 1, 2011. We used multivariable log-binomial regression to compare the two-year period prevalence of screening mammography in 2011 to 2013 among women living with and without HIV and to examine the correlates of screening among women with HIV.

Results: We identified 1,447,015 screen-eligible women, among whom 623 (0.04%) were women with HIV. Women with HIV were less likely to undergo screening than HIV-negative women (50.1% vs. 63.4%, p<0.001). Following multivariable adjustment, HIV-positive status was associated with significantly lower odds of receiving mammography (adjusted prevalence ratio (aPR) 0.83; 95% confidence interval (CI) 0.77 to 0.89). Compared with women with HIV receiving regular care from both a family physician and HIV specialist, women with HIV receiving neither kind of care (aPR 0.64; 95% CI 0.50 to 0.83) or predominantly specialist care (aPR 0.77; 95% CI 0.60 to 0.97) were less likely to receive screening mammography.

Interpretation: Women with HIV are less likely to receive breast cancer screening mammography than HIV-negative women. Addressing this disparity requires optimizing care delivery to ensure adequate provision of comprehensive primary care to people with HIV.

Introduction

Breast cancer is the most common malignancy and second leading cause of cancer-related death among women in North America, with an estimated 5,000 Canadian women dying from this disease in 2015[1]. Although the incidence of breast cancer among women with HIV is similar to that of the general population, some studies have found higher rates of advanced disease at initial diagnosis and greater risk for breast-cancer related death relative to HIV-negative women[2]. In addition, HIV imparts a greater risk of myelosuppression during breast cancer chemotherapy, resulting in treatment interruption, early cessation of therapy and adverse outcomes[3,4].

Screening mammography allows for earlier detection of breast cancer, and has been shown to reduce mortality from this disease in women aged 50 to 69 years[1]. Because women with HIV are living longer, the need for age-appropriate breast cancer screening will increase[5,6]. However, use of mammography by women with HIV in developed settings has been poorly characterized. Inferences from existing studies have been limited by samples that were small, not population-based, or lacking in HIV-negative control groups for comparison[7–12]. Such data are important because women with HIV possess numerous intersecting vulnerabilities associated with inadequate breast cancer screening, including low socioeconomic status, being an immigrant and a high prevalence of mental health illness[13–16]. In addition, the complexity of managing HIV and associated comorbid conditions may compete for preventive care, thus predisposing women with HIV to inadequate breast cancer screening[10,12]. In light of these data

and the gaps in the literature, we compared the use of breast cancer screening mammography among women with and without in HIV in Ontario, Canada and correlates of screening using large provincial administrative databases.

Methods

Setting:

We conducted a population-based study comparing receipt of mammography among screen-eligible women living with and without HIV infection in Ontario between April 1, 2011, and March 31, 2013. Ontario has single payer, universal coverage for physician services, including screening mammography. In Ontario, women can receive a screening mammogram through the Ontario Breast Cancer Screening Program (OBSP), an organized province-wide network of screening sites or through non-OBSP affiliated-centres funded by the Ontario Health Insurance Plan (OHIP). Provincial guidelines recommend screening at 2-year intervals for women aged 50 to 74 years who are at average risk for breast cancer, irrespective of HIV status[17].

Data sources:

We used Ontario's administrative health databases, which are held securely in linkable files without any direct personal identifiers and analyzed at the Institute for Clinical Evaluative Sciences. We identified women with HIV using the Ontario HIV Database, an administrative

data registry of Ontario residents diagnosed with HIV infection, which was generated using a validated case-finding algorithm[18]. We determined receipt of mammography using the OBSP and OHIP databases. We used the Ontario Cancer Registry, a registry of all Ontario residents who have been diagnosed with or died of cancer, to identify women with a diagnosis of breast cancer in order to restrict our sample to screen-eligible women. We used the Immigration, Refugees and Citizenship Canada database to identify women who had immigrated to Ontario and their country of origin. We obtained data regarding patient enrolment with family physicians and physician demographics and trainings through the Client Agency Program Enrolment registry, ICES Physician Database and OHIP database. We used the OHIP database to identify number of primary care visits during the study period. Finally, we used the Registered Persons Database, a registry of all Ontario residents eligible for provincial health services, to identify individual demographic information such as age and postal code.

