CERVICAL CANCER SCREENING AMONG ONTARIO'S URBAN IMMIGRANTS

by

Aisha Kamilah O. Lofters

A thesis submitted in conformity with the requirements for the degree of Doctorate in Philosophy

in Clinical Epidemiology

Institute of Health Policy, Management and Evaluation

University of Toronto

ABSTRACT

Aisha Kamilah O. Lofters
Cervical Cancer Screening Among Ontario’s Urban Immigrants
Doctor of Philosophy, 2012
Institute of Health Policy, Management and Evaluation
University of Toronto

Background: The majority of cervical cancers can be prevented because of the highly effective screening tool, the Papanicolaou (Pap) test. Relevant guidelines recommend routine screening for nearly all adult women. However, inequities in screening exist in Ontario. This dissertation, consisting of three studies, uses administrative data to advance knowledge on barriers to cervical cancer screening for Ontario’s urban immigrant population.

Methods: First, we developed and validated a billing code-based algorithm for cervical cancer screening. We then implemented this algorithm to examine screening rates in Ontario among women with various sociodemographic characteristics for 2003-2005. Second, we compared the prevalence of appropriate cervical cancer screening in Ontario in 2006-2008 among immigrant women from all major geographic regions of the world and Canadian-born women. Third, we used a stratified multivariate analysis to determine if the independent effects of various factors that could serve as screening barriers were modified by region of origin for immigrant women for 2006-2008.

Results: Our first study showed that our algorithm was 99.5% sensitive and 85.7% specific, and that screening inequities in Ontario’s urban areas are largest among women 50 years and older, living in the lowest-income neighbourhoods and new to the province. In our second study, we determined that immigrant women had significantly lower screening rates than their peers, with the most pronounced differences seen for South Asian women aged 50 years and above. In the final study, we demonstrated that living in the lowest-income neighbourhoods, being younger than 35 years or older than 49 years, not being enrolled in a primary care enrolment model, having a male provider, and having a provider from the same region of the world each significantly influenced screening for immigrant women regardless of region of origin.

Conclusion: These results add to the literature on health equity in cancer screening. Our findings demonstrate that Ontario's urban immigrant women experience significant inequities in cervical cancer screening, and may offer guidance toward targeted patient and physician interventions to decrease screening gaps.

ACKNOWLEDGEMENTS

First, I would like to thank my supervisor, Dr. Richard H. Glazier for your mentorship, time, support, advocacy and expertise that you have given both to me and to this work. Your love and enthusiasm for your work was a wonderful example for me, and helped to set me on this path. I also thank the other members of my committee, Dr. Stephen Hwang and Dr. Rahim Moineddin, for your guidance, insight, encouragement and support during this long process. You were all an amazing team to work with.

I would like to thank Dr. Brian Hutchison and Dr. Anna Chiarelli for their participation in my defence examination, and in their thoughtful critique of this work. I would also like to thank Brandon Zagorski, Jun Guan and Alex Kopp for their assistance in data creation. I appreciate the patience with my many questions.

The Canadian Institutes for Health Research (CIHR), the Centre for Research on Inner City Health, the Primary Care Health System, the St. Michael's Hospital Department of Family and Community Medicine, and the University of Toronto Department of Family and Community Medicine have all provided financial support that has allowed me to protect time to devote to research. As well, the Clinical Epidemiology Program in the Institute of Health Policy, Management, and Evaluation has been very helpful throughout this process.

Finally, a truly heartfelt thanks to my husband, Joel, for his unwavering love, support, pride and enthusiasm throughout this long, long process, and to Alexander, who extended this process by one year, but what a great year it was!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

BACKGROUND: PROVIDING CONCEPTS AND CONTEXT

The purposes of this chapter are to discuss the main concepts addressed by, and provide context for, this dissertation by reviewing:

1. Health equity
2. Immigrant health
3. Cervical cancer screening
4. The Behavioral Model for Vulnerable Populations
5. The use of administrative data in health services research
6. Rationale and research objectives for the current research

1.1 HEALTH EQUITY

In 1991, in conjunction with the World Health Organization, health researcher Margaret Whitehead devised one of the most widely used definitions of health inequities in the international literature. To distinguish them from health inequalities, which are simply differences in health achievements, she defined health inequities as differences in health between better- and worse-off socially defined groups that “are not only unnecessary and avoidable but, in addition, are considered unfair and unjust”(1, 2). By inclusion of the words “unfair” and “unjust”, we recognize that the concept of health inequities is a normative one. Indeed, Whitehead goes on to define health equity as the implication that “everyone should have a fair opportunity to attain their full health potential and, more pragmatically, that no one should be disadvantaged from achieving this potential, if it can be avoided.” These words suggest that, where a health inequity is unearthed, efforts must be made to reduce or eliminate that inequity. Equity in health care is an important means (although not the only means) to achieve health equity, suggesting that health equity and health care equity should be an important policy objective in health care (3-5). The vulnerable populations for whom we seek to achieve health equity are typically defined on the basis of sociodemographic factors which can directly lead to discrimination, such as socioeconomic position including education and income, gender, race/ethnicity, age, and immigrant status (2, 6, 7). Mooney & Jan further stratified the concept of equity into two separate subconcepts, namely, horizontal equity and vertical equity. Horizontal equity refers to equal treatment for those with equal needs, whereas vertical equity refers to preferential treatment for those with greater health needs (8). The current research, with a focus on population-level cervical cancer screening, which applies to all women who meet eligibility criteria regardless of sociodemographics, is grounded in the concept of horizontal equity.

If we aim to identify health inequities, how then to best measure them? Family physician and health equity researcher Paula Braveman recommends that the measurement of equity consist of choosing a health indicator of concern, categorizing people by socially relevant groups, calculating rates of the health indicator in each group, calculating rate ratios and differences across groups with the reference group being the social group considered a priori most advantaged, and conducting multivariate analyses to identify particular issues warranting further research or action (6). The most advantaged group is chosen as the referent group because what has been achieved for them is theoretically achievable for all groups. This systematic approach is used in the current research to study health inequities for cervical cancer screening among eligible women in Ontario. The sociodemographic group on which we have chosen to focus is foreign-born persons, a group of particular import in Canada, which has a history of accepting proportionally more immigrants than any other nation (9, 10). Therefore, the next two sections will, first, provide detail on issues related to immigrant health, particularly in Canada and particularly related to use of preventive health services which includes cancer screening, and second, review the epidemiology of cervical cancer and the role of cervical cancer screening.

1.2 IMMIGRANT HEALTH

As mentioned above, foreign-born persons have been one of the groups that have been highlighted in the literature as being frequently at a social disadvantage and in need of access to equitable health care. The issue of health equity for foreign-born persons should be of particular policy importance in Canada and in Ontario due to the sizeable immigrant population in the country and in the province. In 2001, 5.4 million foreign-born persons made up nearly 20% of the nation's population, with 2.5 million of those immigrants landing after 1985 (10, 11). Ontario is the destination for more than half of new immigrants, with India currently being the number one source country for Ontario's immigrants (12, 13). Fifteen percent of recent immigrants came from this developing country, with a further 14% coming from China, 7.5% coming from Pakistan, and 6.5% coming from the Philippines (13). Over 64% of recent immigrants come from Asia (13). This is a noticeable change from earlier eras in Canada, when immigrants from two developed nations, the United Kingdom and Italy, led the way, making up 18% and 10%, respectively, of immigrants who landed before 1986 (10).

Interestingly, when immigrants first arrive in the country, they tend to be in better health than their Canadian-born counterparts, with a lower likelihood of having a chronic condition, lower rates of emergency room visits and hospital admissions, and lower rates of depression and obesity (9, 11, 12, 14-19). This finding is known as the "healthy immigrant effect"(12, 15, 16, 19, 20). The reasons for the healthy immigrant effect are not fully understood, but may include immigrant self-selection, where the healthiest people are most likely to be able to migrate and to be approved for immigration (15, 16).

However, the health status of immigrants and Canadian-born persons converges as immigrants spend more time in Canada, becoming indistinguishable after approximately ten years (9, 11, 12, 15, 18, 19, 21). Indeed, with time, immigrants' health status in some cases becomes worse than that of the native-born (15, 21). This convergence and subsequent reversal of health status between the two groups is believed to be due to a combination of adoption of Canadian lifestyle, economic strain, employment issues, the process of acculturation, systemic discrimination, language issues and importantly, relative under-use of preventive health care (12, 15, 16, 18-20).

Immigrants' use of health care is infrequent upon arrival, but converges to that of their Canadian-born peers significantly quicker than health status does (12, 15, 17, 20, 22). This finding suggests that lack of access to care is not the cause of the deterioration of the healthy immigrant effect over time, but perhaps that it may be the kind of care not received, including preventive health care, that is important. It is important to note that these differences in access to preventive care may emanate from the patient, the provider or even the system itself. Any clinical encounter is the result of a combination of the patient's beliefs, culture, education and biology; the provider's knowledge, attitudes, and biases; and the system's organization (7). For example, many immigrants may be more likely to view the doctor as a place to go for acute issues, not for prevention, especially if there are competing interests to consider such as unemployment, social isolation and discrimination (18, 19, 23). Of note, patient preferences and beliefs can be amenable to intervention and change (7). Providers may assume patients hold beliefs that they do not, or may fail to tailor messages in a culturally appropriate manner (7, 24). If the system cannot accommodate different patient languages or cultural preferences, this can be an important barrier to access to quality care (24).

The benefits of preventive primary care, and therefore the potential harm to immigrants not receiving preventive primary care, become clear when we detail an illustrative example such as cervical cancer screening.

1.3 CERVICAL CANCER SCREENING

Cancer of the uterine cervix, or cervical cancer, is a unique malignancy in that its central causal factor is persistent infection with certain types of the Human Papillomavirus (HPV), namely HPV 16 and HPV 18, which are sexually transmitted (25-27). The association between HPV and cervical cancer is now well established, strong and consistent (25). Although most infections with HPV resolve spontaneously, a small percentage of cases persist and progress slowly and asymptomatically along a spectrum from atypical cells to low-grade lesions to high-grade lesions to invasive cancers (25, 26). Accordingly, risk factors for cervical cancer include multiple sexual partners, early age at first intercourse, multiple pregnancies, long-term oral contraceptive use, HIV co-infection, and multiple partners of the woman's partner (26-28). Other risk factors for cervical cancer include dietary factors, cigarette smoking and low socioeconomic status (25-28). The incidence peaks for cervical cancer occur at ages 35-44 years and at 75 years and over (26).

In high-income nations, the incidence and mortality of cervical cancer have declined steeply and steadily as widespread use of the Papanicolaou (Pap) test as a screening tool has become common in those countries (25-27). The Pap test consists of cytological sampling and examination (26). For example, between 1992 and 2001, Canada's average annual reductions in incidence and mortality of invasive cervical cancer were 2.1% and 1.9% respectively (29). These declines are due to the ability of the Pap test to accurately diagnose pre-cancerous lesions, allowing for early monitoring and treatment (25). Because of the effectiveness of the Pap test and the slow-growing nature of cervical lesions, up to 90% of invasive cervical cancers can be prevented by routine screening (26, 30). Accordingly, Western Europe and North America (excluding Mexico) are considered low-risk areas for cervical cancer (25, 26, 31). Canada currently has one of the world's lowest annual incidences and mortality rates of invasive cervical cancer, at 7.5 cases and 2.5 cases per 100 000 women respectively, with an estimated 1 400 women being diagnosed annually and an estimated 400 women dying of the disease annually (26, 27, 29).

Contributing to the widespread use of Pap tests is the establishment of evidence-based guidelines that physicians can follow for screening eligible women. In 1994, the Canadian Task Force on Preventive Health Care established national guidelines for cervical cancer screening (28). These guidelines recommend annual screening following initiation of any vaginal sexual activity or at the age of 18 years, whichever comes first. After two normal tests, they recommend screening at three-year intervals until the age of 69 years. Increased frequency is suggested for women whose first sexual intercourse occurred before 18 years, women with many sexual partners or with a consort with many sexual partners, women who smoke, and women of low socioeconomic status (28). The province of Ontario has more recent evidence-based guidelines for cervical cancer screening (32). These provincial guidelines recommend that Pap tests be initiated within three years of first vaginal sexual activity, and be performed annually until there are three consecutive negative Pap tests. Screening should then continue at two- to three-year intervals, with a three-year interval recommended if there is an adequate recall mechanism in place for women. Women who have not been screened in more than five years are suggested to have annual screening until there are three consecutive negative Pap tests. The Ontario guidelines recommend cessation of screening at the age of 70 years if there have been three to four negative tests in the previous 10 years (32). Although the guidelines differ in various components, both agree that Pap tests should occur at least once every three years for screening-eligible women.

In contrast to the declining rates seen in high-income nations, many low- and middle-income countries in Latin America, Africa, South Asia and Eastern Europe, where widespread and organized screening generally does not exist, are still considered high-risk areas, with annual incidence rates exceeding 40 per 100 000 women in some cases, and screening rates for three-year intervals averaging 19% (25-27, 33, 34). The highest incidence rate globally is seen in Guinea, in West Africa, where 6.5% of women develop the disease by 75 years of age (35). The highest disease frequency is seen in India, with 134 000 cases annually (35). Similarly, screening rates are as low as 10% in India, and as low as 1% in Bangladesh and Ethiopia (33). As a result of a lack of effective screening in these countries, likely in turn a result of the substantial costs required, cervical cancer is still the fifth most common cancer worldwide and the third most common among women globally (after breast and colorectal), and 80% of incident cases of cervical cancer are among women in low- and middle-income nations (25, 26, 31, 33, 35, 36). The World Health Organization has estimated that if women worldwide had a Pap test every five years, mortality due to cervical cancer would be cut by 85% (34).

When women emigrate from countries where screening does not routinely occur to countries with organized screening programs, an opportunity arises to eliminate an inequity. Many women arrive under-informed about cervical cancer and the need for screening, and at higher risk because of a lack of a regular screening history (34). However, the literature shows that this opportunity is often not taken advantage of around the world, and that patterns of under-screening tend to persist after immigration to Australia, the United States and Canada, the major immigrant-receiving countries of the world (10). For example, in Australia, immigrants have consistently been found to have significantly lower screening rates than native-born women, especially if they are not English-speaking, are from the Middle East or Asia, and are among those women who have been in the country the shortest period of time (37-42). Similar inequities exist in the U.S., with Hispanic and Asian & Pacific Islander immigrants being highlighted as particularly vulnerable (43-52). In Canada, women who speak a foreign language and who are foreign-born have long been noted to have significantly lower rates of cervical cancer screening, particularly for women from the Asian continent (53-61). As most new cases of invasive cervical cancer in Canada occur among women who have either been under-screened or never been screened (26, 62), Canada's immigrant population is likely a group at high risk of the morbidity and mortality associated with cervical cancer and precancerous lesions.

In the following section, we will review the theoretical framework that guides the current body of research, the Behavioral Model for Vulnerable Populations. This framework is chosen as most appropriate because of its emphasis on both vulnerable populations and use of health services.

1.4 THE BEHAVIORAL MODEL FOR VULNERABLE POPULATIONS

In 1974, health services researchers Lu Ann Aday and Ronald Andersen published the Behavioral Model, a theoretical framework to guide researchers in their study of use of health services by populations (Figure 1) (63). This framework suggested that there are three key categories of population characteristics regarding utilization of health care services: predisposing, enabling, and need. Predisposing characteristics are those that encompass the pre-existing tendency of individuals to use services, and include such variables as age, sex, and values concerning health and wellbeing. Enabling characteristics are those factors that assist, or conversely impede, individuals' use of health services. Examples include insurance status and geographic access to health facilities. The need component refers to perceived need by either the individual or the health care delivery system (63).

This model has undergone several revisions, the most relevant to the current research being that proposed in 2000 by Gelberg, Andersen and Leake, the Behavioral Model for Vulnerable Populations (64). In this major adaptation to the model, the three categories of population characteristics were stratified intro traditional and vulnerable domains, "utilization of health services" was expanded to a broader "health behaviour" category which also includes personal health practices, and the impact of health behaviour and health services utilization on health status outcomes was added (Figure 2). The pathways in the revised model are bidirectional, emphasizing that changes in health status often can influence health behaviours and can influence population characteristics. Predisposing vulnerable characteristics in the revised model include social structure characteristics, and in the current research encompass factors such as country of birth and time in Canada. Examples of enabling vulnerable characteristics relevant to the current research include the presence of co-morbidities which can act as competing needs at physician visits, and belonging to primary care enrolment models where physicians are financially incentivized to screen enrolled patients. The need vulnerable domain includes evaluated need regarding conditions of particular relevance to vulnerable populations.

Table 1 provides a complete list of variables used in the current research and how they fit into the population characteristic categories for the Behavioral Model for Vulnerable Populations, with each expected to make an independent contribution to explaining Pap test screening for immigrant women. Details of these variables are found in the corresponding chapters. Of note, Gelberg et al. suggest that the predisposing and enabling domains are relatively more important than the need domain in explaining health service utilization for conditions with less apparent consequences than for conditions with immediate impact. Accordingly, most of our variables are concentrated in the former two categories (64).

To apply the various domains of the Behavioral Model for Vulnerable Populations to Ontario's immigrant women for Pap test screening, the current research relies on administrative data.

1.5 THE USE OF ADMINISTRATIVE DATA IN HEALTH SERVICES RESEARCH

In Chapters 2, 3 and 4, administrative data are used to explore patterns of cervical cancer screening at the population level for women in Ontario, with a particular focus on immigrant women. Administrative data refers to those health care data that are collected for administrative reasons, such as determining eligibility for health insurance or paying providers' claims for medical services (65). The main benefits to the current research of using administrative data are that they provide the ability to conduct research at the population level relatively quickly and cost-effectively, they can be linked with many other data to provide a more complete picture about the population under study, and that they do not rely on self-report which can be subject to acquiescence bias (the tendency of survey respondents to agree with all questions when in doubt), recall bias (where survey participants' answers are influenced by their memory), and social desirability bias (the tendency of survey participants to respond in a manner that they deem will be viewed favourably), particularly for cancer screening (66-70). As well, the information available in Canadian administrative databases has been found to be generally complete and reliable (65).

However, administrative data are not without limitations. The databases being used may not always be complete or accurate, especially as they are not collected for the purpose of rigorous research (70, 71). Also, because they are not collected for research purposes, they may lack information that could be of interest for particular research questions. For example, most administrative data available in Ontario do not include information on individual-level sociodemographic information useful for health equity research, such as race/ethnicity or income

(72). Despite these limitations, administrative data remain a powerful and effective way to study issues of health equity at the population level in Ontario.

1.6 RATIONALE AND RESEARCH OBJECTIVES FOR THE CURRENT RESEARCH

In this introductory chapter, we have discussed the concepts and context necessary to understand patterns of screening for Ontario's immigrant women. We will conclude this chapter with a discussion of the rationale, research objectives and hypotheses for the current research.

Despite what is currently known about cervical cancer screening and about immigrant health, and despite the availability of administrative data, gaps in the literature on cervical cancer screening for immigrant women in Ontario remain. First, although physician billing codes are generally claimed by either the physician performing the Pap test or the cytopathologist interpreting the Pap test whenever cervical cancer screening is performed, a billing code-based algorithm has not previously been validated. Second, much of the relevant literature either is limited to a particular immigrant group or does not stratify immigrants by their regions of origin. Third, it is not known if some barriers to screening for immigrants are of more importance to one group than another or if barriers for one group act as facilitators for another.

Therefore, the overarching objective of the current research is to advance knowledge on barriers to cervical cancer screening for Ontario's immigrant population. Specific objectives are to develop a validated billing code-based algorithm for cervical cancer screening in the Ontario setting and then implement it in a cohort of Ontario women to examine cervical cancer screening rates, to compare the prevalence of appropriate cervical cancer screening in the province among immigrant women from all major geographic regions of the world and Canadian-born women, and to determine if the independent effects of various factors that could serve as barriers to screening were modified by region of origin for immigrant women. Corresponding hypotheses are that billing codes will be able to accurately identify receipt of a Pap test, that all immigrant women will have significantly lower screening rates in Ontario than Canadian-born women with women from developing nations being the most vulnerable to under-screening, and that various sociodemographic, health care-related and migration-related factors will show effect modification by region of origin.

In the subsequent chapters of this dissertation, we will thus describe the validation of a billing code-based algorithm for cervical cancer screening and its implementation to examine cervical cancer screening rates in Ontario for 2003-2005 (Chapter 2), a comparison of the prevalence of appropriate cervical cancer screening for 2006-2008 among immigrant women from all major geographic regions of the world and native-born women (Chapter 3), and a stratified multivariate analysis of factors associated with cervical cancer screening for 2006-2008 among immigrant women from each major geographic region of the world (Chapter 4). In the final chapter, we will revisit the Behavioral Model for Vulnerable Populations and discuss the policy and practice implications of this body of research.

Table 1. Variables used in the current research, where in the current body of research they are addressed, and how they fit into the Behavioral Model for Vulnerable Populations.

Population Characteristics	**Variable**	**Chapter**
Predisposing Characteristics	Age	2, 3, 4
	Foreign-born status	2, 3, 4
	Region of birth	3, 4
	English language ability	4
	Time in Canada	2, 3, 4
	Age at landing in Canada	4
	Immigrant class (economic, family, refugee)	4
	Income	2, 3, 4
	Education level	4
Enabling Characteristics	Region of residence	2, 3, 4
	Regular source of care	2, 3, 4
	Co-morbidities	3, 4
	Specialist gynaecological care	4
	Enrolment in primary care enrolment model	3, 4
	Cultural congruence with family physician	4
	Gender of family physician	4
Need Characteristics	Prenatal care	2, 3, 4

Figure 1. The original Behavioral Model (63).

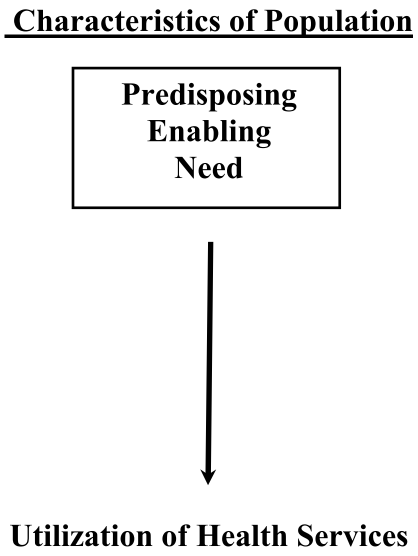
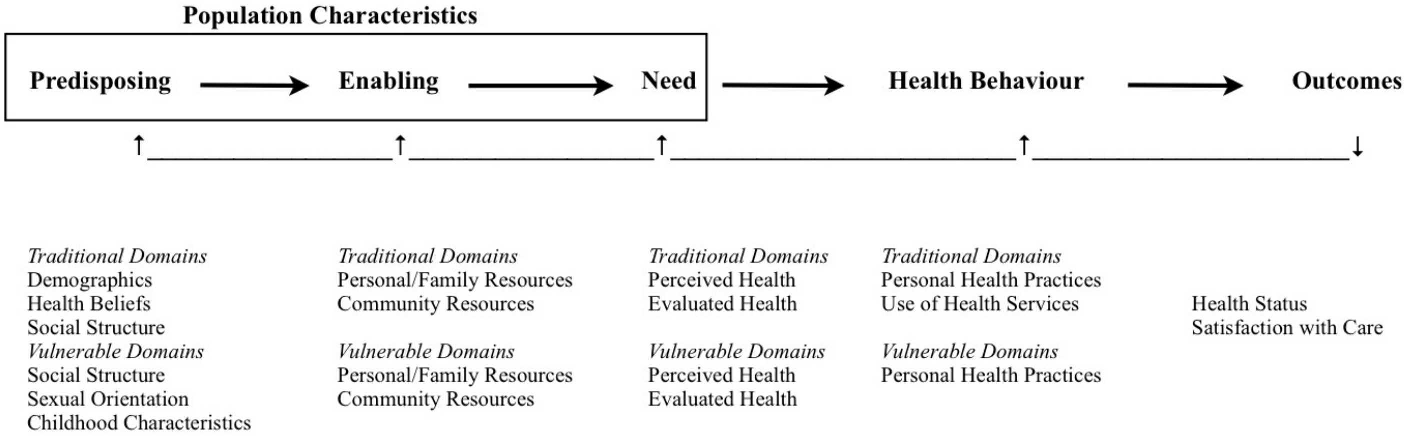


Figure 2. The Behavioral Model for Vulnerable Populations(64).



An abridged version of the following chapter has been previously published. The citation is: Lofters A, Moineddin R, Hwang SW, Glazier RH. Low rates of cervical cancer screening among urban immigrants: a population-based study in Ontario, Canada. Med Care. 2010; 48(7): 611-8. Permission was received to publish in this dissertation.

CHAPTER 2

LOW RATES OF CERVICAL CANCER SCREENING AMONG URBAN IMMIGRANTS: A POPULATION-BASED STUDY IN ONTARIO, CANADA

ABSTRACT

Objective: Women who are immigrants or socioeconomically disadvantaged have been found to have significantly lower cervical cancer screening rates than their peers in Toronto, Ontario, Canada. The objectives of this study were two-fold: to develop a validated billing code-based algorithm for cervical cancer screening, and then to use this algorithm to examine rates of appropriate cervical cancer screening among women living in Ontario, Canada, using recent registration with Ontario's universal health insurance plan as an indicator of immigrant status.

Methods: This retrospective cohort study included 2 273 995 screening-eligible women aged 25 to 69 years, who resided in Ontario's metropolitan areas during the calendar years 2003, 2004 and 2005. A validated algorithm was applied to the Ontario-wide physicians' claims database to determine which women had undergone cervical cancer screening with a Pap test during the three-year period.

Results: Appropriate cervical cancer screening occurred for 61.1% of women. Despite adjustment for physician contact and pregnancy rates, cervical cancer screening rates were especially low among: women aged 50 to 69 years; women living in low-income areas; and women who had registered with Ontario's universal health insurance plan within the preceding 10 years, a group consisting largely of recent immigrants. Women with all three of these characteristics had a screening rate of 31.0% compared to 70.5% among women with none of these characteristics.

Conclusion: Within a system of universal health insurance, appropriate cervical cancer screening is significantly lower among women who are older, living in low-income areas, or recent immigrants. Efforts to reduce inequities in cervical cancer screening should focus on women with these characteristics.

2.1 INTRODUCTION

Since its inception, the Pap test has proven to be a highly effective screening tool for cervical cancer. Due to widespread use in Canada, incidence and mortality rates for cervical cancer decreased by 39% and 53% respectively between 1981 and 2002 (73). Ontario, Canada's most populous province, has evidence-based guidelines that clearly outline the initiation and frequency of screening, stating that Pap tests should begin within three years of first vaginal sexual activity, and should be performed at least every two to three years until the woman reaches 70 years of age. Screening every three years is recommended if the physician has an adequate recall mechanism (32). Ontario has a single, government-run, universal health insurance plan that pays for all medically necessary services, including cervical cancer screening.

In spite of an effective screening tool, established guidelines and a universal health plan, certain groups of women in our setting appear to be inadequately screened. Patient, environment, physician and system variables may all be barriers to having regular Pap tests. For example, immigrant women (53, 54, 57, 60, 61), older women (53, 61, 74, 75) and women of low socioeconomic status (53, 61, 74, 75) have reported lower rates of cervical cancer screening in Ontario and in Canada.

As self-report rates tend to be higher than screening rates from registries and billing code databases (61, 70, 76) and as there is evidence that certain sociodemographic groups may be more likely to over-report screening (69), our previous work (59) used a physician billing code-based algorithm to examine cervical cancer screening in Toronto, Ontario's largest city. We demonstrated that women living in neighbourhoods with low socioeconomic status or high immigration had significantly lower screening rates than their counterparts, as did women who had first registered with the province's health plan in the preceding five years, approximately 80% of whom are expected to be new immigrants (77). However, as our algorithm was not validated, we could not be certain of its accuracy. It was also not known if similar results would be seen throughout Ontario.

Therefore, in this study, our objectives were two-fold. First, we aimed to develop a validated billing code-based algorithm for cervical cancer screening. Second, we aimed to use this algorithm to describe the association between appropriate cervical cancer screening (at least one Pap test in three years) in Ontario's urban centres and several sociodemographic variables. These variables included age, neighbourhood income, prenatal visits during the study period, and when a woman first registered with the province's universal health insurance plan, a proxy for immigrant status.

2.2 METHODS

2.2.1 Data Access

We accessed information about Ontario's population eligible for health services and women receiving Pap tests through a comprehensive research agreement with Ontario's Ministry of Health and Long-Term Care. All personal identifiers were removed from the analytic dataset, leaving only year of birth, date of registration with the health insurance plan, area of residence and a scrambled unique identifier. The research protocol was approved by Research Ethics Boards at the University of Toronto and Sunnybrook Health Sciences Centre in Toronto.

2.2.2 Data Sources

Several databases were accessed for this study: the 2001 Census, the Registered Persons Database (RPDB), the Ontario Physicians' Claims Database, the Ontario Cancer Registry (OCR), and the Canadian Institute of Health Information Discharge Abstract Database (CIHI-DAD). The RDPB is Ontario's health care registry, and includes by age, sex and address all Ontario residents who are eligible for health care coverage. To be eligible, residents must be Canadian citizens, landed immigrants or refugees; make their permanent and principal home in Ontario; and be physically present in Ontario at least 153 days in any 12-month period. In Ontario, health care coverage takes effect three months after the date of establishing residency for those not born in the province. The Ontario Physicians' Claims Database contains fee codes and corresponding diagnostic codes claimed by Ontario's physicians, and covers approximately 95% of physician claims in the province (78, 79). The OCR is a registry of all Ontario residents who have been newly diagnosed with, or have died of, cancer. The CIHI-DAD contains demographic, administrative and clinical data for inpatient hospital discharges. All available data from the Ministry of Health starts on or after April 1, 1988.

2.2.3 Study Population

To assemble our cohort, we used the RPDB to identify all women who were alive and continuously eligible for health coverage from January 1, 2003 to December 31, 2005; had their most recent postal code in a Census Metropolitan Area (CMA), i.e. a geographic area with an urban core whose population is at least 100 000, based on the 2001 Census; and were aged 25 to 69 for the entire three years. As 94% of Canada's new immigrants settle in a metropolitan area (80), the study was limited to CMAs to ensure comparison to an appropriate group with similar access to health care. The majority of Ontario's population (74%) lives in CMAs (81). The defined age group includes those who are appropriate for screening, and minimizes the number of immigrant women in the cohort who arrived in Canada as children and thus may be highly acculturated. The three-year study period concurs with the time frame laid out in provincial guidelines. A total of 2 700 337 women fit these inclusion criteria.

As Pap tests can be performed for both screening and diagnostic purposes, we excluded women where the index of suspicion for diagnostic tests was high i.e. those with any available history of gynaecological cancer in OCR records (14 558 women), or colposcopy in physicians' claims records (274 366 women). We also excluded women with a hysterectomy in CIHI-DAD records

(169 600 women). An end date of December 31, 2005, the last day of the study period, was chosen for all exclusions as multiple Pap tests occurring before the date of procedure or date of definitive diagnosis would likely have been performed for diagnostic purposes. Because of overlap of these three conditions, a total of 426 342 women were excluded; thus, the final cohort consisted of 2 273 995 women: 1 598 441 aged 25 to 49 years on January 1, 2003 and 675 554 aged 50 to 69 years. We stratified by these age groups as women of reproductive age may have more opportunity for screening during family planning visits.

2.2.4 Outcome Measure

After testing five different combinations of billing codes, we selected a billing code-based algorithm that consisted of all procedural codes that can be billed by the physician performing the Pap test and all laboratory codes that can be billed by the cytopathologist interpreting the Pap test. A woman was considered appropriately screened if at least one of the specified billing codes had been claimed for her in the three-year period. This algorithm had 99.5% sensitivity and 85.7% specificity (a detailed description of the validation of the algorithm appears in Appendix A).

2.2.5 Immigration Proxy Variable

It was not possible to determine if a woman was foreign-born in available databases for this particular study. Although immigration status is included in the Census, individual women cannot be identified from Census data. Therefore, we used date of registration with the health insurance plan as a proxy for date of immigration to Canada. Approximately 80% of the most recent registrants (those who registered within 5 years of the end of the study period), and over 70% of recent registrants (those who registered from 5-10 years prior to the end of the study period), were expected to be immigrants based on Census data (77, 82). The remaining new registrants were inter-provincial migrants, an unknown number of whom would also be immigrants. Women who had registered with the health plan more than 10 years prior were considered to be more distant immigrants or Canadian-born.

