Recent Trends in Cancer Screening Uptake Amongst Immigrants in Canada between 2005-2015

by

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submitted by Amina Moustaqim-Barrette in partial fulfillment of the requirements for

the degree of Master of Science

in Population and Public Health

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Abstract

INTRODUCTION: In 2016 alone, an estimated 202,400 Canadians developed cancer, and 78,800 died of the disease. In Canada, the use of reliable screening techniques for three types of cancer – breast, cervical, and colorectal – could help decrease cancer burden on a national scale. However, the literature also suggests that cancer screening uptake may be hampered in specific subpopulations, including among Canadian immigrants. The current study seeks to examine the association between immigration and breast, cervical, and colorectal cancer uptake.

METHODS: This analysis uses ten years of data, 2005 – 2015, from the Canadian Community Health Survey (CCHS). Survey cycles were pooled to create an average pseudo-population and a bootstrap resampling technique was used to estimate variance. Age and sex-standardized rates were used to examine breast, cervical, and colorectal cancer screening rates between recent immigrants, long-term immigrants, and Canadian-born individuals. Multivariate logistic regression was used to evaluate the impact of immigration status on non-adherence and never screening, as well as to look at differences among immigrant subgroups and between screening years.

RESULTS: Results indicate that recent immigrants (residing in Canada for 0 – 9 years) may have higher odds of never screening and non-adherence for breast cancer screening (AOR 2.15 (CI 0.89 – 5.20) and AOR 1.73 (CI 0.90 – 3.33), respectively), for cervical cancer screening (AOR 1.27 (CI 0.70 – 2.29) and AOR 1.47 (CI 0.98 – 2.21), respectively), and for colorectal cancer screening (AOR 1.75 (CI 1.11 – 2.77) and AOR 1.54 (CI 0.98 – 2.44), respectively) compared to Canadian-born individuals, although most results were not statistically significant. Importantly, several sociodemographic factors were significantly associated with never screening and non-adherence, including higher income and higher educational attainment. There was some evidence of differential uptake in immigrants by world region of birth and racial origin. The risk of non-adherence and never-screening among immigrants did not change significantly between 2005 – 2015.

CONCLUSIONS: This study indicates that immigrants residing in Canada for 9 years or less are at higher risk of never screening and non-adherence to breast, cervical, and colorectal cancer screening guidelines. This study supports targeted interventions to increase preventative cancer screening use among newcomers to Canada.

Lay Summary

With projected increases in the Canadian immigrant population from 20% in 2006 to 25% to 28% by 2031, it has become increasingly important to monitor immigrant health and healthcare access in Canada, including preventative cancer screening care, in order to reduce avoidable inequities. My project sought to provide a comprehensive overview of differences in breast, cervical, and colorectal cancer screening uptake in immigrants compared to non-immigrants in Canada.

This project made use of ten cycles of a nationally representative cross-sectional survey data to summarize lifetime and adherence breast, cervical, and colorectal cancer screening rates in immigrants and the Canadian-born population. Results suggest that recent immigrants (<10 years of residency in Canada) had higher odds of never screening and non-adherence to breast, cervical, and colorectal cancer screening guidelines. Differences between immigrant subgroups were also observed, although between the years of 2005 and 2015 there was no significant improvements in immigrant screening uptake. The results of this study demonstrate a need for targeted interventions that address accessibility barriers to preventative health services for new immigrants to Canada.

Preface

This study conducted secondary analyses of confidential data files provided by Statistics Canada. While the study was submitted to the Behavioural Research Ethics Board (REB) at the University of British Columbia (Certificate # H17-01772), the REB determined that a review was not required for research that relies exclusively on secondary analysis of anonymous information, so long as the process of data linkage or recording or dissemination of results does not generate identifiable information.

The work presented in this thesis project was conceived and conducted by the candidate under the supervision of Dr. Trevor Dummer, and with the guidance of the supervisory committee: Dr. Arminée Kazanjian and Dr. John Spinelli. The thesis manuscript was prepared by the candidate with evaluation and feedback from the supervisory committee.

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List of Abbreviations

AIC – Akaike information criterion

CCHS – Canadian Community Health Survey

CHA – Canada Health Act

CPAC – The Canadian Partnership Against Cancer

CTFPHC – Canadian Task Force of Preventive Health Care

CRC – Colorectal Cancer

FOBT – Fecal Occult Blood Test

gFOBT – Guaiac Fecal Occult Blood Test

iFOBT – Immunochemical Fecal Occult Blood Test

IARC - International Agency for Research on Cancer

HBF – Health Behaviour Framework

HPV – Human Papillomavirus

HR – Health Region

LRT – Likelihood Ratio Test

MAM – Mammogram

PAP – Papanicolaou test

RCT – Randomized Controlled Trials

RDC – Research Data Centre

REB – Research Ethics Board

TPB – Theory of Planned Behaviour

UBC – The University of British Columbia

USPSTF – The United States Preventive Service Task Force

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This thesis would not have been possible without the support of several individuals, and I am glad for the opportunity to express my gratitude to them here.

Thank you firstly to my supervisor, Dr. Trevor Dummer, who showed me nothing but encouragement and support throughout this project. I cannot thank you enough for the time and guidance you allotted me, and I feel ever grateful for having found you as a supervisor. Thank you also to my committee members Dr. Arminée Kazanjian and to Dr. John Spinelli, for your time, knowledge, and patience. With Trevor's advice in epidemiological methods and guidance throughout my master's project, Arminée's breadth of knowledge on the subject of minority health, and John's expertise and recommendations regarding statistical methods, I truly do not feel that I could have chosen a better supervisory committee. I feel grateful for having had the opportunity to learn from you all, and I hope to continue to do so in the future.

A big thank you is also due to my partner Alex for his endless love, encouragement, and reassurance. If I have earned this degree it is because you embarked on your own rigorous study of how to deal with me during my bouts of extreme stress and anxiety. Thank you also to my two sisters and my mother for always throwing their full support behind me, and for celebrating all my achievements as if they were their own. Little that I have done in the past three years could have been realised without all of you by my side.

Most of all, thank you to my late father – my baba – to whom I owe every opportunity, every accomplishment, and every joy in life..

Pour baba, mon exemple éternel.

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Chapter 1: Introduction

1.1 Purpose

In 2016 alone, an estimated 202,400 Canadians developed cancer, and 78,800 died of the disease (1). In Canada, colorectal and breast cancers each account for about 13% of cancer cases in the population, and among women breast cancer is the most commonly diagnosed cancer, representing 25% of all cancers among females(2). Cervical cancer is less prevalent, although is the 13th most commonly diagnosed cancer among women and represents about 1.5% of female cases overall. The ability of screening techniques for breast, cervical, and colorectal cancers (Mammography, Pap smears, and fecal tests or sigmoidoscopy, respectively) in reducing the mortality and morbidity of these diseases has been demonstrated(3), and the literature suggests that population screening using these techniques at a population level could help decrease cancer burden on a national scale (4). Indeed, estimates of the premature deaths that could be avoided through cancer screening vary from 25% - 31% for breast(5), 15% - 33% for colorectal cancer(6), and 60% - 80% for cervical cancer(7). In addition to reducing mortality, cancer screening has also been shown to reduce morbidity, as it promotes regular check-ins with physicians and early-stage treatment is often less aggressive than for more advanced-stage cancers(8)(9).

While population-based screening programs for breast, cervical, and colorectal cancer have been implemented, or are in the process of being implemented, in all Canadian provinces (10), several US and Canadian studies have suggested that immigrant subpopulations have a lower rate of cancer screening service utilization as compared to the general population(11)(12). With the proportion of immigrants in Canada – which is currently around 20% - growing steadily over time, it is important to understand disparities in use in order to better tailor Canadian health services to vulnerable communities and subpopulations. To this end, this thesis seeks to provide an overview the evidence of breast mammography, cervical Pap tests, and fecal occult blood test (FOBT) or endoscopy colorectal cancer screening uptake amongst immigrant populations across Canada, in the context of available population screening programs. The aim of this study is to provide an understanding of the difference in utilisation of breast, cervical, and colorectal cancer screening between Canada's general population and its immigrant population, as well as to assess differences between subpopulations, sociodemographic correlates of use, and trends in screening over time. A comprehensive overview of current trends and inequities in screening uptake will help guide future policy decisions and shape improvements to current and future population screening programs.

1.2 Study Objectives

The primary goal of examining screening uptake and factors related to uptake amongst immigrants, as compared to non-immigrants, in the context of established and universally available guidelines and population screening programs in Canada, is to answer the following question: ***Is there an association between immigration status and preventative breast, cervical, and colorectal cancer screening utilisation?*** To answer this question, this thesis will focus on three specific objectives:

> <u>Objective 1.</u> Summarise uptake of lifetime and guideline recommended breast, cervical, and CRC screening in immigrants compared to non-immigrants across Canada, and b) summarise the effect of sociodemographic correlates of screening participation in immigrants compared with non-immigrants;
>
> <u>Objective 2.</u> Explore differences in breast and cervical cancer screening rates among immigrant subgroups based on world region of birth as well as racial/cultural origin;
>
> <u>Objective 3.</u> Assess breast and cervical cancer screening rates across multiple CCHS survey years to determine temporal trends in cancer screening uptake of immigrants and non-immigrants in Canada in relation to the implementation of population screening programs.

1.3 Thesis Overview

The thesis is divided into five chapters. The first chapter presents a brief introduction to the motivations and objectives of this project. The second chapter provides background on key topics and a literature review of current evidence of the associations between immigration status and cancer screening in Canada. The third chapter describes the data sources, variable selection, and statistical methods used to address each objective. The fourth chapter presents the results for each objective. The fifth and final chapter is similarly divided by objectives and aims to situate the results within the literature and current Canadian context, and provides suggestions for future research avenues and policy implications.

Chapter 2: Literature Review and Conceptual Framework

2.1 Cancer Screening in Canada

While Canadian health coverage is considered universal in that it is federally mandated and financed through taxation for all citizens, provinces are responsible for health care provision under the Canadian constitution(13). This has meant that provinces are individually responsible for healthcare provision, including provision of preventative screening programs and services. While provincial jurisdiction over healthcare has the distinct advantage of allowing for provincial governments to address province-specific priorities and to target services to their particular provincial demographics, it has also meant that national-level health strategies and recommendations require constant provincial capacity and cooperation. Importantly, smaller provinces and territories, with more sparse geographies, and fewer workers and financial resources, may have less capacity compared with larger provinces to implement robust population screening programs.

Currently in Canada, a number of national bodies monitor and disseminate recommendations for cancer screening guidelines. One of them, the Canadian Task Force on Preventive Health Care (CTFHC) is a federally funded organisation that regularly reviews the evidence for cancer screening methods and publishes national cancer screening guidelines and targets(14) and outlines the potential benefits and possible harms of screening healthy.

Average risk adults for cancer, cancer screening is delivered via either opportunistic screening (where delivery depends on a patient or physician initiating a conversation on the need for screening) or through programmatic screening, where the systematic screening of average risk individuals is accomplished through organised provincial screening programs(15). Efforts have been made to decrease opportunistic screening and consolidate efforts through programmatic screening - which is designed to provide some quality control over screening, reduce the burden of disease in the population, to maximize the benefit of public health care dollars, and to protect against the potential harms of over-screening or screening outside guideline (15).

The literature suggests that the degree of compliance between opportunistic screening and national screening guidelines in the absence of programmatic screening is low (15,16). And while provincial population screening programs do tend to adhere to the national guidelines set by the CTFPHC and other bodies, provinces do set their criteria according to their own provincial research bodies and conclusions, resulting in slight differences between provincial programs. As an example of the discrepancies that exist between provinces and national guidelines, Prince Edward Island currently recommends breast cancer screening using mammography once every year for women aged 40 – 75, while national guidelines recommend screening one every two years for women aged 50 – 74. Details for screening recommendations for each province are outlined in Appendix C of this thesis.

2.1.1 Breast Cancer Screening Guidelines and Methods

CTFPHC guidelines formerly recommend that women ages 50- 74 years old should participate in routine mammography screening every 2 – 3 years (strong recommendation) (17). In December 2018, the CTFPHC updated their recommendations for breast cancer screening. While screening is still recommended for women ages 50 -74, it is now labeled a 'weak recommendation', and women are encouraged to speak with their physician to determine the best course of action for each individual(18). Because this thesis was in large majority conducted in 2017, the paper reflects pre-2018 recommendations.

Mammography is an x-ray of the breast that uses low doses of radiation to produce an image called a mammogram, which can help physicians identify both malignant and benign tumours in the breast(19). While the test involves placing the breast between two plastic compression plates to be screened and may cause some discomfort, it is not considered painful and does not require any special preparation. The test does require a trip to a physician's office, requires women to undress and to be helped by a technician, and takes about 10 – 15 minutes to complete. As with all screening tests, sensitivity and specificity estimates vary; estimate of mammography sensitivity range from 75% - 90% and specificity from 90% to 95% (20). Observational studies and RCTs have estimate that mammography contribute to a 25% - 31% reduction in breast cancer mortality (5).

While mammography has been used for decades to screen for breast cancer and is generally considered the best screening test currently available, as suggested by randomized controlled trials evaluating its efficacy(5), it is not without its limitations. Indeed, a number of recent studies examining the false positive rate of mammography have renewed debates over the risks associated with regular breast cancer screening. One highly cited study published in the New England Journal of Medicine in 1998 found that 31.7% of women had at least one false positive result for screening using mammography or breast examination (21). Another meta-analysis published in 2000 concluded that screening for breast cancer with mammography was unjustified, and that for every 1000 women screened biennially throughout 12 years, one breast-cancer death is avoided whereas the total number of deaths is increased by six (22). These and other studies have fueled international debates on the use of mammography, especially among younger women aged 40 – 49 years old, and ultimately instigated changes to screening recommendations by both the CTFPHC in 2011 and the United States Preventive Service Task Force (USPSTF) in November 2009, both choosing to remove women under the age of 50 from recommended mammography screening. Nevertheless, in 2014 the International Agency for Research on Cancer (IARC) brought together a group of 29 international experts from 16 countries to assess the benefits and harms associated with breast cancer screening, and concluded that mammography does markedly reduce the risk of breast-cancer related mortality and morbidity and recommended its continued use (23).