Study population:

We used the Registered Persons Database to identify all women between 50 and 74 years of age living in Ontario and eligible for health insurance as of the index date of the study, April 1, 2011. From within this cohort, we identified women with HIV using the Ontario HIV Database, with the remaining HIV-negative women serving as the referent population. From both groups, we excluded women with a history of breast cancer or mastectomy, as well as women who died during the study period to ensure all participants had 2 years of follow up.

Outcomes:

Our primary outcome was the receipt of a screening mammogram during the 2-year period following the index date.

Statistical Analysis:

We compared baseline characteristics between women with and without HIV using summary statistics.

For the primary analysis, we compared the receipt of mammography between women with and without HIV using multivariable log-binomial regression models. We adjusted models for age, urban versus rural residence[19], socioeconomic status, immigration status, [non-immigrant, recent (<5 years from index date) immigrant from HIV endemic country, recent (<5 years from index date) immigrant from non-HIV endemic country, non-recent immigrant from HIV endemic country, non-recent immigrant from non-HIV endemic country, comorbidity burden,], physician demographics (age, sex), and type of physician care received. We determined socioeconomic status at the neighborhood level using postal code information and Statistics Canada census data. We ascertained comorbidity burden in the preceding year using the Johns Hopkins Adjusted Clinical Groups case-mix assignment software (Sun Microsystems Inc., Santa Clara, CA.)[20]. This system uses diagnostic information from administrative databases to describe and predict use of health care resources. In this study, we used Aggregated Diagnosis Groups (ADGs), which are clusters of diagnostic codes that are similar in terms of severity and expected

persistence. The number of ADGs ranges from 0 to a maximum of 32, with a higher number reflecting a higher level of diagnosed comorbidity.

We identified the family physician providing care to each woman first by ascertaining which physician they were enrolled with using Client Agency Enrollment table; those who were not enrolled were assigned to the family physician who provided the majority of their primary care during the study period. Because almost three quarters of Ontario's population are enrolled with physicians practicing in one of several types of reimbursement and organizational practice models, which differ in characteristics such as the presence of interprofessional teams, we also adjusted models for practice model. Categories of these models in Ontario during the study period included: Capitation – team based (e.g. family health teams with allied health support), capitation - non team based (e.g. family health networks, family health organizations), rostered - enhanced fee for service (e.g. family health group), non-patient enrollment model (e.g. fee for service), and other[21]. We counted the number of primary care visits to each patient in the one year prior to the study period. We classified patterns of care received by patients based on whether they had at least 3 visits to their family physician, at least 3 HIV-specific visits to an infectious disease or internal medicine physician (International Classification of Diseases (ICD 10) billing codes 042, 043, or 044), both kinds of care, or neither kind of care during the 2 year study period. Unlike other jurisdictions in which internal medicine may include physicians in generalist practice, in Canada, they act as consultant physicians.

In secondary analyses, we determined predictors for the receipt of mammography in women with HIV only. We adjusted models for all patient, provider and practice characteristics listed above.

We used SAS version 9.3 statistical software (SAS Institute Inc., Cary, NC) for all analyses.

Ethics approval was obtained from the Sunnybrook Health Sciences Centre Research Ethics Board on August 12, 2015. The Sunnybrook Research Ethics Board has an agreement with the Institute for Clinical Evaluative Sciences (ICES) that allows ICES to conduct research using the anonymized administrative databases. The projects conducted under this agreement do not require independent research ethics board review, and no approval number/ID is given. ICES is named as a prescribed entity under section 45 of the Personal Health Information Protection Act (Ontario Regulation 329/04, Section 18). Under this designation, ICES can receive and use health information without consent for the purposes of analysis and compiling statistical information about the health care system of Ontario.