2.2.6 Statistical Analyses

As our outcome is relatively common, estimated adjusted odds ratios using logistic regression would not provide an accurate approximation of rate ratios. Therefore, we used multivariate Poisson regression (83) to determine the adjusted rate ratios for the association between appropriate screening and several variables of interest for the two age groups in our cohort, namely: when they first registered with the provincial health insurance plan (within 5 years vs. 5-10 years prior vs. more than 10 years prior); neighbourhood income quintile based on their most recent postal code and 2001 Census data (84); and, for the younger women, whether they had a major prenatal visit (an initial prenatal visit that involves a detailed history and physical, often including a Pap test) during the study period as determined from the Physicians' Claims database. As well, for all cohort members, the number of family physician visits, gynaecologist visits, and office visits with any type of physician during the study period were obtained from the Physicians' Claims database. General internists were not specified as they generally have referral and hospital practices in Ontario, and rarely provide ongoing primary care.

Ontario is divided into 14 health regions that are responsible for planning local health services, so we also compared screening rates in our study population for the newest health plan registrants versus long-term residents of the province by health region.

2.2.7 Sensitivity Analysis

Although hysterectomy data are expected to be fairly complete for women who are long-term residents of the province, it is not possible in this study to account for hysterectomies performed outside of Ontario. This lack of information could lead to selection bias, artificially increasing the number of eligible migrant women, and thus artificially decreasing the proportion that are appropriately screened. Although hysterectomy rates for Ontario are considered high (estimated prevalence of 16.3%) (85), there is little available data for most non-Western countries. Therefore, screening rates were determined by age group, by neighbourhood income quintile, and by when women first registered for health insurance, this time including all women with a history of hysterectomy in available data. Although this analysis included screening-ineligible women, the possibility of misclassification bias was greatly reduced.

The statistical package SAS 9.1 (SAS Institute, Cary, NC) was used for all data analyses. Forest plots were produced by a SAS macro created by Foster et al. (86).

2.3 RESULTS

Characteristics of the study population are summarized in Table 1. Of the women in our study population, 4.4% had first registered with the provincial health plan within five years of the end of the study period, and 9.0% had first registered within 5 to 10 years of the end of the study period. Newer registrants were disproportionately represented in the lowest neighbourhood income quintile and, among the younger age group, had higher rates of pregnancy than long-term residents during the study period.

Appropriate screening occurred for 61.1% of all women. Women 50 years and older had significantly lower rates of screening than their younger counterparts: 53.3% versus 64.4%; adjusted rate ratio (ARR) = 0.83 [95% CI 0.83-0.83]. Among the younger women, notable gaps in screening were observed for women without a prenatal visit during the study period (ARR=0.89 [95% CI 0.89-0.90] versus women with a prenatal visit), and for women who lived in the lowest-income areas (ARR=0.88 [95% CI 0.88-0.88] versus those living in the highest-income areas) (Figure 1). Among older women, appropriate screening was considerably lower among those who were new to the province (ARR=0.70 [95% CI 0.67-0.72]) versus long-term residents), and among women living in the lowest income quintile (ARR=0.81 [95% CI 0.80-0.81] versus women in the highest income quintile). Relationships were unchanged when the number of physician visits, a potential causal factor, was removed from the analysis (Figure 2).

Geographic variation in screening rates was found across health regions, especially for older women (Figure 3). The rates of screening for the newest health plan registrants compared with long-term residents varied widely across health regions, with the Central West region having the largest screening gaps in both age groups (RR=0.83 [95% CI 0.81-0.86 for women aged 25-49; RR=0.45 [95% CI=0.40-0.49] for women aged 50-66). One health region (North Simcoe Muskoka) was excluded due to small sample size.

Women in both age categories were stratified by both date of health plan registration and income quintile (Figure 4). Among all subgroups, a clear positive gradient in appropriate screening was seen as neighbourhood income increased, more marked for long-term residents of the province in both age groups. Among older women, long-term residents had substantially higher levels of screening compared with their migrant counterparts. The highest screening rate (70.5%) was observed for women in the younger age category, the highest income quintile, and who had been in Ontario the longest. This rate was more than double the screening rate seen for women in the older age category, the lowest income quintile, and who had been in Ontario the shortest amount of time (31.0%).

In our sensitivity analysis, when women with any available history of hysterectomy were included, all relationships remained the same, with only minimal changes in screening rates (Figure 5).

2.4 DISCUSSION

2.4.1 Summary of Findings

We have developed and validated a billing code algorithm to measure cervical cancer screening (Appendix A). This algorithm is highly sensitive (99.5%) and specific (85.7%) when compared with a gold-standard provincial registry. By including laboratory codes in our algorithm, we were able to capture Pap tests done at doctors' offices, as well as Pap tests performed at community health centres, at sexual health clinics, or by nurse practitioners. This outcome measure can be used with confidence by researchers in our setting, and it is likely that a similar outcome measure could be used with confidence by researchers in settings where a registry is not accessible, but where there is access to physician and laboratory claims.

To our knowledge, this is the first study to use a validated billing code algorithm to determine Pap test rates and inequities in screening. We have demonstrated a cervical cancer screening rate of 61.1% in Ontario's metropolitan areas, where the majority of the population resides and where geographic barriers to health care should not be a concern. This rate is substantially lower than would be expected with adherence to guidelines, and is also lower than the 80% to 90% coverage self-reported in national and provincial surveys (60, 75, 85, 87). This discrepancy is not surprising considering that self-report is subject to numerous biases, such as recall bias, social desirability bias, and misclassification bias (66, 88-92). Our rate is in keeping with that of the Ontario Women's Health Equity Report, which used the Pap test registry to determine that 69% of women aged 18-70 throughout the entire province had appropriate screening (93).

Despite adjustment for physician contact and pregnancy rates, screening inequities are especially pronounced among: women aged 50 to 69 years, a mostly post-menopausal group; women living in low-income areas; and women who had registered with the provincial health insurance plan within the preceding 10 years, a group consisting largely of recent immigrants.

We also found regional variation in cervical cancer screening rates in the province, with the Central West region having significantly lower rates than other regions. This finding may be related to its ethnic makeup, as over 25% of the population is of South Asian descent (94). South Asian women have previously been highlighted as vulnerable to inadequate cervical cancer screening (53, 57, 60, 95).

2.4.2 Comparison with Other Literature

Screening inequities based on age, income, and immigration status substantiate our previous findings for the city of Toronto (59), and are in keeping with previous studies that have used self-report on a national and provincial level (53, 54, 57, 60, 61, 70, 74-76). Immigrant women appear to be particularly vulnerable. Using results from national surveys, McDonald and Kennedy (60) reported a three-year cervical cancer screening rate of 80.5% among Canadian-born women versus 70.3% among foreign-born women. Woltman et al. (57) examined self-report of cervical screening in Canada's three largest metropolitan areas (Toronto, Montreal and Vancouver) and found that only 65.1% of women who had lived in Canada for 15 years or less reported a lifetime history of a Pap test versus 88.7% of native-born women and 87.6% of more distant immigrants. In a multivariate analysis, Blackwell et al. (54) found an odds ratio of 0.35 for immigrant women versus Canadian-born women for having a Pap test in the previous three years.

Our findings are particularly problematic because of high incidence of cervical cancer and low screening rates in many of the developing countries from which Ontario's newcomers emigrate (31, 33, 96, 97). Older women and women of the lowest income level have the worst screening rates in these source countries (33) and it is concerning to see these inequities persist after immigration to Canada. As Canada's immigration patterns are similar to global patterns (97, 98), similar findings would be expected for other developed countries with high levels of immigration.

2.4.3 Implications of Findings

Reasons for the screening gaps documented here and in other studies (53, 54, 57, 59-61, 74, 75) are not clear and are likely complex. However, they must be addressed: most women who are diagnosed with invasive cervical cancer have either been seldom or never screened (76, 99), an inverse relationship exists between exposure to screening and stage of disease at presentation (99), and most deaths due to cervical cancer occur in women over 50 years (100). The barriers to screening may stem from the patient, the patient's environment, the physician, or the structure of the health care system, and some combination of all four of these factors is most likely responsible.

Cultural beliefs may play a role as some cultures view the health system as a source of cure, not as a source of prevention (46). Women in difficult socioeconomic situations may not be able to afford the transportation or the childcare required to go to the doctor, and may therefore save visits for more urgent matters (46, 101). Older women may not realize the ongoing needs for Pap tests after menopause (102). Available resources at the neighbourhood level (including physicians), as well as influence of peers, may also affect access to health care (57, 101). Incongruence with physician gender or culture, as well as doctors not offering the test due to their own preconceptions or lack of time and resources, have all been put forward as potential causes for low screening rates (46, 102-104). Certainly physician recommendation increases the likelihood of screening (46, 104). Finally, ably navigating the health care system can be a near-impossible task for some women e.g. those who do not speak the local language or have low health literacy (46, 101, 103).

A cervical screening program that includes organized recruitment and recall and targeted patient and physician education may be an important source for closing screening gaps, and Ontario is moving towards this goal (61). Our results suggest that newly immigrated women commonly reside in low-income enclaves and that there is regional variation in screening rates among immigrants. Any strategy to reduce screening inequities may need to be targeted at not only the affected individuals and their physicians, but also the geographic areas in which they live. The immigrant composition of certain health regions may also be crucial to determine. Previous studies in Canada have highlighted women of South and East Asian origin as particularly at risk for inadequate screening (53, 57, 60, 95, 105). As well, making use of allied health staff who are able to perform Pap testing might ease the load on family physicians and gynaecologists. Finally, Ontario has recently undertaken primary care reform, with many physicians now receiving bonuses for performing screening manoeuvres such as the Pap test. It remains to be seen if these reforms will increase screening, and increase screening for all groups.

2.4.4 Study Limitations and Strengths

Our study has several limitations. First, we defined appropriate screening as at least one Pap test in a three-year time period. However, many women will require more frequent screening e.g. those whose physicians do not have a recall system (32). We could not account for individual screening needs in this study. Second, there are no data available on gynaecological cancers diagnosed outside of Ontario, and similarly, on hysterectomies performed before April 1, 1988; the number of women who were erroneously included might be sizeable. However, the provincial agency responsible for improving cancer services has estimated pre-1988 hysterectomy rates and found a higher overall cervical cancer screening rate at 70%, but similar age differences as those found in the current study (106). It is reasonable to believe the other inequities we observed would remain unchanged, especially as these inequities persisted when all women with hysterectomies were included. Third, we were unable to account for several potential confounders with available data, such as race/ethnicity and marital status. Fourth, not all new registrants are new immigrants. If we had been able to isolate foreign-born women, we would expect the screening inequity to be even larger than reported here. Finally, our algorithm cannot satisfactorily account for all Pap tests performed within a hospital setting. However, the analysis outlined in Appendix C, which showed that approximately 10% of family physicians and gynaecologists practice in or near the hospital setting, suggests that it is unlikely that our results would be significantly changed with inclusion of these tests.

Our study also has several strengths. With a sample size of over two million women, it has nearly full population coverage, allowing much greater precision than is possible with surveys. It uses a validated objective measure of appropriate cervical cancer screening; the type of algorithm used in these analyses may be applicable to other settings internationally. It stratifies women into age categories of clinical significance to avoid confounding based on reproductive status, and to unearth differences between the two groups. It identifies a group of mostly immigrant women and is able to identify both individual characteristics associated with low rates and specific geographic areas for targeting interventions. Finally, patterns of immigration to Ontario are similar to those in many developed countries and the findings of this study are likely applicable broadly.

2.5 CONCLUSIONS

Using a validated physician billing code algorithm for cervical cancer screening and a proxy for immigration, we have found that age, income and immigrant status all play significant roles in cervical cancer screening in Ontario’s metropolitan areas despite a universal health care system. Targeted interventions with particular focus on the immigrant composition of various health regions may be essential to closing the screening gap.

TABLE 1: Baseline characteristics of the 2 273 995 women in the study population who lived in Ontario's metropolitan areas for the study period January 1, 2003 - December 31, 2005

	Women aged 25-49 on January 1, 2003 (n=1 598 441)			**Women aged 50-66 on January 1, 2003 (n=675 554)**		
	Most Recent Registrants[a]	**Recent Registrants[b]**	**Long-Term Residents[c]**	**Most Recent Registrants[a]**	**Recent Registrants[b]**	**Long-Term Residents[c]**
Mean Age (SD)	34.3 (6.4)	35.6 (6.5)	37.6 (6.9)	57.2 (4.8)	56.9 (5.0)	57.0 (4.8)
Major Prenatal Visit During Study Period, No. (%)	13 525 (15.8)	22 073 (12.7)	106 516 (8.0)	≤5 (0.0)	≤5 (0.0)	96 (0.0)
Neighborhood Income Quintile, No. (%)						
Q1	26 941 (31.5)	45 936 (26.4)	229 402 (17.1)	3 388 (24.1)	7 535 (24.4)	99 429 (15.8)
Q2	19 027 (22.2)	36 246 (20.8)	256 626 (19.1)	3 024 (21.5)	6 544 (21.2)	118 604 (18.8)
Q3	15 095 (17.6)	32 438 (18.6)	272 890 (20.4)	2 706 (19.3)	5 960 (19.3)	125 924 (20.0)
Q4	12 249 (14.3)	31 075 (17.8)	284 193 (21.2)	2 699 (19.2)	5 618 (18.2)	129 154 (20.5)
Q5 (highest)	10 579 (12.4)	25 319 (14.5)	273 393 (20.4)	1 974 (14.1)	4 684 (15.2)	147 126 (23.3)
Total (%)	85 610 (100)	174 337 (100)	1 338 494 (100)	14 043 (100)	30 850 (100)	630 661 (100)

[a] Women who first registered with the provincial health insurance plan on or after January 1, 2001: within 5 years of the end of the study period

[b] Women who first registered with the provincial health insurance plan between January 1, 1996 and December 31, 2000: 5-10 before the end of the study period

[c] Women who first registered with the provincial health insurance plan before January 1, 1996: 10 years or more before the end of the study period

		25-49 YEARS
Health Plan Registration Status	**No. (%) screened**	**ARR [95% CI]**
Most Recent Registrants	52 641 (61.5)	0.95 [0.94-0.95]
Recent Registrants	105 230 (60.4)	0.93 [0.92-0.93]
Long-Term Residents	871 643 (65.1)	1.0
Prenatal Visit During Study Period	**No. (%) screened**	**ARR [95% CI]**
No	899 126 (61.7)	0.89 [0.89-0.90]
Yes	130 378 (91.7)	1.0
Neighborhood Income Quintile	**No. (%) screened**	**ARR [95% CI]**
Q1	170 199 (56.3)	0.88 [0.88-0.88]
Q2	190 530 (61.1)	0.96 [0.95-0.96]
Q3	209 766 (65.5)	1.02 [1.01-1.02]
Q4	226 825 (69.3)	1.07 [1.07-1.08]
Q5 (most advantaged)	215 525 (69.7)	1.0
		50-66 YEARS
Health Plan Registration Status	**No. (%) screened**	**ARR [95% CI]**
Most Recent Registrants	4 992 (35.6)	0.70 [0.67-0.72]
Recent Registrants	11 966 (38.8)	0.75 [0.74-0.76]
Long-Term Residents	343 405 (54.5)	1.0
Neighborhood Income Quintile	**No. (%) screened**	**ARR [95% CI]**
Q1	46 372 (42.0)	0..81 [0.80-0.81]
Q2	61 995 (48.4)	0.93 [0.93-0.94]
Q3	71 743(53.3)	1.02 [1.02-1.03]
Q4	79 136 (57.6)	1.10 [1.09-1.11]
Q5 (most advantaged)	95 361 (62.0)	1.0

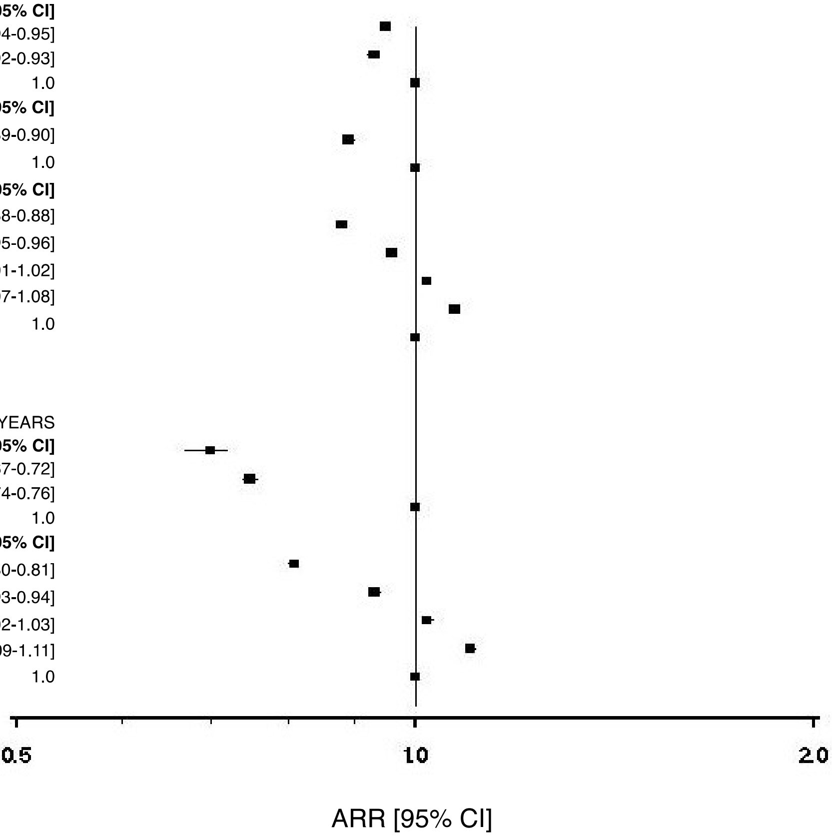


Figure 1. Cervical cancer screening rates and adjusted rate ratios (ARRs) [with 95% confidence intervals] using the most advantaged group as the referent group in Ontario's metropolitan areas, 2003-5: Adjusted for all other variables in the figure as well as for family physician visits, gynaecologist visits, and visits with any physician during the study period.

	25-49 YEARS
Health Plan Registration Status	**ARR [95% CI]**
Most Recent Registrants	0.94 [0.93-0.95]
Recent Registrants	0.93 [0.92-0.93]
Long-Term Residents	1.0
Prenatal Visit During Study Period	**ARR [95% CI]**
No	0.82 [0.81-0.82]
Yes	1.0
Neighbourhood Income Quintile	**ARR [95% CI]**
Q1	0.82 [0.81-0.82]
Q2	0.88 [0.88-0.89]
Q3	0.94 [0.94-0.95]
Q4	0.99 [0.99-1.00]
Q5 (most advantaged)	1.0
	50-66 YEARS
Health Plan Registration Status	**ARR [95% CI]**
Most Recent Registrants	0.68 [0.66-0.70]
Recent Registrants	0.73 [0.72-0.75]
Long-Term Residents	1.0
Neighbourhood Income Quintile	**ARR [95% CI]**
Q1	0.70 [0.69-0.71]
Q2	0.80 [0.79-0.80]
Q3	0.87 [0.86-0.88]
Q4	0.93 [0.93-0.95]
Q5 (most advantaged)	1.0

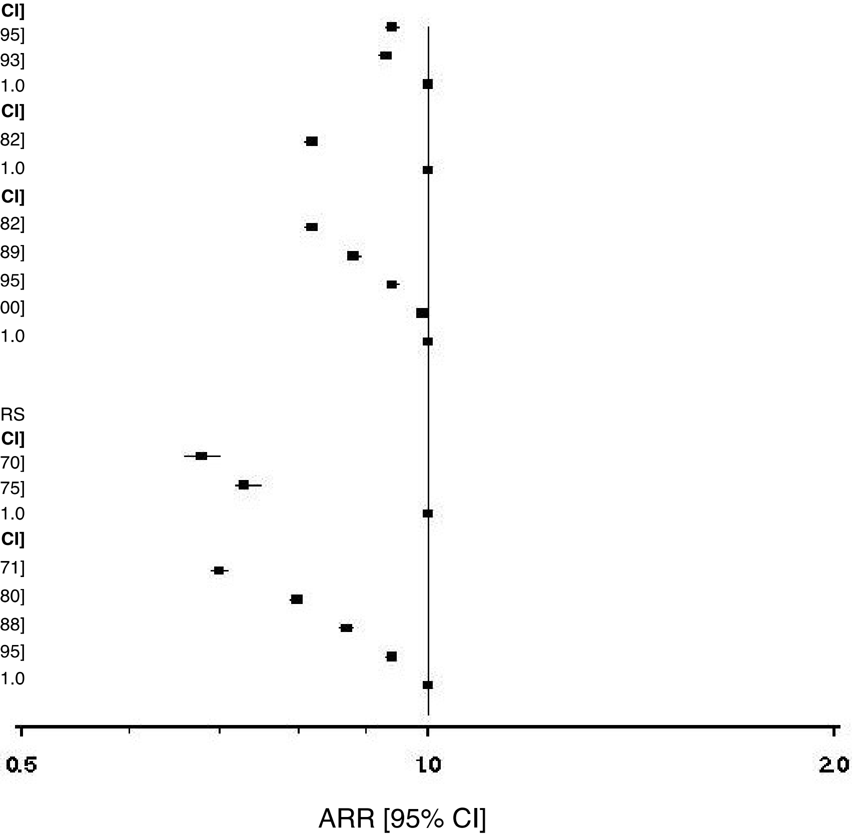


Figure 2. Cervical cancer screening rates and adjusted rate ratios (ARRs) [with 95% confidence intervals] using the most advantaged group as the referent group in Ontario's metropolitan areas, 2003-5: Adjusted for all other variables in the figure.

Local Health Integration Network	No. (%) screened	ARR [95% CI]
		25-49 YEARS
Erie St. Clair	33 094 (61.6)	0.90 [0.85-0.96]
South West	47 870 (65.1)	0.93 [0.88-0.99]
Waterloo Wellington	48 948 (66.3)	0.96 [0.91-1.01]
Hamilton Niagara Haldiman Brant	108 628 (64.8)	0.91 [0.87-0.94]
Central West	79 283 (64.5)	0.83 [0.81-0.86]
Mississauga Halton	122 534 (66.1)	0.91 [0.89-0.93]
Toronto Central	136 992 (60.0)	1.01 [0.99-1.03]
Central	179 523 (65.7)	0.97 [0.95-0.99]
Central East	126 367 (64.1)	0.98 [0.95-1.00]
South East	18 000 (65.7)	0.98 [0.90-1.07]
Champlain	100 695 (66.7)	1.00 [0.98-1.03]
North East	14 968 (63.3)	0.90 [0.76-1.08]
North West	12 249 (62.0)	0.91 [0.77-1.07]
Overall Cohort	*1 029 514(64.4)*	*0.95 [0.94-0.95]*
		50-66 YEARS
Erie St. Clair	10 746 (46.0)	0.67 [0.55-0.82]
South West	17 933 (52.4)	0.71 [0.58-0.86]
Waterloo Wellington	15 983 (53.1)	0.76 [0.65-0.90]
Hamilton Niagara Haldiman Brant	41 266 (49.2)	0.74 [0.65-0.83]
Central West	23 681 (50.1)	0.45 [0.40-0.49]
Mississauga Halton	41 510 (55.8)	0.67 [0.62-0.72]
Toronto Central	44 235 (50.6)	0.78 [0.72-0.84]
Central	64 330 (57.4)	0.71 [0.67-0.75]
Central East	43 103 (52.2)	0.71 [0.66-0.77]
South East	7 494 (56.1)	0.89 [0.70-1.12]
Champlain	38 719 (60.0)	0.82 [0.75-0.88]
North East	6 299 (50.3)	0.88 [0.54-1.43]
North West	4 905 (51.4)	0.88 [0.56-1.32]
Overall Cohort	*360 363 (53.3)*	*0.70 [0.67-0.72]*

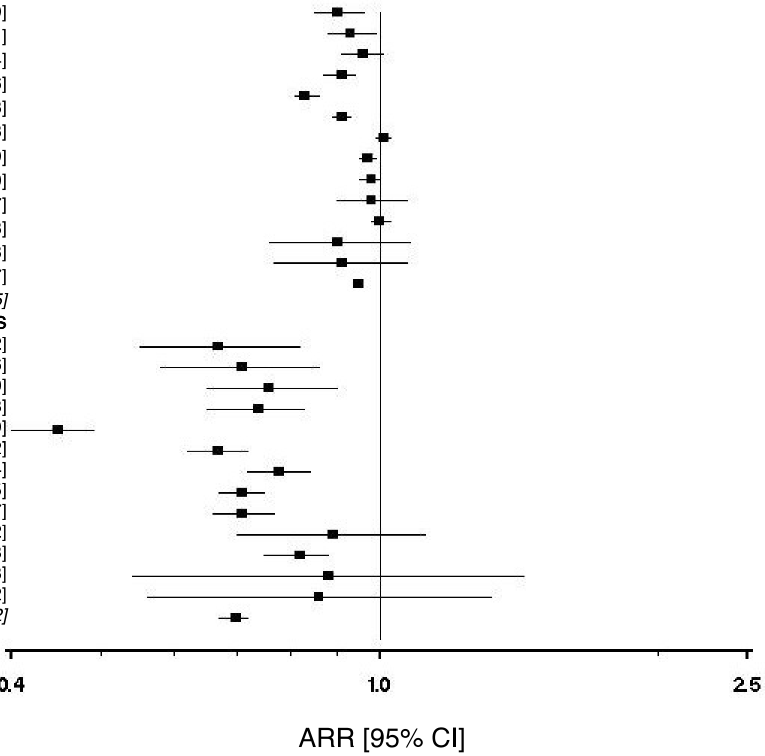


Figure 3. Cervical cancer screening rates and adjusted rate ratios (ARRs) [with 95% confidence intervals] for women who had first registered for the Ontario health care plan within the preceding 5 years versus women who had registered at least 10 years prior by health region, 2003-2005: Adjusted for age, neighbourhood income quintile, prenatal visits during the study period, as well as family physician visits, gynaecologist visits and visits with any physician during the study period.

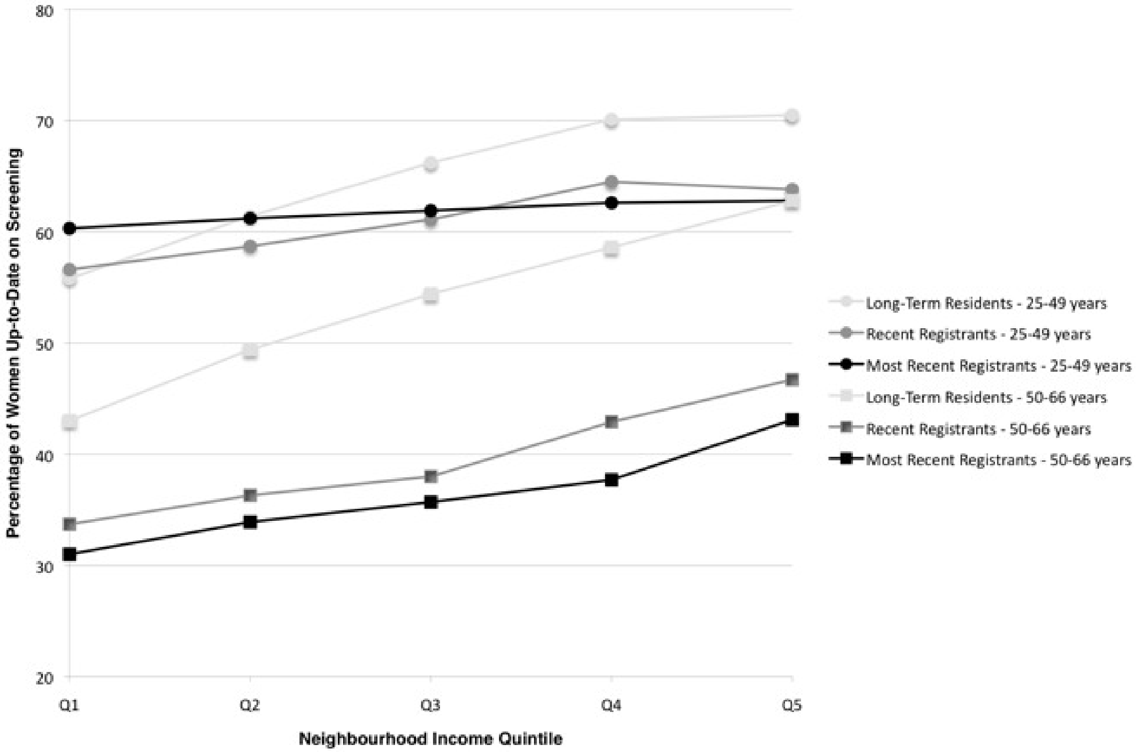


Figure 4. Appropriate cervical cancer screening by income, age, and health plan registration status in Ontario's metropolitan areas, 2003-2005.

		25-49 YEARS
Health Plan Registration Status	**No. (%) screened**	**ARR [95% CI]**
Most Recent Registrants	52 915 (61.5)	0.96 [0.95-0.96]
Recent Registrants	106 281 (60.3)	0.94 [0.93-0.95]
Long-Term Residents	871 643 (65.1)	1.0
Prenatal Visit During Study Period	**No. (%) screened**	**ARR [95% CI]**
No	927 624 (60.8)	0.89 [0.89-0.90]
Yes	130 596 (91.7)	1.0
Neighborhood Income Quintile	**No. (%) screened**	**ARR [95% CI]**
Q1	174 920 (55.5)	0.90 [0.89-0.90]
Q2	196 215 (60.1)	0.96 [0.96-0.97]
Q3	215 923 (64.4)	1.02 [1.01-1.02]
Q4	233 159 (68.2)	1.06 [1.06-1.07]
Q5 (most advantaged)	220 926 (68.8)	1.0

		50-66 YEARS
Health Plan Registration Status	**No. (%) screened**	**ARR [95% CI]**
Most Recent Registrants	5 056 (35.7)	0.73 [0.71-0.75]
Recent Registrants	12 177 (38.7)	0.78 [0.76-0.79]
Long-Term Residents	367 131 (52.3)	1.0
Neighborhood Income Quintile	**No. (%) screened**	**ARR [95% CI]**
Q1	49 454 (40.8)	0.83 [0.82-0.83]
Q2	66 139 (46.7)	0.94 [0.94-0.95]
Q3	76 661 (51.3)	1.02 [1.02-1.03]
Q4	84 572 (55.3)	1.08 [1.08-1.09]
Q5 (most advantaged)	101 388 (59.7)	1.0

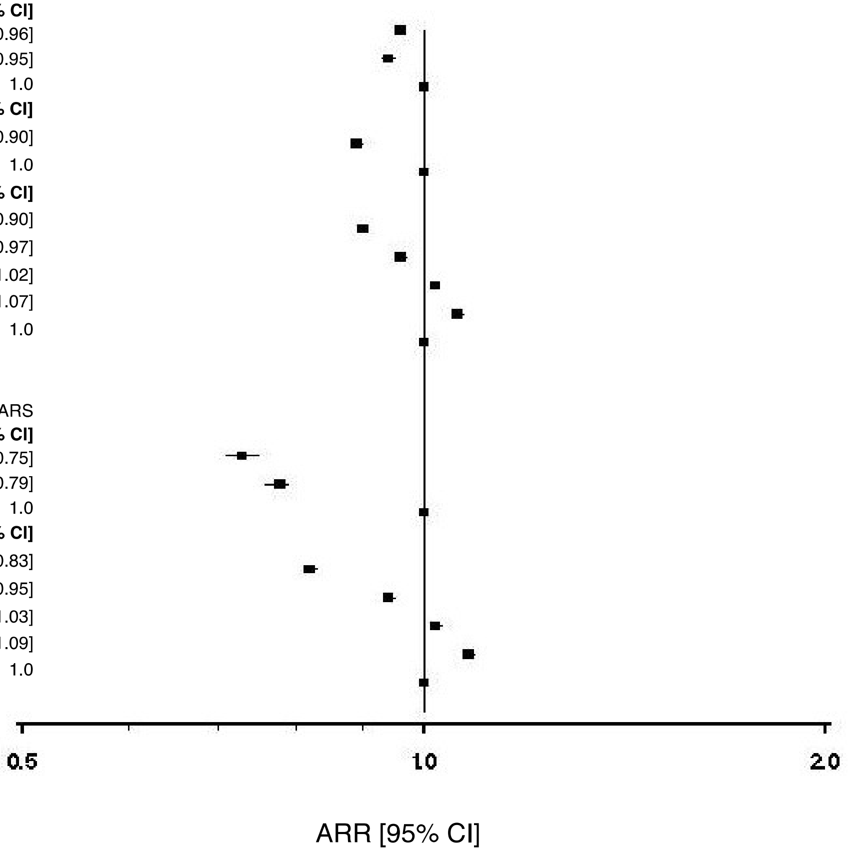


Figure 5. Cervical cancer screening rates and adjusted rate ratios (ARRs) [with 95% confidence intervals], including women with any available history of hysterectomy, using the most advantaged group as the referent group in Ontario's metropolitan areas, 2003-2005: Adjusted for all other variables in the figure as well as for family physician visits, gynaecologist visits and visits with any physician during the study period.