2.1.2 Cervical Cancer Screening Guidelines and Methods

Current CTFPHC guidelines recommend screening in women age 25 - 69 using a Pap test once every three years. For women aged 20 - 24, a weak recommendation with moderate quality evidence against routine screening spurred changes to the guidelines in 2013, although several provinces continue to screen women beginning at age 21 (see Appendix C). The Pap test, or Papanicolaou test, is a procedure that removes a small sample of cells from the cervix. It has been used widely in Canada since 1960(3), and has a sensitivity between 55% - 80% and specificity of around 95% (24). Pap tests are used to check for abnormal cell changes in order to diagnose precancerous conditions of the cervix, a process called cytology, as well as conditions of the vagina and vaginal cancer, and infections and inflammation in the lower female reproductive tract (25). Pap tests are relatively quick (around 5 minutes for the test), require a visit to a physician, require a woman to undress, and are not usually considered to be painful. The process first involves a pelvic exam to check for pain or tenderness. A speculum is then inserted to separate the walls of the vagina so that a physician can see the cervix and take a swab of the surface of the cervix (25).

While Pap tests are currently the most commonly used and cost-effective screening option, false positive and false negative results remain a risk of Pap screening. One long-term cohort study found a 14.4% false-positive rate that resulted in unnecessary interventions and treatments(26). Recently, some studies – including an influential randomized controlled trial out of the BC Cancer Agency - found that HPV-based testing compared with cytology testing is significantly more sensitive(7). This research has spurred efforts to replace the Pap test with the HPV screening test in the future, although Pap tests are still widely recommended, and any possibility of their large-scale replacement may still be some years away.

2.1.3 Colorectal Cancer (CRC) Screening Guidelines and Methods

Colorectal cancer (CRC) screening guidelines are currently under revision by the CTFPHC, but presently recommend that asymptomatic men and women age 50 – 74 be screened every two years using fecal testing or once every 10 years using flexible sigmoidoscopy (27). Randomized controlled trials (RCTs) have demonstrated that screening using Guaiac Fecal Occult Blood Testing (gFOBT) can reduce colorectal cancer mortality and the incidence of late-stage colorectal cancer (28). A Cochrane meta-analysis quantified the relative reduction in mortality to 16% using gFOBT (29), and while there are no RCTs of the effect of Immunochemical Fecal Occult Blood Testing (iFOBT or FIT) on CRC mortality, many studies have shown that FIT has higher sensitivity for both advanced adenoma and for CRC compared with gFOBT (FIT 61% - 91% sensitivity versus gFOBT 25% - 38% sensitivity) (16,30,31). Both tests have high specificity, between 91% - 98% for FIT versus 98% - 99% with gFOBT (32). As a result, FIT tests are the preferred screening tests in most provinces (See Appendix C). RCTs have also shown that flexible sigmoidoscopy decreases the risk of CRC mortality by 22% - 31%, and incidence of late-stage colorectal cancer by 18% - 31% (33–35).

Both gFOBT and FIT are stool based tests that involve essentially the same non-invasive procedure for the patient. Stool is usually collected at home using a clean, dry container, applied to testing paper using a swab provided to the patient, and sent to a laboratory for analysis. gFOBT uses a chemical reaction to find traces of blood in the stool, while iFOBT or FIT uses specific antibodies for human blood to find traces of blood in the sample (33). Importantly, because gFOBT – and not iFOBT – tends to detect animal blood, fasting before testing is required. An important advantage of fecal tests is that the test kit can be mailed to individuals at home, where they are administered by the patient, and mailed back to the physician's office or lab.

Sigmoidoscopy is a procedure performed using a sigmoidoscope (a thin, tube-like structure with a light and lens), which allows a physician to look at the lining of sigmoid colon and the rectum. Flexible sigmoidoscopies, which describe the use of sigmoidoscopes that are soft and able to bend, can help diagnose colorectal cancer and provide an opportunity to examine polyps or other growths. The procedure requires a trip to the physician's office and takes around 20 minutes to complete. The sigmoid colon and rectum need to be clean and empty before the test, so laxatives or an enema is usually prescribed. The patient is required to undress, and a digital rectal exam is done (physician checks for blockage in the rectum by inserting a gloved finger into the anus and rectum). Finally, the physician puts the sigmoidoscope into the anus and slowly passes it through the rectum and sigmoid colon, and air is pumped into the colon to stretch the lining in order for the physician to see the entire surface. This process does cause discomfort and some pressure, but usually does not require any sedation(34).

Unlike flexible sigmoidoscopies, which only allow for an examination of rectum and lower third of the colon, colonoscopies permit a structural inspection of the entire colon, and allow for a same-session polypectomy (biopsy of polyps) (35). Colonoscopies require significant preparation (patient cannot eat solid foods for 1-2 days before the test), and the colon needs to be flushed out before the test. The procedure itself usually takes 30 – 45 minutes, and patients are monitored for 1 -2 hours after the test and are not allowed to drive for 12 hours following a colonoscopy. The side effects colonoscopies are rare of but are potentially serious and include: blood in the stool, nausea, vomiting, bloating and irritation of the rectum, the risk of bowel perforation, and heavy bleeding. Given the cost, side effects, and health care resources of colonoscopies, they are used primarily as a follow-up for other screening tests. In addition, no randomized controlled trials have reported the mortality benefit of screening with colonoscopy, and the CTFPHC's 2016 colorectal cancer screening guidelines recommended against colonoscopies for screening purposes; no recommendations on use of screening colonoscopies were made prior to 2016 (36). The term ‘endoscopy’ is used to describe all procedures used to examine a person’s digestive tract, including sigmoidoscopies and colonoscopies.

2.2 Breast, Cervical, and Colorectal Cancer Screening Programs in Canada

Programmatic screening generally includes: a program policy of the screening test provided, the screening interval and who is eligible for screening, screening invitations and reminders for the eligible population, and monitoring the follow-up of individuals with abnormal screening results (3). And while these basics exist across population screening programs, there remains some differences between provincial program structures. For example, the Ontario Breast Screening Program (OBSP) sends invitations to eligible women beginning at age 50 along with information about breast cancer screening and details of how to find an OBSP site. Result letters are sent to women after their screening visit, and OBSP sites follow up on abnormal screening results and community both normal and abnormal results to a women’s healthcare provider (37). Mobile clinics also exist for more remote regions. However, not all provinces have access to population-based lists, so programs like that in Prince Edward Island and Nova Scotia rely on media campaigns and physician education to increase referrals in order to sign up eligible women to provincial programs.

The first instance of organised cancer screening programs in Canada is from 1960, when British Columbia began offering Pap tests to women in order to address cervical cancer screening. And while cervical cancer screening has been around for decades, the majority of other provinces only introduced organised cervical cancer screening programs in the early 2000’s. There is still no organised cervical cancer screening program in Quebec.

Organised breast cancer screening programs are the most comprehensive throughout Canada; the first was implemented again in British Columbia in 1988, and the last province to implement a breast screening program was Quebec in 1998. All provincial program start dates can be found in Appendix C.

Finally, organised colorectal cancer screening programs are less established across Canada, with the first province to announce its intentions to create an organised screening program in 2007 in Ontario, followed by Alberta and Manitoba. By the end of 2014, programmatic colorectal cancer screening had been implemented in five additional provinces

(British Columbia, Saskatchewan, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador). Some programs have been slow to roll out - there is still no full population coverage in Quebec, Newfoundland and Labrador, or New Brunswick. The relative recency of colorectal cancer screening guidelines and provincial screening programs have made it difficult to interpret the underpinnings of national colorectal cancer screening rates, though this will be further addressed in Chapter 3 of this thesis. The Canadian territories still have no programmatic screening programs, except in the Yukon and Northwest Territories where breast cancer screening programs were introduced in 2018 and 2003, respectively (36).

As stated above, while provincial screening programs, provincial screening recommendations, and national recommendations generally do follow the same trends in reviewing evidence and updating their guidelines accordingly, guidelines and population targets for screening programs can differ slightly from one province to the next. For example, while British Columbia currently recommended Pap tests for women 25 – 69 every three years, Quebec recommendations include women 21 – 65 for screening every two – three years. In this project, adherence to cancer screening is evaluated according to CTFPHC guidelines, although details regarding provincial screening programs are provided in Appendix C.

2.3 Overview of Immigrants to Canada

In 2011, Canada's foreign-born population totalled more than 6 million people, representing 20.6% of the total population – the highest among all G8 countries and the highest in the Canada's history. While the definition of immigrants varies across data sources, Statistics Canada defines an 'immigrant' as "any person who is or has ever been a landed immigrant/permanent resident. This person has been granted the right to live in Canada permanently by immigration authorities. Some immigrants have resided in Canada for a number of years, while others have arrived recently. Some immigrants are Canadian citizens, while others are not." (38). There are many different paths to immigration in Canada, and these can be separated into three main classes: economic class (immigration for federal and Quebec skilled workers), family class (immigration through family sponsorship) and protected persons and refugees (includes government assisted and privately sponsored refugees, and other humanitarian immigrants) (39). In 2016, about 53% of admitted immigrants to Canada were economic class immigrants, 26% were family class immigrants, and 21% were protected persons or refugees(40). The literature generally considers recent immigrants to be those who have resided in Canada for nine years or less, while ‘long term immigrants’ are those who have resided in Canada for ten years or more(42–44).

Figure 2.1 demonstrates the source countries of Canadian immigration until 2011. Until 1971, so for immigrants residing in Canada for 45 years or more, 78.3% of them originally immigrated from Europe. Up to 1967, the Canadian government gave preferential treatment to settlers from the British Isles, the United States, and Western Europe. 1967 marked the year that ended preferential treatment and introduced a points system that would give preference to individuals with certain skills and education, had relatives in the country, or were interested in settling in parts of the country with the greatest need for workers(41). In response, demographics began to shift dramatically in the 1970s, when Canada began accepting larger proportions of immigrants from the United States (6.5%), the Caribbean, Central and South America (17.3%, Africa (5.8%), and Asia, including the Middle East (33.8%), although the highest proportion between 1971 and 1980 was still among European immigrants (35.1%). The proportion of non-European immigrants continued to grow between 1981 and 2011. Between 2006 and 2011, only 13.7% of all immigrants were from Europe, whereas 12.3% were from the Caribbean, Central and South America, 12.5% were from Africa, and a largest majority, 56.9%, were from Asia, including the Middle East.

Between 2006 and 2011, the top source country of immigrants from Asia was the Philippines, which represented 13.1% of all newcomers, followed by China (10.5% of all newcomers), and India (10.4% of all newcomers). Completing the top 10 countries of birth were the United States, Pakistan, the United Kingdom, Iran, South Korea, Colombia, and Mexico. The vast majority (94.8%) of newcomers settle in one of four provinces: Ontario, British Columbia, Quebec and Alberta. In comparison, these four provinces account for 83.7% of all Canadian-born individuals. The proportion of immigrants settling in these four provinces is largest in Ontario (53.3%), then British Columbia (17.6%), Quebec (14.4%), and finally Alberta (9.5%)(42).

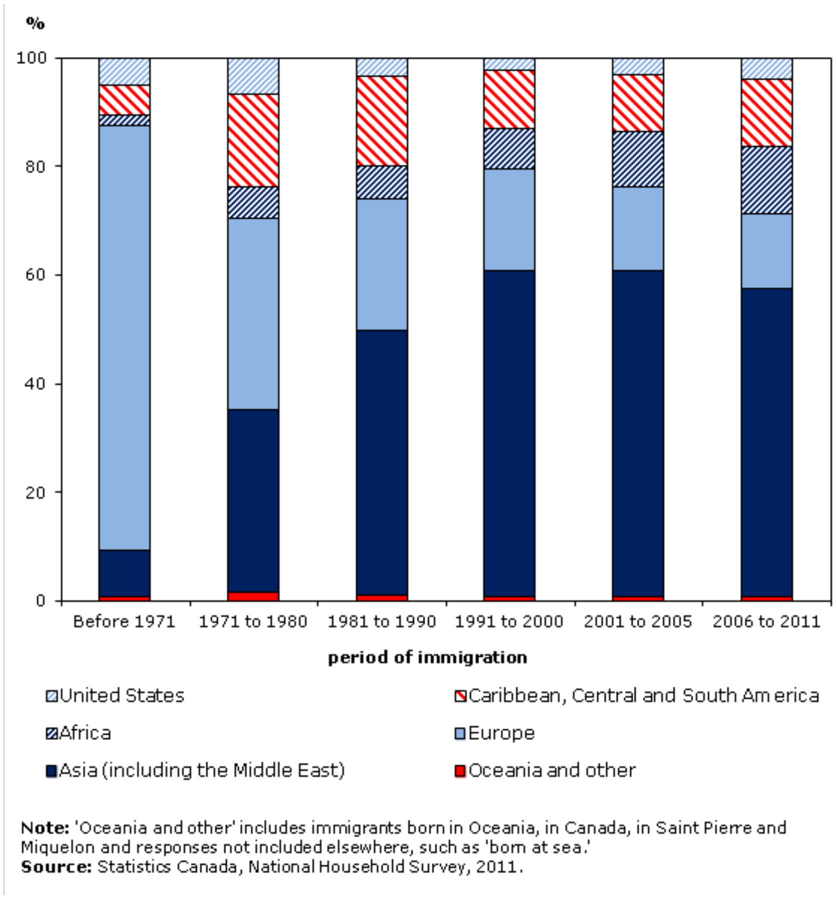


Figure 2-1 Region of birth of recent immigrants to Canada by period of immigration, via Statistics Canada(38)

2.4 Existing Literature on Screening Disparities Among Immigrants in Canada

Preliminary research studies that have examined predictors of breast, cervical and colorectal cancer screening use in Canada have revealed a number of sociodemographic inequities in screening uptake. Many of the studies have suggested that age, marital status, having a family doctor, race and socioeconomic status (SES) are significant predictors of cancer screening (13,46–49). A number of studies have also hypothesized that religion may be a significant predictor of uptake, though many administrative and large survey datasets fail to collect this information(47). Screening disparities among immigrants specifically have been shown in a number of studies from other countries, especially in the United States(48,49). In Canada, while a number of studies have shown immigration status to be a predictor of non-adherence to breast cancer (50), cervical cancer (51), and colorectal cancer screening(52,53), fewer studies have been done to quantify these disparities, many were done evaluating specific immigrant subpopulations or cultural groups, and few studies examine differences between immigrant subgroups.