Results

We identified 1,447,015 women eligible for mammography screening during our study period, of whom 623 (0.04%) were living with HIV. Compared with HIV-negative women, women with HIV were younger, disproportionately represented in low income neighborhoods and more

likely to be immigrants to Canada (Table 1). The family physicians caring for women with HIV were younger and less likely to be female. Women with HIV were less likely to be receiving primary care in any of the enrolment models and had more primary care visits than women without HIV.

Overall, 312 (50.1%) women with HIV underwent screening mammography during the two-year follow-up period, compared with 916,775 (63.5%) HIV-negative women. Following multivariable adjustment, women with HIV were less likely to receive screening mammography than HIV-negative women (adjusted prevalence ratio (aPR) 0.83; 95% confidence interval 0.77 to 0.89) (Table 2). Having a female primary care physician (aPR 1.12; 95% confidence interval 1.12 to 1.13) and a minimum of three visits to a primary care physician in the preceding year (aPR 1.63; 95% confidence interval 1.63 to 1.64) were also associated with mammography.

In secondary analyses restricted only to the cohort of women with HIV, women who received mammograms were more likely to live in high income neighborhoods (27.3% vs. 21.5%; $p < 0.001$), have a high comorbidity burden (30.4% vs. 24.4%; $p = 0.002$) and have a female primary care physician (36.9% vs. 25.7%; $p < 0.001$) (Table 3). In addition, HIV-positive women receiving mammography were more likely to be enrolled in capitation models other than family health teams, have more primary care visits and receive regular care from their family physician either alone or in conjunction with an HIV specialist.

Following multivariable adjustment, only type of care was associated with mammography receipt; compared with women receiving both regular family physician care and regular HIV specialist care, women who saw only a specialist (aPR 0.77; 95% confidence interval 0.60 to 0.97) or who had neither kind of care (adjusted prevalence ratio 0.64; 95% confidence interval 0.50 to 0.83) were less likely to undergo screening (Table 4).

Interpretation

In this population based study, we found that women with HIV in Ontario were less likely to receive breast cancer screening than women without HIV. Furthermore, only half of all screen-eligible women with HIV received a mammogram during the 2 year study period. Among women with HIV, receipt of regular primary care either alone or in conjunction with an HIV specialist was associated with more screening.

Our study has important implications for the care of women with HIV. Most notably, our findings of lower use of screening mammography relative to the general population highlight the need for interventions to facilitate the uptake of this preventive modality. Strategies such as patient letters, reminder phone calls and educational materials have been shown in studies of HIV-negative women to improve screening uptake, and warrant evaluation in this population[22–24]. In particular, reminder letters for breast cancer screening are sent to patients in Ontario, and it is unclear why there is differential uptake among women with HIV.

Interventions directed at physicians may also be required in light of previous research demonstrating that physicians caring for women with HIV may emphasize the provision of HIV-specific primary care services to the detriment of routine health screening, such as mammography[12,25,26]. This phenomenon may be related in part to the time constraints associated with the management of HIV and associated comorbidities[27,28].

Our findings also highlight the role of model of care delivery in ensuring use of screening mammography. Women who had regular primary care, either with or without regular HIV specialist care, were more likely to receive mammography compared to those without regular care or those with only HIV specialist care. This is consistent with our earlier work identifying that models of care in which people with HIV had a usual family physician were more likely to be associated with cancer screening[12] and studies among women in the general population which support that continuity of care with a usual family physician is critical to meeting breast screening recommendations[25,29].