An abridged version of the following chapter has been previously published. The citation is: Lofters A, Hwang S, Moineddin R, Glazier RH. Cervical cancer screening among urban immigrants by region of origin: a population-based cohort study. Prev Med, 2010; 51(6): 509-16. Permission was received to publish in this dissertation.

CHAPTER 3

CERVICAL CANCER SCREENING AMONG URBAN IMMIGRANTS BY REGION OF ORIGIN: A POPULATION-BASED COHORT STUDY

ABSTRACT

Objective: We compared the prevalence of appropriate cervical cancer screening among screening-eligible immigrant women from major geographic regions of the world and native-born women.

Methods: We determined the proportion of women who were screened during the three-year period of 2006-2008 among 2.9 million screening-eligible women living in urban centres in Ontario, Canada. In multivariate analyses, we adjusted for numerous variables including age, neighbourhood-level income, and prenatal visits during the study period.

Results: 61.3% of women were up-to-date on cervical cancer screening. Screening rates were lowest among women from South Asia when compared to the referent group (Canadian-born women and immigrants who arrived before 1985) (adjusted rate ratio 0.81, 95% CI [0.80-0.82] among women aged 18-49 years, adjusted rate ratio 0.67 [0.65-0.69] among women aged 50-66 years). Of the older South Asian women living in the lowest-income neighbourhoods and not in a primary care enrolment model, 21.9% had been appropriately screened. In contrast, among Canadian-born women living in the highest-income neighbourhoods and in a primary care enrolment model, 79.0% had been appropriately screened.

Conclusion: Efforts to reduce cancer screening inequities should focus on women living in the lowest-income neighbourhoods and women from South Asia.

3.1 INTRODUCTION

Cervical cancer is the second most common cancer among women worldwide, with incidence rates almost twice as high in less developed than more developed countries (31). This difference in incidence rates is believed to be largely due to regular and widespread use of the Papanicolaou (Pap) test as a screening measure in more developed countries through either organized or opportunistic screening programs (31). The World Health Organization has estimated that 95% of women in less developed countries have never been screened, and therefore that screening just once every five to ten years can significantly reduce global cervical cancer mortality (107).

Although the Canadian province of Ontario has an opportunistic screening program and is moving toward an organized program, we have previously found that immigrant women in the Canadian province of Ontario have lower cervical cancer screening rates than would be expected with adherence to provincial and national guidelines, which recommend a Pap test at least once every three years (28, 32, 61, 108). They have significantly lower rates than their peers, suggesting that patterns of low screening often continue after immigration. Although Ontario has the highest proportion of immigrants in Canada, this finding is not unique to the province; similar inequities in cervical cancer screening for immigrant women have been found throughout Canada, as well as the US, Australia, the UK and parts of Europe (37, 57, 60, 109-112).

However, existing literature in this area has either focussed on particular ethnic groups or has looked at foreign-born women as a homogeneous group. In this study, we aimed to compare the prevalence of appropriate cervical cancer screening in Ontario among immigrant women from major geographic regions of the world and Canadian-born women.

3.2 METHODS

3.2.1. Data Access

We accessed information about Ontario's population eligible for health services and women receiving Pap tests through a comprehensive research agreement with Ontario's Ministry of Health and Long-Term Care. All available data from the Ministry of Health start on or after April 1, 1988. The research protocol was approved by Research Ethics Boards at the University of Toronto and Sunnybrook Health Sciences Centre in Toronto.

3.2.2. Data Sources

We accessed several databases for this study. The Landed Immigrant Data System (LIDS) contains detailed individual-level demographic information recorded on the date of issue of the landing visa for Ontario's permanent residents and spans landing dates from 1985 to 2000. The Registered Persons Database (RPDB) is Ontario's health care registry, and includes by age, sex and address all Ontario residents who are eligible for the province's single universal health care plan. To be eligible, residents must be Canadian citizens, permanent residents or refugees; make their permanent and principal home in Ontario; and be physically present in Ontario at least 153 days in any 12-month period. The Ontario Physicians' Claims Database contains fee codes and corresponding diagnostic codes claimed by Ontario's physicians, and covers approximately 95% of physician claims in the province. The Ontario Cancer Registry (OCR) registers all Ontario residents who have been newly diagnosed with cancer or who have died of cancer, and the Canadian Institute of Health Information Discharge Abstract Database (CIHI-DAD) contains demographic, administrative and clinical data for inpatient hospital discharges. The Client Agency Program Enrolment consists of all Ontario residents who are enrolled in a primary health care patient enrolment model, and the Corporate Physicians' Database documents which family physicians participate in these models. The Institute for Clinical Evaluative Sciences' Physicians' Database contains specialty and demographic information about physicians practising in Ontario. We also accessed the 2006 Canadian Census for denominators and postal codes. We linked these databases in an anonymous fashion using unique identifiers based on health card numbers. The LIDS was linked probabilistically, successfully linking 84.4% of those with Ontario as an intended destination.

3.2.3 Cohort Creation

We created a cohort that consisted of all women in Ontario who were alive and eligible for health coverage from January 1, 2006 to December 31, 2008, who ranged in age from 18 to 69 years for the entire three year study period, and whose most recent postal code was in a census metropolitan area (CMA) i.e. a geographic area with an urban core whose population is at least 100 000 based on the 2006 Census. We limited the study to CMAs because 94% of Canada's immigrants settle in a CMA, and 74% of the province's population live in a CMA (80, 113). Both the defined age group and the three-year study period are based on provincial and national guidelines (28, 32). A total of 3 519 492 women fit these initial inclusion criteria (Figure 1).

Because we wished to focus on Pap tests performed for screening and not diagnostic purposes, we excluded women where the index of suspicion for diagnostic tests was high due to an available history of gynaecological cancer in OCR records (16 294 women) or colposcopy in physicians' claims records (398 742 women). Because a woman who has had a total hysterectomy, and therefore has had her cervix removed, is no longer eligible for screening, we excluded women with any available history of total hysterectomy in CIHI-DAD records (252 082 women). The tracking code Q140A can be claimed by Ontario physicians who participate in primary care enrolment models for any enrolled female patient aged 35-70 years who is ineligible for cervical screening due to hysterectomy or other reasons. The majority of family physicians in Ontario participate in a primary care enrolment model (22). Therefore, 86 925 women who had a Q140A code claimed at least once in available records were also excluded. A total of 654 179 women were excluded due to overlap of reasons for exclusion. Thus the final cohort consisted of 2 865 313 women: 2 110 260 aged 18-49 years on January 1, 2006 and 755 053 aged 50-66 years. We stratified by these age categories as childbearing potential, number and frequency of sexual partners, and hysterectomies all may be influenced by age and may have a direct impact on the likelihood of screening.

3.2.4 Determination of Immigrant Status

We defined three groups of women based on immigrant status. First, LIDS was used to identify known immigrants in the cohort. However, available LIDS data exclude some immigrants, namely: i) those who declared they intended to move to another province but instead moved to Ontario; ii) the most recent immigrants who landed after 2000; and iii) those who could not be probabilistically linked to other databases. Therefore, a second group was created consisting of those women who were not in LIDS, yet who first registered with the province's universal health plan after relevant available data begins (April 1, 1993). This group, although including an unknown proportion of Canadian-born inter-provincial migrants, also includes many of the immigrant women who were not captured in LIDS. The third group for comparison consisted of all other women in the study cohort i.e. Canadian-born women and long-term immigrants who arrived before 1985.

Among the identified immigrants, LIDS was also used to determine country of birth. The countries were then grouped into regions based on a modification of the classification system used by the World Bank (114). (See Appendix E for both the original and modified classification systems.)

3.2.5 Outcome Definition

To determine if each woman in the cohort had been appropriately screened for cervical cancer, we used a previously validated billing code-based algorithm consisting of all procedural codes that can be billed by the physician performing the Pap test and all laboratory codes that can be billed by the cytopathologist interpreting the Pap test. A woman was considered appropriately screened if at least one of the specified billing codes had been claimed for her in the three-year study period. This algorithm has 99.5% sensitivity and 85.7% specificity (108).

3.2.6 Statistical Analysis

As our outcome is relatively common, estimated adjusted odds ratios using logistic regression would not provide an accurate approximation of adjusted rate ratios. Therefore, we used multivariate Poisson regression (83) to determine the association between appropriate screening and immigration status for women in the cohort. Rate ratios were adjusted for age as a continuous variable, neighbourhood income quintile derived from the Census and the most recent postal code, whether the woman lived in a small urban versus large urban setting based on her Rurality Index of Ontario score (115), and, for the younger age group, whether the woman had at least one major prenatal visit during the study period based on physician billings. Age and income have previously been associated with the likelihood of performing Pap tests in other Canadian jurisdictions, and Pap tests are considered a routing part of prenatal screening (59, 108, 116, 117). We used the Johns Hopkins Adjusted Clinical Groups Case-Mix System (118) to adjust for the presence of co-morbidities in the two years prior to the index date, which may affect the likelihood of screening. This system uses diagnostic information from administrative databases to describe and predict patients' use of health care resources. In this study, we used Resource Utilization Bands (RUBs), which range from 0 (lowest expected health care costs) to 5 (highest expected health care costs), to categorize patients based on their expected use of health care resources, and Aggregated Diagnosis Groups (ADGs), which range from 0 (no diagnosis group) to 32 (a maximum of 32 distinct diagnosis groups) to categorize the level of co-morbidity. This system has been validated for use in Canadian populations (119). We also adjusted for whether the woman was enrolled in a primary care enrolment model that provided financial incentives for cervical cancer screening as of July 1, 2007, the midpoint of the study period.

3.2.7 Secondary Analyses

We conducted several subgroup and sensitivity analyses to assess the robustness of our findings: Women who immigrated to Canada more recently are presumably less likely to be acculturated to Canadian society, and so may have a lower likelihood of screening than their counterparts who immigrated less recently. Accordingly, we conducted a subgroup analysis where the identified immigrants and the other recent registrants were subdivided into those who landed in Canada in the ten years after December 31, 1998 versus in the time period prior to that date.

Women between the ages of 18-24 years may represent a unique population regarding cervical cancer screening. There is evidence that screening is of little benefit in this youngest group (120), and it is possible that a number of women in this age category may not be sexually active. It is not known if immigrant women in this age category would be less likely to be sexually active than Canadian-born women. We therefore conducted a subgroup analysis to exclude this group by including only women aged 25-49 years on the first day of the study period.

Reporting a change of address to Ontario's Ministry of Health and Long-Term Care is voluntary. Some women included in our cohort may have moved out of the province without the address change being documented. As a result, we repeated the analysis, limiting it to those women who had any kind of contact with the health care system during 2006-2008 i.e. a physician office visit, hospitalization, emergency room visit, laboratory test, imaging procedure, or drug benefit claim.

Finally, although hysterectomy data are expected to be fairly complete for women who are long-term residents of the province, it is not possible in this study to account for hysterectomies performed outside of Ontario. This lack of information could lead to misclassification bias. Screening rates were therefore determined for the study population, this time including all women with a history of hysterectomy in available data. Although this sensitivity analysis included screening-ineligible women, the possibility of bias created by misclassification was greatly reduced.

3.3 RESULTS

Identified immigrants and other recent registrants were disproportionately represented among low-income neighbourhoods (Table 1). Among the group of identified immigrants, women from Latin America and the Caribbean and from Sub-Saharan Africa were most likely to live in low-income neighbourhoods (Table 2). Immigrant women from Western Europe and the USA, Australia and New Zealand were disproportionately represented among high-income neighbourhoods.

A total of 1 757 819 (61.3%) women were up-to-date on cervical cancer screening, with the women aged 50+ years having lower rates than the younger women: 56.6% vs. 63.0%, adjusted rate ratio (ARR) 0.83, 95% confidence interval 0.82-0.83. Across neighbourhood income quintiles, the group of Canadian-born and long-term immigrant women (“all others”) consistently had higher rates of appropriate screening than the other two comparison groups (Figure 2). Screening rates generally increased for all groups as income increased, with the increase being most pronounced among the referent group and least pronounced among the identified immigrants.

In our model, there was wide variation in adequate screening based on region of origin (Figure 3a, 3b). Among both age groups, the lowest ARRs were seen for women from South Asia and the Middle East and North Africa. Among immigrants, the highest ARRs in both age categories were seen for women from Latin America and the Caribbean, higher even than the referent group for the under-50 age category. Neighbourhood income was also independently associated with appropriate cervical cancer screening in the model. In both age groups, women in the lowest income quintiles experienced the greatest inequity. Women who were not in a primary care enrolment model were significantly less likely to be appropriately screened in both age groups than those who were enrolled (ARR 0.71 [0.71-0.72] for women aged 18-49 years, ARR 0.69 [0.68-0.69] for women aged 50-66 years). Women with 6-9ADGs were more likely than those with either fewer or more ADGs to be screened in both age groups. Similarly, women with an intermediate amount of expected health care utilization were most likely to be screened in our model (Figure 4a, 4b).

In our subgroup analysis based on years in the province, identified immigrants in Ontario for more than 10 years still had significantly lower ARRs than the referent group (ARR 0.89 [0.89-0.89] for women aged 18-49 years and 0.85 [0.84-0.86] for women aged 50-66 years). Similar findings were noted for the other recent registrants who had been in Ontario for more than 10 years: ARR 0.88 [0.88-0.89] for women aged 18-49 years, 0.86 [0.84-0.88] for women aged 50-66 years. In our subgroup analysis of women aged 25-49 years of age, results similar to the primary analysis but attenuated were observed (Figure 5).

When we limited our analysis to women who had some documented contact with the health care system during the study period, we observed similar but attenuated results to our primary analysis (Figure 6). Of note, in this analysis, screening rates of women from the USA, Australia and New Zealand were no longer significantly different from those of the referent group. Similar but attenuated results were also observed for the sensitivity analysis including women with hysterectomy (Figure 7).

Finally, we compared screening rates for the presumed most advantaged versus least advantaged women. Of the older South Asian women in our study population who were living in the lowest-income neighbourhoods and not enrolled in a primary care enrolment model, 21.9% had at least one Pap test in the study period. In contrast, among the younger Canadian-born and long-term immigrant women living in the highest-income neighbourhoods and enrolled in a primary care enrolment model, 79.0% had been appropriately screened.

3.4 DISCUSSION

3.4.1 Summary of Findings

Ontario's immigrant women are not being screened for cervical cancer at rates comparable to their peers. Screening inequities were most pronounced for women from South Asia, especially for those over 50 years of age. This finding is in the context of India currently being the major source country for Ontario's immigrants (112), and South Asians being one of the fastest growing minority groups in Canada (121). Women with an intermediate level of co-morbidity and health care use had higher screening rates than those with either a higher or lower level, suggesting that some degree of regular physician contact may be required for consistent screening, but also that too many competing interests at visits may decrease the likelihood of screening. Older age, living in low-income neighbourhoods, and not being enrolled in a primary care enrolment model were also independently associated with lower rates of screening. Interestingly, immigrant women were disproportionately represented among low-income women and women not enrolled in a primary care enrolment model.

3.4.2 Comparison with Other Literature

The inverse association we observed between age and cervical cancer screening is well documented in the literature (33, 54). The association between socioeconomic status and cervical cancer screening is also well documented in the literature, with high income being a protective factor for appropriate screening (93, 101, 117). Although high income was a protective factor in this study, it was less so for immigrant women, suggesting that other factors are more important for this group, likely including cultural differences. As well, all women in the cohort who were identified immigrants had been in the country for over five years at the beginning of the study period, and those who were in Canada for more than 10 years still had significant differences in screening rates, implying that a longer time spent in Canada does not eliminate these screening barriers. Similarly, although Woltman et al. (57) and McDonald & Kennedy (60) observed higher self-reported screening rates for immigrant women with longer time living in Canada, the rates never reached those of their native-born peers for many immigrant groups.

Other Canadian studies have highlighted South Asian women as vulnerable to inadequate cervical cancer screening (57, 60, 121), and we have previously found significant screening inequities in a health region with a known large South Asian population (108). Not surprisingly, screening rates in many South Asian countries are quite low, reaching as low as 1% in Bangladesh, even for those women of the highest income stratum (33). We also observed quite low screening rates among women from the Middle East and North Africa. Accordingly, low knowledge about the Pap test and low screening rates have been found in some Middle Eastern countries (122, 123). The U-shaped relationship that we observed between level of co-morbidity and appropriate screening, where having either too few or too many co-morbidities decreased screening, may help to explain conflicting findings in the literature about the impact that co-morbidities have on Pap test rates (124-126).

3.4.3 Study Strengths and Limitations

This study has several strengths. It is a large, population-based study with broad inclusion criteria, and to our knowledge is the first to simultaneously examine cervical cancer screening among women known to be immigrants at the provincial level, to distinguish immigrant women from major regions of the world, to use a previously validated outcome measure, and to examine the effects of primary care enrolment models and co-morbidities on sociodemographic inequities in cervical cancer screening. As well, we performed multiple subgroup and sensitivity analyses to confirm the robustness of our findings.

Our study also has several limitations. First, although we excluded women where there was any history of gynaecological cancer in available data, we cannot account for women who were diagnosed with one of these cancers outside of Ontario. Similarly, we excluded women where there was any evidence of a hysterectomy in available data, but we cannot identify out-of-province hysterectomies, which would be expected to more common among the immigrant women in the cohort. However, we also excluded women who had a Q140 code billed, which allows physicians in primary care enrolment models to flag those patients whom they have deemed ineligible for screening. All identified immigrants had been in Ontario for over five years by the first day of the study period, and on average, had been in the province for over 10 years, decreasing the likelihood of out-of-province cancer diagnoses and out-of-province hysterectomies. As well, we conducted a sensitivity analysis including all women with evidence of hysterectomies and found similar results. Second, those immigrant women who are not identified through LIDS, but arrived between 1985 and 1993, would be included in the referent group. Similarly, the referent group included immigrant women who arrived before 1985. However, the proportion of women this applies to should be relatively small and our results are likely not greatly affected. If we had been able to isolate Canadian-born women, we would expect the screening inequity to be larger than reported here. Third, identified immigrants were classified based on their country of birth, which may not always be reflective of their cultural origins. Fourth, we used an ecological-level variable i.e. neighbourhood income in our analysis, which might lead to ecological fallacy. However, use of area-level variables is common in health equity research, and can provide conservative estimates of scioceconomic effects (127). Fifth, our algorithm cannot satisfactorily account for all Pap tests performed within a hospital setting. However, the analysis outlined in Appendix C, which showed that approximately 10% of family physicians and gynaecologists practice in or near the hospital setting, suggests that it is unlikely that our results would be significantly different with inclusion of these tests. Finally, the applicability of these findings to other settings is not known, but Canada's immigration patterns are similar to global patterns (97, 98).

3.4.4. Implications of Findings

In this study, we have demonstrated significant cervical cancer screening inequities based on age, income, immigration status, and world region of origin. Screening differences also exist based on primary care enrolment models created from recent primary care reform, and based on co-morbidities and health care utilization. Primary care providers should consider the identified risk factors when seeing screening-eligible women in their practices, and when inspecting patient rosters for women overdue for screening. Our findings also highlight particular subgroups of women that policy makers may need to target in culturally appropriate public education campaigns. Development of such campaigns should be informed by further research on cultural barriers to screening, particularly in the South Asian and Middle Eastern and North African communities. Further research is also needed on other potential barriers to screening in our setting, such as provider gender and ethnicity (111) and lack of provider recommendation (123), and on the reasons for relatively high screening rates among women from Latin America and the Caribbean in our setting. International studies may also be informative to determine the generalizability of our findings. Such research could inform future interventional studies, targeted at both providers and screening-eligible women, with a goal of reducing screening gaps.

Table 1: Demographic characteristics of the 2 865 313 women in the study population who lived in Ontario's metropolitan areas for the study period January 1, 2006 - December 31, 2008

	Identified immigrants		**Other recent registrants**		**All others**	
	18-49 years	**50-66 years**	**18-49 years**	**50-66 years**	**18-49 years**	**50-66 years**
n	367 417	88 447	364 213	59 538	1 378 630	607 068
Mean age (SD)	35.1 (8.8)	56.2 (4.9)	33.3 (8.1)	56.5 (4.8)	34.2 (9.4)	57.1 (4.8)
Neighbourhood Income Quintile, No. (%)						
Q1	105 117 (28.6)	25 750 (29.1)	109 835 (30.2)	15 029 (25.2)	226 621 (16.4)	95 801 (15.8)
Q2	85 506 (23.3)	20 983 (23.7)	78 783 (21.6)	12 905 (21.7)	262 472 (19.0)	114 141 (18.8)
Q3	72 910 (19.8)	16 888 (19.1)	66 157 (18.2)	11 242 (18.9)	279 653 (20.3)	116 836 (19.3)
Q4	60 364 (16.4)	13 854 (15.7)	57 756 (15.9)	10 299 (16.8)	298 752 (21.7)	128 529 (21.2)
Q5 (highest)	42 951 (11.7)	10 864 (12.3)	50 900 (14.0)	9 975 (16.8)	308 740 (22.4)	150 795 (24.8)
No. (%) with at least one major prenatal visit during study period	26 979 (7.3)	n/a	45 844 (12.6)	n/a	106 114 (7.7)	n/a
No. (%) in a patient enrolment model	237 806 (64.7)	56 813 (64.2)	198 667 (54.6)	34 266 (57.6)	1 016 422 (73.7)	460 233 (75.8)
No. (%) living in large urban area	347 439 (94.6)	84 366 (95.4)	336 171 (92.3)	53 919 (90.6)	1 100 158 (79.9)	488 945 (80.7)
No. (%) in RUB category:						
0-1	83 178 (22.6)	18 167 (20.5)	95 600 (26.3)	13 836 (23.2)	246 514 (17.9)	76 598 (12.6)
2	52 648 (14.3)	8 717 (9.9)	60 207 (16.5)	7 629 (12.8)	238 644 (17.3)	71 934 (11.9)
3	165 913 (45.2)	49 236 (55.7)	135 608 (37.2)	31 043 (52.1)	666 111 (48.3)	358 413 (59.0)
4-5	65 678 (17.9)	12 327 (13.9)	72 798 (20.0)	7 030 (11.8)	227 361 (16.5)	100 123 (16.5)
No. (%) in ADG category:						
1-5	221 409 (60.3)	49 484 (56.0)	247 075 (67.8)	38 262 (64.3)	867 947 (63.0)	332 522 (54.8)
6-9	112 937 (30.7)	28 911 (32.7)	92 970 (25.5)	16 298 (27.4)	408 159 (29.6)	204 485 (33.7)
≥10	33 071 (9.0)	10 052 (11.4)	24 168 (6.6)	4 978 (8.4)	102 524 (7.4)	70 061 (11.5)

RUB = Resource Utilization Bands, which range from 0 (lowest expected health care costs) to 5 (highest expected health care costs), used to categorize patients based on their expected use of health care resources

ADG = Aggregated Diagnosis Groups, which range from 0 (no diagnosis group) to 32 (32 distinct diagnosis groups) used to measure the level of co-morbidity

Table 2: Demographic characteristics of the 455 864 women in the study population who were identified in the LIDS database as landed immigrants who lived in Ontario's metropolitan areas for the study period January 1, 2006 - December 31, 2008

	East Asia & Pacific		Eastern Europe & Central Asia		Latin America & Caribbean		Middle East & North Africa	
	18-49 years	**50-66 years**	**18-49 years**	**50-66 years**	**18-49 years**	**50-66 years**	**18-49 years**	**50-66 years**
n	101 178	27 787	53 550	14 295	56 788	13 396	28 076	5 573
Mean age (SD)	36.4 (8.6)	56.0 (4.8)	35.3 (9.2)	55.5 (4.6)	34.7 (8.9)	56.3 (4.8)	33.5 (9.2)	56.3 (5.0)
Neighbourhood Income Quintile, No. (%)								
Q1	24 720 (24.4)	7 035 (25.3)	13 152 (24.6)	4 439 (31.1)	20 055 (35.3)	5 297 (39.5)	7 625 (27.2)	1 420 (25.5)
Q2	25 314 (25.0)	7 073 (25.5)	10 212 (19.1)	2 924 (20.5)	14 350 (25.3)	3 346 (25.0)	5 368 (19.1)	1 034 (18.6)
Q3	20 457 (20.2)	5 405 (19.5)	10 814 (20.2)	2 589 (18.1)	11 316 (19.9)	2 352 (17.6)	5 413 (19.3)	1 098 (19.7)
Q4	17 681 (17.5)	4 516 (16.3)	11 586 (21.6)	2 629 (18.4)	7 048 (12.4)	1 470 (11.0)	5 426 (19.3)	1 111 (19.9)
Q5 (highest)	12 835 (12.7)	3 721 (13.4)	7 732 (14.4)	1 702 (11.9)	3 929 (6.9)	912 (6.8)	4 201 (15.0)	904 (16.2)
No. (%) with at least one major prenatal visit during study period	5 732 (5.7)	n/a	3 577 (6.7)	n/a	4 609 (8.1)	n/a	1 903 (6.8)	n/a
No. (%) in a patient enrolment model	63 070 (62.4)	17 537 (63.1)	33 343 (62.3)	8 598 (60.1)	38 682 (68.1)	8 935 (66.7)	17 662 (62.9)	3 573 (64.1)
No. (%) living in large urban area	97 336 (96.2)	27 069 (97.5)	49 479 (92.4)	13 509 (94.5)	54 054 (95.2)	12 921 (96.5)	26 640 94.9)	5 331 (95.7)
No. (%) in RUB category:								
0-1	27 937 (27.6)	6 503 (23.4)	10 775 (20.1)	2 593 (18.1)	9 080 (16.0)	1 887 (14.1)	6 936 (24.7)	1 234 (22.1)
2	16 249 (16.1)	3 102 (11.2)	9 112 (17.0)	1 731 (12.1)	7 360 (13.0)	1 079 (8.1)	3 500 (12.5)	446 (8.0)
3	42 836 (42.3)	15 100 (54.3)	25 724 (48.0)	8 019 (56.1)	28 696 (50.5)	8 086 (60.4)	12 299 (43.8)	2 871 (51.5)
4-5	14 156 (14.0)	3 082 (11.1)	7 939 (14.8)	1 952 (13.7)	11 652 (20.5)	2 344 (17.5)	5 341 (19.0)	1 022 (18.3)
No. (%) in ADG category:								
1-5	67 292 (66.5)	16 488 (59.3)	34 122 (63.7)	8 368 (58.5)	30 578 (53.9)	6 559 (49.0)	16 154 (57.5)	2 855 (51.2)
6-9	27 356 (27.0)	8 570 (30.8)	15 955 (29.8)	4 518 (31.6)	20 008 (35.2)	4 901 (35.6)	8 699 (31.0)	1 828 (32.8)
≥10	6 530 (6.5)	2 729 (9.8)	3 473 (6.5)	1 409 (9.9)	6 202 (10.9)	1 936 (14.5)	3 223 (11.5)	890 (16.0)
Mean no. of years in Canada (SD)	12.0 (3.9)	13.3 (3.7)	12.0 (4.0)	13.4 (4.0)	13.6 (4.1)	14.5 (4.1)	11.7 (3.9)	12.8 (4.0)

RUB = Resource Utilization Bands, which range from 0 (lowest expected health care costs) to 5 (highest expected health care costs), used to categorize patients based on their expected use of health care resources

ADG = Aggregated Diagnosis Groups, which range from 0 (no diagnosis group) to 32 (32 distinct diagnosis groups) used to measure the level of co-morbidity

Table 2. cont.

	South Asia		**Sub-Saharan Africa**		**USA, Australia & New Zealand**		**Western Europe**	
	18-49 years	**50-66 years**	**18-49 years**	**50-66 years**	**18-49 years**	**50-66 years**	**18-49 years**	**50-66 years**
n	71 469	16 638	22 805	3 320	7 946	2 057	24 978	5 189
Mean age (SD)	34.2 (8.1)	57.2 (5.0)	34.4 (8.7)	55.8 (4.8)	35.5 (9.2)	55.8 (4.6)	35.0 (8.9)	56.1 (4.7)
Neighbourhood Income Quintile, No. (%)								
Q1	22 833 (32.0)	5 045 (30.3)	10 663 (46.8)	1 245 (37.5)	1 187 (14.9)	252 (12.3)	4 764 (19.1)	966 (18.6)
Q2	18 782 (26.3)	4 499 (27.0)	4 411 (19.3)	631 (19.0)	1 313 (16.5)	278 (13.5)	5 634 (22.6)	1 154 (22.2)
Q3	15 349 (21.5)	3 689 (22.2)	3 100 (13.6)	529 (15.9)	1 388 (17.5)	304 (14.8)	4 925 (19.7)	882 (17.0)
Q4	9 608 (13.4)	2 245 (13.5)	2 509 (11.0)	476 (14.3)	1 565 (19.7)	383 (18.6)	4 802 (19.2)	998 (19.2)
Q5 (highest)	4 822 (6.8)	1 142 (6.9)	2 046 (9.0)	432 (13.0)	2 476 (31.2)	835 (40.6)	4 812 (19.3)	1 185 (22.8)
No. (%) with at least one major prenatal visit during study period	7 309 (10.2)	n/a	1 998 (8.8)	n/a	321 (4.0)	n/a	1 505 (6.0)	n/a
No. (%) in a patient enrolment model	51 223 (71.7)	11 999 (72.1)	14 506 (63.6)	2 175 (65.5)	4 116 (51.8)	980 (47.6)	14 817 (59.3)	2 893 (55.7)
No. (%) living in large urban area	69 088 (96.7)	16 102 (96.8)	22 030 (96.6)	3 191 (96.2)	6 501 (81.9)	1 626 (79.3)	21 705 (87.0)	4 437 (85.6)
No. (%) in RUB category:								
0-1	11 361 (15.9)	2 474 (14.9)	4 898 (21.5)	693 (20.9)	3 578 (45.0)	1 014 (49.3)	8 418 (33.7)	1 720 (33.2)
2	9 026 (12.6)	1 393 (8.4)	2 802 (12.3)	246 (7.4)	1 025 (12.9)	185 (9.0)	3 473 (13.9)	516 (9.9)
3	33 921 (47.5)	10 199 (61.3)	9 950 (43.6)	1 841 (55.5)	2 490 (31.3)	664 (32.3)	9 756 (39.1)	2 362 (45.5)
4-5	17 161 (24.0)	2 572 (15.5)	5 155 (22.6)	540 (16.3)	853 (10.7)	194 (9.4)	3 331 (13.3)	591 (11.4)
No. (%) in ADG category:								
1-5	36 473 (51.0)	8 372 (50.3)	12 674 (55.6)	1 752 (52.8)	6 083 (76.6)	1 547 (75.2)	17 611 (70.5)	3 435 (66.2)
6-9	25 870 (36.2)	6 165 (37.1)	7 415 (32.5)	1 127 (34.0)	1 520 (19.1)	382 (18.6)	5 945 (23.8)	1 355 (26.1)
≥10	9 126 (12.8)	2 101 (12.6)	2 716 (11.9)	441 (13.3)	343 (4.3)	128 (6.2)	1 422 (5.7)	399 (7.7)
Mean no. of years in Canada (SD)	10.9 (3.8)	11.6 (3.8)	12.2 (3.8)	13.5 (4.1)	14.8 (3.9)	15.8 (3.7)	13.6 (4.4)	14.9 (4.3)

RUB = Resource Utilization Bands, which range from 0 (lowest expected health care costs) to 5 (highest expected health care costs), used to categorize patients based on their expected use of health care resources
ADG = Aggregated Diagnosis Groups, which range from 0 (no diagnosis group) to 32 (32 distinct diagnosis groups) used to measure the level of co-morbidity

Figure 1. Flowchart of exclusions and final study cohort in Ontario's metropolitan areas, 2006-2008.