A scoping review was first done in March 2017, and updated in May 2018, to understand the most current evidence evaluating the association between immigration status and cancer screening uptake in Canada and to identify gaps in the literature. This section aims to summarise the literature available for each cancer screening outcome and to provide a critical appraisal of the current evidence. To conduct the scoping review, two major research databases, MEDLINE (OvidSP; 1946- present) and PubMed (The United States National Library of Medicine, National Institutes of Health; 1946-Present) were used in March 2017. Both MEDLINE and PubMed were used to update the review in May 2018, though Google Scholar was also added to the process of selecting the literature, as well as a review of bibliographies of previously selected articles. The same terms were included across all three databases and were 'exploded' to include subheadings. These terms were: 'Mass Screening' (MeSH terms including anonymous testing, multiphasic screening, neonatal screening) OR 'Early Detection of Cancer' (MeSH terms including 'incidental findings, early diagnosis', AND 'Emigrants and Immigrants' (MeSH terms including 'Undocumented Immigrants') OR 'Ethnic Minorities' (MeSH terms including 'minority women') OR 'Foreign Born'.

The search returned 419 results upon the first iteration of this search in March 2017, and another 29 research articles were included during the second iteration in May 2018. Articles were chosen for having a Canadian study population or focus, examining breast, cervical, and colorectal cancer screening, and being published in the last 18 years (since 2001). After deleting duplicates and examining abstracts for inclusion, 33 research articles were included in this scoping review. A flowchart demonstrating the process for the study selection can be found in Appendix E of this thesis.

2.4.1 Evidence of Mammography uptake amongst Canadian Immigrants

Of the studies that examined mammography uptake in Canadian immigrants since 2003, estimates of breast cancer screening uptake within 24 - 30 months varied from 53% - 72.7%, and estimates of ever screening with mammography varied from 75% to 92%, in the general population. Across all studies comparing mammography rates between immigrants and Canadian-born individuals, all found that uptake was lower in immigrants. In a 2013 study by Borkhoff et al., which used multiple linked administrative databases with a cohort size of over 7 million, 45.7% of immigrant woman reported ever having had a mammogram compared to 59.9% of women in the general population. The largest gap in lifetime use of mammography screening found was 71% in immigrants as compared to 89% in the general population, an eighteen point gap, as reported by Sun et al. One study by Adu et al. reported higher recent mammography uptake amongst non-recent (>10 years in Canada) immigrants (72.7%) compared to recent (0-9 years in Canada) immigrants (56.1%), but in an adjusted logistic regression found that recent mammography was not statistically associated with recency of immigration(43). They did not compare these rates to that of the general population. A recent 2018 study by Woods et al. also looked at differences in breast cancer participation and retention by birth country, and found significant differences across birth countries – the lowest participation being amongst Eastern European and Central Asian women. Women from the most common birth countries also had lower rates compared to non-immigrants (54).

A number of studies, many of which used qualitative or mixed-methods, examined barriers and predictors associated with mammography use. In a qualitative study done by Donnelly et al., Vietnamese-Canadian immigrant participants cited a number of barriers to accessing mammogram screening, including low socioeconomic status, access to transportation and time constraints, and feelings of embarrassment and modesty in getting a mammogram(45). Many participants stressed the need for more culturally sensitive practices, including having access to female physicians and physicians who speak their language. Another study by Todd et al. found that many patients held their physicians' views in high esteem, and made their own decisions based primarily on physician's authority, guidance and recommendation for such tests (55). One 2017 study evaluating a community-based program in Toronto aimed at improving breast and cervical cancer screening among marginalised women, and suggests that having 'lay health educators' can be effective in overcoming language and cultural barriers to preventive care (56).

2.4.2 Evidence of Pap uptake amongst Canadian Immigrants

Of the studies that compared Pap screening uptake amongst immigrants to the general population, all studies found lower rates of screening in immigrant women compared to the Canadian-born population (12,47,48,59–65)(11,44,45,56–62)(12,45,46,57–63) A study by Lofters et al. in 2007, which used health care registration as a proxy for immigration, reported much lower rates of Pap screening within 3 years in recent registrants as compared to non-recent registrants (36.9% versus 60.9%) (59). The same group reported similar results in 2010, finding the newest health insurance registrants had a 17% higher risk of not being screened appropriately compared with long-term registrant (RR 0.83 (CI 0.81 – 0.86)) (11).

Among published studies, the largest number of evaluating disparities in cancer screening between immigrants and non-immigrants assessed cervical cancer screening. Evidence from a number of the cervical cancer screening studies suggested that the proportion of immigrants screened increases with increased time residing in Canada. In a national study done with a sample of around 5800, Latif et al. found that the screening gap between recent immigrants (defined as having been in Canada 4 years or less) and non-immigrants was 13%, and that this gap was attenuated to 12% when evaluating differences between non-immigrants and immigrants landed between 5 and 9 years ago (44). Similarly, Khadilkar et al. demonstrated that recent immigrant women (defined as having spent less than 10 years in Canada) were less likely to have had a Pap test in the past 3 years than those who were Canadian-born (PR = 0.77 (CI 0.71-0.84)). In contrast, immigrants who had lived in Canada for 10 years or longer showed similar compliance with recommended Pap testing compared to non-immigrant subjects (62).

A few of the studies evaluating cervical cancer screening also presented evidence of differential screening by region of origin. When Brotto et al. compared cervical cancer screening between three groups of immigrants (Euro-Canadians, Indo-Canadians and Filipino-Canadians), they found that Euro-Canadian women were more likely than the other two groups of ever having a Pap smear, while there was no significant difference between the Indo-Canadian and Filipino-Canadian groups(63). Similarly, a 2015 study by Vahabi et al. demonstrated that overall immigrant women had slightly lower screening adherence rates (57%) compared with Canadian-born women (61%). Among new immigrants, South Asian women had the lowest rates (38.9%), while Western European women had the highest rates (60.8%) (64). Indeed, poor screening uptake among South Asian women was a consistent trend across the reviewed literature (65,66).

A number of studies also reported on barriers and facilitators to Pap use amongst immigrant populations in Canada. A 2016 mix-methods study by Vahabi et al. interviewed thirty Muslim immigrant women from various countries, all of whom settled in Ontario upon arrival in Canada. The study identified a number of common themes, including a lack of knowledge about cervical cancer risk factors and screening procedures, as well as about the Canadian health care system. Participants stressed the importance of receiving information and recommendation for screening from their physician, without which they felt there was no way for them to become informed. Major barriers identified including language and cultural understanding, as well as having a male physician(47). Another qualitative study from 2016 identified similar themes to breast and cervical cancer screening, including 'navigating newness', including transportation, language barriers, arrangements for time off work and childcare, as well as fear of screening and fear of cancer. This study also stressed the importance of having a female physician(67). A separate qualitative study by Redwood-Campbell et al. in 2011 also support these findings, and stressed the need for information on the necessity of cervical cancer screening, and culturally specific feelings of embarrassment and modesty associated with such exams(68).

2.4.3 Evidence of FOBT or Sigmoidoscopy Uptake Among Immigrant Populations

The first population colorectal cancer screening program was only introduced in Ontario in 2007, and there are therefore still very few studies evaluating colorectal cancer screening uptake among under-served populations. Only five studies were found in the literature examining uptake in colorectal cancer screening between immigrants and non-immigrants. A first study from 2013 evaluated inequities in screening participation in Ontario from 2005 to 2011, and found that introduction of Ontario's population screening program increased screening participation among recent residents in low-income neighbourhoods, compared with long-term residents in high-income neighbourhoods (53). A 2013 study by Borkhoff et al., also based in Ontario, examined linked data from multiple administrative databases and found that the total proportion of women and men having at least one FOBT or large bowel endoscopy in their lifetime was 61.6% and 55.1%, respectively, in Canada. When they compared this to high immigrant' neighbourhood groups, used as a proxy for immigration status, they found that only 48.6% of women and 40.6% of men participated in colorectal cancer screening (12).

Three more studies examined colorectal cancer screening uptake among specific immigrant subpopulations. The first interviewed Chinese immigrants in Ontario and found that 78% of respondents reported ever having a FOBT, sigmoidoscopy or colonoscopy in their lifetime, and that longer residence in Canada was a significant predictor of use. The second study was a qualitative examination of cancer screening behaviours among South Asian immigrants, and suggests that fatalism, lack of knowledge, individual barriers (lack of time, financial burdens, competing demands) and structural barriers (gender or culture of family physician, lack of culturally sensitive health education programs, lack of doctor recommendation) limited screening access for South Asian immigrants (69). Lastly, a study published by Shen et al. in 2018 examined predictors of non-adherence to colorectal cancer screening among Ontarian immigrants aged 60 – 74 and found that immigrants from low and low-middle income countries and refugees were at higher risk of non-adherence to colorectal cancer screening compared to those from the United States, Australia, and New Zealand (52).

2.5 **Summary of Evidence of Current Literature**

The literature provides evidence of lower immigrant uptake of breast, cervical and colorectal cancer screening as compared to the general population in Canada. Throughout all studies evaluating immigrant screening rates compared to Canadian-born rates, immigrants consistently demonstrated lower screening rates. Some, though not all, studies compared recent and long-term immigrants, generally assigning recent immigrants as those residing in Canada for under 10 years, and long-term immigrants as those residing in Canada for 10 years or more. Recent immigrants had lower screening rates compared to long-term immigrants, though the difference was not always significant. A few studies evaluated differences between immigrant subgroups in relation to breast cancer screening uptake (47,54,64) and cervical cancer screening uptake (63), and found generally that Asian and South Asian immigrants had lower screening rates compared to non-immigrants.

Several studies have pointed towards overlapping barriers and factors affecting utilisation, irrespective of screening type or immigrant region of origin. These included language barriers and differences in cultural understandings of cancer and cancer prevention, structural barriers such as time allowances, physician recommendation, transportation issues, and financial burdens, and cultural barriers (feelings of modesty or awkwardness, importance of a same-sex physician) (53,59,67,68).

2.6 **Critical Appraisal and Addressing Research Gaps**

There are several important gaps in relation to the quality and content of the current literature evaluating the association between immigration status and breast, cervical, and colorectal cancer screening status. First, the nature of the Canada's provincial jurisdiction over health has meant that several of the above studies have relied upon provincial sources of health data, especially from Ontario (12,52,53,62,64,70), each with their own sets of inclusion and exclusion criteria, as well as study designs and methodologies. This, along with the fact that studies have been done at differing time points, makes it difficult to consolidate information and get an estimate of national screening uptake among immigrants and non-immigrants. Many of the studies were also focused on a specific cultural or racial immigrant subgroup (48,49,58,63,69–71,76,77) - for example, South Asian, Vietnamese, or Chinese immigrants only – as opposed to providing an overview of all immigrants.

Second, though some studies did look at differences in screening among immigrant subgroups by world region of birth (54,64), these were limited to provincial data sources and so are not necessarily generalizable to the rest of the country. Province specific screening programs and screening availability may be a significant predictor of screening use, and findings are not directly comparable between provinces. Very few studies have examined differences between world regions of birth or cultural or racial groups.

Finally, findings across studies were difficult to interpret given different research methods and evaluation criteria. For example, many studies used a proxy measurement for immigration status, which may not provide the most accurate representation of the immigrant population (11,12,59). Importantly, the only study examined that sought to evaluate screening differences for all three cancer types, also used a proxy estimation for immigration status based on recency of health insurance registration and was based on Ontario residents only. Studies that did seek to evaluate cancer screening outcomes across Canada tended to use single cross-sectional datasets, limiting their ability to assess changes over time (47,48,62,64–66,77).

The nature of evolving cancer screening guidelines and population screening program implementation has meant for an evolving screening landscape in Canada, and the review of the current literature has confirmed a need for an up-to-date overview of cancer screening uptake amongst immigrants and non-immigrants, in relation to national screening targets and in the context of provincial screening programs. The need for a study which evaluates screening uptake for breast, cervical, and colorectal cancers nationwide, with a set study design and informed criteria for exclusion and inclusion, is called for. The current study will provide an overview of screening uptake among immigrants and non-immigrants for all three cancer outcomes using data up to 2015. To my knowledge, the current study will also be the first to evaluate immigrant cancer screening uptake across Canada for all three cancer outcomes, while also providing an assessment of differences among recent and long-term immigrants, as well as the relationship between recency of immigration, racial and country-of-birth subgroups, and time.

2.7 Conceptual Framework – The Health Behaviour Framework (HBF)

Theoretical or conceptual frameworks are often employed in epidemiological studies in order to map the complex inter-relationships between determinants of disease or health behaviours, and to guide decisions regarding data or variable selection. Conceptual frameworks also help guide the use of research in program, intervention, and policy planning, and thus is an important tool to standardize the understanding of epidemiological research results.