Our study is strengthened by the population-based nature of our data, which allowed us to comprehensively evaluate breast cancer screening among women in Ontario. Furthermore, physician care and mammography are universally covered for Ontario residents, mitigating the potential effect of disparities in health insurance on screening rates[29]. However, our study has some limitations. First, we did not have access to laboratory data, such as CD4 cell count and viral load, although immune status has not specifically been found to be associated with breast cancer screening in other studies[7,30]. Second, characteristics such as socioeconomic status were

assigned at the neighborhood rather than at the individual level. Third, we did not have individual level data for characteristics such socioeconomic Fourth, we could not identify women with HIV who are unaware of their status or who have not linked to care; we hypothesize that mammography screening would be even lower among these populations. Fifth, we lacked data on organizational features that may influence breast cancer screening, including electronic decision support tools[27,28], practice size[27], and co-location of screening services[22]. Finally, with only 623 women with HIV who were old enough to be eligible for screening, we may have been under-powered to detect associations in our secondary analysis.

In conclusion, our study builds upon previous research finding a lower prevalence of breast cancer screening among women with HIV. We have also delineated that regular care, especially including a usual family physician, is associated with improved uptake of mammography for these women. These findings have important implications for practice and policy as strategies to improve the care for people with HIV increasingly encompass the prevention and management of comorbidities across the lifespan and requires communication and integration across both primary and specialist care[27,31]. Future work to identify reasons for underuse of mammography in women with HIV as well as interventions to improve uptake of this intervention is warranted.

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Author disclosure

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Table 1. Characteristics of women in Ontario between 50-74 years by HIV status

Characteristic	HIV-negative (n, %) N=1,446,392	HIV-positive (n, %) N=623	P-value
Sociodemographics			
Age (mean (SD))	57.5 (5.1)	55.7 (4.8)	<.001
Income quintile			
Lowest	252,164 (17.4%)	233 (37.4%)	<.001
Low	278,680 (19.3%)	133 (21.3%)	
Middle	285,235 (19.7%)	104 (16.7%)	
High	305,018 (21.1%)	72 (11.6%)	
Highest	320,413 (22.2%)	80 (12.8%)	
Rurality			
Urban	1,254,081 (86.7%)	583 (93.6%)	<.001
Rural	191,138 (13.2%)	40 (6.4%)	
Comorbidity (number of ADGs*)			
<=5 (low comorbidity)	609,242 (42.1%)	164 (26.3%)	<.001
6-9	666,617 (46.1%)	288 (46.2%)	
10+ (high comorbidity)	170,533 (11.8%)	171 (27.4%)	
Immigrant status			
Non immigrant	1,243,282 (86.0%)	444 (71.3%)	<.001
Recent (<5 years), endemic country of origin	3,054 (0.2%)	<=42	
Recent (<5 years), non-endemic country of origin	23,683 (1.6%)	<=5	
Non-recent (5+ years), endemic country of origin	27,005 (1.9%)	97 (15.6%)	
Non-recent (5+ years), non-endemic country of origin	149,368 (10.3%)	37 (5.9%)	
Physician characteristics			
Family physician age (mean (SD))	53.0 (10.3)	51.8 (10.8)	0.004
Family physician sex			
Female	536,768 (37.1%)	195 (31.3%)	0.002
Male	834,215 (57.7%)	383 (61.5%)	
Years since family physician graduation (mean (SD))	27.3 (10.7)	26.0 (11.1)	0.004
Primary care model †			
Capitation – non team based	369,274 (25.5%)	107 (17.2%)	
Enhanced fee for service	564,598 (39.0%)	207 (33.2%)	<.001
Capitation – team based (family health team)	317,364 (21.9%)	159 (25.5%)	
Non-patient enrolment model	181,840 (12.6%)	106 (17.0%)	
Other	13,316 (0.9%)	44 (7.1%)	
Number of primary care visits in the year prior to index (mean (SD))	3.8 (4.3)	4.5 (5.0)	<.001
Screened for breast cancer			
Did not receive mammography	529,617 (36.6%)	311 (49.9%)	<.001
Received mammography	916,775 (63.4%)	312 (50.1%)	