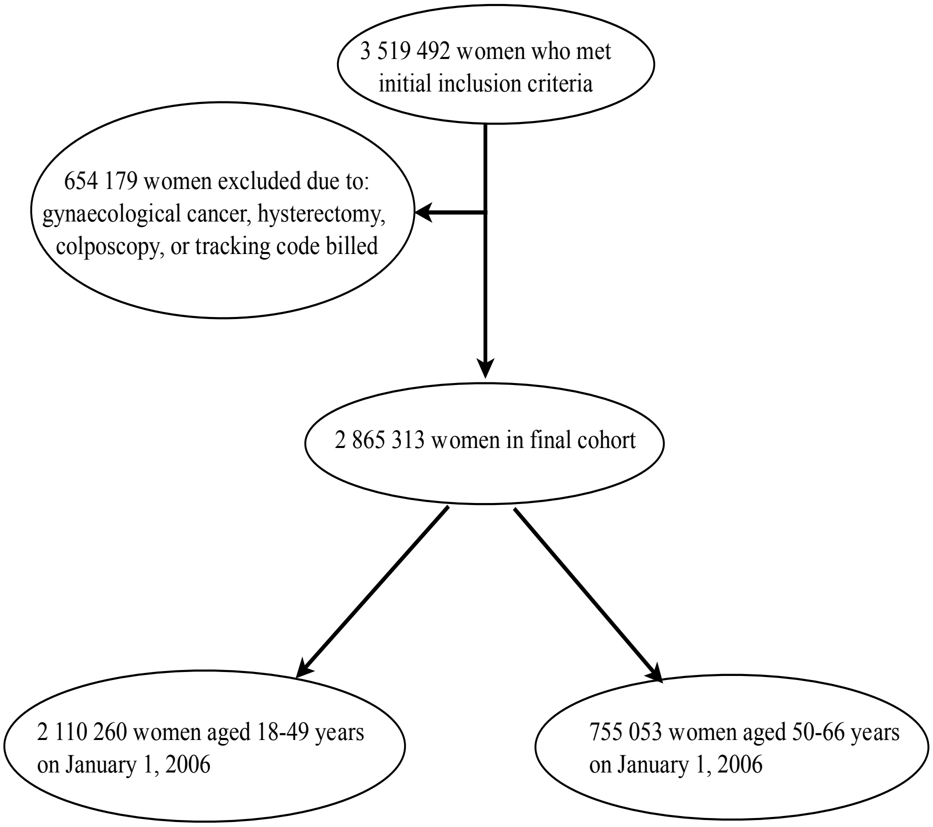
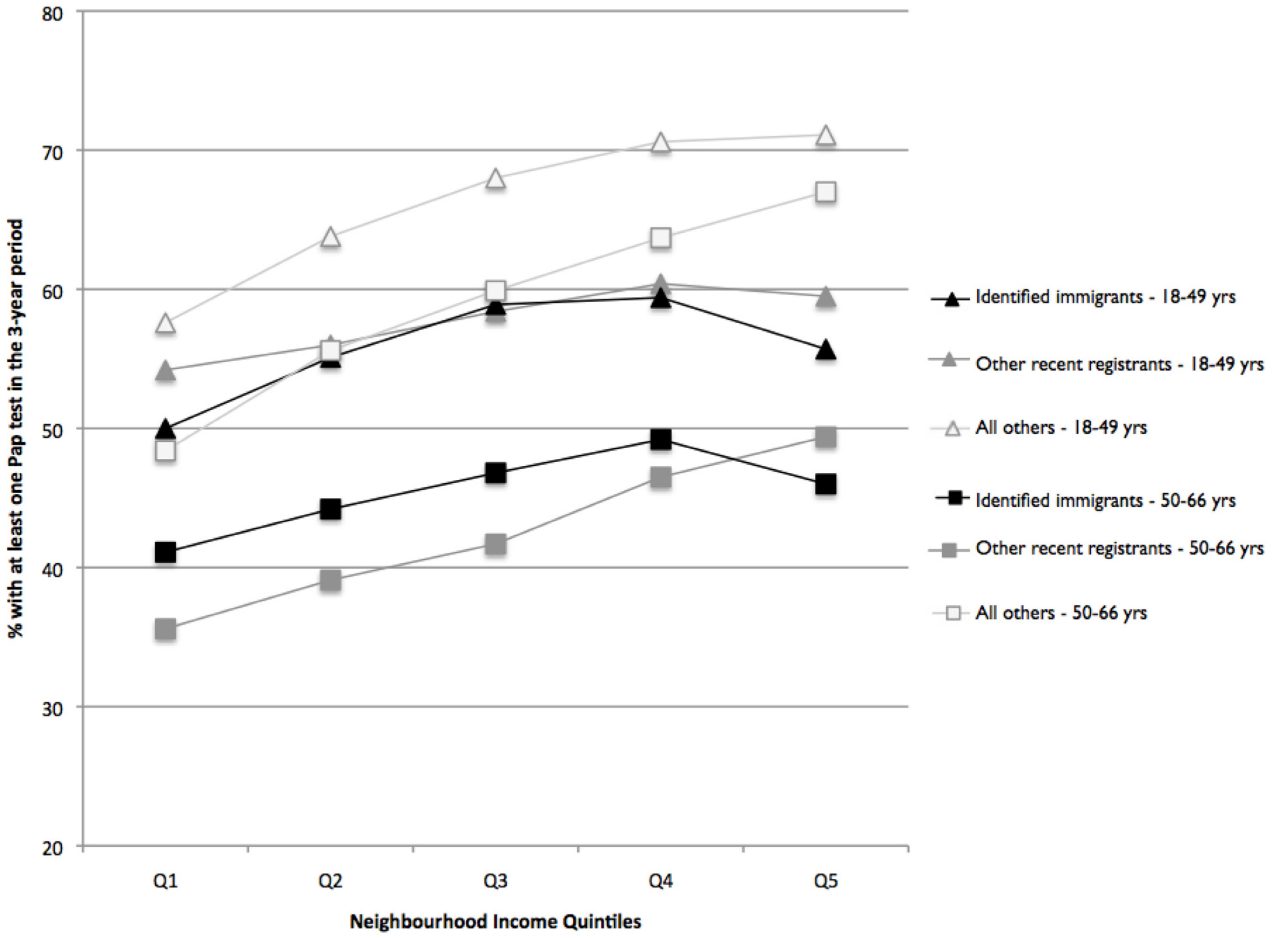
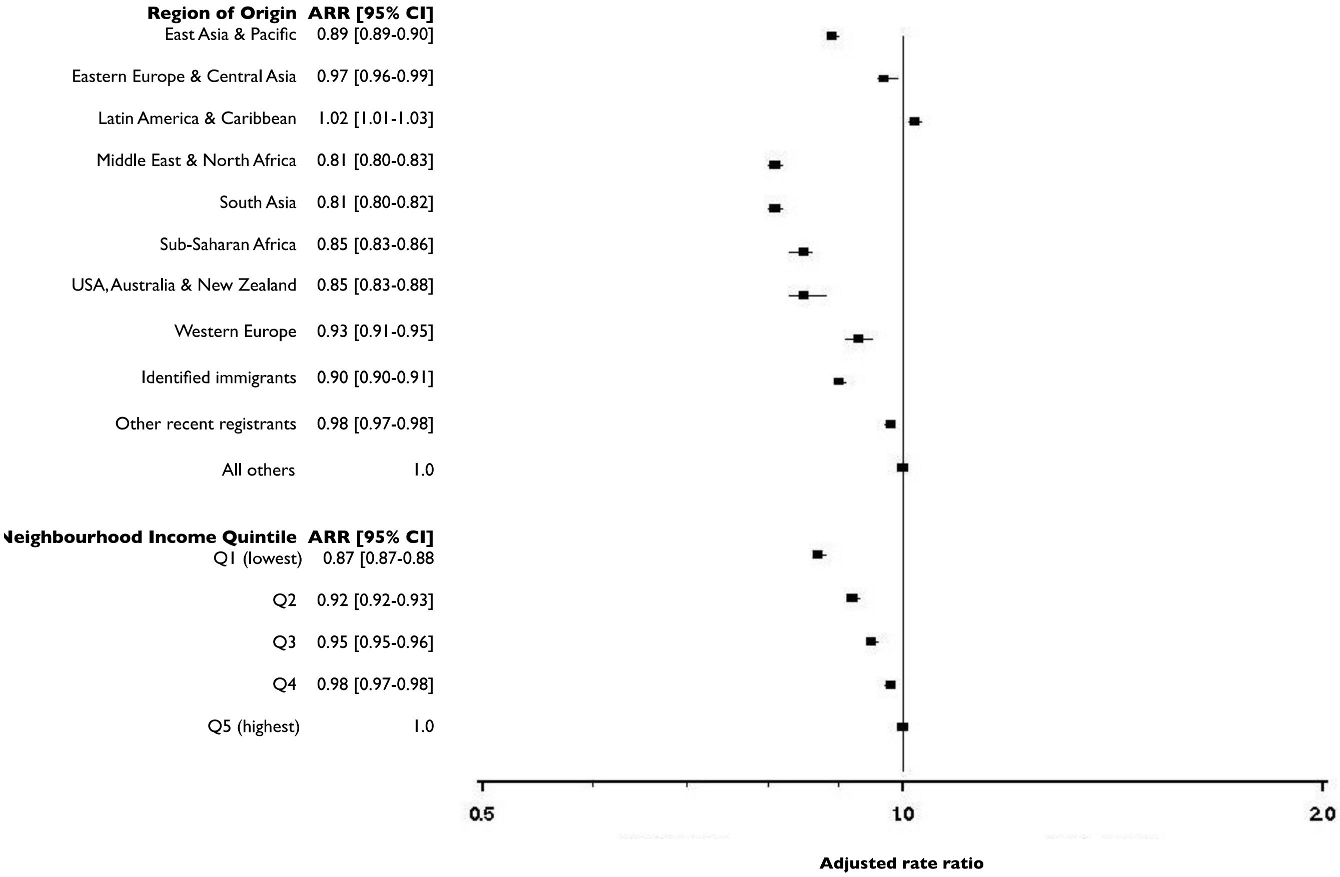


Figure 2. Appropriate cervical cancer screening by age, immigration status and neighbourhood income quintile in Ontario's metropolitan areas, 2006-2008.

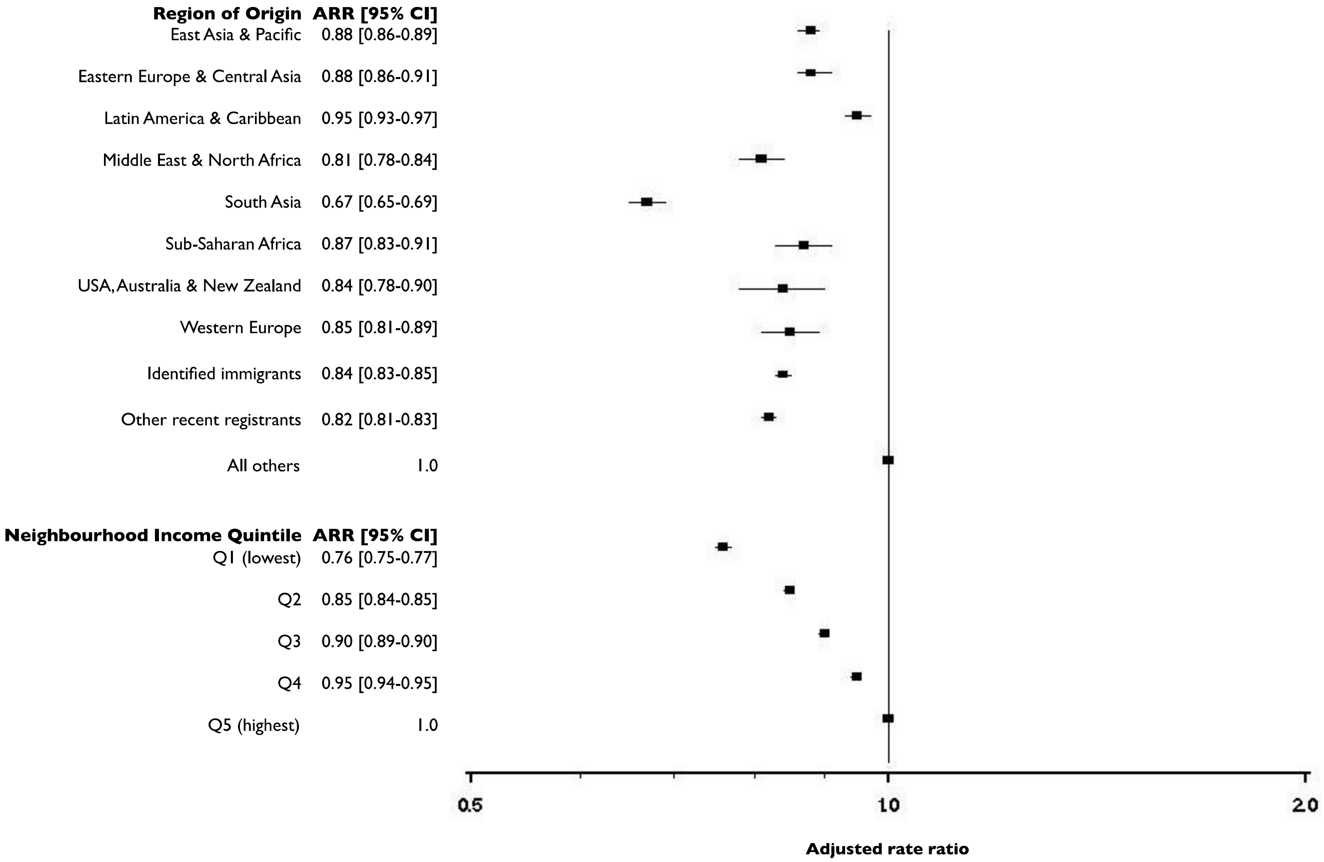




Region of Origin	ARR [95% CI]
East Asia & Pacific	0.89 [0.89-0.90]
Eastern Europe & Central Asia	0.97 [0.96-0.99]
Latin America & Caribbean	1.02 [1.01-1.03]
Middle East & North Africa	0.81 [0.80-0.83]
South Asia	0.81 [0.80-0.82]
Sub-Saharan Africa	0.85 [0.83-0.86]
USA, Australia & New Zealand	0.85 [0.83-0.88]
Western Europe	0.93 [0.91-0.95]
Identified immigrants	0.90 [0.90-0.91]
Other recent registrants	0.98 [0.97-0.98]
All others	1.0

Neighbourhood Income Quintile	ARR [95% CI]
Q1 (lowest)	0.87 [0.87-0.88
Q2	0.92 [0.92-0.93]
Q3	0.95 [0.95-0.96]
Q4	0.98 [0.97-0.98]
Q5 (highest)	1.0

Figure 3a. Adjusted rate ratios (ARRs) with 95% confidence intervals for appropriate cervical cancer screening for women aged 18-49 years on January 1, 2006 in Ontario's metropolitan areas. Model includes region of origin, neighbourhood income quintile, patient enrolment model, prenatal visit during study period, Rurality Index of Ontario score, Aggregate Diagnosis Group, Resource Utilization Band, and age. Referent group for each category demarcated by an ARR of 1.0.



Region of Origin	ARR [95% CI]
East Asia & Pacific	0.88 [0.86-0.89]
Eastern Europe & Central Asia	0.88 [0.86-0.91]
Latin America & Caribbean	0.95 [0.93-0.97]
Middle East & North Africa	0.81 [0.78-0.84]
South Asia	0.67 [0.65-0.69]
Sub-Saharan Africa	0.87 [0.83-0.91]
USA, Australia & New Zealand	0.84 [0.78-0.90]
Western Europe	0.85 [0.81-0.89]
Identified immigrants	0.84 [0.83-0.85]
Other recent registrants	0.82 [0.81-0.83]
All others	1.0

Neighbourhood Income Quintile	ARR [95% CI]
Q1 (lowest)	0.76 [0.75-0.77]
Q2	0.85 [0.84-0.85]
Q3	0.90 [0.89-0.90]
Q4	0.95 [0.94-0.95]
Q5 (highest)	1.0

Figure 3b.Adjusted rate ratios (ARRs) with 95% confidence intervals for appropriate cervical cancer screening for women aged 50-66 years on January 1, 2006 in Ontario's metropolitan areas. Model includes region of origin, neighbourhood income quintile, patient enrolment model, Rurality Index of Ontario score, Aggregate Diagnosis Group, Resource Utilization Band, and age. Referent group for each category demarcated by an ARR of 1.0.

ADG	ARR [95% CI]
1-5	0.92 [0.92-0.92]
6-9	1.02 [1.02-1.03]
≥10	1.0

RUB	ARR [95% CI]
0-1	0.57 [0.57-0.58]
2	1.16 [1.16-1.17]
3	1.24 [1.24-1.24]
4-5	1.0

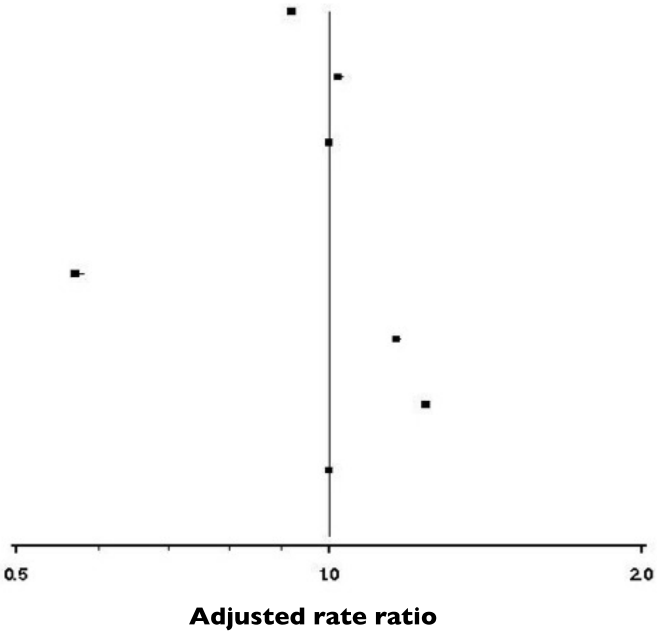


Figure 4a. Adjusted rate ratios (ARRs) with 95% confidence intervals for appropriate cervical cancer screening for women aged 18-49 years on January 1, 2006 in Ontario's metropolitan areas. Model includes region of origin, neighbourhood income quintile, patient enrolment model, prenatal visit during study period, Rurality Index of Ontario score, Aggregate Diagnosis Group, Resource Utilization Band, and age. Referent group for each category demarcated by an ARR of 1.0.

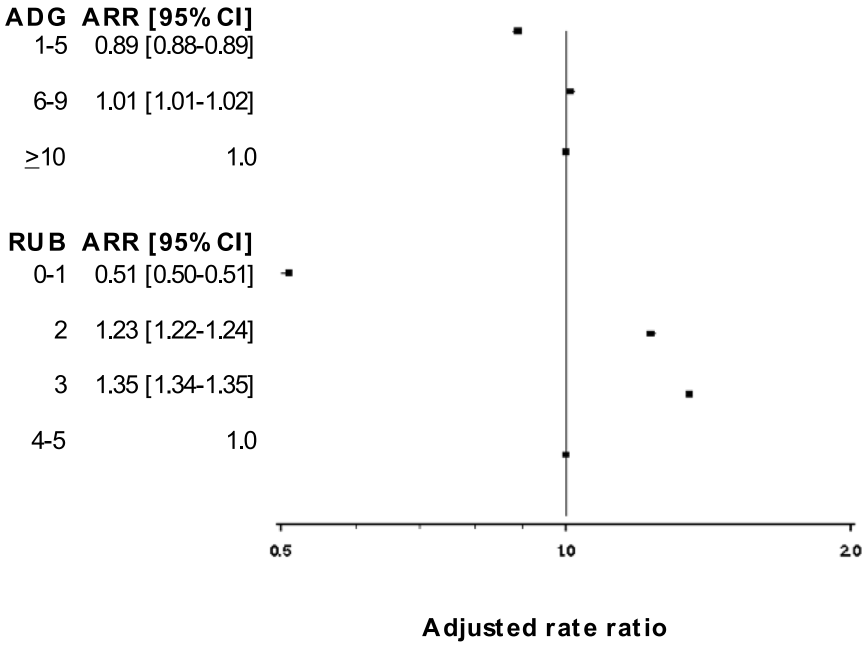
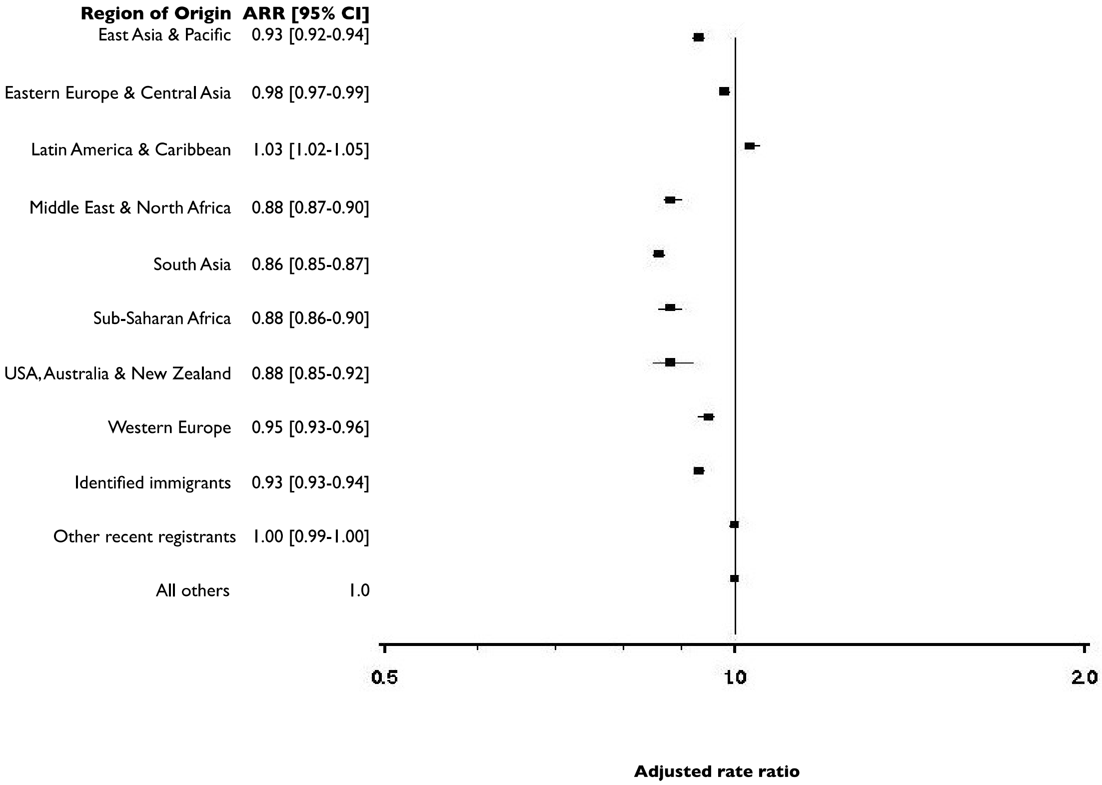


Figure 4b. Adjusted rate ratios (ARRs) with 95% confidence intervals for appropriate cervical cancer screening for women aged 50-66 years on January 1, 2006 in Ontario's metropolitan areas. Model includes region of origin, neighbourhood income quintile, patient enrolment model, Rurality Index of Ontario score, Aggregate Diagnosis Groups (ADG), Resource Utilization Band (RUB), and age. Referent group for each category demarcated by an ARR of 1.0.



Region of Origin	ARR [95% CI]
East Asia & Pacific	0.93 [0.92-0.94]
Eastern Europe & Central Asia	0.98 [0.97-0.99]
Latin America & Caribbean	1.03 [1.02-1.05]
Middle East & North Africa	0.88 [0.87-0.90]
South Asia	0.86 [0.85-0.87]
Sub-Saharan Africa	0.88 [0.86-0.90]
USA, Australia & New Zealand	0.88 [0.85-0.92]
Western Europe	0.95 [0.93-0.96]
Identified immigrants	0.93 [0.93-0.94]
Other recent registrants	1.00 [0.99-1.00]
All others	1.0

Figure 5. Adjusted rate ratios (ARRs) with 95% confidence intervals for appropriate cervical cancer screening, limiting to women aged 25-49 years on January 1, 2006 in Ontario's metropolitan areas. Model includes region of origin, neighbourhood income quintile, patient enrolment model, prenatal visit during study period, Rurality Index of Ontario score, Aggregate Diagnosis Group, Resource Utilization Band, and age. Referent group for each category demarcated by an ARR of 1.0.

Region of Origin	ARR [95% CI]
	18-49 YEARS
East Asia & Pacific	0.93 [0.92-0.93]
Eastern Europe & Central Asia	0.94 [0.93-0.94]
Latin America & Caribbean	1.02 [1.01-1.03]
Middle East & North Africa	0.85 [0.83-0.86]
South Asia	0.83 [0.82-0.84]
Sub-Saharan Africa	0.87 [0.85-0.88]
USA, Australia & New Zealand	0.98 [0.95-1.02]
Western Europe	0.99 [0.97-1.01]
Identified immigrants	0.93 [0.92-0.93]
Other recent registrants	0.97 [0.96-0.97]
All others	1.0

Region of Origin	ARR [95% CI]
	50-66 YEARS
East Asia & Pacific	0.91 [0.90-0.93]
Eastern Europe & Central Asia	0.89 [0.87-0.91]
Latin America & Caribbean	0.96 [0.94-0.98]
Middle East & North Africa	0.84 [0.81-0.87]
South Asia	0.68 [0.67-0.70]
Sub-Saharan Africa	0.89 [0.85-0.94]
USA, Australia & New Zealand	0.98 [0.91-1.05]
Western Europe	0.90 [0.87-0.94]
Identified immigrants	0.87 [0.86-0.88]
Other recent registrants	0.84 [0.83-0.85]
All others	1.0

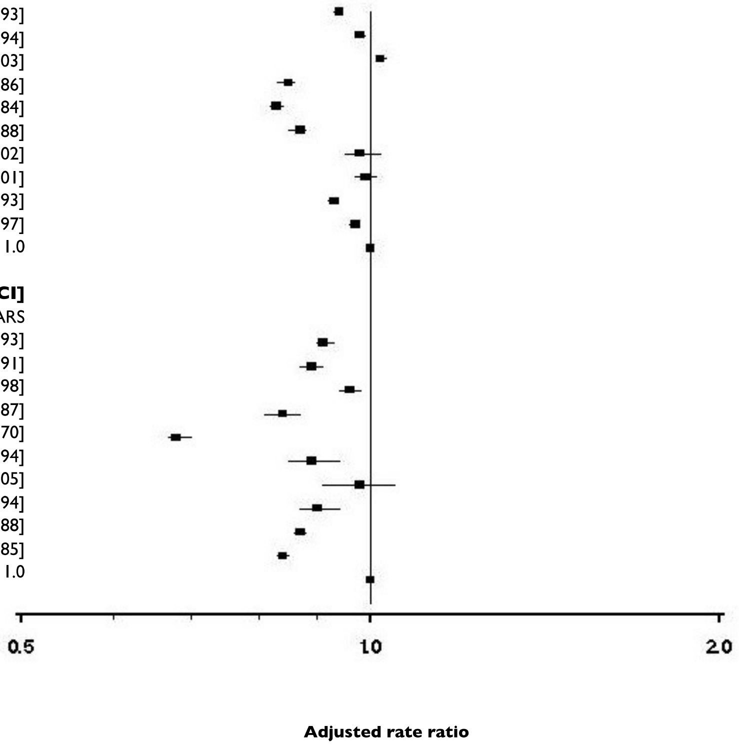


Figure 6. Adjusted rate ratios (ARRs) with 95% confidence intervals for appropriate cervical cancer screening, limiting to women who had at least one contact with the health care system during the study period. Model includes region of origin, neighbourhood income quintile, patient enrolment model, prenatal visit during study period, Rurality Index of Ontario score, Aggregate Diagnosis Group, Resource Utilization Band, and age. Referent group for each category demarcated by an ARR of 1.0.

Region of Origin	**ARR [95% CI]**
	18-49 YEARS
East Asia & Pacific	0.91 [0.91-0.92]
Eastern Europe & Central Asia	0.99 [0.98-1.00]
Latin America & Caribbean	1.03 [1.02-1.04]
Middle East & North Africa	0.83 [0.81-0.84]
South Asia	0.82 [0.82-0.83]
Sub-Saharan Africa	0.87 [0.85-0.88]
USA, Australia & New Zealand	0.86 [0.83-0.89]
Western Europe	0.94 [0.92-0.96]
Identified immigrants	0.92 [0.91-0.92]
Other recent registrants	0.99 [0.98-0.99]
All others	1.0

Region of Origin	**ARR [95% CI]**
	50-66 YEARS
East Asia & Pacific	0.91 [0.89-0.92]
Eastern Europe & Central Asia	0.91 [0.89-0.94]
Latin America & Caribbean	0.95 [0.93-0.97]
Middle East & North Africa	0.83 [0.80-0.87]
South Asia	0.69 [0.67-0.71]
Sub-Saharan Africa	0.89 [0.85-0.93]
USA, Australia & New Zealand	0.86 [0.80-0.92]
Western Europe	0.86 [0.83-0.90]
Identified immigrants	0.86 [0.86-0.86]
Other recent registrants	0.86 [0.85-0.87]
All others	1.0

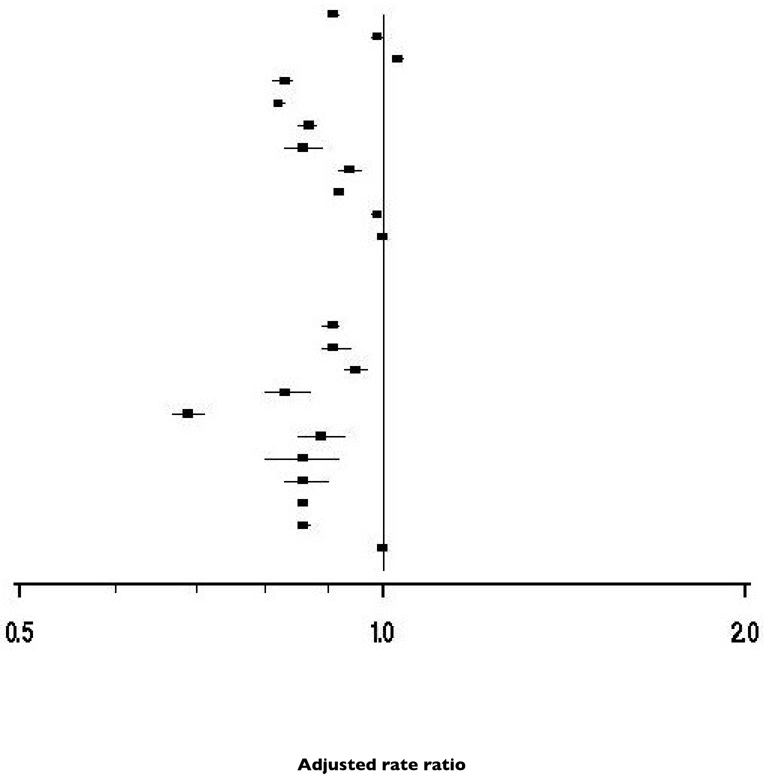


Figure 7. Adjusted rate ratios (ARRs) with 95% confidence intervals for appropriate cervical cancer screening, including women with any available history of hysterectomy, for Ontario's metropolitan areas. Model includes region of origin, neighbourhood income quintile, patient enrolment model, prenatal visit during study period, Rurality Index of Ontario score, Aggregate Diagnosis Group, Resource Utilization Band, and age. Referent group for each category demarcated by an ARR of 1.0.

An abridged version of the following chapter has been previously published. The citation is: Lofters A, Moineddin R, Hwang SW, Glazier RH. Predictors of low cervical cancer screening among immigrant women in Ontario, Canada. BMC Women's Health, 2011; 11: 20 (27 May 2011). Permission was not required to publish in this dissertation.

CHAPTER 4

PREDICTORS OF LOW CERVICAL CANCER SCREENING AMONG IMMIGRANT WOMEN IN ONTARIO, CANADA

ABSTRACT

Background: Inequities in cervical cancer screening are known to exist in Ontario, Canada for foreign-born women. The relative importance of various barriers to screening may vary across ethnic groups. This study aimed to determine how predictors of low cervical cancer screening, reflective of sociodemographics, the health care system, and migration, varied by region of origin for Ontario's immigrant women.

Methods: Using a validated billing code algorithm, we determined the proportion of women who were not screened during the three-year period of 2006-2008 among 455 864 identified immigrant women living in Ontario's urban centres. We created eight identical multivariate Poisson models, stratified by eight regions of origin for immigrant women. In these models, we adjusted for various sociodemographic, health care-related and migration-related variables. We then used the resulting adjusted relative risks to calculate population-attributable fractions for each variable by region of origin.

Results: Region of origin was not a significant source of effect modification for lack of recent cervical cancer screening. Certain variables were significantly associated with lack of screening across all or nearly all world regions. These consisted of not being in the 35-49 year age group, residence in the lowest-income neighbourhoods, not being in a primary care patient enrolment model, having a provider from the same region, and not having a female provider. For all women, the highest population-attributable risk was seen for not having a female provider, with values ranging from 16.8% [95% CI 14.6-19.1%] among women from the Middle East and North Africa to 27.4% [95% CI 26.2-28.6%] for women from East Asia and the Pacific.

Conclusions: To increase screening rates across immigrant groups, efforts should be made to ensure that women have access to a regular source of primary care, and ideally access to a female health professional. Efforts should also be made to increase the enrolment of immigrant women in new primary care patient enrolment models.