There is not one conceptual framework that dominates the health promotion or health behavior research domain, and several prominent theories have been used to understand the effect of health promotion programs and corresponding behavioural changes, including cancer screening programs and guidelines. The Health Behaviour Framework (HBF) (Figure 2-2), first introduced by Bastani et al. in 1999 to evaluate the use of screening mammography by women with first-degree relatives with a history of breast cancer, presents a synthesis of some of the major conceptual frameworks in the area of health behaviour, including the Social Cognitive

Theory(74), the Theory of Planned Behaviour (75), and the Health Belief Model(76). Where these other models have relied heavily on an individual's intention to predict behaviour(77), the HBF presents the distinct advantage of explicitly including external factors that may impact intention and adherence behaviour, including power relationships and social positioning. Furthermore, the HBF considers the context within which behaviours are enacted, including characteristics of the provider, the health care setting and other structural barriers, and larger community and societal influences. The HBF was thus explicitly chosen for this study, given the complex sociocultural and structural factors that may influence new immigrants' behaviour in the Canadian health system.

Figure 2-2 represents a generic version of the Health Behaviour Model. This model assumes that individual variables, as well as provider and health care system factors, directly influence individuals' 'intentions' -- in this case, to seek preventative cancer screening services. In the model, 'intentions' are not the only determinants of an individual's health seeking behaviours. For example, the path between 'intention' and 'behaviour' depends on the presence or absence of structural supports which may function on the level of the individual (e.g. cultural beliefs), health system (e.g. screening facilities/availability) or society (e.g. impoverished neighbourhood). The model also includes considerations for broader macro-level socio-ecological conditions which affect people's capacity and desire to seek health services, like social norms and the built environment. Finally, the model suggests that behaviours may be directly affected by various mutable and immutable factors, such as demographic factors and medical history. All of these factors will also influence an individual's long-term behaviour -- in this case, repeated and guideline recommended screening behaviours.

An adaptation of this theoretical framework is presented in Chapter 3. While this framework in useful in conceptualising the complex relationships between factors associated with preventative health care utilisation, it still represents a simplification of these dynamics. While the framework is kept general in order to be able to apply it to different population subgroups, different factors would likely call for more emphasis than others depending on the specific subpopulation.

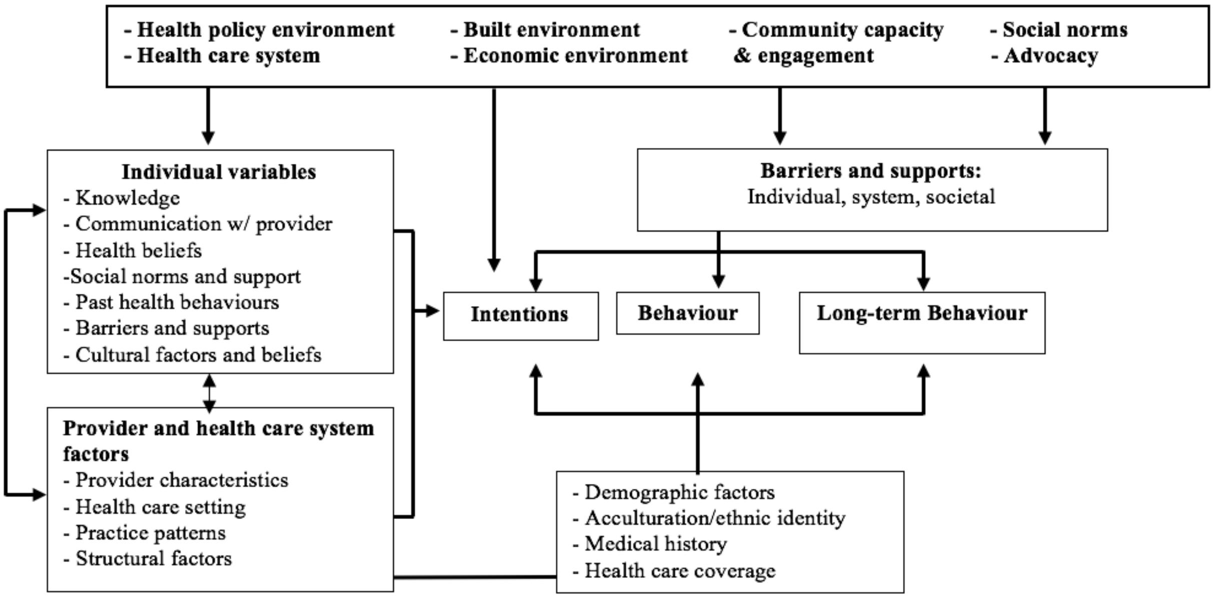


Figure 2-2- The Health Behaviour Framework (HBF)

Chapter 3: Research Methods

3.1 Overview

The purpose of this thesis is to provide an overview of immigrant and non-immigrant breast, cervical and colorectal cancer screening uptake amongst asymptomatic and average-risk individuals in Canada. This chapter describes the process of selecting the data and study variables used in the study. Covariate selection was first informed by findings in the literature and the use of a theoretical framework, the Health Behaviour Framework, was employed to consider the conceptual soundness of variables.

To address the study objectives outlined in Chapter 1 of this thesis, I make use of 10 years' worth of data from a nationally representative cross-sectional health survey, the Canadian Community Health Survey (CCHS), conducted by the federal government's central statistical office, Statistics Canada. The nature of the CCHS data and sampling strategy is further explained in this chapter. Finally, I will describe the specific methods used to analyze each of the study objectives outlined in Chapter 1 of this thesis.

3.2 Study Data – The Canadian Community Health Survey (CCHS)

Data for this study was extracted from the 2005 (cycle 3.1), 2007-2008 (cycle 4.1), 2009-2010, 2011–2012, 2013-2014, and 2015 Canadian Community Health Survey (CCHS). The CCHS is a nationally representative cross-sectional survey conducted by Statistics Canada, and collects self-reported data on a variety of health status, health determinants and behaviours, and health service utilization factors in Canadians ages 12 years and older. Prior to 2007, CCHS data was collected biannually. After 2007, data was collected and released annually, as well as released biannually as a combination of two annual surveys (e.g. 2007-08).

The survey uses a multi-stage cluster sampling strategy to conduct over 65,000 in-person interviews annually, lasting 60 minutes each, to collect self-reported data on a variety of health status, health determinants, and health service utilization factors for

Canadians aged 12 years and older. The CCHS sampling frame represents approximately 98% of the Canadian population, with individuals living on First Nations' Reserves, in certain remote regions, or who are full-time members of the Canadian Forces among those excluded from the sampling frame. For administrative purposes, each province is divided into Health Regions (HR) and each territory represents its own HR. The CCHS aims to produce reliable estimates at the HR and provincial level, and uses a three step approach to allocate sample sizes to ensure sufficient samples for each HR with minimal disturbance to the proportionality of the allocation by province(78).

Three sampling frames were used to select households: an area frame, a list frame of telephone numbers, and a Random Digit Dialing (RDD) sampling frame. After a selected household is contacted, a person aged 12 or older was selected according to various age-based selection probabilities (79). The overall response rate of the CCHS was 79.1% in 2005, 84.6% in 2007-2008, 80.7% in 2009-10, 86.9% in 2011-2012, 75.9% in 2013-2014, and 60.1% in 2015 (81–85). Importantly, during the interviews, if a respondent did not speak English or French, an attempt was made to schedule an interview with an interviewer who could speak the respondent's native language. If this was not possible, the interviewer asked to get someone in the household to translate the interview and responses for the chosen respondent. A detailed description of the CCHS's sampling and interviewing methods is available from Statistics Canada(82).

Confidential 'master files' from the Canadian Community Health Survey (CCHS) were made available through the Statistics Canada Research Data Centre (RDC) of the British Columbia Inter-University branch. The application to gain access to the RDC consisted of an online form, a letter of support from the student's supervisor, and a project proposal. Research data analysts examine data outputs for soundness and minimum unweighted cell counts are strictly enforced before data files can be released, in order to protect the anonymity of respondents.

3.3 Adapting the HBF to the Current Study

For the current study, the Health Behaviour Framework (HBF) presented in Chapter 2 of this thesis has been adapted to suit the Canadian context and the variables available through the

CCHS. Figure 3-1 presents this adapted version of the HBF, with all variables chosen according to factors previously identified in the literature to affect the relationship between immigrant status and cancer screening, relevant to this particular study, and which best fit the constructs outlined in the original HBF.

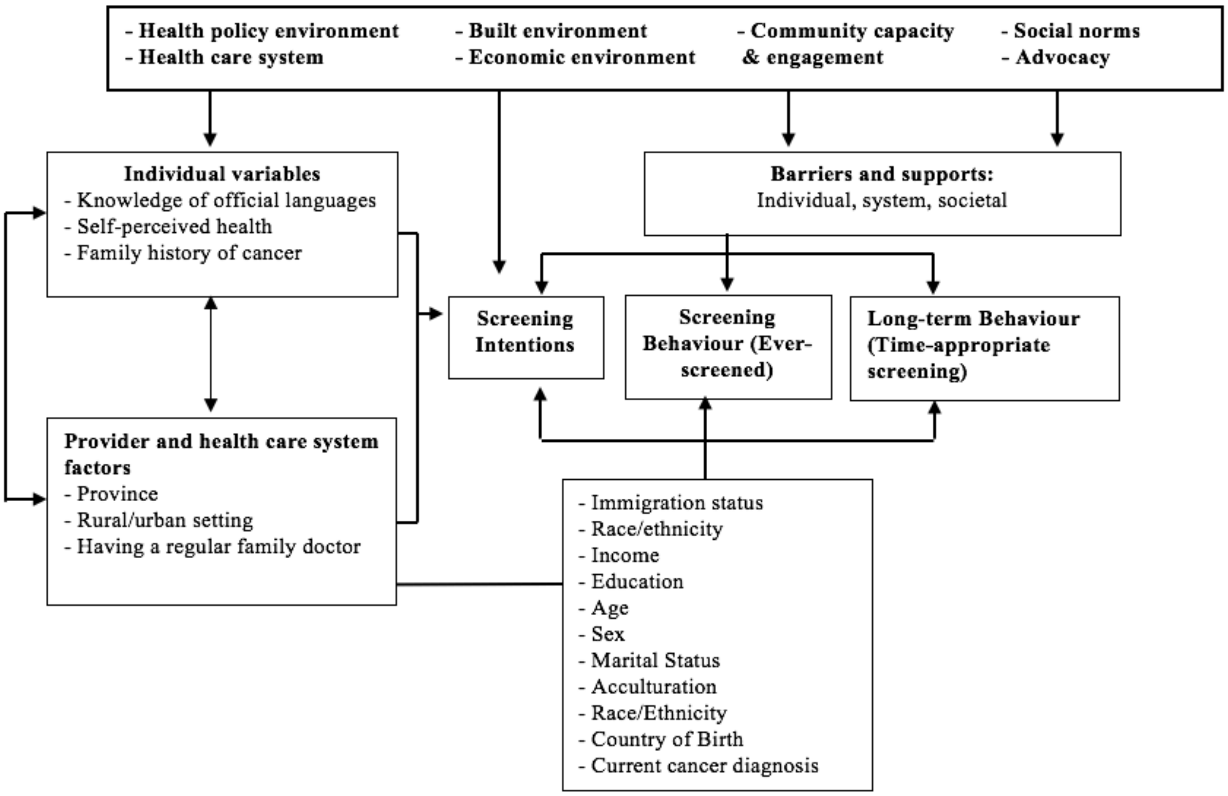


Figure 3-1 - An adapted version of the Health Behaviour Framework (HBF)

In the original HBF model, 'individual variables' describe in particular a number of factors relating to an individual's personal beliefs, past behaviours, and knowledge surrounding health practices, as well as communication with health professionals. For this study, the variables chosen to fit the framework's 'individual variables' were limited to what variables were available in the data set used, relating to these concepts. These include 'knowledge of official Languages' to indicate the capacity to communicate with health professionals and in general to interact with the health system, 'Self-Perceived Health' to indicate an individual's personal health beliefs', and 'Family history of a particular cancer', which would influence an individual's knowledge and health beliefs, as well as past health behaviours. For all three of these variables, we expect a positive association between these and receiving cancer screening. Unfortunately, the variable indicating ‘Knowledge of Official Languages’ was removed from the CCHS from the 2013-14 cycle onwards, and so this variable was dropped during final variable selection in order to ensure consistency in the data.

Since the CCHS survey focuses on individuals’ health practices and perceptions, there were a limited number of variables that would allow us to measure the ‘Provider and health care system factors’ construct. In the original HBF, this category subsumes information about provider characteristics, health care setting, and structural factors affecting health. To this end, the current study included ‘Province’ and ‘Rural/urban’ residence to measure the effects of the healthcare system and provider on health behaviour. While healthcare is available to all citizens across all provinces with little or no upfront costs (although out-of-pocket costs do exist with the rise of privately financed clinics and diagnostic imaging(83)), there exists discrepancies in the quality and availability of care between provinces based on availability of population screening programs and practices, political influences, and provincial health financing strategies(84,85). Further, individuals living in rural settings experience disparities in many health outcomes compared to their urban counterparts (86). Finally, ‘Having a Regular family doctor’ has also been shown to be positively associated with cancer screening(68,87). Unfortunately, after the 2013-14 CCHS survey, this survey question was not asked in their proxy interviews, which limited the respondents to a small subsample of the population each cycle year. In order to ensure the consistency of the data, this variable was excluded from the final model.