*ADG = aggregated diagnosis groups

† Capitation – team based (e.g. family health teams with allied health support), capitation - non team based (e.g. family health networks, family health organizations), rostered - enhanced fee for service (e.g. family health group), non-patient enrollment model (e.g. fee for service)

Table 2. Unadjusted and adjusted* prevalence ratios for receipt of mammography among all women

Covariate	Unadjusted prevalence ratio	Lower 95% CI	Upper 95% CI	Adjusted* prevalence ratio	Lower 95% CI	Upper 95% CI
HIV status						
HIV positive	**0.79**	**0.73**	**0.86**	**0.83**	**0.77**	**0.89**
HIV negative	1			1		
Age (per 10 years)	**1.09**	**1.09**	**1.09**	**1.04**	**1.04**	**1.05**
Income quintile						
Lowest	1			1		
Low	**1.08**	**1.08**	**1.09**	**1.07**	**1.06**	**1.07**
Middle	**1.13**	**1.12**	**1.13**	**1.10**	**1.09**	**1.10**
High	**1.16**	**1.16**	**1.17**	**1.12**	**1.12**	**1.12**
Highest	**1.20**	**1.20**	**1.21**	**1.15**	**1.14**	**1.15**
Rurality						
Rural	1.00	1.00	1.00	**0.99**	**0.99**	**0.99**
Urban	1			1		
Comorbidity (number of ADGs†)						
<=5 (low comorbidity)	1			1		
6-9	**1.31**	**1.31**	**1.32**	**1.11**	**1.11**	**1.11**
10+ (high comorbidity)	**1.34**	**1.34**	**1.35**	**1.12**	**1.12**	**1.12**
Immigrant status						
Recent (<5 years), endemic country of origin	**0.85**	**0.83**	**0.88**	**0.93**	**0.90**	**0.96**
Recent (<5 years), non-endemic country of origin	**0.78**	**0.77**	**0.79**	**0.85**	**0.84**	**0.86**
Non-recent (5+ years), endemic country of origin	**0.95**	**0.94**	**0.95**	1.00	1.00	1.01
Non-recent (5+ years), non-endemic country of origin	**0.88**	**0.87**	**0.88**	**0.94**	**0.94**	**0.95**
Non immigrant	1			1		
Physician age (per 10 years)	**0.98**	**0.97**	**0.98**	**0.99**	**0.99**	**0.99**
Family physician sex						
Female	**1.12**	**1.12**	**1.13**	**1.09**	**1.09**	**1.09**
Male	1			1		
Primary care model‡						
Capitation – non team based	**0.98**	**0.98**	**0.98**	**0.97**	**0.97**	**0.97**
Enhanced fee for service	**0.95**	**0.94**	**0.95**	**0.95**	**0.95**	**0.95**
Non-patient enrolment model	**0.60**	**0.60**	**0.61**	**0.86**	**0.86**	**0.87**
Other	**0.94**	**0.93**	**0.95**	**0.98**	**0.97**	**0.99**
Capitation – team based	1			1		
3+ visits to usual family physician during the study period	**1.63**	**1.63**	**1.64**	**1.43**	**1.42**	**1.43**

* models adjusted for all listed covariates

† ADG = aggregated diagnosis groups

‡ Capitation – team based (e.g. family health teams with allied health support), capitation - non team based (e.g. family health networks, family health organizations), rostered - enhanced fee for service (e.g. family health group), non-patient enrollment model (e.g. fee for service)

Table 3. Demographic tables of women with HIV in Ontario between 50–74 years by screened status (n=623)