4.1 INTRODUCTION

Widespread screening using the Papanicolaou (Pap) test has been proven to dramatically reduce cervical cancer rates, and women who develop cervical cancer are most often women who have not been appropriately screened (32-34, 36, 61). Therefore, in Ontario, Canada, evidence-based guidelines recommend that screening occur at least once every three years for all women with a history of vaginal sexual activity until 70 years of age (32). However, the literature suggests that adherence to guidelines is not complete or equitable in our setting. Inequities in cervical cancer screening for foreign-born women have long been documented in the Ontario and Canadian literature, using both self-report and administrative data (53, 55, 57, 59, 60, 108, 128, 129). This risk of non-screening is not equal across immigrant groups. In our previous work, although all immigrant groups had significantly lower screening rates than long-term residents of the province (53.1% vs. 64.6%), women from South Asia and from the Middle East and North Africa were the most vulnerable to lack of screening, and women from Western Europe and from Latin America and the Caribbean were the least vulnerable (130). These findings were in the context of screening rates and knowledge about the Pap test being quite low in many South Asian and Middle Eastern countries (33, 122, 123).

The underlying mechanisms for screening inequities for immigrant women may lie in sociodemographic barriers, barriers rooted in the health care system, cultural or migration-related barriers or, most likely, some combination of the three (47, 61, 93, 109, 111, 131-133). As well, it is feasible that the relative importance of these barriers varies between ethnic groups. For example, the gender of the physician performing the Pap test or language barriers may be of more importance for women from one cultural or language group than from another. Therefore, the aims of this study were to: i) determine if the independent effects on cervical cancer screening of various factors reflective of sociodemographics, the health care system, and culture and migration were modified by region of origin for identified immigrant women in Ontario, and ii) to calculate population-attributable fractions for these factors for each region of origin.

4.2 METHODS

4.2.1. Study Setting

According to the 2006 Census, Ontario is Canada's largest province with a population of over 12 million people, over 28% of whom are foreign-born (134). More than half of all Canada's immigrants settle in Ontario (135). Asia is currently the main source continent, and India the number one source country, for newcomers to the province (135). Nearly 75% of the province's population live in one of fifteen census metropolitan areas (CMAs) i.e. a geographic area with a total population of at least 100 000, of which 50 000 or more live in an urban core (113, 136). For Ontario's foreign-born population, 94.0% live in a CMA (82). Therefore, we limited the study setting to Ontario's CMAs. Ontario has a single, government-run, universal health insurance plan that pays for all medically necessary services, including cervical cancer screening.

4.2.2. Data Sources

We accessed data about Ontario's population eligible for health services and women receiving Pap tests through a comprehensive research agreement with Ontario's Ministry of Health and Long-Term Care. All personal identifiers were removed from the analytic dataset, leaving only date of birth, date of registration with the health insurance plan, area of residence and a scrambled unique identifier. The research protocol was approved by Research Ethics Boards at the University of Toronto and Sunnybrook Health Sciences Centre in Toronto.

Several databases were accessed for this study. The Registered Persons Database (RPDB) is Ontario's health care registry, and includes all Ontario residents who are eligible for the province's single universal health care plan by age, sex and address. To be eligible, residents must be Canadian citizens, permanent residents or refugees; make their permanent and principal home in Ontario; and be physically present in Ontario at least 153 days in any 12-month period. In Ontario, health care coverage takes effect three months after the date of establishing residency for those not born in the province.

The Ontario Physicians' Claims Database contains fee codes and corresponding diagnostic codes claimed by Ontario's physicians, and covers approximately 95% of physician claims in the province (78, 79). The Ontario Cancer Registry (OCR) registers all Ontario residents who have been newly diagnosed with cancer or who have died of cancer, and the Canadian Institute of

Health Information Discharge Abstract Database (CIHI-DAD) contains demographic, administrative and clinical data for inpatient hospital discharges. The Client Agency Program Enrolment consists of all Ontario residents who are enrolled in a primary health care patient enrolment model (PEM). These models provide financial incentives for family physicians to perform cervical cancer screening on enrolled women aged 35-69 years. The Corporate Physicians' Database documents which family physicians participate in these models. The Institute for Clinical Evaluative Sciences' Physicians' Database contains specialty and demographic information about physicians practicing in Ontario including sex and country of medical school graduation. The Landed Immigrant Data System (LIDS) contains detailed individual-level demographic information recorded on the date of issue of the landing visa for Ontario's permanent residents and spans landing dates from 1985 to 2000. It consists of foreign-born residents who declared that they intended to move to Ontario at the time of landing. It includes country of origin, class of migration, educational attainment and languages spoken. We also accessed the 2006 Canadian Census to determine neighbourhood income quintiles based on postal code (84). We linked these various databases in an anonymous fashion using unique identifiers based on health card numbers. The LIDS was linked probabilistically, successfully linking 84.4% of those with Ontario as an intended destination.

4.2.3. Study Cohort

Our cohort consisted of all women in Ontario who were alive and eligible for health coverage from January 1, 2006 to December 31, 2008, who ranged in age from 18 to 69 years for the entire three-year study period, whose most recent postal code was in a CMA, and who were identified immigrants based on the Landed Immigrant Data System (LIDS). A total of 524 997 women fit these initial inclusion criteria.

To ensure that we captured Pap tests performed for screening and not diagnostic purposes, we excluded women with an available history of gynaecological cancer in Ontario Cancer Registry records (1 427 women), or colposcopy in physicians' claims records (42 704 women). Women who have had a total hysterectomy are no longer screening-eligible, therefore we also excluded 26 598 women with an available history of such in hospital discharge records. Ontario has newly instituted primary care patient enrolment models (PEMs), which include financial incentives for family physicians to perform cervical cancer screening on enrolled women aged 35-69 years. Because the tracking code Q140A can be claimed by Ontario physicians who participate in these models for any enrolled female patient aged 35-69 years who is ineligible for cervical cancer screening for any reason, we excluded 6 008 women who had a Q140A code claimed at least once in available records. Due to overlap of reasons for exclusion, a total of 69 133 women were excluded. Therefore, the final cohort consisted of 455 864 women.

4.2.4. Stratified Multivariate Analysis

To classify women by region of origin, we accessed LIDS to determine country of birth for each woman. The countries were then grouped into eight world regions based on a modification of the classification system used by the World Bank (see Appendix E) (137). To determine if region of origin acted as an effect modifier, we conducted a stratified multivariate analysis by creating eight identical models stratified by the regions. A stratified analysis approach, generating separate analyses for each level of a modifier, allows us to investigate effect modification by direct comparison of relative risks and their confidence intervals (138). Although this approach does not provide a statistical test of the differences between relative risks, it provides intuitively interpretable results. The use of interaction terms is probably most commonly used to test for effect modification, however, this approach becomes increasingly difficult to interpret as the number of levels of the potential effect modifier increases (138).

As our outcome is relatively common, odds ratios determined from logistic regression would not provide an accurate estimate of relative risks. Therefore, we used multivariate Poisson regression (83) to estimate adjusted relative risks. Models included variables in three categories: sociodemographic, health care-related and migration-related variables that may influence the likelihood of cervical cancer screening.

For sociodemographic variables, we considered age category (18-34 years, 35-49 years [referent], 50-66 years) as there are financial incentives in patient enrolment models for screening women 35 years and over and as women 50 years and over have previously been found to be under-screened (53, 108, 116), neighbourhood income quintile as we have found this variable to be associated with cervical cancer screening (108, 130), whether each woman lived in a small urban versus large urban setting based on her Rurality Index of Ontario score (115), and whether she had a university degree at the time of landing in Ontario.

Health care-related variables included whether each woman had at least one major prenatal visit during the study period as Pap tests are expected aspects of these visit types and may be more acceptable during these visits, whether she had seen a gynaecologist at least once during the study period, whether she was rostered in a patient enrolment model, and whether she was virtually rostered. Being virtually rostered refers to being assigned to a family physician who participates in a patient enrolment model, based on pattern of care, despite the woman not being officially enrolled herself. Assignment is based on the family physician who has billed the largest dollar amount of services for that patient in the previous two years (139). This approach has been found to be accurate with 85% of patients appropriately virtually rostered to a family physician who participates in a patient enrolment model (139). We also examined whether the woman had at least one female provider (either family physician or gynaecologist), whether she had at least one provider from the same region of the world (either family physician or gynaecologist) based on the physician's medical school, and the presence of co-morbidities in the two years prior to the index date based on the Johns Hopkins Adjusted Clinical Groups Case-Mix System (118), which uses diagnostic information from administrative databases to describe and predict patients' use of health care resources. In this study, we used Resource Utilization Bands, which range from 0 (lowest expected health care costs) to 5 (highest expected health care costs), to categorize patients based on their expected use of health care resources, and Aggregated Diagnosis Groups, which range from 0 (no diagnosis group) to 32 (a maximum of 32 distinct diagnosis groups) to categorize the level of co-morbidity. This system has been validated for use in Canadian populations (119).

Migration-related variables included immigrant class (economic [referent], family, refugee), English speaking ability at landing, whether the woman had been in Canada less than 10 years, and age at landing. SAS Version 9.1 (SAS Institute Inc, Cary, NC) was used to fit all models and determine adjusted relative risks.

Adjusted relative risks (ARRs) were then used to calculate population-attributable fractions (PAFs) for each variable using the following formula:

$PAF = p(ARR-1)/(1+p(ARR-1))$

where p was the proportion of the study population with the variable of interest.

4.2.5. Outcome Definition

To determine if each woman in the cohort had been appropriately screened for cervical cancer, we used our previously validated billing code-based algorithm consisting of all procedural codes that can be billed by the physician performing the Pap test and all laboratory codes that can be billed by the cytopathologist interpreting the Pap test. A woman was considered appropriately screened if at least one of the specified billing codes had been claimed for her in the three-year study period. This algorithm had 99.5% sensitivity and 85.7% specificity when compared to a Pap test registry (108).

4.3 RESULTS

Characteristics of the study population are summarized in Table 1. The largest immigrant groups were from East Asia and the Pacific (128 965 women) and from South Asia (88 107 women). The smallest group was from the USA, Australia and New Zealand (10 003 women). Women from Latin America and the Caribbean and from Sub-Saharan Africa were most likely to be living in the poorest neighbourhoods, and least likely to have a university degree. There was a mismatch between university-level education and neighbourhood income for South Asian women, with a high representation in low-income neighbourhoods but a high level of educational attainment. Women from the USA, Australia and New Zealand had the highest educational attainment, and had the least amount of health care contact. South Asian women were the most likely to have at least one female provider and to have a provider from the same region of the world, and were most commonly rostered in patient enrolment models. Eastern European and Central Asian women were the least likely to be able to speak English at landing, and women from Sub-Saharan Africa were the most likely to arrive as refugees.

A total of 213 729 women (46.9%) were not screened for cervical cancer during the three-year study period. Table 2 displays numbers and percentages of women who were not recently screened by region of origin for particular variables of interest. Women who had at least one female provider were the least likely to be unscreened, with the lowest number of unscreened women seen among Caribbean and Latin American women who had at least one female provider (21.2%). The highest proportions of unscreened women were seen among those women who were neither in an enrolment model nor virtually rostered to a family physician in a patient enrolment model, with percentages consistently above 90%. Among those women who were neither in a patient enrolment model nor virtually rostered, only 11.8% had any contact at all with the health care system during the study period (i.e. a physician office visit, hospitalization, emergency room visit, laboratory test, imaging procedure, or drug benefit claim). Of those women who had health care contact, 70.1% were still not recently screened, ranging from 61.1% for women from the USA, Australia and New Zealand to 77.4% for Middle Eastern and North African women (Table 3).

In our eight stratified models, when relative risks and their confidence intervals were compared, there was little effect modification by region (Table 4). Certain variables were significantly associated with lack of screening across all or nearly all world regions. These consisted of being in either the youngest or oldest age groups and in the lowest income quintiles among the sociodemographic variables, and not being in a patient enrolment model, having a provider from the same region, and not having a female provider among the health care-related variables. None of the migration-related variables were consistently significantly associated with lack of screening. Being unable to speak English at landing trended toward increased risk for most women, but was associated with significantly decreased risk for East Asian and Pacific women. Immigrant class was only significant for Sub-Saharan African women and Western European women, with refugees being at higher risk of non-screening in these two groups. Post-hoc, we tested for an interaction between female provider and provider from the same region of the world, but it was not consistently statistically significant so we did not include this interaction in the models.

We then determined PAFs for these variables (Table 5). For all women, the highest PAFs were seen for not having a female provider, with values ranging from 16.8% [95% CI 14.6-19.1%] among women from the Middle East and North Africa to 27.4% [95% CI 26.2-28.6%] for women from East Asia and the Pacific. The next highest PAFs varied by region of origin. Risk of non-screening could be attributed to being in the youngest age group for Latin American and Caribbean women (7.4% [95% CI 5.7-9.1%]), Middle Eastern and North African women (7.5% [95% CI 5.1-9.9%]), and South Asian women (7.7% [95% CI 6.4-9.1%]). Being neither rostered nor virtually rostered in a primary care model was of especial importance for women from East Asia and the Pacific (5.9% [95% CI 5.3-6.5%]), the USA, Australia and New Zealand (9.5% [95% CI 6.2-12.8%]), and Western Europe (12.1% [95% CI 10.4-13.8%]), as was not having a university degree for Eastern European and Central Asian women (6.9% [95% CI 4.7-9.1%]), and being in the lowest income quintile for Sub-Saharan African women (8.9% [95% CI 5.7-12.1%]).

4.4 DISCUSSION

4.4.1. Summary of Findings

The cervical cancer screening rate of 53.1% that we have demonstrated for a three-year period for Ontario's immigrant women living in urban areas, all of whom were eligible for the provincial universal health care system, is substantially lower than would be expected with adherence to provincial guidelines (32), and substantially lower than the 64.6% we have previously found for long-term residents of Ontario living in urban areas during the same time period (130). Sociodemographic and health care-related factors, namely living in the lowest-income neighbourhoods, not being in the 35-49 year age group, not being either rostered or virtually rostered in a patient enrolment model, and having either a male provider or a provider from the same region of the world were independently associated with lower rates of screening for immigrant women across most or all regions of origin, suggesting that these variables tend to negatively affect screening for immigrant women regardless of their culture or ethnicity. Even when limiting to women with at least one contact with the health care system during the study period, the prevalence of non-screening was still quite high for women who were neither rostered nor virtually rostered to a patient enrolment model, suggesting that complete lack of health care system contact did not explain this finding.

4.4.2. Comparison with Other Literature

Our findings are similar to those of other studies that have shown that the gender and cultural origin of the family physician, and income and age of the patient, matter for cervical cancer screening. In another Canadian study, Decker et al. demonstrated that Canadian medical graduates and female physicians were more likely than international medical graduates and male physicians respectively to perform Pap tests (117). In their literature review, Akers et al. noted that female doctors were consistently more likely to perform cervical screening and that having a doctor of the same ethnicity was associated with lower rates of screening (46). Tu et al. showed that female physicians were more likely to screen for breast and cervical cancer among Chinese immigrants in both Seattle, USA and Vancouver, Canada (140), and in qualitative studies, immigrant women consistently report that having a female perform the Pap test would increase their comfort level (42, 95, 105, 141, 142). Low-income women have frequently been highlighted as vulnerable to under-screening, both among foreign-born women and among the general population (33, 53, 59, 93, 101, 108, 117, 143). Although many international studies have shown that older age is associated with lower rates of cervical cancer screening among both immigrants and the general population (33, 34, 53, 54, 95, 144-149), only a few studies have highlighted women in the youngest age group as vulnerable to under-screening and most of these have focussed on women younger than 25 years (23, 93, 149, 150). It must be noted that the benefits of screening for women less than 25 years may be limited (120).

We also used PAFs to determine the screening barriers of most importance for each cultural group, and found that access to a female provider had the highest attributable risk across regions of origin. Other characteristics that decision makers could focus on were also highlighted with some differences across regions. These findings can be used for screening interventions that are targeted at particular ethnic groups. For example, researchers and policymakers aiming to increase screening among Sub-Saharan African women may wish to focus their efforts on women living in the poorest neighbourhoods.

4.4.3. Strengths and Limitations

This study has several strengths. It is a large, population-based study with broad inclusion criteria that distinguishes immigrant women from all major geographic regions of the world. It uses a previously validated outcome measure (108) instead of self-report to document cervical cancer screening. Self-report is known to systematically overestimate screening attendance (151, 152). It also relies on objective data instead of self-reported data for immigration status and region of origin. The effects of sociodemographics, health care-related factors and migration-related factors on screening for immigrant women from all regions of the world were considered. As well, this is the only study that we are aware of that has examined region of origin as a potential source of effect modification and calculated region-specific population-attributable fractions in order to determine barriers to Pap test use of the most importance for each cultural group.

This study also has several limitations. First, not all potentially relevant information, such as religion, is available from administrative data. Second, some data were only available for women at the time of landing, such as education attainment and language ability. These may have changed for many women by the beginning of the study period. Third, identified immigrants were classified based on their country of birth, which may not always reflect their ethnic and cultural origins. For example, 238 women born in the U.S. were in the refugee class, most likely reflective of women of other ethnic origins whose families lived for a time in the U.S. before settling in Canada. Fourth, although we excluded women where there was any evidence of a gynaecological cancer or hysterectomy in available data, we could not identify out-of-province cancer diagnoses or hysterectomies, which may be relatively common among the immigrant women in the cohort. However, we also excluded women who had a Q140 code billed, which allows physicians in primary care enrolment models to flag those patients whom they have deemed ineligible for screening. All identified immigrants had been in Ontario for over five years by the first day of the study period, and on average, had been in the province for over 10 years, decreasing the likelihood of out-of-province cancer diagnoses or hysterectomies. Fifth, our validated algorithm cannot satisfactorily account for all Pap tests performed within a hospital setting. However, the analysis described in Appendix C showed that approximately 10% of family physicians and gynaecologists practice in or near the hospital setting, suggesting that it is unlikely that our results would be significantly changed with inclusion of these tests. Finally, our results may not be generalizable to other settings, either inside or outside Canada, as other settings may have different immigrant demographic profiles.

4.4.5. Implications

Our findings suggest that several interventions may be beneficial for improving cervical cancer screening rates among immigrant women in Ontario. First, efforts need to be made to ensure that immigrant women get connected with the health care system after arrival and find a regular source of primary care. Settlement agencies may be able to play a substantial role toward this goal. Moving from Ontario's current system of opportunistic screening to one of centrally organized screening with periodic invitations may also be of benefit for increasing screening rates. Although it is neither feasible nor desirable for every immigrant woman to see a female provider, efforts should also be made to increase the enrolment of immigrant women in primary care patient enrolment models. Importantly, some primary care models may also make it feasible for male physicians to have female health professionals, such as trained nurses, physician assistants or nurse practitioners, available to provide cervical cancer screening, which may increase immigrant women's comfort with having the procedure performed. As well, targeted physician education campaigns for physicians trained abroad may be beneficial for improving screening rates. Future work should examine the reasons for lower screening rates when there is ethnic congruence between a physician and patient. Targeted patient education campaigns and interventions for all immigrant women will likely also be of utmost importance, with a particular focus on younger and older women, and on women of low income.

Table 1. Demographic characteristics of the 455 864 identified immigrant women in the cohort who were aged 18-66 on January 1, 2006 by region of origin.

	East Asia & Pacific	**Eastern Europe & Central Asia**	**Latin America & Caribbean**	**Middle East & North Africa**	**South Asia**	**Sub-Saharan Africa**	**USA, Australia & New Zealand**	**Western Europe**	**All identified immigrants**
n	128 965	67 845	70 184	33 649	88 107	26 125	10 003	30 167	455 864
SOCIODEMOGRAPHIC FACTORS									
Mean age (SD)	40.6 (11.3)	39.5 (11.8)	38.8 (11.8)	37.2 (12.1)	38.6 (11.8)	37.1 (10.9)	39.7 (11.8)	38.7 (11.5)	39.2 (11.7)
Age category, No. (%):									
18-34 years	37 321 (28.9)	22 413 (33.0)	25 852 (36.8)	14 333 (42.6)	35 565 (40.4)	10 428 (39.9)	3 043 (30.4)	10 382 (34.4)	159 581 (35.0)
35-49 years	63 857 (49.5)	3 137 (45.9)	30 936 (44.1)	13 743 (40.8)	35 904 (40.8)	12 377 (47.4)	4 903 (49.0)	14 596 (48.4)	207 836 (45.6)
50-66 years	27 787 (21.6)	14 295 (21.1)	13 396 (19.1)	5 573 (16.6)	16 638 (18.9)	3 320 (12.7)	2 057 (20.6)	5 189 (17.2)	88 447 (19.4)
Income Quintile, No. (%)									
Q1 (lowest)	31 755 (24.6)	17 591 (25.9)	25 352 (36.1)	9 045 (26.9)	27 878 (31.6)	11 908 (45.6)	1 439 (14.4)	5 730 (19.0)	130 867 (28.7)
Q2	32 387 (25.1)	13 136 (19.4)	17 696 (25.2)	6 402 (19.0)	23 281 (26.4)	5 042 (19.3)	1 591 (15.9)	6 788 (22.5)	106 489 (23.4)
Q3	25 862 (20.1)	13 403 (19.8)	13 668 (19.5)	6 511 (19.4)	19 038 (21.6)	3 629 (13.9)	1 692 (16.9)	5 807 (19.3)	89 798 (19.7)
Q4	22 197 (17.2)	14 215 (21.0)	8 518 (12.1)	6 537 (19.4)	11 853 (13.5)	2 985 (11.4)	1 948 (19.5)	5 800 (19.2)	74 218 (16.3)
Q5 (highest)	16 556 (12.8)	9 434 (13.9)	4 841 (6.9)	5 105 (15.2)	5 964 (6.8)	2 478 (9.5)	3 311 (33.1)	5 997 (19.9)	53 815 (11.8)
No. (%) with university degree*	28 369 (22.0)	16 729 (24.7)	4 029 (5.7)	6 832 (20.3)	21 923 (24.9)	2 317 (8.9)	3 390 (33.9)	2 740 (9.1)	86 525 (19.0)
No. (%) living in large urban area	124 405 (96.5)	62 988 (92.9)	66 975 (95.5)	31 971 (95.1)	85 190 (96.7)	25 221 (96.6)	8 127 (81.4)	26 142 (86.7)	431 805 (94.8)
HEALTH CARE-RELATED FACTORS									
No. (%) in RUB category:									
0-1	34 440 (26.7)	13 368 (19.7)	10 967 (15.6)	8 170 (24.3)	13 835 (15.7)	5 591 (21.4)	4 592 (45.9)	10 138 (33.6)	101 345 (22.2)
2	19 351 (15.0)	10 843 (16.0)	8 439 (12.0)	3 946 (11.7)	10 419 (11.8)	3 048 (11.7)	1 210 (12.1)	3 989 (13.2)	61 365 (13.5)
3	57 936 (44.9)	33 743 (49.7)	36 782 (52.4)	15 170 (45.1)	44 120 (50.1)	11 791 (45.1)	3 154 (31.5)	12 118 (40.2)	215 149 (47.2)
4-5	17 238 (13.4)	9 891 (14.6)	13 996 (19.9)	6 363 (18.9)	19 733 (22.4)	5 695 (21.8)	1 047 (10.5)	3 922 (13.0)	78 005 (17.1)
No. (%) in ADG category:									
0-5	83 780 (65.0)	42 490 (62.6)	37 137 (52.9)	19 009 (56.5)	44 845 (50.9)	14 426 (55.2)	21 046 (69.8)	21 046 (69.8)	270 893 (59.4)
6-9	35 926 (27.9)	20 473 (30.2)	24 909 (35.5)	10 527 (31.3)	32 035 (36.4)	8 542 (32.7)	7 300 (24.2)	7 300 (24.2)	141 848 (31.1)
10+	9 259 (7.2)	4 882 (7.2)	8 138 (11.6)	4 113 (12.2)	11 227 (12.7)	3 157 (12.1)	1 821 (6.0)	1 821 (6.0)	43 123 (9.5)

	East Asia & Pacific	Eastern Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	South Asia	Sub-Saharan Africa	USA, Australia & New Zealand	Western Europe	All identified immigrants
No. (%) with prenatal visit during study period	5 736 (4.5)	3 579 (5.3)	4 610 (6.6)	1 905 (5.7)	7 312 (8.3)	2 000 (7.7)	321 (3.2)	1 507 (5.0)	26 995 (5.9)
No. (%) in:									
Patient enrolment model	80 584 (62.5)	41 953 (61.8)	47 620 (67.9)	21 227 (63.1)	63 195 (71.7)	16 682 (63.9)	5 101 (51.0)	17 707 (58.7)	294 553 (64.6)
Virtually rostered	23 706 (18.4)	17 131 (25.3)	14 979 (21.3)	6 302 (18.7)	15 499 (17.6)	5 374 (20.6)	1 123 (11.2)	4 482 (14.9)	88 732 (19.5)
Neither	24 675 (19.1)	8 761 (12.9)	7 585 (10.8)	6 120 (18.2)	9 413 (10.7)	4 069 (15.6)	3 779 (37.8)	7 978 (26.5)	72 579 (15.9)
No. (%) with female provider	45 676 (35.4)	28 917 (42.6)	23 234 (33.1)	12 555 (37.3)	42 068 (47.8)	9 679 (37.1)	3 188 (31.9)	10 866 (36.0)	176 471 (38.7)
No. (%) with provider from same region	28 081 (21.8)	19 713 (29.1)	5 397 (7.7)	8 380 (24.9)	34 374 (39.0)	1 937 (7.4)	58 (0.6)	2 911 (9.7)	100 851 (22.1)
No. (%) with gynaecologist	27 739 (21.5)	20 547 (30.3)	22 028 (31.4)	8 822 (26.2)	23 768 (27.0)	7 557 (28.9)	1 472 (14.7)	5 985 (19.8)	118 075 (25.9)
MIGRATION-RELATED FACTORS									
No. (%) able to speak English*	73 105 (56.7)	24 623 (36.3)	57 012 (81.2)	17 673 (52.5)	43 638 (49.5)	18 700 (71.6)	9 675 (96.7)	19 901 (66.0)	264 848 (58.1)
No. (%) in Canada less than 10 yrs	18 931 (14.7)	10 919 (16.1)	6 184 (8.8)	5 578 (16.6)	20 179 (22.9)	3 700 (14.2)	1 094 (10.9)	1 908 (6.3)	68 827 (15.1)
Mean age at landing (SD)	28.8 (11.5)	27.8 (12.0)	25.5 (12.0)	25.8 (12.4)	28.1 (11.9)	25.2 (11.0)	26.3 (12.1)	24.2 (11.9)	27.2 (11.9)
Immigrant class, No. (%)									
Economic	74 615 (57.9)	26 577 (39.2)	21 684 (30.9)	16 956 (50.4)	30 904 (35.1)	7 669 (29.4)	3 508 (35.1)	19 438 (64.4)	201 872 (44.3)
Family	47 632 (36.7)	21 099 (31.1)	41 312 (58.9)	8 688 (25.8)	43 243 (49.1)	8 450 (32.3)	6 255 (62.5)	9 783 (32.4)	186 444 (40.9)
Refugee	5 817 (4.5)	19 621 (28.9)	7 010 (10.0)	7 836 (23.3)	13 278 (15.1)	9 834 (37.6)	238 (2.4)	940 (3.1)	64 618 (14.2)

*Recorded on date of landing in Canada
RUB = Resource Utilization Bands, which range from 0 (lowest expected health care costs) to 5 (highest expected health care costs), used to categorize patients based on their expected use of health care resources.
ADG = Aggregated Diagnosis Groups, which range from 0 (no diagnosis group) to 32 (32 distinct diagnosis groups) used to measure the level of co-morbidity.

Table 2. Number (and percentage) of women without a Pap test in 2006-8 among the 455 864 identified immigrant women in the cohort who were aged 18-66 on January 1, 2006 by region of origin.

	East Asia & Pacific	**Eastern Europe & Central Asia**	**Latin America & Caribbean**	**Middle East & North Africa**	**South Asia**	**Sub-Saharan Africa**	**USA, Australia & New Zealand**	**Western Europe**	**All identified immigrants**
SOCIODEMOGRAPHIC FACTORS									
Age category:									
18-34 years	19 513 (52.3)	8 640 (38.6)	9 305 (36.0)	8 082 (56.4)	17 828 (50.1)	5 443 (52.2)	1 913 (62.9)	4 991 (48.1)	75 863 (47.5)
35-49 years	28 916 (45.3)	12 327 (39.6)	10 214 (33.0)	6 358 (46.3)	15 689 (43.7)	5 643 (45.6)	2 670 (54.5)	7 009 (48.0)	89 019 (42.8)
50-66 years	15 053 (54.2)	7 456 (52.2)	6 412 (47.9)	3 146 (56.5)	10 503 (63.1)	1 768 (53.3)	1 344 (65.3)	3 057 (58.9)	48 847 (55.2)
Income Quintile:									
Q1 (lowest)	16 980 (53.5)	9 102 (51.7)	10 078 (39.8)	5 375 (59.4)	15 358 (55.1)	6 494 (54.5)	976 (67.8)	3 330 (58.1)	67 778 (51.8)
Q2	15 677 (48.4)	5 827 (44.4)	6 612 (37.4)	3 472 (54.2)	11 534 (49.5)	2 405 (47.7)	985 (61.9)	3 522 (51.9)	50 126 (47.1)
Q3	11 974 (46.3)	5 078 (37.9)	4 519 (33.1)	3 103 (47.7)	8 794 (46.2)	1 658 (45.7)	972 (57.5)	2 750 (47.4)	38 957 (43.4)
Q4	10 279 (46.3)	4 933 (34.7)	2 839 (33.3)	3 112 (47.6)	5 445 (45.9)	1 225 (41.0)	1 063 (54.6)	2 580 (44.5)	31 565 (42.5)
Q5 (highest)	8 443 (51.0)	3 441 (36.5)	1 832 (37.8)	2 492 (48.8)	2 838 (47.6)	1 017 (41.0)	1 913 (57.8)	2 845 (47.4)	24 893 (46.3)
University degree:									
Yes	14 141 (49.9)	6 605 (39.5)	1 661 (41.2)	3 495 (51.2)	10 426 (47.6)	1 046 (45.1)	1 815 (53.5)	1 349 (49.2)	40 665 (47.0)
No	49 341 (49.1)	21 818 (42.7)	24 270 (36.7)	14 091 (52.6)	33 594 (50.8)	11 808 (49.6)	4 112 (62.2)	13 708 (50.0)	173 064 (46.9)
HEALTH CARE-RELATED FACTORS									
Patient enrolment model	29 196 (36.2)	13 403 (32.0)	13 366 (28.1)	8 545 (40.3)	27 200 (43.0)	6 358 (38.1)	1 770 (34.7)	5 512 (31.1)	105 538 (35.8)
Virtually rostered	10 262 (43.3)	6 803 (39.7)	5 465 (36.5)	3 072 (48.8)	7 707 (49.7)	2 594 (48.3)	450 (40.1)	1 760 (39.3)	38 177 (43.0)
Neither	24 024 (97.4)	8 217 (93.8)	7 100 (93.6)	5 969 (97.5)	9 113 (96.8)	3 902 (95.9)	3 707 (98.1)	7 785 (97.6)	70 014 (96.5)
Female provider:									
Yes	11 434 (25.0)	7 359 (25.5)	4 924 (21.2)	3 971 (31.6)	13 947 (33.2)	2 961 (30.6)	873 (27.4)	2 653 (24.4)	48 220 (27.3)
No	52 048 (62.5)	21 064 (54.1)	21 007 (44.7)	13 615 (64.5)	30 073 (65.3)	9 893 (60.2)	5 054 (74.2)	12 404 (64.3)	165 509 (59.2)
Provider from same region:									
Yes	11 279 (40.2)	6 474 (32.8)	1 546 (28.7)	3 653 (43.6)	14 760 (42.9)	614 (31.7)	19 (32.8)	992 (34.1)	39 337 (39.0)
No	52 203 (51.8)	21 949 (45.6)	24 385 (37.6)	13 933 (55.1)	29 260 (54.5)	12 240 (50.6)	5 908 (59.4)	14 065 (51.6)	174 392 (49.1)
MIGRATION-RELATED FACTORS									
Able to speak English:									
Yes	36 886 (50.5)	10 012 (40.7)	20 479 (35.9)	9 165 (51.9)	21 656 (49.6)	8 974 (48.0)	5 718 (59.1)	9 867 (49.6)	123 036 (46.5)
No	26 596 (47.6)	18 411 (42.6)	5 452 (41.4)	8 421 (52.7)	22 364 (50.3)	3 880 (52.3)	209 (63.7)	5 190 (50.6)	90 693 (47.5)

	East Asia & Pacific	**Eastern Europe & Central Asia**	**Latin America & Caribbean**	**Middle East & North Africa**	**South Asia**	**Sub-Saharan Africa**	**USA, Australia & New Zealand**	**Western Europe**	**All identified immigrants**
In Canada:									
less than 10 years	8 055 (42.6)	4 381 (40.1)	2 049 (33.1)	2 840 (50.9)	10 272 (50.9)	1 744 (47.1)	541 (49.5)	851 (44.6)	30 930 (44.9)
10+ years	55 427 (50.4)	24 042 (42.2)	23 882 (37.3)	14 746 (52.5)	33 748 (49.7)	11 110 (49.5)	5 386 (60.5)	14 206 (50.3)	182 799 (47.2)
Immigrant class:									
Economic	39 334 (52.7)	10 684 (40.2)	8 599 (39.7)	9 589 (56.6)	16 810 (54.4)	3 465 (45.2)	2 395 (68.3)	9 995 (51.4)	101 173 (50.1)
Family	21 369 (45.1)	9 060 (42.9)	14 442 (35.0)	4 150 (47.8)	20 514 (47.4)	3 821 (45.2)	3 396 (54.3)	4 584 (46.9)	81 461 (43.7)
Refugee	2 412 (41.5)	8 451 (43.1)	2 822 (40.3)	3 761 (48.0)	6 357 (47.9)	5 499 (55.9)	135 (56.7)	475 (50.5)	29 932 (46.3)
TOTAL WITHOUT A PAP TEST IN 2006-8	63 482 (49.2)	28 423 (41.9)	25 931 (36.9)	17 586 (52.3)	44 020 (50.0)	12 854 (49.2)	5 927 (59.2)	15 057 (49.9)	213 729 (46.9)

Table 3. Number (and percentage) of women without a Pap test among the 8 565 identified immigrant women in the cohort who were neither in a patient enrolment model nor virtually rostered, but still had at least one contact with the health care system during the study period: January 1, 2006-December 31, 2008.