Finally, the HBF indicates that several factors may directly influence behaviours, including demographic and identity factors, medical history, and health care coverage. In this study, sex and age were chosen as key demographic characteristics, as both are indicated in the literature to be highly associated with healthcare utilisation. In regards to colorectal cancer screening, several studies have found that women are less likely to be screened for colorectal cancer than men(92–96) , and several studies have reported an association between increasing age and screening rates(93). Age has also been found in the literature to be independently associated with compliance to screening with mammography(94), as well as with PAP(11), both showing decreased use in older ages. In addition to immigrant status, marital status(95), race/ethnicity(91,96,97), education and income(98,99), and country of birth (54,64) have been shown to be predictors of cancer screening practices and were included as demographic predictors. Consistent with previous literature, we expect a positive association between higher education and cancer screening, as well as a positive association between being married, being white, and being born in Canada with receiving cancer screening.

Macro level socio-ecological factors included in the HBF, such as the health policy environment, health care system, social norms, and community engagement, were not able to be measured accurately in this analysis. While breast and cervical cancer screening programs are long-standing and well-adjusted in the Canadian health care environment, recommendations for colorectal cancer screening, and population colorectal cancer screening programs, are relatively new and less integrated into the Canadian health system. Given major advances in research and practice relating to colorectal cancer screening since 2001, the screening guidelines continue to change(100), and it cannot be assumed that public knowledge of colorectal cancer screening guidelines and recommendations are similar to that of breast and cervical cancers. Indeed, as most population colorectal cancer screening were introduced between 2007 and 2014, it becomes more complex to draw national-level conclusions or explanations for differences in colorectal cancer screening across time and between subpopulations. To further obscure the analysis of colorectal cancer screening uptake, the CCHS does not differentiate between sigmoidoscopies, which are recommended for screening, and colonoscopies, which are not, and instead include both procedures in a single survey question. For these reasons, analysis of colorectal cancer screening rates was limited to the first objective – describing differences in uptake between immigrants and non-immigrants – and conclusions should be drawn with reservations.

3.4 Survey Variance and Weighting

Population surveys with complex survey designs or multistage sampling, such as the CCHS, result in unequal probabilities of selection, variation in response rates across different subgroups, and other particularities that would not be found in a simple random sample model. To compensate for this, Statistics Canada assigns a survey weight to each individual in the final sample, which corresponds to the number of persons in the entire population represented by that respondent. For surveys with multistage sampling however, it has been suggested that more robust techniques are needed to accurately estimate sampling variance and standard errors(101).

To this end, Statistics Canada also creates and provides bootstrap weights for analyst to estimate variance using the Bootstrap Resampling Technique.

3.4.1 Bootstrap Resampling Technique

In this section, I will briefly explain the concept and methodology of the Bootstrap Resampling Technique, or ‘bootstrapping’. Bootstrapping essentially allows a researcher to imitate the process of drawing repeated samples of the same size from a population of interest, and repeat this process however many times they desire, without actually spending the time and resources of redrawing the study sample from the population. In other words, bootstrapping allows you to use your study sample – here, the 65,000+ annual participants of the CCHS – to create a large number of ‘pseudo’ samples, known as bootstrap samples, that allow you to repeatedly create new estimates and calculate the variance between them. This process, including for the calculation of the CCHS’s bootstrap weights, is completed using the following set of generic steps:

1. x number of bootstrap samples are drawn from the data set

2. Calculate the summary statistic or estimate – the bootstrap statistic – for each of the x samples

3. Estimate the standard error for each bootstrap statistic and use the standard deviation of the bootstrap distribution in place of your sampling distribution(102).

In the CCHS, replicates are selected and the variation between the replicates is calculated. For each stratum in the sampling frame, a simple random sample of $n-1$ clusters is selected with replacement to form a replicate. This process is replicated x = 500 times, to create 500 bootstrap weights. The bootstrap weights provided by Statistics Canada take into account several separate adjustments as part of the weighting strategy, including household (unit) non-response and person (item) non-response (103).

3.4.2 Combining Cycles of the CCHS

Despite the large sample sizes used in the CCHS surveys, this study seeks to assess changes in screening uptake over time, so a single survey was not deemed appropriate for this project. Further, immigrants in Canada account for only around 20% of the population (104), and fewer still when considering recent immigrants (42). As such, the study involves combining 10 years of survey data in order to increase the sample size and get accurate estimates for immigrant subgroups, as well as to examine changes in screening uptake over time.

Over the ten-year period between 2005 and 2015, various changes were made to the CCHS survey -- primarily related to the frequency and quantity of data collection, as well as some content and methodology changes. The most important of these changes was the change from the CCHS cycle 3.1 (2005) from collecting a bi-annual sample of around 130,000 participants, to conducting an annual survey of around 65,000 respondents in 2007 and after. In the CCHS, each individual sampled within the sampling frame 'represents', besides him or herself, several other people in the population based on demographic factors, which is achieved through the application of simple sampling weights in order to accurately represent the diversity of the Canadian population. Due to privacy considerations imposed by Statistics Canada, this study refers primarily to the sample size by its 'weighted N' – the number of individuals represented by the raw sample size, or 'unweighted N'. Covariates that were not available in each survey year or appeared in incompatible formats were also dropped from the study. Otherwise, changes to health regions across survey are minor(105).

There are two suggested methods for combining data from different CCHS surveys; the separate approach, whereby estimates are calculated for each survey separately and then combined, and the pooled approach, where sample data are combined at the micro-data level and the resulting dataset is treated as a single large random pseudo-sample from the population(105). While both methods are valid (105), this study uses a pooled approach, primarily for the relative simplicity of calculating many regression parameters from one sample, as opposed to calculating and combining many parameters from different samples. Using this approach, it is also necessary to combine and rescale sampling and bootstrap weights in order to treat the combined surveys as a sample from one population. Rescaling was done according to the approach described by Thomas and Wannell in 2009 (105). Here, rescaling by a factor of *k*, where *k* is the number of surveys pooled together, is suggested for providing an unbiased estimate of the total when using CCHS data.

3.5 Study Sample Characteristics

The study sample was chosen to best represent asymptomatic, average-risk individuals eligible for breast, cervical, or colorectal cancer screening. To achieve this, three subsamples were created to include age-eligible and gender-specific adults for each screening outcome based on national screening recommendations set by the Canadian Task Force of Preventive Health Care, and several exclusions were applied. The following details the specifications for each of the three subsamples:

i. **Breast Cancer Screening Subsample (BCS-SS)**

All women aged 50 - 74 years old were included. Women with a history of full mastectomy, with a family history of breast cancer, or who were currently (at the time of each survey) living with any type of cancer were excluded (17).

ii. **Cervical Cancer Screening Subsample (CCS-SS)**

All women aged 20 - 69 years old were included. Women with a history of full hysterectomy, with a family history of cervical cancer, or who were currently (at the time of each survey) living with any type of cancer were excluded (106).

iii. **Colorectal Cancer Screening Subsample (CRCS-SS)**

All men and women aged 50 – 74 years old were included. Individuals with a family history of colorectal cancer, who reported living with colitis, Crohn's disease or inflammatory bowel disease, or who were currently (at the time of each survey) living any type of cancer were excluded (27).

Importantly, cancer screening survey questions are encompassed in the CCHS's optional content, which is only asked in provinces and territories that select to opt-in to this module. This means that varying provinces are surveyed for each cancer screening outcome on any given survey year, and all subsamples were thus restricted to individuals who had been surveyed for the given cancer screening outcome as part f the CCHS's optional modules. For information regarding the provinces opted-in to each cancer screening module on any given survey year, see Appendix A.

Across the ten years and seven CCHS survey cycles used in this thesis, there was a total of 695,276 participants: 132,221 participants from CCHS cycle 3.1 (2005), 131,061 participants from 2007-08, 124,188 participants from 2009-10, 124,929 participants in 2011-12, 128,310 participants from 2013-14, and 59,948 participants in 2015. As described in section 3.7 of this thesis, study-specific restrictions were applied to each data file separately, before finally appending the ten survey cycles together. Using this process three separate subsamples were generated using complete case analysis, one each for those eligible for breast, cervical and colorectal cancer screening, with restrictions derived from CTFPHC screening guidelines.

A flowchart showing the process for study sample selection can be seen in Figure 3-2. Across the three subsamples used in the analysis, 5.7% - 12.2% of the initial sample remained after exclusions based on age, personal or family history of cancer and other disease, provinces opted-in to each CCHS survey cycle, as well as exclusions of missing data/non-response to covariate survey questions. The largest exclusions made were due to the age restrictions of the group, and exclusions based on responses to the screening modules. Of the covariates included in the study, the largest proportion of missing data were from the income, race and country of origin and education. Around 8% of the BCS-SS, 10% of the CCS-SS, and 6% of the CRCS-SS were lost due to invalid, non-response or missing data on income. Another 11% of the remaining BCS-SS, 6% of the remaining CCS-SS, and 3% of the remaining CRCS-SS were removed due to invalid, non-response or missing data on race or country of origin. Of the remaining subsamples, another 6% of the BCS-SS, 2% of the CCS-SS, and 7% of the CRCS-SS were removed due to invalid, non-response or missing data on educational attainment. Missing data in response to other covariates accounted for exclusions representing 4% of the remaining BCS-SS, 3% of the CCS-SS, and less than 1% of the remaining CRCS-SS. Complete case analysis relies on the assumption that data is missing completely at random (MCAR). While imputation techniques were also considered in this study to deal with missingness, complete case analysis was deemed the most appropriate method, as a rather small proportion of the total were dropped in the listwise deletions, and there was otherwise no indication that there was a relationship between the missingness of the data and any of the observed or missing values. In particular, there was no association between dropped variables and any immigration status.

As stated previously, in the CCHS each individual sampled is applied sampling weights, (unweighted) 'represents', besides him or herself, several other people in the population (weighted). A grand total of 39,851 participants (representing 1,251,761 weighted individuals) were included in the BCS-SS, of which 277 were recent immigrants, 5411 were long-term immigrants, and 34,163 were Canadian-born residents. A total of 61,323 participants (representing 2,311,807 weighted individuals) were included in the CCS-SS, of which 2125 were recent immigrants, 6635 were long-term immigrants, and 52,563 were Canadian-born residents. Lastly, the CRCS-SS included 84,995 participants (representing 2,735,274 weighted individuals), of which 620 were recent immigrants, 12,243 were long-term immigrants, and 72,132 were Canadian-born residents. Due to Statistics Canada's confidentiality rules, unweighted counts cannot be released from the Research Data Centre and descriptive summaries are thus presented as weighted proportions.

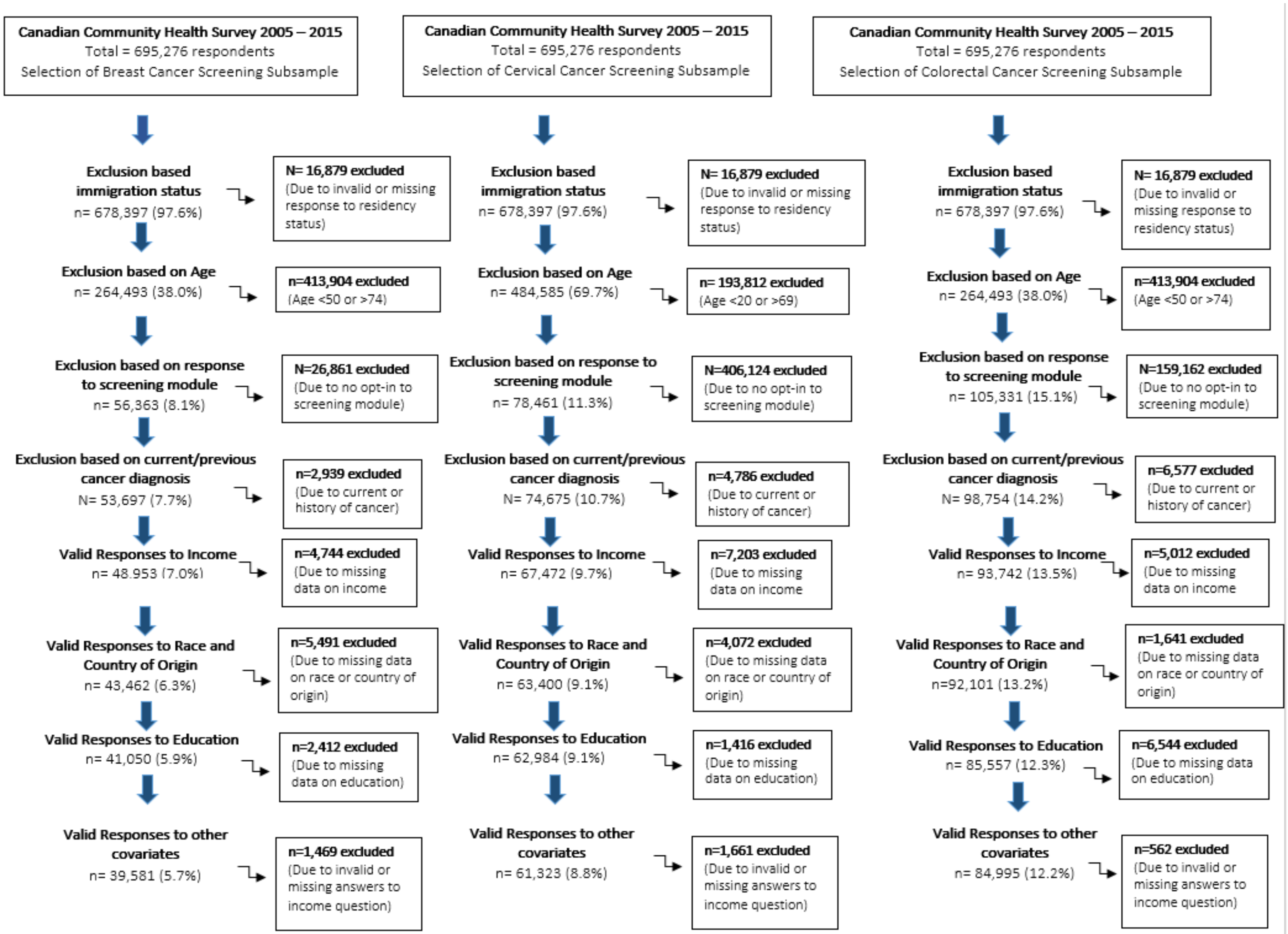


Figure 3-2 – Flowchart demonstrating the sample selection for each of the subsample

3.6 Study Variables

The independent variables used in this study were chosen based on covariates previously identified in the literature to be important predictors of breast, cervical, or colorectal cancer, as well as guided by the operationalisation of the Health Behaviour Framework (HBF) described previously. The final set of variables chosen to examine the effect of immigration status on lifetime and guideline-recommended adherence to cancer screening can be found in Table 3-1. A detailed list of each variable's overarching concept and corresponding CCHS study question can be found in the Appendix B.