Characteristic	Non Screened N=311	Screened N=312	P-value
Age (mean (SD))	55.4 (4.7)	56.1 (4.9)	0.056
Income quintile			
Lowest	122 (39.2%)	111 (35.6%)	<.001
Low	71 (22.8%)	62 (19.9%)	
Middle	50 (16.1%)	54 (17.3%)	
High	30 (9.6%)	42 (13.5%)	
Highest	37 (11.9%)	43 (13.8%)	
Missing	<=5	0 (0.0%)	
Rurality			
Urban	291 (93.6%)	292 (93.6%)	0.992
Rural	20 (6.4%)	20 (6.4%)	
Comorbidity (number of ADGs*)			
<=5 (low comorbidity)	101 (32.5%)	63 (20.2%)	0.002
6-9	134 (43.1%)	154 (49.4%)	
10+ (high comorbidity)	76 (24.4%)	95 (30.4%)	
Immigrant status			
Non immigrant	232 (74.6%)	212 (67.9%)	0.37
Recent (<5 years), endemic country of origin	17 (5.5%)	24 (7.7%)	
Recent (<5 years), non-endemic country of origin	<=5	<=5	
Non-recent (5+ years), endemic country of origin	45 (14.5%)	52 (16.7%)	
Non-recent (5+ years), non-endemic country of origin	<=20	<=22	
Family physician age (mean (SD))	51.8 (10.2)	51.9 (11.3)	0.99
Family physician sex			
Female	80 (25.7%)	115 (36.9%)	<.001
Male	197 (63.3%)	186 (59.6%)	
Years since family physician graduation (mean (SD))	26.1 (10.7)	26.1 (11.4)	0.967
Primary care model†			
Capitation – non team based	48 (15.4%)	59 (18.9%)	<.001
Enhanced fee for service	92 (29.6%)	115 (36.9%)	
Capitation – team based (family health team)	85 (27.3%)	74 (23.7%)	
Non-patient enrolment model	72 (23.2%)	34 (10.9%)	
Other	14 (4.5%)	30 (9.6%)	
Type of physician care received during the study period‡			
Regular HIV specialist care‡	77 (24.8%)	51 (16.3%)	<.001
3+ visits to usual family physician only	92 (29.6%)	130 (41.7%)	
Both regular family physician care and HIV specialist care	53 (17.0%)	93 (29.8%)	
Neither regular family physician care nor HIV specialist care	89 (28.6%)	38 (12.2%)	
Number of primary care visits during the study period (mean (SD))	3.9 (4.7)	5.13 (5.3)	0.003

*ADG = aggregated diagnosis groups

† Capitation – team based (e.g. family health teams with allied health support), capitation - non team based (e.g. family health networks, family health organizations), rostered - enhanced fee for service (e.g. family health group), non-patient enrollment model (e.g. fee for service)

‡ Regular HIV specialist care defined as 3+ visits to an infectious disease or internal medicine specialist for HIV specific care

Table 4. Unadjusted and adjusted* prevalence ratios for receipt of mammography among women with HIV