	East Asia & Pacific	**Eastern Europe & Central Asia**	**Latin America & Caribbean**	**Middle East & North Africa**	**South Asia**	**Sub-Saharan Africa**	**USA, Australia & New Zealand**	**Western Europe**	**All identified immigrants**
Number (percentage) inadequately screened	1 551 (70.4)	1 141 (67.7)	886 (64.6)	518 (77.4)	964 (76.3)	435 (72.3)	113 (61.1)	383 (66.5)	6 000 (70.1)

Table 4. Adjusted relative risks [with 95% confidence intervals] for risk of non-screening for the 455 864 identified immigrant women in the cohort who were aged 18-66 on January 1, 2006 by region of origin. Relative risks adjusted for all variables listed in Table 1.

	East Asia & Pacific	**Eastern Europe & Central Asia**	**Latin America & Caribbean**	**Middle East & North Africa**	**South Asia**	**Sub-Saharan Africa**	**USA, Australia & New Zealand**	**Western Europe**	**All identified immigrants**
SOCIODEMOGRAPHIC FACTORS									
Age category:									
18-34 years	1.20 [1.16-1.23]	1.16 [1.11-1.21]	1.22 [1.17-1.27]	1.19 [1.13-1.26]	1.21 [1.17-1.25]	1.16 [1.10-1.24]	1.13 [1.03-1.25]	1.19 [1.12-1.27]	1.24 [1.22-1.26]
35-49 years	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
50-66 years	1.20 [1.17-1.24]	1.08 [1.04-1.13]	1.24 [1.19-1.30]	1.16 [1.10-1.23]	1.30 [1.25-1.35]	1.09 [1.02-1.17]	1.06 [0.97-1.16]	1.10 [1.04-1.17]	1.15 [1.13-1.17]
Income Quintile:									
Q1 (lowest)	1.10 [1.08-1.13]	1.15 [1.11-1.20]	1.10 [1.05-1.16]	1.14 [1.08-1.19]	1.12 [1.08-1.17]	1.21 [1.13-1.30]	1.09 [1.00-1.18]	1.12 [1.06-1.18]	1.14 [1.12-1.15]
Q2	1.03 [1.01-1.06]	1.09 [1.05-1.14]	1.06 [1.00-1.11]	1.09 [1.03-1.15]	1.07 [1.03-1.11]	1.12 [1.04-1.20]	1.06 [0.98-1.15]	1.09 [1.03-1.14]	1.07 [1.06-1.09]
Q3	1.01 [0.98-1.04]	1.03 [0.99-1.08]	0.97 [0.92-1.03]	1.01 [0.96-1.07]	1.02 [0.98-1.07]	1.12 [1.03-1.21]	1.03 [0.95-1.11]	1.06 [1.01-1.12]	1.03 [1.01-1.04]
Q4	0.99 [0.96-1.02]	1.00 [0.95-1.04]	0.97 [0.91-1.03]	1.01 [0.96-1.07]	1.00 [0.96-1.05]	1.01 [0.93-1.10]	0.99 [0.91-1.06]	1.00 [0.95-1.06]	1.0 [0.98-1.01]
Q5 (highest)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
University degree:									
No	0.98 [0.96-1.00]	1.10 [1.07-1.13]	1.05 [0.99-1.10]	1.01 [0.97-1.05]	1.06 [1.03-1.08]	1.03 [0.96-1.10]	1.06 [1.00-1.13]	1.04 [0.98-1.11]	1.01 [1.00-1.02]
Yes	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
HEALTH CARE-RELATED FACTORS									
Not rostered	1.33 [1.30-1.36]	1.47 [1.41-1.52]	1.56 [1.49-1.62]	1.31 [1.24-1.37]	1.21 [1.17-1.26]	1.31 [1.24-1.39]	1.28 [1.17-1.39]	1.52 [1.44-1.60]	1.39 [1.37-1.41]
Virtually rostered	1.19 [1.16-1.21]	1.23 [1.19-1.27]	1.28 [1.24-1.32]	1.18 [1.13-1.23]	1.13 [1.10-1.16]	1.21 [1.15-1.26]	1.17 [1.05-1.29]	1.26 [1.20-1.33]	1.18 [1.17-1.20]
Patient enrolment model	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Female provider:									
No	1.58 [1.55-1.62]	1.44 [1.40-1.49]	1.40 [1.35-1.45]	1.32 [1.27-1.38]	1.44 [1.41-1.47]	1.33 [1.27-1.39]	1.43 [1.31-1.55]	1.44 [1.38-1.52]	1.43 [1.41-1.45]
Yes	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

	East Asia & Pacific	**Eastern Europe & Central Asia**	**Latin America & Caribbean**	**Middle East & North Africa**	**South Asia**	**Sub-Saharan Africa**	**USA, Australia & New Zealand**	**Western Europe**	**All identified immigrants**
Provider from same region:									
Yes	1.06 [1.04-1.09]	1.08 [1.05-1.12]	1.08 [1.02-1.13]	1.13 [1.08-1.17]	1.09 [1.07-1.11]	0.94 [0.86-1.02]	0.98 [0.62-1.53]	1.14 [1.07-1.22]	1.15 [1.13-1.16]
No	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
MIGRATION-RELATED FACTORS									
Able to speak English:									
No	0.98 [0.96-0.99]	1.01 [0.98-1.04]	1.04 [1.01-1.08]	1.04 [1.00-1.07]	1.09 [1.06-1.11]	1.06 [1.02-1.10]	1.05 [0.90-1.22]	1.03 [1.00-1.07]	1.04 [1.03-1.05]
Yes	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
In Canada:									
less than 10 years	1.00 [0.98-1.03]	1.01 [0.98-1.05]	0.97 [0.92-1.02]	1.06 [1.02-1.11]	1.09 [1.06-1.11]	1.05 [0.99-1.11]	1.10 [1.00-1.22]	1.05 [0.97-1.13]	1.05 [1.04-1.07]
10+ years	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Immigrant class:									
Family	1.00 [0.99-1.02]	1.01 [0.98-1.04]	0.98 [0.95-1.01]	0.96 [0.93-1.00]	0.98 [0.95-1.00]	1.05 [1.00-1.10]	0.97 [0.91-1.02]	0.98 [0.95-1.02]	0.99 [0.98-1.00]
Refugee	0.96 [0.92-1.00]	1.00 [0.97-1.03]	1.03 [0.99-1.08]	1.00 [0.96-1.04]	1.02 [0.99-1.05]	1.20 [1.15-1.26]	1.07 [0.89-1.29]	1.08 [0.98-1.18]	1.06 [1.04-1.07]
Economic	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 5. Population-attributable fractions as percentages [and 95% confidence intervals] for risk of non-screening for the 455 864 identified immigrant women in the cohort who were aged 18-66 on January 1, 2006 by region of origin.

	East Asia & Pacific	**Eastern Europe & Central Asia**	**Latin America & Caribbean**	**Middle East & North Africa**	**South Asia**	**Sub-Saharan Africa**	**USA, Australia & New Zealand**	**Western Europe**	**All identified immigrants**
SOCIOECONOMIC FACTORS									
Age category:									
18-34 years	5.4 [4.5-6.4]	4.9 [3.4-6.5]	7.4 [5.7-9.1]	7.5 [5.1-9.9]	7.7 [6.4-9.1]	6.2 [3.7-8.6]	3.9 [0.9-7.0]	6.3 [4.1-8.4]	7.8 [7.2-8.3]
50-66 years	4.2 [3.5-4.9]	1.7 [0.8-2.6]	4.5 [3.5-5.5]	2.6 [1.6-3.7]	5.4 [4.6-6.3]	1.2 [0.2-2.2]	1.2 [-0.7-3.2]	1.7 [0.6-2.9]	2.9 [2.6-3.2]
Income Quintile:									
Q1	2.5 [1.8-3.2]	3.8 [2.8-5.0]	3.6 [1.8-5.5]	3.6 [2.2-5.0]	3.7 [2.4-5.1]	8.9 [5.7-12.1]	1.2 [0.1-2.5]	2.2 [1.1-3.3]	3.8 [3.3-4.2]
Q2	0.8 [0.1-1.5]	1.7 [0.9-2.6]	1.4 [0.0-2.7]	1.7 [0.7-2.7]	1.8 [0.7-2.9]	2.2 [0.7-3.8]	1.0 [-0.3-2.3]	1.9 [0.7-3.1]	1.7 [1.3-2.0]
Q3	0.2 [-0.4-0.7]	0.6 [-0.2-1.5]	-0.5 [-1.5-0.5]	0.2 [-0.8-1.3]	0.5 [-0.4-1.4]	1.6 [0.4-2.8]	0.5 [-0.8-1.9]	1.1 [0.1-2.2]	0.5 [0.2-0.8]
Q4	-0.1 [-0.6-0.4]	-0.1 [-1.0-0.9]	-0.4 [-1.1-0.3]	0.2 [-0.8-1.3]	0.0 [-0.6-0.6]	0.1 [-0.8-1.1]	-0.3 [-1.7-1.2]	0.1 [-0.9-1.1]	-0.1 [-0.3-0.2]
No university degree	-1.4 [-3.1-0.2]	6.9 [4.7-9.1]	4.1 [-0.7-8.8	0.6 [-2.9-3.9]	4.0 [2.1-5.8]	2.5 [-3.6-8.3]	4.1 [0.1-8.0]	3.7 [-1.5-8.8]	0.8 [-0.1-1.8]
HEALTH CARE-RELATED FACTORS									
Virtually rostered	3.3 [2.8-3.8]	5.5 [4.7-6.3]	5.6 [4.8-6.4]	3.2 [2.3-4.1]	2.2 [1.7-2.7]	4.1 [3.1-5.2]	1.8 [0.6-3.2]	3.8 [2.8-4.7]	3.4 [3.2-3.7]
Neither	5.9 [5.3-6.5]	5.7 [5.0-6.3]	5.7 [5.0-6.3]	5.3 [4.3-6.3]	2.2 [1.8-2.7]	4.6 [3.6-5.7]	9.5 [6.2-12.8]	12.1 [10.4-13.8]	5.9 [5.6-6.1]
No female provider	27.4[26.2-28.6]	20.2[18.7-21.8]	21.1[19.2-23.0]	16.8[14.6-19.1]	18.7[17.6-19.8]	17.1[14.5-19.6]	22.5[17.4-27.4]	22.1[19.4-24.8]	20.8[20.2-21.4]
Provider from same region	1.4 [0.9-1.9]	2.4 [1.5-3.3]	0.6 [0.2-1.0]	3.0 [2.0-4.1]	3.4 [2.5-4.2]	-0.5 [-1.0-0.1]	0.0 [-0.2-0.3]	1.3 [0.6-2.1]	3.2 [2.9-3.4]
MIGRATION-RELATED FACTORS									
Not able to speak English	-0.1 [-1.8-(-0.3)]	0.5 [-1.1-2.2]	0.8 [0.2-1.4]	1.7 [0.2-3.2]	4.2 [3.1-5.4]	1.7 [0.5-2.8]	0.2 [-0.3-0.7]	1.1 [-0.1-2.4]	1.8 [1.4-2.2]
In Canada less than 10 years	0.1 [-0.3-0.5]	0.2 [-0.4-0.8]	-0.3 [-0.7-0.1]	1.1 [0.3-1.8]	2.0 [1.4-2.6]	0.7 [-0.1-1.5]	1.1 [0.0-2.3]	0.3 [-0.2-0.8]	0.8 [0.6-1.0]
Immigrant class:									
Family	0.2 [-0.5-0.8]	0.3 [-0.6-1.3]	-1.3 [-3.0-0.3]	-0.9 [-1.9-0.0]	-1.2 [-2.4-(-0.1)]	1.5 [-0.1-3.2]	-2.2 [-5.8-1.4]	-0.6 [-1.7-0.6]	-0.3 [-0.7-0.1]
Refugee	-0.2 [-0.4-0.0]	0.1 [-0.8-1.0]	0.3 [-0.1-0.8]	0.0 [-0.9-1.0]	0.3 [-0.1-0.8]	7.0 [5.2-8.9]	0.2 [-0.3-0.7]	0.2 [-0.1-0.6]	0.8 [0.6-1.0]

CHAPTER 5

SUMMARY AND CONCLUSIONS

The purposes of this chapter are to:

1. Summarize the major findings of the dissertation
2. Discuss strengths and limitations of the dissertation
3. State the implications of the dissertation for clinicians and policymakers
4. State possible directions for future research

5.1 SUMMARY OF MAJOR FINDINGS

Through the three studies described in Chapter 2, 3 and 4, this dissertation has contributed new findings to the area of immigrant health research in Ontario with regard to cervical cancer screening. Together, these studies help to create a better understanding of the screening inequities that exist for Ontario's foreign-born women, the barriers that contribute to these inequities, and how these barriers can best be addressed.

5.1.1 Validation

In Chapter 2, we identified, validated and implemented a combination of billing codes that comprised a 99.5% sensitive and 85.7% specific algorithm to use as a measure of cervical cancer screening in Ontario. This algorithm can be used by Ontario researchers, as well as by researchers in other settings where physician and laboratory claims are accessible but a cytology registry is not. In addition, we demonstrated that, in Ontario's urban areas, screening inequities were most pronounced among women aged 50 years and above, a mostly post-menopausal group; women living in the lowest-income neighbourhoods; and women who had registered for provincial health care within the preceding ten years, 70-80% of whom are estimated to be foreign-born. Women with all three of these characteristics had a screening rate of 31.0% compared to 70.5% among women with none of these characteristics. Regional variation existed across the province, with the Central West region, a region with a large South Asian population, having the largest screening inequities between recent registrants to the health care plan and long-term residents.

5.1.2 Comparison

In Chapter 3, we compared the prevalence of appropriate cervical cancer screening among identified immigrant women from major geographic regions of the world versus other recent registrants (a combination of unidentified immigrants and interprovincial migrants) versus Canadian-born and more distant immigrants in Ontario's urban areas. We found that the latter group consistently had higher rates of screening than the other two comparison groups across all income levels. Ontario's identified immigrant women were being screened at rates significantly lower than their peers, with screening inequities being largest for women from South Asia, especially for those in the post-menopausal age category. Living in the lowest-income neighbourhoods and not being enrolled in a primary care enrolment model, where financial incentives are provided to physicians for cervical cancer screening, were also associated with significantly lower rates of cervical cancer screening. In a secondary analysis, increased time in Ontario was not associated with increased screening.

5.1.3 Stratified Multivariate Analysis

In Chapter 4, we conducted a stratified multivariate analysis to determine the independent effects of sociodemographic, health care-related, and migration-related factors on cervical cancer screening in Ontario's urban areas, and to investigate if region of origin was a significant source of effect modification for these factors. We demonstrated that, across nearly all immigrant groups, living in the lowest income neighbourhoods, not being in the 35-49 year age group, not being enrolled in a patient enrolment model, and having either a male provider or a provider from the same region of the world were independently associated with lower rates of screening for immigrant women. These variables influenced screening for immigrant women regardless of their region of origin. We also used population-attributable fractions to determine potential barriers to screening of most importance for each immigrant group, demonstrating that the greatest population-attributable risk across all groups was associated with not having a female provider. We further found sociodemographic, health care-related and migration-related variables that decision-makers could focus on to decrease inequities in particular immigrant populations.

5.2 STRENGTHS AND LIMITATIONS

5.2.1 Strengths

This dissertation has several strengths. First, we used linked administrative databases. These databases allowed us to have very large sample sizes, the smallest being nearly half a million women in Chapter 4, and to provide population-based estimates of cervical cancer screening rates. As well, access to databases such as the Landed Immigrant Data System meant that we had rich sources of information about the characteristics of women in our cohort and the health care that they received. We were able to capture some key elements that relate to the acculturation process from available data. The process of acculturation refers to the cultural changes that result when individuals who have developed in one cultural context manage to adapt to new contexts that result from migration, and consists of two separate domains: the maintenance or loss of one's original culture and the adoption or resistance of the new culture (153, 154). This construct is sometimes oversimplified in health research studies to just a single proxy variable, such as language ability or years in the new country (155-157). However, through our data sources we were able to simultaneously capture multiple variables likely relevant to the acculturation process, such as region of origin, language ability, years in Canada, education level at landing, age at landing, and immigrant class (153). Use of these variables paints a clearer picture of the role of cultural factors in cervical cancer screening in Ontario. Third, by using an objective and validated measure of screening instead of self-report, we were able to avoid acquiescence bias (the tendency of survey respondents to agree with all questions when in doubt), recall bias (when a survey respondent's answer is affected by their memory of the event at question), and social desirability bias (where survey participants respond in a manner that they believe will be viewed favourably). As well, the algorithm we developed may be broadly applicable and easily adaptable to other settings where a cytology registry is not accessible or available. Fourth, we were able to identify specific regions of origin, specific characteristics, and specific geographic areas in Ontario for whom screening inequities were largest, which can help steer the prioritization of targeted policy and practice changes. Our findings suggest that South Asian Ontarians, the Central West region of Ontario where a large population of South Asians lives, and immigrant women not participating in new primary care patient enrolment models are in particular need of intervention. Fifth, we performed multiple subgroup and sensitivity analyses throughout the chapters to confirm the robustness of our findings. These analyses verified that screening inequities held despite adjustment for physician contact, adjustment for health care contact, inclusion of women with a known history of hysterectomy to reduce misclassification bias, stratification of women by length of time in Ontario, and examination of different age groups. Sixth, throughout the chapters, we used multivariate Poisson regression instead of multivariate logistic regression to determine adjusted rate ratios and adjusted relative risks. Although logistic regression results in an adjusted odds ratio that approximates the adjusted rate ratio or relative risk when the incidence of the outcome is rare (i.e. less than 10%), the odds ratio will overestimate the relative risk when the outcome is more common (83). For cohort studies where all patients have equal follow-up times, Poisson regression can be used to provide an accurate estimate of adjusted rate ratios or relative risks with conservative confidence intervals (83). Finally, this work was guided by the Behavioral Model for Vulnerable Populations (64), a well-known and important framework for questions of equity and access to health services. Through use of this theoretical framework, we were able to capture and account for the essential components of health behaviours, namely the predisposing, enabling and need characteristics relevant to receipt of cervical cancer screening for Ontario's immigrants. This framework also provides us with a basis for conceptualizing the implications of this work, as discussed in detail below.

5.2.2. Limitations

Although this work benefitted from the use of administrative data, it also has several limitations as a result of these data. First, our findings suggest that a woman's cultural and/or ethnic origin may play a large and significant role in the likelihood of cervical cancer screening after immigration to Ontario, even many years after immigration. However, there are some key elements of culture and the acculturation process that are not available in administrative data, such as religion, access to social supports, interactions with people from other cultures, cultural beliefs about the need for cancer screening and cervical cancer screening in particular, beliefs about the curative versus preventive roles of the health system, modesty in the context of a genital examination, and exposure to prejudice and discrimination both within and outside of the health care system (153, 155). As well, in Chapter 4, we did not have access to data on women's language ability or educational attainment at the beginning of the study period, which would have been informative of both the acculturation process and barriers to health care access. Other factors that have been shown to play a role in cervical cancer screening in other settings, such as marital status, employment status and health literacy, were also not available in our data (143, 158-166). Women who are married, who are employed, and who have a high level of health literacy and are knowledgeable about Pap tests have been found to be more likely to be appropriately screened; we were unable to verify if these findings hold true in our setting and for our target population (143, 158-166).

The second limitation is that we only included women in this work with legal access to health care. Women who were living in the country illegally, or who were in the country on a temporary basis and were therefore ineligible for the universal health care program, were excluded from all study cohorts. Some of the immigrants most vulnerable to under-screening and to under-use of health care are likely foreign-born persons without legal status. Therefore, our findings looking only at women with universal health coverage likely underestimate the size of the gradients that would have been observed if we had been capable of including women without provincial health insurance. In other settings where universal health insurance does not exist, such as the U.S., lack of insurance has been consistently significantly associated with a lower likelihood of cervical cancer screening among immigrant women (167-173).

Third, some of our findings must be interpreted with caution due to the ecological nature of the data. We used income at the dissemination area (DA) as a measure of income. A DA is a small area composed of one or neighbouring blocks, and 400 to 700 people. All of Canada is divided into DAs (174). We have shown that women living in low-income neighbourhoods, or DAs, are subject to significantly lower rates of cervical cancer screening, but we have not necessarily shown that low-income women have significantly lower rates of cervical cancer screening. However, we ensured that all our stated conclusions concerned women living in low-income neighbourhoods, which is still quite important information for both practitioners and policymakers. Use of neighbourhood-level characteristics is increasingly common in health services and health equity research, and can provide us with conservative estimates of socioeconomic effects (127). As well, our findings are consistent with those of surveys conducted in our setting, where low-income women have reported screening inequities when compared to their more well-to-do counterparts (53, 75).

Fourth, we were not able to capture gynaecological cancers performed outside of Ontario, or hysterectomies performed outside of Ontario or performed before April 1, 1988 with available data. Importantly, this means that we have less accurate information about cancer diagnoses and hysterectomies for foreign-born women than we do for Canadian-born women, and likely less accurate information for the oldest women in the cohort, leading to misclassification bias. A fair number of women might have been incorrectly included in the denominator of our cohorts as a result, making screening rates for immigrant women appear to be lower than they actually are and therefore making inequities appear to be larger than they actually are. Cervical cancer rates are known to be higher in less developed countries (31). Little is known about hysterectomy rates in other parts of the world, particularly in less developed countries. Women of lower socioeconomic position in Ontario are more likely to have a hysterectomy; yet even after adjustment for hysterectomy, women of low income and low educational attainment have been found to have lower rates of Pap test use (85). Although we were unable to account for these out-of-province and more distant hysterectomies, in Chapters 2 and 3 we performed secondary analyses where women with a known history of hysterectomy were included to reduce misclassification bias. We found that screening inequities remained, suggesting that this limitation is not a source of excessive bias throughout this work.

Fifth, available data do not include provider service information from the provincially funded community health centres (CHCs), as physicians at these centres are paid on salary and do not bill the provincial health plan for services rendered. Ontario's CHCs focus on primary care, illness prevention and health promotion, using a community development approach (175). They are an especially important resource for marginalized populations, such as those of low income, the disabled, and immigrants (175). By not having access to these data, we may have missed a proportion of Pap tests that were performed on disadvantaged women within our cohorts. However, most CHCs would be expected to send their Pap tests to community laboratories that billed the provincial health insurance plan for preparation and interpretation, which would be captured by our billing code algorithm.

Sixth, our algorithm, although validated, cannot satisfactorily account for all Pap tests performed within a hospital setting. Many hospital laboratories rely on a global budget and therefore do not bill the provincial health insurance plan for their services and some hospital Pap tests may occur at visits where procedural codes cannot be billed, such as general assessments, gynaecologists' assessments and major prenatal visits. However, there is no obvious reason why foreign-born women, low-income women or older women would be more likely to exclusively visit a family doctor or gynaecologist within a hospital than their peers. As well, hospital-based Pap tests may be more likely to be performed for diagnostic purposes than for screening purposes. Our analysis described in Appendix C suggests that the number of women who would have screening Pap tests in a hospital setting would be relatively small and unlikely to significantly affect our findings.

Our final limitation concerns our choice of denominator throughout this work. We had three options for our denominators. We could have used all women registered in the Registered Persons’ Database (RPDB) for the province’s health insurance plan, we could have limited the denominator to those women who had at least one contact with the health system during the study periods, or we could have used the female population from the Census. Because updating addresses in the RPDB is voluntary and not done systematically, and because there is a lag time between a death and when a person is removed from the RPDB, the first option would likely overestimate the size of the denominator by including dead women and women who had moved out of province. However, the second option would exclude women who have no contact with the health system. The likelihood of accessing care might be related to foreign-born status and socioeconomic position, suggesting that these women could be an important and vulnerable group for our analyses. Finally, the third option only provides data in aggregate form, which would not have allowed for individuals in the denominator to be tracked between the various databases we used throughout this work (e.g. Landed Immigrant Data System, Ontario Cancer Registry). Therefore, for our studies, we chose the first method, which means our denominator might be artificially inflated. However, in Chapter 3, we performed a subgroup analysis where our denominator consisted of only those women who had at least one contact with the health care system during the study period and found similar inequities as with our primary denominator. In

Chapter 4, we demonstrated that women who had at least one contact with the health care system during the study period but were neither enrolled nor virtually enrolled in patient enrolment models had a very high likelihood of inadequate screening. As well, although address inaccuracy has previously been found in the RPDB, serious misclassification (disagreement by more than one income quintile) has been show to have a relatively low prevalence (7.4%), without introducing significant bias into calculations (176).

5.3 IMPLICATIONS AND FUTURE RESEARCH

5.3.1 Implications

In Ontario's urban areas, there is a gap between screening rates that would be expected from provincial and national guidelines and screening rates that are actually occurring in practice. Screening rates are even lower for women with particular characteristics. Although we are not able to determine with certainty the causes of the screening inequities that we have observed for immigrant women, South Asian women in particular, older women, and women living in low-income neighbourhoods, our research has several important implications. In Chapter 1, we reviewed the Behavioral Model for Vulnerable Populations, which postulates that predisposing, enabling and need characteristics explain health service utilization, with the former two being most important for behaviours related to conditions without immediate impact, such as screening for cervical cancer. Our findings from Chapters 2, 3 and 4 have confirmed the importance of certain predisposing characteristics, namely age, foreign-born status, region of birth, and income, and certain enabling characteristics, namely region of residence, regular source of care, co-morbidities, enrolment in a primary care model, and cultural congruence and gender of the family physician, as factors associated with screening for immigrant women. One need characteristic, prenatal care, was also a significant factor for screening.

Predisposing characteristics are those that encompass the pre-existing tendency of individuals to use services. The named predisposing characteristics are mostly reflective of either a woman's socioeconomic position or, likely, of her culture. In the case of socioeconomic position, health care providers and policymakers cannot change these characteristics without widespread political overhaul, and in the case of an immigrant woman's culture, they should generally have no desire to change these characteristics. Therefore, to address these predisposing factors, policymakers should focus efforts to improve screening rates on targeted, culturally sensitive patient education for particular ethnic groups and particular socioeconomic groups, and on widespread education of family physicians on which groups of women are vulnerable to under-screening. As well, efforts need to be made to determine the specific cultural barriers to screening for particular ethnic groups, from both the patient and the provider perspective, and ways that these can be feasibly addressed in provider practices. Caution must be taken to explore these cultural barriers while not inadvertently laying blame on any particular culture, as patients should not feel the need or pressure to reject their cultural beliefs in order to appreciate and take advantage of efforts aimed at increasing screening. The presence of ethnic enclaves in Ontario, such as the Central

West region, means that policymakers can also target particular regions of the province for education campaigns in efforts to bring screening rates up to levels that guidelines would suggest. For example, Ahmad et al. developed and evaluated an intervention to improve breast cancer screening among South Asian immigrant women in Toronto, Ontario (177). The intervention consisted of a series of breast health newspaper articles published in local Urdu and Hindi community papers. The articles, as well as pre- and post-intervention surveys, were mailed out to 74 participants to determine the effect on knowledge, beliefs, and behaviours. The content of the health articles was determined by comprehensive literature review on factors associated with screening for South Asian women. The socioculturally tailored intervention was found to significantly increase the rate of clinical breast examination and knowledge about breast cancer, and to decrease misperceptions about susceptibility to breast cancer and survival after diagnosis (177). By targeting a particular ethnic group and using culturally sensitive educational materials, the authors were able to create a change in behaviour. This project could serve as a model for similar efforts in the realm of cervical cancer screening.

In contrast to the predisposing characteristics, many of the significant enabling characteristics we investigated are ones that could and should be addressed directly in order to improve screening rates. Enabling characteristics, as we will recall, are those factors that either assist or impede individuals' use of health services. For example, efforts should be intensified to ensure that every Ontarian has a family physician. With regular access to primary health care, preventive techniques such as Pap tests are much more likely to be administered and administered consistently. We should also aim to enroll more immigrant women in primary care patient enrolment models, where there are financial incentives for screening and where screening rates were found to be significantly higher. In these models, physicians receive annual lists of enrolled patients in the 35-69 year age group who have and have not been screened and there are financial incentives to contact patients to come in for cervical cancer screening, ensuring compensation for the considerable effort required to reach out to unscreened patients. Reasons why physicians are less likely to enroll immigrant women in these models than their Canadian-born peers need to be explored and addressed. As well, for male family physicians, more female health professionals need to be available to perform screening for those immigrant women who are not comfortable with Pap tests being performed by a male practitioner. Again, this may be easier enabled by participation in those patient enrolment models where funding is provided for incorporating non-physician health staff into daily practice.

Finally, the inequities that exist for foreign-born and marginalized women for cervical cancer screening may have implications for other forms of cancer screening. Similar to screening for cervical cancer, screening for colorectal and breast cancer can be uncomfortable and intimate procedures. As well, they are facilitated by primary care physicians, and financial incentives exist for these screening types in patient enrolment models. Therefore, it is quite feasible that the inequities and barriers that we have observed for cervical cancer screening may apply for breast and colorectal cancer as well.

5.3.2. Future Research

Our findings from Chapter 4 imply that foreign-trained physicians may also benefit from targeted education campaigns, and further, that they should be the subjects of future studies. The relationship that we observed, where immigrant women who were culturally congruent with their provider were less likely to be screened than immigrant women who were not, has previously been documented (46). However, the reasons for this finding are not clear from our work or from the literature. Possibilities include presumptions on the part of the physician about the necessity of the test, unwillingness on the part of the patient to recognize the need for the test, and less training on preventive techniques in other settings. These possibilities and others should be considered and explored in surveys and qualitative studies. Such studies would constitute an important addition to the literature, especially as the number of foreign-trained physicians in Ontario increases.

With substantial focus on new primary care patient enrolment models in the province, future research should also include an exploration of screening rates in Ontario's community health centres (CHCs), which are targeted toward marginalized populations including immigrants, and which are set up to deliver comprehensive primary care services through the utilization of interdisciplinary teams of professionals using a health promotion framework (45). Some of the elements of new enrolment models, such as comprehensiveness of care and the interdisciplinary team, have long been key features of CHCs. Screening rates for foreign-born and disadvantaged women in CHCs and in patient enrolment models should be directly compared. If screening rates were higher in CHCs, it would be informative to determine what factors about the community health centre model allow for higher rates. Conversely, if screening rates are higher in the new models, changes to the current CHCs could be explored and implemented.

In this dissertation, we focussed on the effects of individual-level variables on cervical cancer screening. However, in health equity research, it is increasingly being recognized that factors related to, not just the individual, but also his or her home, neighbourhood and community are important determinants of health and should therefore be considered for multivariate analyses (2, 6). Accordingly, certain neighbourhood-level variables may play an important role in screening inequities for immigrant women. For example, screening behaviour may be influenced by the education level of neighbours (101), by the proportion of immigrants and recent immigrants in one's neighbourhood (57), or by the degree of cultural congruence with one's neighbours. Multi-level models that incorporate both these neighbourhood-level variables and the variables that we studied in this investigation at the individual level, and that also test for intra-level and cross-level interactions, may help to quantify the relative importance of each level on screening for immigrant women, and to delineate which neighbourhood-level variables, if any, significantly impact the likelihood of screening. Such an analysis could further highlight areas of the province for policymakers that would be important targets for screening campaigns.

As well, future studies using a diagnosis of cervical cancer as an outcome among foreign-born women should be considered. As annual incidence rates of cervical cancer in Canada are quite low (and thus would be even lower in Ontario), many years of data would likely have to be compiled for such studies. However, this work would prove informative around cancer rates and cancer risk among foreign-born women, and would be useful information for policy-makers, providers and immigrant communities.