Table 3-1 – Study Variables

Dependent Variables	Independent Variables
Lifetime Breast Cancer Screening	Immigration Status
Time-appropriate mammography	CCHS Survey Year
Lifetime Cervical Cancer Screening	Age Group
Time-appropriate PAP screening	Household Income
Lifetime Colorectal Cancer Screening	Educational Attainment
Time-appropriate CRC Screening	Marital Status
	Self-Perceived Health
	Province of Residence
	World Region of Birth
	Race/cultural Origin
	Urban/rural dwelling

3.6.1 Independent Variables

The key explanatory variable in this study is immigrant status (three categories), where 'Recent Immigrants' describes immigrants with 9 years or less of residence in Canada, 'Long-term Immigrants' describes those with 10 or more years of residence in Canada, and 'Canadian-born' describes non-immigrants or Canadian-born individuals. The following independent variables were also included in the study, as measures of the individual, provider and health care system, and demographic constructs of the HBF: age (5-year age groupings between 50- 74 years for the breast and colorectal cancer subsamples, and 10-year age groupings between 20- 69 years for the cervical cancer subsample), sex (Male or Female), marital status (Married, Common-law, Widowed, Separated, Divorced, or Single/Never married), educational attainment (Less than secondary school, Secondary school graduation, and Some post-secondary school/ post-secondary graduation), household income (No income or <$20,000, $20,000-39,999, $40,000-59,999, $60,000-79,999K and $80,000 - $99,999, and $100,000 or more in CAD), self-perceived health (excellent, very good, good, fair, poor), race/cultural identity (white, south asian, east and southeast asian, black, latin american, arab or middle eastern), province of residence (a. Maritimes [Newfoundland & Labrador, New Brunswick, Nova Scotia, Prince Edward Island], b. Quebec, Ontario, c. Prairies [Manitoba and Saskatchewan], d. Western Province [Alberta and British Columbia], and e. Territories [Yukon, Northwest Territories, Nunavut], rurality (rural vs urban residence), CCHS survey year (2005, 2007-08, 2009-10, 2011-12, 2013-14, and 2015), and world region of birth (Canada, North America, South and Central America and the Caribbean, Europe, Africa, and Asia).

3.6.2 Dependent Variables

This study will focus on six main outcomes, derived according to screening tests recommended for each of the three cancer sites of interest (breast (17), cervical (106), and colorectal (27)), and describing both 'lifetime screening' and 'time-appropriate' screening (screening adherence based on CTFPHC guidelines). The first binary outcome variable of interest was therefore *(a)* 'Lifetime breast cancer screening', indicating screening 'yes' or '1' if the respondent had ever been screened with a mammogram, and 'no' or '0' if they had never had a mammogram; *(b)* 'Time-appropriate mammography (MAM)' indicated screening 'yes' or '1' if a woman had had a mammogram within the past two years, and 'no' or '0' if she had not had any screening or had a mammogram more than two years ago; *(c)* 'Lifetime cervical cancer screening' indicated 'yes' or '1' if an individual had ever had a Pap smear, and 'no' or '0' if they had not; *(d)* 'Time-appropriate Pap' indicated screening 'yes' or '1' if a woman had had a Pap test within the last three years, and ‘no’ or ‘0’ if she had never been screened or had a Pap smear more than 3 years ago; *(e)* ‘Ever had colorectal cancer (CRC) screening’ indicated ‘yes’ or ‘1’ if an individual had ever been screened using a Fecal Occult Blood Test (FOBT) or endoscopy and; *(f)* ‘Time-appropriate CRC screening’ indicated receipt of screening ‘yes’ or ‘1’ if an individual had had a FOBT within the past three years *or* had been screened using endoscopy within the past ten years. Studies have suggested that self-reporting breast, cervical, and colorectal cancer screening use is fairly accurate and shows good concordance with administrative and medical record data to overestimate prevalence estimates (107).

In the CCHS survey, the question regarding FOBT is described to respondents as a ‘test to check for blood in your stool, where you have a bowel movement and use a tick to smear a small sample on a special card’. This describes the procedures for both Guaiac and immunochemical-based FOBTs. Endoscopy is described for respondents as “a colonoscopy or sigmoidoscopy is when a tube is inserted into the rectum to view the bowel for early signs of cancer and other health problems (108).” As mentioned briefly above, there is no way to separate those who received a sigmoidoscopy and those who received a coloscopy using CCHS survey data, and this may obscure conclusions of colorectal cancer screening uptake and may lead to an overestimation of screening rates.

3.7 Statistical Analyses

All statistical analyses were performed using SAS software package version 9.1 (SAS Institute Inc, Cary, NC) (109) through the Statistics Canada remote access service at the University of British Columbia (UBC). Sampling weights and Bootstrap Resampling Technique was used to estimate coefficients of variation, p-values, and significance tests, in order to provide a more accurate estimate of variance and to account for uneven probabilities of selection. In all instances, statistical significance was determined at a level of $\alpha = 0.05$. The Bootstrap Resampling Technique was performed using 500 bootstrap weights provided by Statistics Canada, and using the SAS-compatible Bootvar macro (a programming feature which allows the user to avoid repetitive sections of code) (103).

To create the analysis file, I first derived and recoded the variables in each CCHS survey year individually, sorted the data according to individuals' identification number, and merged the bi-annual files with their corresponding bootstrap data files in order to account for the complex survey design used in the CCHS. I applied the restrictions to each data file separately, before finally appending the ten survey cycles together.

3.7.1 Descriptive Statistics and Outcome Modifiers

In order to summarise uptake of lifetime and guideline recommended breast, cervical, and CRC screening in immigrants compared to non-immigrants across Canada, and to summarise the effect of socio-demographic correlates of screening participation, I first calculated frequency statistics for each study variable, and stratified these by immigration status, to examine the differences between the three 'residency' groups. A chi-square test for independence was used to compare proportions between the key strata groups, and 95% confidence intervals were produced using bootstrap weights. Age-stratified rates are presented for each subsample, as well as age-standardized screening rates for breast and cervical cancer screening outcomes, and age and sex-standardized rates are presented for colorectal cancer screening outcomes. Age and Age/sex standardized rates were calculated using the age and sex distribution of the Canadian-born population for each subsample. Age stratification is first presented to give a detailed overview of screening rates across residency groups, and age-standardized rates are presented for ease of comparison of rates presented in the sensitivity analyses for each subsample. Standardization is performed in order to account for differences in age and sex structure – both often important predictors of health outcomes – so that different groups can be more directly comparable.

A sensitivity analysis was performed in order to evaluate whether differences in uptake among recent immigrants, compared to the other two groups, was due to very low health service utilization among immigrants that had resided in Canada for two years or less. This allows to account for other settlement factors that may have arisen in the first two years of settlement, and thus may have contributed to lower screening rates in this group. The sensitivity analysis is further discussed in Chapter 4 and Chapter 5 of this thesis.

3.7.2 Multivariate Logistic Regression

Multivariate Logistic Regression, a statistical method that allows for the analysis multiple predictors to estimate a dichotomous outcome, was the primary method of analysis in this thesis study. The model assumes that the relationship between more than one independent variables and the probability of a binary outcome follows a logistic function:

$$\textbf{Equation 1.} \qquad P(y|x) = \frac{1}{1+ e^{-(b_0+b_1X_1+..b_iX_i)}}$$

Where $P(y|x)$ denotes the probability (P) of the binary outcome (y) for a given value x. The outcome of this equation is a probability, and is constrained to values between 0 and 1. To adsress this problem of restricted range, probabilities are most often transformed into odds ratio estimates through the logit scale (110), following form:

$$\textbf{Equation 2.} \qquad \log\left(\frac{P}{1-P}\right) = \log(odds) = b_0 + b_1X_1 + b_2X_2 + \cdots b_iX_i$$

Where P is used to denote the $P(y|x)$ in Equation 1, b_0 is an estimate of the log odds of the outcome when $x = 0$, or when all the coefficients = 0, and the coefficient b_{1x} is the estimated increase in the log odds of the outcome per unit increase in the value of x. In the current study, all dependent variables were nominal dichotomous, and all independent variables included in this study were nominal or ordinal categorical variables. The 'ever screening' and 'time-appropriate screening' variables were coded as screening *yes* = 1 and screening *no* = 0, the 'urban/rural' categorisation were coded as *urban*= 1 and *rural* = 0, and the 'sex' variable coded as *male* = 1 and *female* = 0. Responses indicating *Don't know*, *Refusal*, or *Not Stated* were treated as missing variables. Indicator or 'dummy' variables were used to correspond to different categories of the variables 'Immigration Status', 'CCHS Survey Year', 'Age Group', 'Household Income', 'Educational Attainment', 'Marital Status', 'Self-Perceived Health', 'Province of Residence', 'World Region of Birth' and 'Race'. In the regression equation using dummy variables, one of the categories is chosen as the reference and each of the remaining categories is assigned a value of 1 for one of the dummy variables and the reference will have 0 values.

For Objective 1, the reference values chosen for this study are *Canadian Born*, *2015*, *70 – 74 years* (*60 – 69 years* for the cervical cancer subsample), *$100,000 or more*, *Some or Graduation of Post-Secondary*, *Married*, *Excellent, Maritimes, Canada,* and *White*, and the regression equation for Objective 1 can thus generically be written for each of the BCS-SS and CCS-SS as the following:

Equation 3. $\log\left(\frac{p}{1-p}\right)_{NoScreening} = b_0 + b_1 CanadianBorn_1 + b_2 Age70-74_2 + b_3 > \$100{,}000_3 + b_4 Post-SecondaryEdu_4 + b_5 Married_5 + b_6 ExcellentHealth_6 + b_7 Maritimes_7 + b_8 Canada_8 + b_9 WhiteRace_9 + b_{10} Rural_{10} + b_{11} 2015_{11}$

For Objective 1, the regression equation for the CRCS-SS differs only in the inclusion of the categorical variable 'Sex', for which *Female* is used as the reference. The regression equation for Objective 1 fit to CRCS-SS data can thus be written generically as:

Equation 4. $\log\left(\frac{p}{1-p}\right)_{NoScreening} = b_0 + b_1 CanadianBorn_1 + b_2 Female_2 + b_3 Age70-74_3 + b_4 > \$100{,}000_4 + b_5 Post-SecondaryEdu_5 + b_6 Married_6 + b_7 ExcellentHealth_7 + b_8 Maritimes_8 + b_9 Canada_9 + b_{10} WhiteRace_{10} + b_{11} Rural_{11} + b_{12} 2015_{12}$

For Objective 2, the aim was to explore differences in breast and cervical cancer screening rates among immigrant subgroups. To achieve this, different multivariate logistic regression models were fit separately for recent and long-term immigrants in the BCS-SS and CCS-SS. The regression equation for Objective 2 can be written generically as:

Equation 5 (for recent immigrants) and **Equation 6** (for long-term immigrants).

$\log\left(\frac{p}{1-p}\right)_{NoScreening} = b_0 + b_1 WhiteRace_1 + b_2 Age70-74_2 + b_3 North\ America_3 +$

$$b_4 > \$100{,}000_4 + b_5 Post - SecondaryEdu_5 + b_6 Married_6 + b_7 ExcellentHealth_7 + b_8 Maritimes_8 + b_9 Rural_9 + b_{10} 2015_{10}$$

Above, white race is used as the reference.

Equation 7 (for recent immigrants) and **Equation 8** (for long-term immigrants)

$$\log\left(\frac{p}{1-p}\right)_{NoScreening} = b_0 + b_1 North\ America_1 + b_2 WhiteRace_2 + b_3 Age70 - 74_3 + b_4 > \$100{,}000_4 + b_5 Post - SecondaryEdu_5 + b_6 Married_6 + b_7 ExcellentHealth_7 + b_8 Maritimes_8 + b_9 Rural_9 + b_{10} 2015_{10}$$

Finally for Objective 3, the aim was to assess the association between time and cancer screening uptake of immigrants and non-immigrants in Canada. To achieve this, different multivariate logistic regression models were fit separately for recent immigrants, long-term immigrants, and Canadian-born individuals in the BCS-SS and CCS-SS. The regression equation for Objective 3 can be written generically as:

Equation 9 (for recent immigrants) and **Equation 10** (for long-term immigrants)

$$\log\left(\frac{p}{1-p}\right)_{NoScreening} = b_0 + b_1 2015_1 + b_2 WhiteRace_2 + b_3 Age70 - 74_3 + b_4 > \$100{,}000_4 + b_5 Post - SecondaryEdu_5 + b_6 Married_6 + b_7 ExcellentHealth_7 + b_8 Maritimes_8 + b_9 Rural_9 + b_{10} North\ America_{10}$$

Equation 11 (for Canadian-born individuals

$$\log\left(\frac{p}{1-p}\right)_{NoScreening} = b_0 + b_1 2015_1 + b_2 WhiteRace_2 + b_3 Age70 - 74_3 + b_4 > \$100{,}000_4 + b_5 Post - SecondaryEdu_5 + b_6 Married_6 + b_7 ExcellentHealth_7 + b_8 Maritimes_8 + b_9 Rural_9$$

In all models, the odds predict the likelihood of never being screened or non-adherence to cancer screening, and reference is the Canadian-born group.