Covariate	Unadjusted prevalence ratio	Lower 95% CI	Upper 95% CI	Adjusted* prevalence ratio	Lower 95% CI	Upper 95% CI
Age (per 10 years)	1.16	1.00	1.35	1.03	0.89	1.20
Income quintile						
Lowest	1			1		
Low	0.98	0.78	1.23	0.94	0.77	1.16
Middle	1.09	0.87	1.37	1.06	0.87	1.30
High	1.22	0.97	1.55	1.24	0.99	1.55
Highest	1.13	0.88	1.44	1.14	0.90	1.44
Rurality						
Rural	1.02	0.75	1.41	0.95	0.69	1.31
Urban	1			1		
Comorbidity (number of ADGs†)						
<=5 (low comorbidity)	1			1		
6-9	**1.38**	**1.11**	**1.73**	1.15	0.94	1.40
10+ (high comorbidity)	**1.44**	**1.14**	**1.82**	1.18	0.95	1.47
Immigrant status						
Recent (<5 years), endemic country of origin	1.22	0.93	1.61	1.23	0.93	1.63
Recent (<5 years), non-endemic country of origin	1.57	0.88	2.78	1.19	0.56	2.52
Non-recent (5+ years), endemic country of origin	1.12	0.91	1.38	1.03	0.85	1.24
Non-recent (5+ years), non-endemic country of origin	1.19	0.88	1.60	1.09	0.83	1.43
Non immigrant	1			1		
Physician age (per 10 years)	1.00	0.93	1.08	1.01	0.94	1.09
Family physician sex						
Female	1.21	1.04	1.42	1.10	0.95	1.28
Male	1			1		
Primary care model‡						
Capitation – non team based	1.18	0.93	1.50	1.09	0.87	1.35
Enhanced fee for service	1.19	0.97	1.47	1.09	0.89	1.33
Non-patient Enrolment model	0.70	0.50	0.96	0.94	0.68	1.31
Other	1.46	1.13	1.90	1.28	0.99	1.66
Captiation – team based (family health team)	1			1		
Type of physician care received during study period						
Regular HIV specialist care§	**0.63**	**0.49**	**0.80**	**0.77**	**0.60**	**0.97**
3+ visits to usual family physician only	0.92	0.78	1.08	0.97	0.82	1.15

Neither regular family physician care nor HIV specialist care	**0.47**	**0.35**	**0.63**	**0.64**	**0.50**	**0.83**
Both regular family physician care and HIV specialist care	1			1		

* Models adjusted for all listed covariates
† ADG = aggregated diagnosis groups
‡ Capitation – team based (e.g. family health teams with allied health support), capitation - non team based (e.g. family health networks, family health organizations), rostered - enhanced fee for service (e.g. family health group), non-patient enrollment model (e.g. fee for service)
§ Regular HIV specialist care defined as 3+ visits to an infectious disease or internal medicine specialist for HIV specific care

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
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	Title	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Title – too many databases to list separately, please see item 8
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			p. 5
Objectives	3	State specific objectives, including any prespecified hypotheses			p. 6, last line of introduction
Methods					
Study Design	4	Present key elements of study design early in the paper			p. 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			p. 6
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the		RECORD 6.1: The methods of study population selection (such as codes or	p.7 (study population,

		sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	validated algorithm) A flow diagram of participants within each linked database is not possible given the nature of the data holdings, however a flow diagram of exclusions could be provided
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Reference for HIV ascertainment provided p7. Code for breast screening ascertainment: Receipt of mammogram during follow-up; numerator = women belonging to denominator group who had mammogram between April 1, 2011 to March 31, 2013

					Defined as: o OBSP screening [SCREENED variable set as 2 (mammogram only) or 3 (yes, both PE and mammogram)] or o OHIP feecode X185, X172, X178, or o Patient enrollment model tracking code Q131A Count as mammogram received if meets any of above
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			P6-7
Bias	9	Describe any efforts to address potential sources of bias			
Study size	10	Explain how the study size was arrived at			Population based – all women in Ontario were included
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen,			p.8

		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) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			p.8-9
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	n/a for this provincial data source
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	p.6
Results					

Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, 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		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	p.10
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			P 10-11, Table 1. Missing data: Income quintile missing for n=4,882 (0.3%) of people without HIV and n<=5 (0.2%) of people with HIV Rurality missing for n=1,173 (0.1%) of people without HIV and 0(0%) of people with HIV Physician sex missing for n=75,409 (5.2%) of people without HIV and n=45 (7.2%) of people with HIV Missing may be added to tables at the editor's request
Outcome data	15	*Cohort study* - Report numbers of			p. 11 first full para

		outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 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			p. 11 and 12, Tables 2 and 4
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			n/a
Discussion					
Key results	18	Summarise key results with reference to study objectives			p. 12, first para of interpretation
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		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	p. 13 last para

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			p. 12/13
Generalisability	21	Discuss the generalisability (external validity) of the study results			p. 13
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			p. 15
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Raw data not available for ICES data

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.