Although much more still needs to be learned about barriers to cervical cancer screening for immigrant women in Ontario, likely best ascertained through qualitative studies, future research should ultimately be focussed on the development of effective interventions. Numerous efforts have been made to increase screening rates for immigrant women in other settings, and these studies can be informative. For example, in Vancouver, British Columbia, Grewal et al. established a Pap test clinic for cervical cancer (178). The South Asian Pap Test Clinic was a specialized clinic for immigrant South Asian women, created as a community-initiated response to under-screening and high rates of cervical cancer. The clinic was initiated by collaboration between South Asian community health nurses, influential women in the South Asian community, local physicians, and health board authorities. Radio talk shows, ethnic newspapers, presentations at community functions and presentations at relevant women's groups were all used to make the community aware of the clinic, and a community advisory committee was established consisting of local, influential South Asian women. Pap test results were forwarded to women's family physicians who were responsible for follow-up. Although women described their experiences as positive and frequently encouraged peers to attend, attendance patterns were not maintained. The authors listed the most significant challenges to maintaining success as: i) maintaining stakeholder involvement in developing long-term strategies, ii) creating mechanisms to strengthen community physicians' support, and iii) meeting the other needs of the underserved that were outside the clinic's mandate (178). Other interventions to increase cervical cancer screening that have shown some degree of success among immigrant and minority women include face-to-face education (179, 180), the use of lay health workers (181-184), reminder and recall systems (183, 185), feedback to physicians (186), and multimedia campaigns (183, 186). Of note, the Ontario Cervical Screening Program is actively planning to implement a patient recall and follow-up system (61). Interventional research in the Ontario setting should incorporate the findings from studies like these as it moves forward on the quest for evidence-based effective interventions suitable for the local immigrant population. The proposed research will most likely also benefit from a community-based participatory research (CBPR) approach. With a CBPR approach, the participation of those communities affected by the issue under study is a necessary component of action to affect change, and the emphasis is on research with the community rather than research on the community (187). Such an approach may best be able to directly target cultural barriers to cervical cancer screening.

The current investigation has confirmed that significant inequities in cervical cancer screening exist in Ontario's urban areas for marginalized women, especially foreign-born women. The findings from these three studies have provided important contributions to, and advanced knowledge on, our understanding of the actionable barriers to screening for our target population. We hope that that it will steer further research toward targeted efforts designed to decrease screening gaps.

APPENDIX A: DETAILED INFORMATION ABOUT BILLING CODE ALGORITHM VALIDATION

The best method by which to determine that a woman is up-to-date on screening in Ontario has not been clear. Previous research in the province has used multiple methods: a single laboratory billing code claimed by cytopathologists for interpretation (116), multiple laboratory and procedural billing codes claimed by both cytopathologists and clinicians (59), and self-reported results from national surveys (60, 85, 87). Unfortunately, none of these methods is ideal. Hospital laboratories do not bill the provincial health insurance plan for their services; Pap tests that are performed as part of a general, major prenatal or gynaecologist's assessment are not billed separately by clinicians; and self-report is subject to bias, such as recall bias, social desirability bias and misclassification bias (66, 88-92). Billing codes hold more promise than self-report to determine cervical cancer screening rates; however, the relevant billing codes had not previously been validated. Not surprisingly, these various methods have found differing screening rates for Ontario's eligible population, ranging from less than 60% to 80% (29, 59, 60, 85, 87).

Ontario is one of few sites around the world that has an electronic Pap test registry. Although this registry, Cytobase, is not 100% sensitive due to a lack of reporting from some smaller private laboratories and some hospital laboratories, it is the closest measure we have had to date of a gold standard. However, access to the Cytobase database is limited. Therefore, we aimed to validate a billing code-based algorithm against Cytobase for determining Ontario's cervical cancer screening rates among the women in our study population. This algorithm could potentially be used by other researchers when Cytobase is not available or accessible, or by researchers in settings where no such registry exists but where there is access to physician and laboratory claims.

Development of Billing Code Algorithms

Billing codes that can be claimed when a Pap test is performed fall into three general categories: procedural codes billed by the physician performing the Pap test; laboratory codes billed by cytopathologists; and billing codes for visits where Pap tests are assumed, but not required, to be performed i.e. general assessments, gynaecologists' assessments and major prenatal visits. Therefore, five different combinations of billing codes were tested. We sequentially added laboratory codes, procedural codes, and visit codes into our algorithms. Additionally, we tested procedural codes on their own, and both procedural and laboratory codes combined with the code for a general assessment on a well woman, as Pap tests are presumably more likely to be performed if the woman is otherwise well. For each algorithm, a woman was considered appropriately screened if at least one of the included billing codes had been claimed in the three-year period. A detailed description of billing codes used appears in Appendix B, Table 1.

Validation of Billing Code Algorithms

Cytobase was used to identify women who had at least one Pap test during our study period and, with the woman as the unit of analysis, each of the five algorithms was validated against Cytobase by calculating the sensitivity, specificity, positive and negative predictive values (PPV and NPV), and positive and negative likelihood ratios (+LR and -LR).

Secondary Analyses

We performed two secondary analyses:

1) In Kingston, Ontario, physicians affiliated with the local university used an alternative payment program during our time period and did not bill the provincial health insurance plan for services rendered. It is possible that screening Pap tests performed by academic family physicians or gynaecologists may not be as well-captured by our billing code algorithms. Therefore, we also compared screening rates for Kingston for both Cytobase and the selected algorithm, and re-calculated validation measures for the selected algorithm for women living in Kingston.

2) When both a Pap test registry and billing code data are available, another option exists for measuring screening rates. A composite reference standard (CRS), often used in microbiology, is a reference standard that combines a highly specific test that has lower sensitivity with another highly specific test that has higher sensitivity. It is positive if either test is positive, and negative if both are negative (188). A CRS retains the high specificity of its components while being more

sensitive than either test alone (188). Thus, considering the imperfect sensitivity of Cytobase, another potential measure of appropriate cervical cancer screening in Ontario might be a CRS consisting of Cytobase combined with our chosen algorithm, as a billing code algorithm may be more sensitive than Cytobase. A combination of Cytobase and billing codes has been used by Cancer Care Ontario to quantify overall screening rates in the province (189). Therefore, we also compared screening rates for women in the cohort based on Cytobase, our selected algorithm, and a CRS consisting of a combination of the two.

SAS Version 9.1 (SAS Institute Inc, Cary, NC) was used for all analyses.

Validation Results

Validation results are shown in Appendix B, Table 2. We selected the combination of procedural and laboratory codes as the best algorithm for identifying women who had been appropriately screened. It had near 100% sensitivity while maintaining high specificity. Similarly, the -LR and NPV were near perfect, but not at the expense of the +LR and PPV. Although this algorithm was found to have lower specificity, +LR, and PPV than the laboratory codes on their own, this is likely reflective of the algorithm capturing Pap tests that Cytobase, our imperfect gold standard, did not. As well, the selected algorithm has higher face validity; false negatives should be minimized as six different codes were included and the claiming of each of these codes provides physicians with remuneration. False positives should be low, as such claims would constitute fraudulent billings to the provincial health plan.

Secondary Analyses

When we compared screening rates for Kingston using the selected algorithm versus Cytobase, results were quite similar (Appendix B, Table 3). Validation measures were re-calculated for the selected algorithm for women living in Kingston (Appendix B, Table 4) and showed near 100% sensitivity and very high specificity. Similarly, the -LR and NPV were near perfect, while maintaining high +LR and PPV. These findings confirm that our selected algorithm is valid for women living in Kingston, Ontario.

In our secondary analyses comparing screening using the CRS (Appendix B, Table 5), the overall screening rate of 61.1% found in this study would minimally change to 61.4% had the proposed CRS been used.

Discussion

We have developed and validated a sensitive and specific physician billing code algorithm for appropriate cervical cancer screening that can be used when a Pap test registry is not available but billing code data are. Our algorithm does have limitations. Specifically, it cannot satisfactorily account for all Pap tests performed within a hospital setting. Hospital laboratories generally do not bill the provincial health insurance plan for their services and some Pap tests occur during visits where procedural codes cannot be billed i.e. general assessments, gynaecologists' assessments and major prenatal visits. There is no obvious reason, however, why newcomers, low-income women or older women would be more likely to exclusively visit a family doctor or gynaecologist within a hospital. As well, hospital-based Pap tests are more likely to be diagnostic. A separate analysis was performed to attempt to ascertain cervical cancer screening practices of doctors whose primary practice is in a hospital; a full description of the analysis and results is outlined in Appendix C.

The overall screening rate of 61.1% found in this study would minimally change to 61.4% had the proposed CRS been used, providing us with further confidence in our algorithm as a valid measure of appropriate cervical cancer screening in Ontario.

APPENDIX B:
TABLES RELATED TO BILLING CODE ALGORITHM VALIDATION

TABLE 1: Ontario Health Insurance Plan billing codes used in algorithms, from Ontario’s Ministry of Health and Long-Term Care Schedule of Benefits for Physician Services

Laboratory Codes

L713 = technical code for cervicovaginal specimen

L733 = technical code for cervicovaginal specimen (monolayer cell methodology)

L812 = interpretation of cervicovaginal specimens including cellular abnormalities, assessment of flora, and/or cytohormonal evaluation

Procedural Codes

G365 = procedure code for a Pap smear, excluding smears provided in conjunction with a consultation, repeat consultation, general or specific assessment or reassessment

G394 = procedure code for follow-up Pap smear after abnormal or inadequate smears

E430 = tray fee for when Pap smear is performed outside of hospital

Other Physician Visits, Well-Woman Visit

A203 = specific assessment by an obstetrician/gynaecologist

A205 = consultation by an obstetrician/gynaecologist

P003 = general assessment (major prenatal visit)

A003 + 917 diagnostic code = general assessment on a well woman (well-woman visit)

TABLE 2: Validation of physician billing code algorithms against Cytobase as a measure of appropriate cervical cancer screening among screening-eligible women in Ontario

	Accuracy [95% CI]	Sensitivity [95% CI]	Specificity [95% CI]	+LR [95% CI]	-LR [95% CI]	PPV [95% CI]	NPV [95% CI]
Laboratory codes	94.3 [94.3-94.3]	98.5 [98.5-98.5]	89.1 [89.1-89.2]	9.1 [9.0-9.1]	0.0 [0.0-0.0]	91.7 91.7-91.8]	98.0 [98.0-98.0]
Procedure codes	85.5 [85.4-85.5]	83.2 [83.1-83.3]	88.2 [88.2-88.3]	7.1 [7.0-7.1]	0.2 [0.2-0.2]	89.6 [89.5-89.7]	81.1 [81.1-81.2]
Procedure + laboratory codes	93.3 [93.3-93.3]	99.5 [99.5-99.5]	85.7 [85.7-85.8]	7.0 [7.0-7.0]	0.0 [0.0-0.0]	89.5 [89.5-89.6]	99.3 [99.3-99.3]
Procedure, laboratory codes + well-woman visit	89.1 [89.1-89.2]	99.7 [99.7-99.7]	76.2 [76.2-76.3]	4.2 [4.2-4.2]	0.0 [0.0-0.0]	83.7 [83.6-83.7]	99.5 [99.5-99.5]
Procedure, laboratory codes + other physician visits	82.2 [82.1-82.2]	99.9 [99.9-99.9]	60.6 [60.5-60.7]	2.5 [2.5-2.5]	0.0 [0.0-0.0]	75.6 [75.7-75.6]	99.8 [99.8-99.8]

CI, confidence interval; +LR, positive likelihood ratio; -LR, negative likelihood ratio; PPV, positive predictive value; NPV, negative predictive value

TABLE 3: Number and percentage of women appropriately screened for cervical cancer among screening-eligible women living in Kingston, Ontario using the selected algorithm (combination of laboratory codes and procedural codes) versus Cytobase, the gold standard.

	Selected Algorithm	**Cytobase**
No. (%) of women aged 18-49 years on January 1, 2003	17 933 (65.7)	17 180 (62.9)
No. (%) of women aged 50-66 years on January 1, 2003	7 448 (56.0)	7 056 (53.1)
No. (%) of all women in the cohort	25 381 (62.5)	24 258 (59.7)

TABLE 4: Validation of selected physician billing code algorithm against Cytobase as a measure of appropriate cervical cancer screening among screening-eligible women living in Kingston, Ontario.

	Accuracy [95% CI]	**Sensitivity [95% CI]**	**Specificity [95% CI]**	**+LR [95% CI]**	**-LR [95% CI]**	**PPV [95% CI]**	**NPV [95% CI]**
Procedure + laboratory codes	96.8 [96.6-96.9]	99.6 [99.5-99.7]	92.6 [92.1-93.0]	13.4 [12.7-14.1]	0.0 [0.0-0.0]	95.2 [94.9-95.5]	99.4 [99.2-99.5]

TABLE 5: Number and percentage of women appropriately screened for cervical cancer among screening-eligible women using the selected algorithm (combination of laboratory codes and procedural codes), Cytobase, and a composite reference standard consisting of a combination of the two.

	Selected Algorithm	**Cytobase**	**Composite Reference Standard**
No. (%) of women aged 18-49 years on January 1, 2003	1 029 514 (64.4)	929 391 (58.1)	1 033 990 (64.7)
No. (%) of women aged 50-66 years on January 1, 2003	360 363 (53.3)	320 603 (47.5)	361 926 (53.6)
No. (%) of all women in the cohort	1 389 877 (61.1)	1 249 994 (55.0)	1 395 916 (61.4)

APPENDIX C: ANALYSIS OF PAP TESTS PERFORMED WITHIN HOSPITALS

There is a lack of reporting to Cytobase from some hospital laboratories. As well, hospital laboratories generally do not bill the provincial health insurance plan for their services, one of the Pap test procedural codes (E430) is not billed in some hospitals, and some Pap tests occur during visits where procedural codes cannot be billed i.e. general assessments, gynaecologists' assessments and major prenatal visits. As a result, some Pap tests performed and interpreted within a hospital setting are captured neither by Cytobase nor by our selected billing code algorithm. Although the proportion of family physicians and gynaecologists in Ontario whose primary practice is within a hospital is likely small, physicians who are affiliated with a hospital but do not work within the hospital may send their Pap tests to the hospital laboratory for interpretation. If these tests are done at a physical exam or consultation, they also will not be captured by our algorithm. Our reported proportion of women screened in the original analysis (see Chapter 2) may therefore be an under-estimation. We aimed to perform an additional analysis, to extrapolate a more accurate proportion of women screened overall in the original analysis from the proportion of women screened outside of the hospital setting.

Methods

Using the Ontario Physicians' Claims Database and the Institute for Clinical Evaluative Sciences Physician Database (IPDB), we identified the primary practice address of every Ontario family physician or gynaecologist who saw at least one of the women in the cohort at least one time for an office visit during the study period. Using the postal code of each physician's primary practice address, we categorized that primary practice address as being in one of three zones: at a hospital, within 100 metres of a hospital, or in the community (where in the community was defined as not being in the former two groups). The purpose of the 100-metre buffer was to capture potential hospital-affiliated physicians.

We determined the proportion of office visits with women in the cohort where cervical cancer screening occurred during the study period as determined by the selected billing code algorithm (see Chapter 2, see Appendices A and B), performed by either a family physician or gynaecologist in each primary practice address zone, with the expectation that screening would appear to increase going from hospital to hospital buffer to community, as the sensitivity of the algorithm increased. We also determined the proportion of office visits with women in the cohort where the billing code for a general assessment was claimed by either a family physician or gynaecologist in each primary practice address zone during the study period, with the hypothesis that there would be very similar proportions of this code claimed across address zones, reflecting very similar practice profiles across physicians. We looked at the proportion of office visits instead of the proportion of women because some women had visits with multiple physician types in multiple zones.

If these hypotheses were not proven false, we planned to calculate the ratio of the proportion of office visits where cervical cancer screening occurred in the community to the proportion of office visits where cervical cancer screening occurred in all primary practice address zones combined, with the assumption that the former would be the more accurate representation of screening in all zones. We then planned to use this ratio to extrapolate a more accurate proportion of women screened in the original cohort than the 61.1% that was found in the primary analysis (see Chapter 2).

Results

There were a total of 11 894 physicians who had 11 288 781 visits with women in the cohort during 2003 to 2005 (Appendix D). Screening rates using the selected algorithm appeared to increase going from hospital to hospital buffer to community for family physicians. Screening rates appeared to increase going from hospital to hospital buffer and community for gynaecologists. However, general assessments also showed a large increase going from hospital to hospital buffer to community for family physicians, while general assessments were lowest in the hospital buffer zone, and similar in the community and hospital for gynaecologists. As our second hypothesis proved false, we did not continue the analysis.

Discussion

Surprisingly, we found a discrepancy between physicians whose primary practice address was in the community versus in the hospital on the basis of billings for general assessments. The reason for this discrepancy is not known. Although family physicians working in a hospital are more likely to be emergency room physicians or hospitalists, we limited our analysis to physicians who had an office visit with a cohort member, which should minimize the number of these two family physician types.

These findings make it impossible for us to come to any definite conclusions about a more accurate proportion of women screened in the original analysis. However, what does seem apparent is that only a minority of family physicians and gynaecologists are practicing in (8.1%) or near (2.5%) the hospital setting. Therefore, it is unlikely that the overall proportion of women in our cohort with adequate screening would be significantly changed with inclusion of hospital-interpreted Pap tests.

APPENDIX D: TABLE OF RESULTS OF ANALYSIS OF PAP TESTS PERFORMED WITHIN HOSPITALS

Table. Percentage of visits where cervical cancer screening occurred as determined by the selected billing code algorithm and percentage of visits that were for general assessments, by physician type and physician's primary practice address zone.

Physician Type	Primary Practice Address Zone	Number of Physicians	Number of Visits	Selected Algorithm	General Assessments
All		11 894	11 288 781	17.5	17.0
Family physician	**Community**	10 062	8 528 664	17.6	21.5
	Hospital buffer	237	280 774	12.6	15.3
	Hospital	871	983 849	1.9	3.2
Gynaecologist	**Community**	575	1 184 335	30.1	1.0
	Hospital buffer	59	147 301	34.3	0.1
	Hospital	90	163 858	8.6	0.7

APPENDIX E: WORLD BANK CLASSIFICATION SYSTEM AND MODIFIED COUNTRY CLASSIFICATION SYSTEM

Table 1. World Bank Classification System (187)

East Asia & Pacific
- American Samoa
- Cambodia
- China
- Fiji
- Indonesia
- Kiribati
- Korea, Dem. Rep.
- Lao PDR
- Malaysia
- Marshall Islands
- Micronesia, Fed. Sts.
- Mongolia
- Myanmar
- Palau
- Papua New Guinea
- Philippines
- Samoa
- Solomon Islands
- Thailand
- Timor-Leste
- Tonga
- Vanuatu
- Vietnam

Europe & Central Asia
- Albania
- Armenia
- Azerbaijan
- Belarus
- Bosnia and Herzegovina
- Bulgaria
- Croatia
- Georgia
- Kosovo
- Kyrgyz Republic
- Macedonia, FYR
- Moldova
- Kazakhstan
- Latvia
- Lithuania
- Montenegro
- Poland
- Romania
- Russian Federation
- Serbia
- Tajikistan
- Turkey
- Turkmenistan
- Ukraine
- Uzbekistan

Latin America & Caribbean
- Argentina
- Belize
- Bolivia
- Brazil
- Chile
- Colombia
- Costa Rica
- Cuba
- Dominica
- Dominican Republic
- Ecuador
- El Salvador
- Grenada
- Guatemala
- Guyana
- Haiti
- Honduras
- Jamaica
- Mexico
- Nicaragua
- Panama
- Paraguay
- Peru
- St. Kitts and Nevis
- St. Lucia
- St. Vincent and the Grenadines
- Suriname
- Uruguay
- Venezuela, RB

Middle East & North Africa
- Algeria
- Djibouti
- Egypt, Arab Rep.
- Iran, Islamic Rep.
- Iraq
- Jordan
- Lebanon
- Libya
- Morocco
- Syrian Arab Republic
- Tunisia
- West Bank and Gaza
- Yemen, Rep.

South Asia
- Afghanistan
- Bangladesh
- Bhutan
- India
- Maldives
- Nepal
- Pakistan
- Sri Lanka

Sub-Saharan Africa
- Angola
- Benin
- Botswana
- Burkina Faso
- Burundi
- Cameroon
- Cape Verde
- Central African Republic
- Chad
- Comoros
- Congo, Dem. Rep.
- Congo, Rep.
- Côte d'Ivoire
- Eritrea
- Ethiopia
- Gabon
- Gambia, The
- Ghana
- Guinea
- Guinea-Bissau
- Kenya
- Lesotho
- Liberia
- Madagascar
- Malawi
- Mali
- Mauritania
- Mauritius
- Mayotte
- Mozambique
- Namibia
- Niger
- Nigeria
- Rwanda
- São Tomé and Principe
- Senegal
- Seychelles
- Sierra Leone
- Somalia
- South Africa
- Sudan
- Swaziland
- Tanzania
- Togo
- Uganda
- Zambia
- Zimbabwe

High-income non-OECD nations
- Andorra
- Antigua and Barbuda
- Aruba
- Bahamas, The
- Bahrain
- Barbados
- Bermuda
- Brunei Darussalam
- Cayman Islands
- Channel Islands
- Croatia
- Cyprus
- Equatorial Guinea
- Estonia
- Faeroe Islands
- French Polynesia
- Greenland
- Guam
- Hong Kong, China
- Isle of Man
- Israel
- Kuwait
- Liechtenstein
- Macao, China
- Malta
- Monaco
- Netherlands Antilles
- New Caledonia
- Northern Mariana Islands
- Oman
- Puerto Rico
- Qatar
- San Marino
- Saudi Arabia
- Singapore
- Slovenia
- Trinidad and Tobago
- United Arab Emirates
- Virgin Islands, (U.S.)

OECD nations
- Australia
- Austria
- Belgium
- Canada
- Czech Republic
- Denmark
- Finland
- France
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- Italy
- Japan
- Korea, Rep.
- Luxembourg
- Netherlands
- New Zealand
- Norway
- Portugal
- Slovak Republic
- Spain
- Sweden
- Switzerland
- United Kingdom
- United States

OECD = Organization for Economic Cooperation & Development

Table 2. Modified country classification system, based strictly on geography, and including additional countries from the Landed Immigrant Data Set.

East Asia & Pacific
- American Samoa
- Asia NES
- Australasia NES
- Brunei Darussalam
- Cambodia
- China
- Cook Islands
- Fiji
- French Polynesia
- Guam
- Hong Kong
- Indonesia
- Japan
- Kiribati
- Korea, Dem. Rep.
- Korea, Rep.
- Lao PDR
- Macao, China
- Malaysia
- Marshall Islands
- Micronesia, Fed. Sts.
- Mongolia
- Myanmar
- Nauru
- New Caledonia
- Northern Mariana Islands
- Oceania NES
- Palau
- Papua New Guinea
- Philippines
- Samoa
- Singapore
- Solomon Islands
- Taiwan
- Thailand
- Tibet
- Timor-Leste
- Tonga
- Vanuatu
- Vietnam

Eastern Europe & Central Asia
- Albania
- Armenia
- Azerbaijan
- Belarus
- Bosnia and Herzegovina
- Bulgaria
- Croatia
- Cyprus
- Czech Rebublic
- Estonia
- Georgia
- Kazakhstan
- Kosovo
- Kyrgyz Republic
- Macedonia, FYR
- Moldova
- Latvia
- Lithuania
- Montenegro
- Poland
- Romania
- Russian Federation
- Serbia
- Slovak Republic
- Slovenia
- Tajikistan
- Turkey
- Turkmenistan
- Ukraine
- Uzbekistan

Latin America & Caribbean
- Anguilla
- Antigua & Barbuda
- Argentina
- Aruba
- Bahamas, The
- Barbados
- Belize
- Bermuda
- Bolivia
- Brazil
- Cayman Islands
- Chile
- Colombia
- Costa Rica
- Cuba
- Dominica
- Dominican Republic
- Ecuador
- El Salvador
- French Guiana
- Grenada
- Guadeloupe
- Guatemala
- Guyana
- Haiti
- Honduras
- Jamaica
- Martinique
- Mexico
- Montserrat
- Netherlands Antilles
- Nicaragua
- Panama
- Panama Canal Zone
- Paraguay
- Peru
- Puerto Rico
- St. Kitts and Nevis
- St. Lucia
- St. Vincent and the Grenadines
- Suriname
- Trinidad and Tobago
- Turks & Caicos
- Uruguay
- Venezuela, RB
- Virgin Islands, (U.S.)
- Virgin Islands, British

Middle East & North Africa
- Algeria
- Bahrain
- Djibouti
- Egypt, Arab Rep.
- Iran, Islamic Rep.
- Iraq
- Israel
- Jordan
- Kuwait
- Lebanon
- Libya
- Morocco
- Oman
- Qatar
- Saudi Arabia
- Syrian Arab Republic
- Tunisia
- United Arab Emirates
- West Bank and Gaza
- Western Sahara
- Yemen, Rep.

South Asia
- Afghanistan
- Bangladesh
- Bhutan
- India
- Maldives
- Nepal
- Pakistan
- Sri Lanka

Sub-Saharan Africa
- Angola
- Benin
- Botswana
- Burkina Faso
- Burundi
- Cameroon
- Cape Verde
- Central African Republic
- Chad
- Comoros
- Congo, Dem. Rep.
- Congo, Rep.
- Côte d'Ivoire
- Eritrea
- Ethiopia
- Gabon
- Gambia, The
- Ghana
- Guinea
- Guinea-Bissau
- Kenya
- Lesotho
- Liberia
- Madagascar
- Malawi
- Mali
- Mauritania
- Mauritius
- Mayotte
- Mozambique
- Namibia
- Niger
- Nigeria
- Reunion
- Rwanda
- São Tomé and Principe
- Senegal
- Seychelles
- Sierra Leone
- Somalia
- South Africa
- Sudan
- Swaziland
- Tanzania
- Togo
- Uganda
- Zambia
- Zimbabwe

Western Europe
- Andora
- Austria
- Azores
- Belgium
- Channel Islands
- Denmark
- Faeroe Islands
- Finland
- France
- Germany
- Gibraltar
- Greece
- Greenland
- Hungary
- Iceland
- Ireland
- Isle of Man
- Italy
- Liechtenstein
- Luxembourg
- Madeira
- Malta
- Monaco
- Netherlands
- Northern Ireland
- Norway
- Portugal
- San Marino
- Spain
- St. Pierre and Miquelon
- Sweden
- Switzerland
- United Kingdom

REFERENCES

1. Whitehead M. The concepts and principles of equity and health. Health Promotion International. 1991; 6 (3): 217-28.
2. Kawachi I, Subramanian SV, Almeida-Filho N. A glossary for health inequalities. J Epidemiol Community Health. 2002 Sep; 56 (9): 647-52.
3. Culyer AJ. Equity - some theory and its policy implications. J Med Ethics. 2001 Aug; 27 (4): 275-83.
4. Culyer AJ, Wagstaff A. Equity and equality in health and health care. J Health Econ. 1993 Dec; 12 (4): 431-57.
5. Woodward A, Kawachi I. Why reduce health inequalities? J Epidemiol Community Health. 2000 Dec; 54 (12): 923-9.
6. Braveman P. Health disparities and health equity: concepts and measurement. Annu Rev Public Health. 2006; 27: 167-94.
7. Kilbourne AM, Switzer G, Hyman K, Crowley-Matoka M, Fine MJ. Advancing health disparities research within the health care system: a conceptual framework. American Journal of Public Health. 2006 Dec; 96 (12): 2113-21.
8. Mooney G, Jan S. Vertical equity: weighting outcomes? or establishing procedures? Health Policy. 1997 Jan; 39 (1): 79-87.
9. Perez C. Health status and health behaviour among immigrants. Stat Canada Health Rep. 2002; 13 (Supplement).
10. Strategic Research and Statistics. Recent Immigrants in Metropolitan Areas, Canada: A Comparative Profile Based on the 2001 Census. Ottawa 2005.
11. Beiser M. The health of immigrants and refugees in Canada. Can J Public Health. 2005 Mar-Apr; 96 Suppl 2: S30-44.
12. Kinnon D. Canadian Research on Immigration and Health: An Overview. Ottawa: Health Canada 1999.
13. Ministry of Finance. 2006 Census Highlights: Factsheet 7 - Immigration and Citizenship. 2007 [updated October 7, 2009]; Available from: http://www.fin.gov.on.ca/en/economy/demographics/census/cenhi06-7.html.
14. Ahmad F, Stewart DE. Predictors of clinical breast examination among South Asian immigrant women. Journal of Immigrant Health. 2004 Jul; 6 (3): 119-26.
15. McDonald JT, Kennedy S. Insights into the 'healthy immigrant effect': health status and health service use of immigrants to Canada. Soc Sci Med. 2004 Oct; 59 (8): 1613-27.
16. Ali JS, McDermott S, Gravel RG. Recent research on immigrant health from statistics Canada's population surveys. Can J Public Health. 2004 May-Jun; 95 (3): I9-13.
17. Glazier RH MR, Agha MM, Zagorski B, Hall R, Manuel DG, Sibley LM, Kopp A. The Impact of Not Having a Primary Care Physician Among People with Chronic Conditions: ICES Investigative Report. Toronto: Institute for Clinical Evaluative Sciences 2008.
18. Vissandjee B, Carignan P, Bourdeau-Marchand M. [New immigrant women and health].

Canadian Nurse. 1999 Apr; 95 (4): 35-41.
19. Hyman I. Immigration and Health: Working Paper 01-05. Ottawa: Health Canada2001.
20. Gushulak B. Healthier on arrival? Further insight into the "healthy immigrant effect". CMAJ. 2007 May 8; 176 (10): 1439-40.
21. Newbold KB, Danforth J. Health status and Canada's immigrant population. Soc Sci Med. 2003 Nov; 57 (10): 1981-95.
22. Wen SW, Goel V, Williams JI. Utilization of health care services by immigrants and other ethnic/cultural groups in Ontario. Ethn Health. 1996 Mar; 1 (1): 99-109.
23. Matuk LC. Pap smear screening practices in newcomer women. Womens Health Issues. 1996 Mar-Apr; 6 (2): 82-8.
24. Marshall KJ, Urrutia-Rojas X, Mas FS, Coggin C. Health status and access to health care of documented and undocumented immigrant Latino women. Health care for women international. 2005 Nov-Dec; 26 (10): 916-36.
25. Mohar A, Frias-Mendivil M. Epidemiology of cervical cancer. Cancer Invest. 2000; 18 (6): 584-90.
26. Duarte-Franco E, Franco EL. Cancer of the Uterine Cervix. BMC Womens Health. 2004 Aug 25; 4 Suppl 1: S13.
27. Franco EL, Duarte-Franco E, Ferenczy A. Cervical cancer: epidemiology, prevention and the role of human papillomavirus infection. CMAJ. 2001 Apr 3; 164 (7): 1017-25.
28. Morrison BJ. Screening for cervical cancer. In: Examination CTFotPH, editor. Canadian Guide to Clinical Preventive Health Care. Ottawa: Health Canada; 1994. p. 870-81.
29. National Cancer Institute of Canada. Canadian Cancer Statistics 2006. Toronto 2006.
30. Miller AB, Anderson G, Brisson J, Laidlaw J, Le Pitre N, Malcolmson P, et al. Report of a National Workshop on Screening for Cancer of the Cervix. CMAJ. 1991 Nov 15; 145 (10): 1301-25.
31. Kamangar F, Dores GM, Anderson WF. Patterns of cancer incidence, mortality, and prevalence across five continents: defining priorities to reduce cancer disparities in different geographic regions of the world. Journal of Clinical Oncology. 2006 May 10; 24 (14): 2137-50.
32. McLachlin CM, Mai, V., Murphy, J., Fung Kee Fung, M., Chambers, A. Cervical screening: a clinical practice guideline. In: Ontario Cervical Screening Program GCDSG, editor. Toronto, ON: Cancer Care Ontario; 2005.
33. Gakidou E. Coverage of cervical cancer screening in 57 countries: low average levels and large inequalities. PLoS medicine. 2008; 5 (6): 132.
34. Owusu GA, Eve SB, Cready CM, Koelln K, Trevino F, Urrutia-Rojas X, et al. Race and ethnic disparities in cervical cancer screening in a safety-net system. Matern Child Health J. 2005 Sep; 9 (3): 285-95.
35. Arbyn M, Castellsague X, de Sanjose S, Bruni L, Saraiya M, Bray F, et al. Worldwide burden of cervical cancer in 2008. Ann Oncol. 2011 Apr 6.
36. Sankaranarayanan R, Budukh AM, Rajkumar R. Effective screening programmes for

cervical cancer in low- and middle-income developing countries. Bull World Health Organ. 2001; 79 (10): 954-62.