Logistic regression models rely on four key assumptions that must be met in order to make reliable conclusions. The first assumption, independence of errors, requires that all outcomes are independent of one another (no repeated measures). The second assumption is linearity for any independent continuous variables, such as age. The third assumption states that there must be an absence of multicollinearity among the independent variables. Finally there must not be strongly influential outliers, which usually is addressed by maintaining a large sample size and minimum cell counts(111). These assumptions are further addressed below.

To begin fitting the model, the widely-used model-building strategy described by Hosmer and Lameshow in 1989 (112), and further explained by Canchola et al. (113), was employed. The phases to building the model were condensed here into three steps:

Step 1: Univariate and bivariate analysis of each variable chosen for consideration through literature review and fit with the Health Behaviour Framework (HBF) was done to explore trends and examine distribution by each of the six screening outcomes. Variables were cross-tabulated with the outcomes and Chi-square statistics were used to evaluate variables for significance at the 0.25 confidence level. This less conservative confidence level was used due to suggestions in the literature that more strict confidence levels at this stage of variable selection can result in variables otherwise known to be important to be excluded from the model (114)(115). Possible interactions were also selected.

Step 2: A forward addition of variables was used to test variables for inclusion in the final logistic regression model for each of the six outcomes using a SAS macro (an automation process for repetitive lines of code). A null model consisting of the outcome variable (Lifetime or Time-Appropriate Screening) only and no predictors was created and called 'null model'. The null model was used as a baseline for the Akaike information criterion (AIC) and Likelihood

Ratio Test (LRT), which estimate the relative quality or 'goodness of fit' of a statistical model. The bivariate relationships between screening and predictor variables were examined for AIC and LRT, and the most significant predictor is added to the model. This is repeated for all variables until none of the remaining variables are significant when added into the model, and excludes non-significant variables. None of the tested interaction terms – which included all interactions between immigration status and each of the other covariates – were found to be significant (data not shown). This process was repeated for each of the six outcomes and final models were fit. Results from the forward addition method for model selection can be found in Appendix D.

Step 3: The Hosmer and Lemeshow method for model building also suggests at this stage to do final assessments of the fitted model for goodness-of-fit, namely using the Hosmer-Lemeshow Goodness-of-Fit Test. However, traditional goodness-of-fit statistics rely on maximum likelihood estimations, which are not appropriate for logistic regression models fit to complex survey data(116). There are however tests that examine the assumptions of the logistic regression model, which will be discussed briefly here.

The assumption of independence is assumed and there is no formal test. While this study does use multiple cycles of a national cross-sectional survey, it is assumed that the chance of repeated measures across cycles is low due to the CCHS's sampling strategy. The test for linearity was done for the only continuous predictor, age, in the univariate stage of this analysis. The assumption of multicollinearity is met through the forward selection procedure done through SAS, which removes the least significant of multiple collinear variables from the model. While one of the logistic regression model's key assumptions is that there must not be strong influential outliers in the data, the use of large sample sizes is thought to mitigate this concern by minimizing the contribution of any given outlier. However, it has been suggested that observations may still exert influence if the observations have large weights(117). DFbetas were thus used to identify and remove potentially influential observations, by the process described by Ryan et al. (118).

Chapter 4: Results

4.1 Descriptive Overview of Screening Eligible Sample

As mentioned in Chapter 3, after exclusions a total of 39,851 participants (representing 1,251,761 weighted individuals) were included in the Breast Cancer Screening Subsample (BCS-SS), 61,323 participants (representing 2,311,807 weighted individuals) were included in the CCS-SS, and 84,995 participants (representing 2,735,274 weighted individuals) were included in the CRCS-SS. Due to Statistics Canada's confidentiality rules, unweighted counts cannot be released from the Research Data Centre and descriptive summaries are thus presented as weighted proportions.

A descriptive summary of the Breast Cancer Screening Subsample (BCS-SS) is included in Table 4-1. Weighted proportions and 95% bootstrap-generated confidence intervals are presented and stratified by residency status. Overall, the crude lifetime screening rates were 75.5% (CI 63.9 – 81.0%) for recent immigrants, compared to 90.5% (CI 88.7 – 92.2%) among long-term immigrants, and 91.5% (CI 91.0 – 92.0%) among Canadian-born individuals. Crude time-appropriate (adherence) screening rates were 53.0% (CI 42.4 – 63.7%) for recent immigrants, compared with 71.7% (CI 69.3 – 74.1) for long-term immigrants and 74.0% (CI 73.2 – 74.9%) for Canadian-born individuals.

In regard to the covariates in this study, recent immigrants appeared to be younger overall compared with long-term immigrants and Canadian-born individuals. A large majority (more than 67%) of recent immigrants were between the ages of 50-59, compared to around 50% in both long-term immigrant and Canadian-born groups. Income distribution appeared to be consistent across the different residency statuses, with around 50% of individuals earning no income to $59,999, and another 50% earning $60,000 or more across all groups. A larger proportion of recent immigrants were highly educated compared to the other two groups, with 86.3% having some post-secondary school or graduated post-secondary school, compared with 76.8% of long-term immigrants and 71.1% of Canadian-born residents. The majority of each recent immigrants, long-term immigrants, and Canadian-born individuals reported being married or in common-law relationships. Importantly, these two categories were combined due to confidentiality restrictions around release of small unweighted cell sizes by Statistics Canada, due to very few reporting being in a common-law relationship. More than 80% of recent immigrants, long-term immigrants and Canadian-born individuals reported having good or better self-perceived health. The largest proportion of recent and long-term immigrants were of Asian or European countries, and correspondingly of White, South Asian, or East and Southeast Asian racial origin. Over 90% of all immigrants lived in urban areas, compared with 74.1% of Canadian-born individuals.

Table 4-1- Summary Characteristics of Canadian Community Health Survey Respondents (2005-2015), Investigation of the Association between Immigrant Status and Breast Cancer screening, Stratified by Residency Status

	Recent Immigrants Unweighted n=277 Weighted N = 28,615	**Long-term Immigrants** Unweighted n = 5411 Weighted n= 261,169	**Canadian –born** Unweighted n=34,163 Weighted N = 961,978
Lifetime Mammography Screening [A]			
Ever	72.5 (63.9 – 81.0)	90.5 (88.7 – 92.2)	91.5 (91.0 – 92.0)
Never	27.6 (19.01 – 36.1)	9.5 (7.8 – 11.3)	8.5 (8.0 – 9.0)
MAM Screening Adherence [A B]			
Yes	53.0 (42.4 – 63.7)	71.7 (69.3- 74.1)	74.0 (73.2 – 74.9)
No	47.0 (36.3 – 57.7)	28.3 (25.9 -30.8)	26.0 (25.1 – 26.8)
CCHS Survey Year			
2015	17.9 (9.5 - 26.3)	10.6 (8.8 -12.5)	25.9 (24.8 – 27.0)
2013-14	12.0 (1.3 – 22.7)	6.2 (5.2 – 7.3)	10.9 (10.3 – 11.4)
2011-12	30.2 (21.3 – 39.1)	41.2 (38.5 – 44.0)	25.1 (24.2 – 25.9)
2009-2010	7.7 (2.2 – 13.3)	5.7 (4.7 – 6.7)	10.0 (9.5 – 10.5)
2007-2008	30.0 (21.5 – 38.6)	32.9 (30.6 – 35.1)	22.3 (21.6 – 22.9)
2005	2.2 (0.3 – 4.0)	3.3 (2.9 – 3.8)	5.9 (5.6 – 6.2)
Age			
50-54	43.1 (32.1- 54.1)	22.5 (20.0 – 24.9)	25.7 (24.7 – 26.6)
55-59	23.6 (15.0 – 32.1)	23.4 (21.0 – 25.7)	24.2 (23.7 – 25.4)
60-64	16.3 (10.10 -22.4)	23.1 (20.8 – 25.4)	20.4 (19.6 – 21.1)
65-69	10.2 (5.5 – 15.0)	17.6 (15.9 – 19.2)	16.8 (16.1 – 17.5)
70-74	6.9 (3.1 – 10.8)	13.5 (12.1 – 15.0)	12.6 (12.0 – 13.1)
Household Income			

No income or <$20,000	10.9 (5.7 – 16.1)	9.1 (7.8 – 10.3)	9.4 (9.0 – 9.9)
$20,000 - $39,999	21.5 (10.5 - 32.5)	20.5 (18.3 – 22.8)	19.3 (18.6 – 20.0)
$40,000 - $59,999	19.3 (12.2 – 26.4)	19.7 (17.6 – 21.7)	18.3 (17.6 – 19.1)
$60,000- $79,999	16.2 (8.9 – 23.5)	15.8 (14.0 – 17.5)	15.8 (15.1 – 16.5)
$80,000 - $99,999	7.3 (2.7 – 11.8)	12.8 (11.0 – 14.5)	12.3 (11.6 – 13.0)
$100,000 or more	24.9 (15.9 – 33.8)	22.2 (19.8 – 24.6)	24.8 (23.9 – 25.8)
Education			
Less than Secondary School	4.2 (1.7 – 6.7)	9.5 (8.3 – 10.7)	12.6 (12.1 – 13.1)
Second School Graduation	9.5 (4.2 – 14.9)	13.7 (11.8 – 15.5)	16.3 (15.6 – 17.0)
Post-Secondary School	86.3 (80.4 – 92.2)	76.8 (74.7 – 78.9)	71.1 (70.3 – 71.9)
Marital Status			
Married or common-law	74.5 (65.3 – 83.9)	70.5 (67.5 – 67.6)	69.8 (67.5 – 70.2)
Widowed	12.5 (6.6 – 18.4)	10.2 (8.9 – 11.5)	9.9 (9.4 – 10.4)
Separated	4.6 (0.7 – 8.5)	3.0 (2.2 – 3.9)	2.9 (2.6 – 3.3)
Divorced	4.4 (0.0 – 9.5)	10.2 (8.4 – 11.9)	11.1(10.5 – 11.7)
Single, Never Married	4.0 (1.3 – 6.6)	6.1 (5.1 – 7.1)	7.0 (6.5 – 7.5)
Self-Perceived Health			
Excellent	12.9 (6.2 – 19.6)	16.3 (14.3 – 18.3)	20.0 (19.1 –20.8)
Very Good	30.1 (20.7 – 39.5)	31.3 (28.9 – 33.7)	37.4 (36.5 – 38.4)
Good	46.3 (35.7 – 57.0)	33.1 (30.6 – 35.5)	28.3 (27.5 – 29.2)
Fair	9.8 (4.7 – 14.9)	14.1 (12.1 – 16.2)	10.6 (10.0 – 11.1)
Poor	0.8 (0.1 – 1.6)	5.2 (3.9 – 6.5)	3.7 (3.4 – 4.0)
Province of Residence			
Maritimes	3.2 (1.4 - 5.0)	2.8 (2.4 – 3.3)	17.6 (17.0 – 18.1)
Quebec	7.4 (1.6 – 13.1)	5.8 (4.4 – 7.2)	20.9 (19.9 – 22.0)
Ontario	55.7 (44.6 – 66.7)	69.6 (67.1 – 72.1)	36.0 (35.1- 37.0)
Other	33.7 (20.7 – 45.5)	21.8 (19.3 – 24.2)	25.5 (24.4 – 26.5)
Country of Birth			
Canada	.	.	99.2 (99.0 – 99.5)
United States	3.9 (0.4 – 7.4)	5.8 (4.9 – 6.7)	.
South and Central America & Carb	7.0 (3.5 – 10.5)	10.9 (9.1 – 12.8)	.
Europe	16.9 (11.4 – 22.4)	51.2 (48.5 – 53.9)	.
Africa	9.2 (2.4 – 16.0)	4.2 (3.1 – 5.3)	.
Asia	62.9 (53.6 – 72.3)	27.9 (25.3 – 30.6)	.
Race/Cultural Origin			
White	24.2 (16.8 – 31.6)	61.5 (58.7 – 64.2)	99.3 (99.1 – 99.5)
South Asian	21.4 (13.9 – 29.0)	9.2 (7.6 – 10.9)	.
East and Southeast Asian	35.1 (23.7 – 46.5)	19.2 (16.7 – 21.7)	.

Black	8.8 (3.3 – 14.3)	5.8 (4.3 – 7.4)	.
Latin American	2.9 (0.7 – 5.2)	2.2 (1.5 – 2.9)	.
Arab and Middle Eastern	7.5 (1.7 – 13.3)	2.1 (1.3 – 2.9)	.
Rurality			
Urban	97.1 (95.7 – 98.4)	91.8 (90.9 – 92.7)	74.1 (73.3 – 74.8)
Rural	2.9 (1.6 – 4.3)	8.2 (7.3 – 9.1)	25.9 (25.2 – 26.7)

All statistics are weighted
A = Chi square test shows a significant difference (P < 0.05) between recent immigrants and Canadian-born population
B = Chi square test shows a significant difference (P < 0.05) between long-term immigrants and Canadian-born population

A descriptive summary of the Cervical Cancer Screening Subsample (CCS-SS) is included in Table 4-2. Overall, 71.0% (CI 67.9 – 74.0%) of recent immigrants reported ever having a Pap smear in their lifetime, compared to 88.5% (CI 87.1 – 90.0%) of long-term immigrants and 94.4% (CI 94.0 – 94.8%) of Canadian-born individuals. A chi-square test of independence showed a significant difference (p <0.05) between the crude lifetime screening rates of recent immigrants compared with Canadian-born individuals, as well as between long-term immigrants and Canadian-born individuals. Crude screening adherence rates were lower than lifetime rates for all groups, with 64.0% (CI 60.8 – 67.2%) of recent immigrants reporting having had a Pap smear within the last three years, compared with 76.8% (75.0 – 78.5%) of long-term immigrants and 82.7% (CI 82.1 – 83.2%) for Canadian-born individuals. Differences between recent vs. Canadian-born and long-term vs. Canadian-born adherence rates were significantly different (p < 0.05), as demonstrated by a chi-square test for independence.