37. Taylor RJ, Morrell SL, Mamoon HA, Macansh S, Ross J, Wain GV. Cervical cancer screening in a Vietnamese nominal cohort. Ethn Health. 2003 Aug; 8 (3): 251-61.
38. Perkins JJ, Sanson-Fisher RW, Byles JE, Tiller K. Factors relating to cervical screening in New South Wales, Australia. Health Place. 1999 Sep; 5 (3): 223-33.
39. Cheek J, Fuller J, Gilchrist S, Maddock A, Ballantyne A. Vietnamese women and Pap smears: issues in promotion. Aust N Z J Public Health. 1999 Feb; 23 (1): 72-6.
40. Siahpush M, Singh GK. Sociodemographic predictors of pap test receipt, currency and knowledge among Australian women. Prev Med. 2002 Oct; 35 (4): 362-8.
41. Jirojwong S, Maclennan R, Manderson L. Health beliefs and Pap smears among Thai women in Brisbane, Australia. Asia Pac J Public Health. 2001; 13 (1): 20-3.
42. Lesjak M, Hua M, Ward J. Cervical screening among immigrant Vietnamese women seen in general practice: current rates, predictors and potential recruitment strategies. Aust N Z J Public Health. 1999 Apr; 23 (2): 168-73.
43. Chavez LR, Hubbell FA, Mishra SI, Valdez RB. The influence of fatalism on self-reported use of Papanicolaou smears. Am J Prev Med. 1997 Nov-Dec; 13 (6): 418-24.
44. Hewitt M, Devesa S, Breen N. Papanicolaou test use among reproductive-age women at high risk for cervical cancer: analyses of the 1995 National Survey of Family Growth. Am J Public Health. 2002 Apr; 92 (4): 666-9.
45. Carrasquillo O, Pati S. The role of health insurance on Pap smear and mammography utilization by immigrants living in the United States. Prev Med. 2004 Nov; 39 (5): 943-50.
46. Akers AY, Newmann SJ, Smith JS. Factors underlying disparities in cervical cancer incidence, screening, and treatment in the United States. Current problems in cancer. 2007 May-Jun; 31 (3): 157-81.
47. Schleicher E. Immigrant Women and Cervical Cancer Prevention in the United States. Baltimore: Women's and Children's Health Policy Center, Johns Hopkins Bloomberg School of Public Health 2007.
48. Tsui J, Saraiya M, Thompson T, Dey A, Richardson L. Cervical cancer screening among foreign-born women by birthplace and duration in the United States. J Womens Health (Larchmt). 2007 Dec; 16 (10): 1447-57.
49. Kandula NR, Wen M, Jacobs EA, Lauderdale DS. Low rates of colorectal, cervical, and breast cancer screening in Asian Americans compared with non-Hispanic whites: Cultural influences or access to care? Cancer. 2006 Jul 1; 107 (1): 184-92.
50. Schulmeister L, Lifsey DS. Cervical cancer screening knowledge, behaviors, and beliefs of Vietnamese women. Oncol Nurs Forum. 1999 Jun; 26 (5): 879-87.
51. Scarinci IC, Beech BM, Kovach KW, Bailey TL. An examination of sociocultural factors associated with cervical cancer screening among low-income Latina immigrants of reproductive age. J Immigr Health. 2003 Jul; 5 (3): 119-28.

52. Carey Jackson J, Taylor VM, Chitnarong K, Mahloch J, Fischer M, Sam R, et al. Development of a cervical cancer control intervention program for Cambodian American women. J Community Health. 2000 Oct; 25 (5): 359-75.
53. Maxwell CJ, Bancej CM, Snider J, Vik SA. Factors important in promoting cervical cancer screening among Canadian women: findings from the 1996-97 National Population Health Survey (NPHS). Can J Public Health. 2001 Mar-Apr; 92 (2): 127-33.
54. Blackwell DL, Martinez ME, Gentleman JF. Women's compliance with public health guidelines for mammograms and pap tests in Canada and the United States: an analysis of data from the Joint Canada/United States Survey Of Health. Womens Health Issues. 2008 Mar-Apr; 18 (2): 85-99.
55. Xiong H, Murphy M, Mathews M, Gadag V, Wang PP. Cervical cancer screening among Asian Canadian immigrant and nonimmigrant women. Am J Health Behav. 2010 Mar-Apr; 34 (2): 131-43.
56. Fitch MI, Greenberg M, Cava M, Spaner D, Taylor K. Exploring the barriers to cervical screening in an urban Canadian setting. Cancer Nurs. 1998 Dec; 21 (6): 441-9.
57. Woltman KJ, Newbold KB. Immigrant women and cervical cancer screening uptake: a multilevel analysis. Can J Public Health. 2007 Nov-Dec; 98 (6): 470-5.
58. Woltman K, Newbold, K.B. Immigrant women, preventive health and place in Canadian CMAs. In: Paez A, Gallo, J., Buliung, R.N., editor. Progress in Spatial Analysis: Methods and Applications: Springer Berlin Heidelberg; 2010. p. 498.
59. Lofters A, Glazier RH, Agha MM, Creatore MI, Moineddin R. Inadequacy of cervical cancer screening among urban recent immigrants: a population-based study of physician and laboratory claims in Toronto, Canada. Prev Med. 2007 Jun; 44 (6): 536-42.
60. McDonald JT, Kennedy S. Cervical cancer screening by immigrant and minority women in Canada. Journal of immigrant and minority health. 2007; 9 (4): 323.
61. Cancer Care Ontario. Ontario Cervical Screening Program, Program Report 2001-2005. Toronto, ON.
62. Stuart G, Taylor G, Bancej CM, Beaulac J, Colgan T, Franco EL, et al. Report of the 2003 pan-Canadian forum on cervical cancer prevention and control. J Obstet Gynaecol Can. 2004 Nov; 26 (11): 1004-28.
63. Aday LA, Andersen R. A framework for the study of access to medical care. Health Serv Res. 1974 Fall; 9 (3): 208-20.
64. Gelberg L, Andersen RM, Leake BD. The Behavioral Model for Vulnerable Populations: application to medical care use and outcomes for homeless people. Health services research. 2000 Feb; 34 (6): 1273-302.
65. Williams JI, Young, W. Appendix 1: A Summary of Studies on the Quality of Health Care Administrative Databases in Canada. In: Goel V, Williams, JI., Anderson, GM., Blackstein-Hirsch, P., Fooks, C., Naylor, CD., editor. Patterns of Health Care in Ontario: The ICES Practice Atlas 2nd Edition. Toronto: Institute for Clinical Evaluative Sciences; 1996.

66. Insinga RP, Glass AG, Rush BB. Pap screening in a U.S. health plan. Cancer Epidemiol Biomarkers Prev. 2004 Mar; 13 (3): 355-60.
67. Fiscella K, Franks P, Meldrum S. Estimating racial/ethnic disparity in mammography rates: it all depends on how you ask the question. Prev Med. 2004 Aug; 39 (2): 399-403.
68. Howard M, Agarwal G, Lytwyn A. Accuracy of self-reports of Pap and mammography screening compared to medical record: a meta-analysis. Cancer Causes Control. 2009 Feb; 20 (1): 1-13.
69. Burgess DJ, Powell AA, Griffin JM, Partin MR. Race and the validity of self-reported cancer screening behaviors: development of a conceptual model. Prev Med. 2009 Feb; 48 (2): 99-107.
70. Li Wang X, Nie, J, Upshur, REG. Determining use of preventive health care in Ontario: Comparison of rates of 3 maneuvers in administrative and survey data. Can Fam Physician. 2009 February 2009; 55: 178-9.e5.
71. Thompson BL, O'Connor P, Boyle R, Hindmarsh M, Salem N, Simmons KW, et al. Measuring clinical performance: comparison and validity of telephone survey and administrative data. Health Serv Res. 2001 Aug; 36 (4): 813-25.
72. Gallaher G, Kim, S., Kirst, M., Lofters, A., Murphy, K., O'Campo, P., Quinonez, C., Schaefer-McDaniel, N., Shankardass, K. Measuring Equity of Care in Hospital Settings: From Concepts to Indicators. Toronto: Centre for Research on Inner City Health 2009.
73. Cancer Care Ontario: Insight on Cancer. News and Information on Cervical Cancer. Toronto: Canadian Cancer Society (Ontario Division) 2005.
74. Qi V, Phillips SP, Hopman WM. Determinants of a healthy lifestyle and use of preventive screening in Canada. BMC Public Health. 2006; 6: 275.
75. Damba C, Vahabi, M. Toronto Health System Monitoring: Equity Analysis. Toronto: Toronto Dsitrict Health Council 2001.
76. Fehringer G, Howlett R, Cotterchio M, Klar N, Majpruz-Moat V, Mai V. Comparison of papanicolaou (Pap) test rates across Ontario and factors associated with cervical screening. Canadian Journal of Public Health/Revue Canadienne de Sante Publique. 2005; 96 (2): 140-4.
77. 2001 Canadian Census Tables. Toronto: CHASS; [October 12 2009]; Available from: http://dc1.chass.utoronto.ca.myaccess.library.utoronto.ca/census/2001_rp_all.html.
78. Chan B, Anderson, GM. Trends in Physician Fee-for-service Billing Patterns. In: Goel V, Williams, JI., Anderson, GM., Blackstein-Hirsch, P., Fooks, C., Naylor, CD., editor. Patterns of Health Care in Ontario The ICES Practice Atlas. 2nd ed. Ottawa: Canadian Medical Association; 1996.
79. Maaten S GA, Kopp A, Handa M, Jaakkimainen L. Care of Women During Pregnancy and Childbirth. In: Jaakkimainen L UR, Klein-Geltink J, Leong A, Maaten S, Schultz S, Wang L., editor. Primary Care in Ontario: A Practice Atlas. Toronto: Institute for Clinical Evaluative Sciences; 2006.
80. Ethnic diversity and immigration. Overview 2007. Statistics Canada; 2007; [document].

Available from: http://www41.statcan.gc.ca/2007/30000/ceb30000_000-eng.htm.

81. Ministry of Finance. Census 2001 Highlights: Factsheet 1: Population Growth in Ontario's CMAs and the GTA. 2007 [updated October 7, 2009]; [document]. Available from: http://www.fin.gov.on.ca/english/economy/demographics/census/cenhi1.html.

82. 2006 Census Profile. Toronto: Canadian Census Analyser @ CHASS; [updated November 13, 2008]; Available from: http://dc2.chass.utoronto.ca.myaccess.library.utoronto.ca/census/2006/.

83. McNutt LA, Wu C, Xue X, Hafner JP. Estimating the relative risk in cohort studies and clinical trials of common outcomes. Am J Epidemiol. 2003 May 15; 157 (10): 940-3.

84. Wilkins R. PCCF+ Version 4E User's Guide. Automated Geographic Coding Based on the Statistics Canada Postal Code Conversion Files, Including Postal Codes to December 2003. Health Analysis and Measurement Group. Ottawa: Statistics Canada; 2004.

85. Snider JA, Beauvais JE. Pap smear utilization in Canada: estimates after adjusting the eligible population for hysterectomy status. Chronic diseases in Canada. 1998; 19 (1): 19.

86. Foster G, Goldsmith, C.H. Problems commonly associated with forest plots addressed using high resolution graphics in SAS (Paper 139-31). SAS Users Group International 31 Proceedings; 2006-03-26/29; San Francisco, CA.

87. Scott F, Fleiszer, P., Day, N., Kennedy, E. Public Health in Toronto, 2004: Program Profiles and Indicators. Toronto: Toronto Public Health 2005.

88. Tremblay M. The need for directly measured health data in Canada [editorial]. Can J Public Health. 2004; 95 (3): 165-6.

89. Pizarro J, Schneider TR, Salovey P. A source of error in self-reports of pap test utilization. J Community Health. 2002 Oct; 27 (5): 351-6.

90. Bowman JA, Sanson-Fisher R, Redman S. The accuracy of self-reported Pap smear utilisation. Social science & medicine. 1997 Apr; 44 (7): 969-76.

91. Mamoon H, Taylor R, Morrell S, Wain G, Moore H. Cervical screening: population-based comparisons between self-reported survey and registry-derived Pap test rates. Aust N Z J Public Health. 2001 Dec; 25 (6): 505-10.

92. McGovern PG, Lurie N, Margolis KL, Slater JS. Accuracy of self-report of mammography and Pap smear in a low-income urban population. American Journal of Preventive Medicine. 1998 Apr; 14 (3): 201-8.

93. Krzyzanowska M, Barbera, L., Elit, L., Kwon, J., Lofters, A., Saskin, R., Yeritsan, N., Bierman, A. Cancer. In: AS B, editor. Project for an Ontario Women's Health Evidence-Based Report. Toronto 2009.

94. 2006 Community Profiles - Health Region: Central West Health Integration Network (HR). Statistics Canada; [January 4, 2009]; Available from: http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=HR&Code1=3505&Geo2=PR&Code2=35&Data=Count&SearchText=Central%20West%20Health%20Integration%20Network&SearchType=Begins&SearchPR=01&B1=All&Custom=.

95. Oelke ND, Vollman AR. "Inside and outside": Sikh women's perspectives on cervical cancer screening. Canadian Journal of Nursing Research. 2007 Mar; 39 (1): 174-89.
96. National Cancer Institute of Canada. Canadian Cancer Statistics 2004. Toronto: The National Cancer Institute 2004.
97. Citizenship and Immigration Canada. Facts and Figures, 2002 Immigration Overview. Ottawa: Minister of Public Works and Government Services, Canada2003.
98. Global Commission on International Migration. Migration In An Interconnected World: New Directions For Action. Geneva: The Global Commission on International Migration 2005.
99. Spayne J, Ackerman I, Milosevic M, Seidenfeld A, Covens A, Paszat L. Invasive cervical cancer: a failure of screening. Eur J Public Health. 2008 Apr; 18 (2): 162-5.
100. Colgan TJ, Clarke A, Hakh N, Seidenfeld A. Screening for cervical disease in mature women: strategies for improvement. Cancer. 2002 Aug 25; 96 (4): 195-203.
101. Coughlin SS, King J, Richards TB, Ekwueme DU. Cervical cancer screening among women in metropolitan areas of the United States by individual-level and area-based measures of socioeconomic status, 2000 to 2002. Cancer Epidemiology, Biomarkers & Prevention. 2006 Nov; 15 (11): 2154-9.
102. Van Til L, MacQuarrie C, Herbert R. Understanding the barriers to cervical cancer screening among older women. Qualitative health research. 2003 Oct; 13 (8): 1116-31.
103. De Alba I, Sweningson JM. English proficiency and physicians' recommendation of Pap smears among Hispanics. Cancer Detection & Prevention. 2006; 30 (3): 292-6.
104. Garner EI. Cervical cancer: disparities in screening, treatment, and survival. Cancer Epidemiology, Biomarkers & Prevention. 2003 Mar; 12 (3): 242s-7s.
105. Donnelly TT. The health-care practices of Vietnamese-Canadian women: cultural influences on breast and cervical cancer screening. Canadian Journal of Nursing Research. 2006 Mar; 38 (1): 82-101.
106. Cervical Cancer Screening (With Pap Tests). Cancer Care Ontario; 2008; Available from: http://www.cancercare.on.ca/english/csqi2008/csqiaccess/csqi-cerv-screen/.
107. Comprehensive Cervical Cancer Control: A guide to essential practice. Geneva: World Health Organization. 2006.
108. Lofters AK, Moineddin R, Hwang SW, Glazier RH. Low rates of cervical cancer screening among urban immigrants: a population-based study in Ontario, Canada. Med Care. 2010 Jul; 48 (7): 611-8.
109. Wang JH, Sheppard VB, Schwartz MD, Liang W, Mandelblatt JS. Disparities in cervical cancer screening between Asian American and Non-Hispanic white women. Cancer Epidemiol Biomarkers Prev. 2008 Aug; 17 (8): 1968-73.
110. van Leeuwen AW, de Nooijer P, Hop WC. Screening for cervical carcinoma. Cancer. 2005 Oct 25; 105 (5): 270-6.
111. Webb R, Richardson J, Pickles A. A population-based study of primary care predictors of non-attendance for cervical screening. Journal of medical screening. 2004; 11 (3): 135-

40.
112. 2006 Census Highlights: Fact Sheet 7, Immigration and Citizenship. Ministry of Finance; [November 7, 2009]; Available from: http://www.fin.gov.on.ca/en/economy/demographics/census/cenhi06-7.pdf.
113. Census 2001 Highlights: Factsheet 1: Population Growth in Ontario's CMAs and the GTA. Ministry of Finance; 2007; [document]. Available from: http://www.fin.gov.on.ca/english/economy/demographics/census/cenhi1.html.
114. Data & Statistics - Country Classification. World Bank; 2008; Available from: http://go.worldbank.org/K2CKM78CC0.
115. Kralj B. Measuring "rurality" for purposes of health-care planning: an empirical measure for Ontario. Toronto: Ontario Medical Association; 2005 [December 9, 2009]; Available from: http://www.oma.org/Shortage/Data/00rurality.asp.
116. Finkelstein M. Preventive screening. What factors influence testing? Canadian family physician. 2002; 48: 1494-501.
117. Decker K, Demers, A., Chateau, D., Must, G., Nugent, Z., Lotocki, R., Harrison, M. Papanicolaou test utilization and frequency of screening opportunities among women diagnosed with cervical cancer. Open Medicine. 2009; 3 (3): 140-7.
118. The Johns Hopkins University ACG Case-Mix Adjustment System. Baltimore (MD): Johns Hopkins University School of Hygiene and Public Health; 1997.
119. Reid RJ, MacWilliam L, Verhulst L, Roos N, Atkinson M. Performance of the ACG case-mix system in two Canadian provinces. Med Care. 2001 Jan; 39 (1): 86-99.
120. Sasieni P, Castanon A, Cuzick J. Effectiveness of cervical screening with age: population based case-control study of prospectively recorded data. BMJ. 2009; 339: b2968.
121. Hislop GT, Bajdik CD, Regier MD, Barroetavena MC. Ethnic differences in survival for female cancers of the breast, cervix and colorectum in British Columbia, Canada. Asian Pac J Cancer Prev. 2007 Apr-Jun; 8 (2): 209-14.
122. Barghouti FF, Takruri AH, Froelicher ES. Awareness and behavior about Pap smear testing in family medicine practice. Saudi Med J. 2008 Jul; 29 (7): 1036-40.
123. Al Sairafi M, Mohamed FA. Knowledge, attitudes, and practice related to cervical cancer screening among Kuwaiti women. Med Princ Pract. 2009; 18 (1): 35-42.
124. Kiefe CI, Funkhouser E, Fouad MN, May DS. Chronic disease as a barrier to breast and cervical cancer screening. J Gen Intern Med. 1998 Jun; 13 (6): 357-65.
125. Heflin MT, Oddone EZ, Pieper CF, Burchett BM, Cohen HJ. The effect of comorbid illness on receipt of cancer screening by older people. J Am Geriatr Soc. 2002 Oct; 50 (10): 1651-8.
126. Marshall JG, Cowell JM, Campbell ES, McNaughton DB. Regional variations in cancer screening rates found in women with diabetes. Nurs Res. 2010 Jan-Feb; 59 (1): 34-41.
127. Subramanian SV, Chen JT, Rehkopf DH, Waterman PD, Krieger N. Comparing individual- and area-based socioeconomic measures for the surveillance of health disparities: A multilevel analysis of Massachusetts births, 1989-1991. Am J Epidemiol. 2006 Nov 1;

164 (9): 823-34.
128. Brotto LA, Chou AY, Singh T, Woo JS. Reproductive health practices among Indian, Indo-Canadian, Canadian East Asian, and Euro-Canadian women: the role of acculturation. Journal of Obstetrics & Gynaecology Canada: JOGC. 2008 Mar; 30 (3): 229-38.
129. Amankwah E, Ngwakongnwi E, Quan H. Why many visible minority women in Canada do not participate in cervical cancer screening. Ethn Health. 2009 Aug; 14 (4): 337-49.
130. Lofters AK, Hwang SW, Moineddin R, Glazier RH. Cervical cancer screening among urban immigrants by region of origin: A population-based cohort study. Prev Med, 2010; 51(6): 509-16.
131. Johnson CE, Mues KE, Mayne SL, Kiblawi AN. Cervical cancer screening among immigrants and ethnic minorities: a systematic review using the Health Belief Model. J Low Genit Tract Dis. 2008 Jul; 12 (3): 232-41.
132. Hislop TG, Inrig KM, Bajdik CD, Deschamps M, Tu SP, Taylor VM. Health care services and Pap testing behavior for Chinese women in British Columbia. J Immigr Health. 2003 Oct; 5 (4): 143-52.
133. Hislop TG, Teh C, Lai A, Ralston JD, Shu J, Taylor VM. Pap screening and knowledge of risk factors for cervical cancer in Chinese women in British Columbia, Canada. Ethn Health. 2004 Aug; 9 (3): 267-81.
134. Census 2006. Toronto: CHASS; [updated November 13 2008; cited 2009]; Available from: http://dc1.chass.utoronto.ca/myaccess.library.utoronto.ca/census/2006.
135. Ministry of Finance. 2006 Census Highlights: Fact Sheet 7, Immigration and Citizenship. [November 7, 2009]; Available from: http://www.fin.gov.on.ca/en/economy/demographics/census/cenhi06-7.pdf.
136. Ministry of Finance. 2006 Census Highlights: Factsheet 1. Population Counts: Canada, Ontario and Regions: Queen's Printer for Ontario; [updated October 7, 2009]; Available from: http://www.fin.gov.on.ca/en/economy/demographics/census/cenhi06-1.html.
137. Country Classifications, Data, The World Bank. The World Bank Group; 2010; Available from: http://data.worldbank.org/about/country-classifications.
138. Van Ness PH, Allore HG. Using SAS To Investigate Effect Modification. (Paper 195-31). SAS Users Group International 31 Proceedings; 2006-03-26/29; San Francisco, CA.
139. Dahrouge S, Glazier R, Hogg W. Defining Measures of Panel Size. Ottawa: CT Lamont Primary Health Care Research Centre; 2010; Available from: http://www.uwo.ca/fammed/csfm/siiren/primaryhealth/seed_funding_reports/simon_dahrouge_defining%20measures_of_panel_size.html.
140. Tu SP, Jackson SL, Yasui Y, Deschamps M, Hislop TG, Taylor VM. Cancer preventive screening: a cross-border comparison of United States and Canadian Chinese women. Prev Med. 2005 Jul; 41 (1): 36-46.
141. Black ME, Frisina A, Hack T, Carpio B. Improving early detection of breast and cervical cancer in Chinese and Vietnamese immigrant women. Oncology Nursing Forum Online. 2006; 33 (5): 873-6.

142. Donnelly TT. Challenges in providing breast and cervical cancer screening services to Vietnamese Canadian women: the healthcare providers' perspective. Nursing inquiry. 2008; 15 (2): 158-68.
143. Lee EE, Fogg L, Menon U. Knowledge and beliefs related to cervical cancer and screening among Korean American women. West J Nurs Res. 2008 Dec; 30 (8): 960-74.
144. Seidel D, Becker N, Rohrmann S, Nimptsch K, Linseisen J. Socio-demographic characteristics of participation in the opportunistic German cervical cancer screening programme: results from the EPIC-Heidelberg cohort. J Cancer Res Clin Oncol. 2009 Apr; 135 (4): 533-41.
145. Johnston GM, Boyd CJ, MacIsaac MA. Community-based cultural predictors of Pap smear screening in Nova Scotia. Can J Public Health. 2004 Mar-Apr; 95 (2): 95-8.
146. Simoes EJ, Newschaffer CJ, Hagdrup N, Ali-Abarghoui F, Tao X, Mack N, et al. Predictors of compliance with recommended cervical cancer screening schedule: a population-based study. J Community Health. 1999 Apr; 24 (2): 115-30.
147. Mishra SI, Luce-Aoelua PH, Hubbell FA. Predictors of papanicolaou smear use among american samoan women. J Gen Intern Med. 2001 May; 16 (5): 320-4.
148. Cabeza E, Esteva M, Pujol A, Thomas V, Sanchez-Contador C. Social disparities in breast and cervical cancer preventive practices. Eur J Cancer Prev. 2007 Aug; 16 (4): 372-9.
149. Wang PD, Lin RS. Sociodemographic factors of Pap smear screening in Taiwan. Public Health. 1996 Mar; 110 (2): 123-7.
150. Rodvall Y, Kemetli L, Tishelman C, Tornberg S. Factors related to participation in a cervical cancer screening programme in urban Sweden. Eur J Cancer Prev. 2005 Oct; 14 (5): 459-66.
151. Arbyn M, Simoens C, Van Oyen H, Foidart JM, Goffin F, Simon P, et al. Analysis of 13 million individual patient records pertaining to Pap smears, colposcopies, biopsies and surgery on the uterine cervix (Belgium, 1996-2000). Prev Med. 2009 May; 48 (5): 438-43.
152. Montano DE, Phillips WR. Cancer screening by primary care physicians: a comparison of rates obtained from physician self-report, patient survey, and chart audit. Am J Public Health. 1995 Jun; 85 (6): 795-800.
153. Berry JW. Immigration, acculturation, and adaptation. Applied Psychology: An International Review. 1997; 46 (1): 5-68.
154. Berry JW. Acculturation and health: theory and research. In: Kazarian SS, Evans, D.R., editor. Cultural Clinical Psychology: Theory, Research and Practice: Oxford University Press; 1998.
155. Lara M, Gamboa C, Kahramanian MI, Morales LS, Bautista DE. Acculturation and Latino health in the United States: a review of the literature and its sociopolitical context. Annu Rev Public Health. 2005; 26: 367-97.
156. Salant T, Lauderdale DS. Measuring culture: a critical review of acculturation and health in Asian immigrant populations. Soc Sci Med. 2003 Jul; 57 (1): 71-90.

157. Escobar JI, Vega WA. Mental health and immigration's AAAs: where are we and where do we go from here? J Nerv Ment Dis. 2000 Nov; 188 (11): 736-40.
158. Green EH, Freund KM, Posner MA, David MM. Pap smear rates among Haitian immigrant women in eastern Massachusetts. Public Health Rep. 2005 Mar-Apr; 120 (2): 133-9.
159. Lindau ST, Tomori C, Lyons T, Langseth L, Bennett CL, Garcia P. The association of health literacy with cervical cancer prevention knowledge and health behaviors in a multiethnic cohort of women. Am J Obstet Gynecol. 2002 May; 186 (5): 938-43.
160. Scott TL, Gazmararian JA, Williams MV, Baker DW. Health literacy and preventive health care use among Medicare enrollees in a managed care organization. Med Care. 2002 May; 40 (5): 395-404.
161. Ralston JD, Taylor VM, Yasui Y, Kuniyuki A, Jackson JC, Tu SP. Knowledge of cervical cancer risk factors among Chinese immigrants in Seattle. J Community Health. 2003 Feb; 28 (1): 41-57.
162. Risendal B, DeZapien J, Fowler B, Papenfuss M, Giuliano A. Pap smear screening among urban Southwestern American Indian women. Prev Med. 1999 Dec; 29 (6 Pt 1): 510-8.
163. Sutton S, Rutherford C. Sociodemographic and attitudinal correlates of cervical screening uptake in a national sample of women in Britain. Soc Sci Med. 2005 Dec; 61 (11): 2460-5.
164. Liao CC, Wang HY, Lin RS, Hsieh CY, Sung FC. Addressing Taiwan's high incidence of cervical cancer: factors associated with the Nation's low compliance with Papanicolaou screening in Taiwan. Public Health. 2006 Dec; 120 (12): 1170-6.
165. Boonpongmanee C, Jittanoon P. Predictors of Papanicolaou testing in working women in Bangkok, Thailand. Cancer Nurs. 2007 Sep-Oct; 30 (5): 384-9.
166. Amarin ZO, Badria LF, Obeidat BR. Attitudes and beliefs about cervical smear testing in ever-married Jordanian women. East Mediterr Health J. 2008 Mar-Apr; 14 (2): 389-97.
167. Peterson NB, Murff HJ, Cui Y, Hargreaves M, Fowke JH. Papanicolaou testing among women in the southern United States. J Womens Health (Larchmt). 2008 Jul-Aug; 17 (6): 939-46.
168. Reyes-Ortiz CA, Velez LF, Camacho ME, Ottenbacher KJ, Markides KS. Health insurance and cervical cancer screening among older women in Latin American and Caribbean cities. Int J Epidemiol. 2008 Aug; 37 (4): 870-8.
169. Ma GX, Toubbeh JI, Wang MQ, Shive SE, Cooper L, Pham A. Factors associated with cervical cancer screening compliance and noncompliance among Chinese, Korean, Vietnamese, and Cambodian women. J Natl Med Assoc. 2009 Jun; 101 (6): 541-51.
170. Glenn BA, Chawla N, Surani Z, Bastani R. Rates and sociodemographic correlates of cancer screening among South Asians. J Community Health. 2009 Apr; 34 (2): 113-21.
171. Islam N, Kwon SC, Senie R, Kathuria N. Breast and cervical cancer screening among South Asian women in New York City. J Immigr Minor Health. 2006 Jul; 8 (3): 211-21.
172. Tsui J, Tanjasiri SP. Cervical cancer screening among Thai women in Northern California. Journal of Women's Health. 2008 Apr; 17 (3): 393-401.

173. Juon HS, Seung-Lee C, Klassen AC. Predictors of regular Pap smears among Korean-American women. Prev Med. 2003 Dec; 37 (6 Pt 1): 585-92.
174. Dissemination Area (DA), 2001 Census. Statistics Canada; [updated September 15, 2010September 15, 2010]; Available from: http://www12.statcan.ca/english/census01/Products/Reference/dict/geo021.htm.
175. Association of Ontario Health Centres. Association of Ontario Health Centres; 2005 [September 15, 2010]; Available from: http://www.aohc.org.
176. Glazier RH, Creatore MI, Agha MM, Steele LS. Socioeconomic misclassification in Ontario's Health Care Registry. Can J Public Health. 2003 Mar-Apr; 94 (2): 140-3.
177. Ahmad F, Cameron JI, Stewart DE. A tailored intervention to promote breast cancer screening among South Asian immigrant women. Social Science and Medicine. 2005 February; 60 (3): 575-86.
178. Grewal S, Bottorff JL, Balneaves LG. A Pap test screening clinic in a South Asian community of Vancouver, British Columbia: challenges to maintaining utilization. Public Health Nurs. 2004 Sep-Oct; 21 (5): 412-8.
179. McAvoy BR, Raza R. Can health education increase uptake of cervical smear testing among Asian women? BMJ. 1991 Apr 6; 302 (6780): 833-6.
180. Arevian M, Noureddine S, Kabakian-Khasholian T. Raising awareness and providing free screening improves cervical cancer screening among economically disadvantaged Lebanese/Armenian women. J Transcult Nurs. 2006 Oct; 17 (4): 357-64.
181. Fernandez ME, Gonzales A, Tortolero-Luna G, Williams J, Saavedra-Embesi M, Chan W, et al. Effectiveness of Cultivando la Salud: a breast and cervical cancer screening promotion program for low-income Hispanic women. Am J Public Health. 2009 May; 99 (5): 936-43.
182. Mock J, Nguyen T, Nguyen KH, Bui-Tong N, McPhee SJ. Processes and capacity-building benefits of lay health worker outreach focused on preventing cervical cancer among Vietnamese. Health Promot Pract. 2006 Jul; 7 (3 Suppl): 223S-32S.
183. Nguyen TT, McPhee SJ, Bui-Tong N, Luong TN, Ha-Iaconis T, Nguyen T, et al. Community-based participatory research increases cervical cancer screening among Vietnamese-Americans. J Health Care Poor Underserved. 2006 May; 17 (2 Suppl): 31-54.
184. Larkey L. Las mujeres saludables: reaching Latinas for breast, cervical and colorectal cancer prevention and screening. J Community Health. 2006 Feb; 31 (1): 69-77.
185. de Nooijer DP, de Waart FG, van Leeuwen AW, Spijker WW. [Participation in the Dutch national screening programme for uterine cervic cancer higher after invitation by a general practitioner, especially in groups with a traditional low level of attendance]. Ned Tijdschr Geneeskd. 2005 Oct 15; 149 (42): 2339-43.
186. Bastani R, Berman BA, Belin TR, Crane LA, Marcus AC, Nasseri K, et al. Increasing cervical cancer screening among underserved women in a large urban county health system: can it be done? What does it take? Med Care. 2002 Oct; 40 (10): 891-907.

187. Leung MW, Yen IH, Minkler M. Community based participatory research: a promising approach for increasing epidemiology's relevance in the 21st century. Int J Epidemiol. 2004 Jun; 33 (3): 499-506.
188. Alonzo TA, Pepe MS. Using a combination of reference tests to assess the accuracy of a new diagnostic test. Stat Med. 1999 Nov 30; 18 (22): 2987-3003.
189. Cervical Cancer Screening (With Pap Tests). Cancer Care Ontario; 2008; Available from: http://www.cancercare.on.ca/english/csqi2008/csqiaccess/csqi-cerv-screen/.
190. Country Classifications, Data, The World Bank. The World Bank Group; 2010; Available from: http://data.worldbank.org/about/country-classifications.