In regard to the covariates included in the Cervical Cancer Screening Subsample, the recent immigrant group had a higher proportion (65.2%) of young people (between the age of 20 – 39 years) compared with both long-term immigrants (25.2%) and Canadian-born individuals (43.5%). There was a higher proportion of recent immigrants making no income to <$20,000 compared to long-term and Canadian-born individuals (10.9% vs. 6.8% vs. 6.4%, respectively), as well as a lower proportion of recent immigrants in the highest income bracket, $100,000 or more, compared with long-term immigrants and Canadian-born individuals (16.45 vs. 20.5% vs 21.7%, respectively). Recent immigrants reported significantly higher educational attainment, with 90.9% having attended and/or graduated post-secondary school, compared with 84.8% of long-term immigrants and 84.7% of Canadian-born individuals. Ontarians were largely over-represented in this sample, with more than 50% of Canadian-born and more than 80% of immigrant women reporting Ontario residency. The number of married recent immigrants was higher than both long-term immigrants and Canadian born individuals (73.6% vs. 65.6% vs. 54.4%, respectively). The majority of recent immigrants were born in Asia (63.4%) and were of south, east, or southeast Asian origin (59.2%), while a majority of long-term immigrants were born in Europe (39.6%) and reported being of white racial origin (47.8%). Similar to the Breast Cancer Screening Subsample, the vast proportion of recent and long-term immigrants were urban dwellers (97.7% and 93.7% respectively), compared with 76.9% of Canadian-born individuals. Over 90% of recent and long-term immigrants lived in urban centres, compared 78.4% of Canadian-born individuals.

Table 4-2 - Summary Characteristics of Canadian Community Health Survey Respondents (2005-2015), Investigation of the Association between Immigrant Status and Cervical Cancer Screening

	Recent Immigrants Unweighted n=2125 Weighted N = 174,832	**Long-term Immigrants** Unweighted n=6635 Weighted N = 392,868	**Canadian-Born** Unweighted n=52,563 Weighted N = 1,744,107
Lifetime Pap Screening [A B]			
Ever	71.0 (67.9 - 74.0)	88.5 (87.1 – 90.0)	94.4 (94.0 – 94.8)
Never	29.0 (26.0 - 32.1)	11.5 (10.0 – 12.9)	5.6 (5.2 – 6.0)
Pap Screening Adherence [A B]			
Yes	64.0 (60.8 – 67.2)	76.8 (75.0 – 78.5)	82.7 (82.1 – 83.2)
No	36.0 (32.8 – 39.2)	23.2 (21.5 – 25.0)	17.3 (16.8 – 17.9)
CCHS Cycle Year			
2015	12.6 (9.9 – 15.3)	7.0 (5.6 – 8.4)	11.1 (10.3 – 11.9)
2013-14	0.4 (0.2 – 0.5)	0.5 (0.3 – 0.6)	3.1 (2.9 – 3.3)
2011-12	31.3 (27.4 – 35.2)	35.0 (32.6 – 37.4)	21.3 (20.4 – 22.2)
2009-2010	0.9 (0.5 – 1.4)	0.6 (0.4 – 0.8)	3.7 (3.4 – 4.0)
2007-2008	38.2 (35.0 – 41.4)	37.6 (35.6 – 39.6)	26.8 (26.1 – 27.4)
2005	16.6 (14.6 – 18.7)	19.5 (18.1 – 20.9)	34.0 (33.4 – 34.7)
Age			
20-29	27.1 (24.2 – 29.9)	9.6 (8.4 – 10.8)	22.0 (21.4 – 22.6)
30-39	38.1 (35.0 – 41.2)	15.6 (14.2 – 17.1)	21.5 (20.9 – 22.2)
40-49	24.3 (21.1 – 27.5)	24.7 (22.8 – 26.6)	24.0 (23.3 – 24.7)
50-59	7.1 (5.2 – 9.0)	27.6 (25.6 – 29.6)	19.7 (19.2 – 20.3)

60-69	3.4 (2.3 – 4.6)	22.4 (20.7 – 24.1)	12.7 (12.3 – 13.1)
Household Income			
No income or <$20,000	10.9 (9.0 – 12.9)	6.8 (5.9 – 7.7)	6.4 (6.04 – 6.7)
$20,000 - $39,999	20.9 (18.3 – 23.5)	16.1 (14.5 – 17.8)	13.7 (13.2 – 14.1)
$40,000 - $59,999	21.0 (18.2 – 23.8)	18.4 (16.8 – 20.0)	16.0 (15.5 – 16.5)
$60,000- $79,999	20.6 (18.0 – 23.2)	20.2 (18.6 – 21.8)	22.5 (21.9 – 23.1)
$80,000 - $99,999	10.2 (8.3 – 12.1)	18.1 (16.4 – 19.7)	19.8 (19.2 – 20.4)
$100,000 or more	16.4 (13.8 – 19.0)	20.5 (18.6 – 22.3)	21.7 (21.0 – 22.4)
Education			
Less than Secondary School	2.0 (1.0 – 3.2)	5.0 (4.1 – 6.0)	5.2 (4.8 – 5.6)
Second School Graduation	7.1 (5.2 – 9.4)	10.2 (8.5 – 11.8)	10.0 (9.4- 10.6)
Post-Secondary School	90.9 (89.1 – 92.7)	84.8 (83.3 – 86.3)	84.8 (84.3 – 85.3)
Marital Status			
Married	73.7 (70.9 – 75.4)	65.6 (63.6 – 67.6)	54.4 (53.6 – 55.1)
Common-Law	3.8 (3.0 – 4.7)	3.9 (3.2 – 4.7)	12.0 (11.5 – 12.5)
Widowed	3.1 (2.0 – 4.3)	5.8 (5.0 – 6.6)	5.5 (5.3 – 5.8)
Separated	3.3 (2.5 – 4.1)	3.9 (3.0 – 4.8)	4.3 (4.0 – 4.5)
Divorced	3.6 (2.7 – 4.5)	7.3 (6.1 – 8.5)	6.8 (6.6 – 7.2)
Single, Never Married	12.4 (10.4 – 14.5)	13.5 (12.1 – 15.1)	17.0 (16.3 – 17.6)
Self-Perceived Health			
Excellent	25.2 (22.4 – 27.9)	20.9 (19.2 – 22.6)	24.3 (23.6 – 24.9)
Very Good	34.0 (31.0 – 36.1)	36.8 (34.8 – 38.9)	42.7 (42.0 – 43.5)
Good	33.8 (30.5 – 37.0)	30.1 (28.2 – 32.1)	24.5 (23.8 – 25.1)
Fair	6.4 (4.5 – 8.2)	8.1 (6.6 – 9.6)	6.5 (6.1 – 7.0)
Poor	0.8 (0.3 – 1.3)	4.1 (3.0 – 5.2)	2.1 (1.9 – 2.4)
Province of Residence			
Maritimes	1.6 (1.2 – 2.1)	1.5 (1.2 – 1.8)	12.3 (11.9 – 12.6)
Quebec	1.6 (1.2 – 2.0)	1.9 (1.4 – 2.4)	9.7 (9.3 – 10.2)
Ontario	81.1 (78.7 – 83.5)	83.5 (82.0 – 85.0)	57.7 (56.9 – 58.4)
Prairies	0.9 (0.6 – 1.2)	1.2(0.9 – 1.4)	4.3(4.1 – 4.5)
Western Provinces	14.7 (12.4 – 17.0)	11.8 (10.4 – 13.1)	15.7 (15.1 – 16.4)
Territories	0.2 (0.1 – 0.2)	0.2 (0.1 – 0.2)	0.3 (0.2 – 0.3)
Country of Birth			
Canada	.	.	99.0 (98.9 – 99.2)
United States	3.9 (2.8 – 5.0)	5.5 (4.7 – 6.2)	.
South and Central America & Carb	10.1 (8.2 – 12.1)	14.8 (13.1 – 16.5)	.
Europe	13.3 (11.46 – 15.2)	39.6 (37.6 – 41.6)	.
Africa	7.6 (5.5 – 9.7)	5.6 (4.3 – 7.0)	.
Asia	63.4 (59.8 – 67.0)	32.6 (30.3 – 34.9)	.
Race/Cultural Origin			

White	21.0 (18.5 – 23.4)	47.8 (45.7 – 49.9)	96.6 (96.3 – 97.0)
South Asian	26.8 (23.9 – 28.6)	12.2 (10.8 – 13.6)	.
East and Southeast Asian	32.4 (29.1 – 35.7)	22.8 (20.9 – 24.8)	.
Black	8.6 (6.8 – 10.5)	9.6 (8.0 – 11.2)	.
Latin American	3.9 (2.7 – 5.1)	3.6 (2.8 – 4.5)	.
Arab and Middle Eastern	7.3 (5.6 – 9.0)	3.9 (3.1 – 4.8)	.
Rurality			
Urban	97.5 (96.9 – 98.2)	93.7 (93.0 – 94.4)	78.4 (77.9 – 78.9)
Rural	2.5 (1.9 – 3.1)	6.3 (5.6 –7.0)	21.6 (21.1 – 22.1)

All statistics are weighted
A = Chi square test shows a significant difference (P < 0.05) between recent immigrants and Canadian-born population
B = Chi square test shows a significant difference (P < 0.05) between long-term immigrants and Canadian-born population

Finally, a descriptive summary of the Colorectal Cancer Screening Sample can be found in Table 4-3. Overall, a chi-square test of independence suggests that lifetime screening in recent immigrants (37.7% (CI 31.0 – 44.3) was significantly (p<0.05) lower than in Canadian-born individuals (64.7% (CI 64.0 – 65.3%), whereas long-term immigrants showed similar lifetime screening rates (61.0% (CI 59.2 – 62.7%) to the Canadian group. In terms of colorectal cancer screening adherence, 35.7% (CI 29.1 – 42.3%) of recent immigrants reported having been screened with FOBT within 2 years or sigmoidoscopy within 10 years, compared with 55.1% (CI 53.3 – 56.8%) of long-term immigrants and 57.2% (CI 56.5 – 57.8%) of Canadian-born individuals. There was a statistically significant difference between both recent immigrants (p<0.01) and long-term immigrants (p<0.01) compared with the Canadian-born group.

Covariate distribution was similar for this subsample as with the BCS-SS and CCS-SS. As with the other two subsamples, recent immigrants were younger than Canadian-born individuals, with 67.8% between the ages of 50 and 69 compared with 52.6% of the Canadian-born group and 47.3% of long-term immigrants. A large majority of this sample reported Ontario residency, followed by Western provinces (Alberta and British Columbia). Recent immigrants had a higher proportion (14.1%) of individuals in the lowest income group (No income or less than $20,000) compared to long-term immigrants (7.7%) and Canadian-born individuals (7.2%). A larger proportion of recent immigrants (82.9%) were married compared to long-term immigrants (74.8%) and Canadian-born individuals (65.8%). Among recent immigrants, 61.3%

were born in Asia, compared with 50.9% of long-term immigrants who were born in Europe. Accordingly, 56.1% of recent immigrants reported being of South, East, or Southeast Asian racial origin, and 60.0% of long-term immigrants reported being of White racial origin. Finally, over 90% of recent and long-term immigrants reported living in urban areas, compared with 73.1% of Canadian-born individuals.

Table 4-3- Summary Characteristics of Canadian Community Health Survey Respondents (2005-2015), Investigation of the Association between Immigrant Status and Colorectal Cancer screening

	Recent Immigrants Unweighted n=620 Weighted N = 63,195	**Long-term Immigrants** Unweighted n=12,243 Weighted N = 636,957	**Canadian-Born** Unweighted n=72,132 Weighted N = 2,035,122
Lifetime Colorectal Cancer Screening [A] [B]			
Ever	37.7 (31.0 – 44.3)	61.0 (59.2 – 62.7)	64.7 (64.0 – 65.3)
Never	62.3 (55.7 – 69.0)	39.0 (37.3 – 40.8)	35.3 (34.7 – 36.0)
Time Appropriate Colorectal Cancer Screening [A]			
Yes	35.7 (29.1 – 42.3)	55.1 (53.3 – 56.8)	57.2 (56.5 – 57.8)
No	64.3 (57.7 – 70.9)	44.9 (43.2 – 46.7)	42.8 (43.2 – 43.5)
CCHS Cycle Year			
2015	7.6 (3.6 – 11.5)	5.0 (4.1 – 6.0)	9.3 (8.8 – 9.8)
2013-14	18.0 (12.2 – 23.7)	11.3 (10.2 – 12.3)	27.3 (26.7 – 27.9)
2011-12	27.4 (20.3 – 34.4)	29.8 (28.1 – 31.6)	22.6 (22.0 – 23.2)
2009-2010	22.1 (16.8 – 27.3)	26.9 (25.4 – 28.4)	22.1 (21.6 – 22.7)
2007-2008	23.3 (18.3 – 28.3)	25.4 (24.0 – 26.9)	16.7 (16.3 – 17.2)
2005	1.7 (0.3 – 3.2)	1.5 (1.3 – 1.8)	2.0 (1.8 – 2.1)
Sex			
Male	53.4 (46.5 – 60.2)	48.4 (46.6 – 50.1)	48.3 (47.6 – 49.0)
Female	46.6 (39.8 – 53.5)	51.6 (49.9 – 53.4)	51.7 (51.0 – 52.4)
Age			
50-54	46.0 (38.9 – 53.0)	22.8 (21.2 – 24.5)	27.3 (26.6 – 28.0)
55-59	21.8 (15.6 – 28.1)	24.5 (22.9 – 26.2)	25.3 (24.7 – 26.0)
60-64	14.8 (10.0 – 19.5)	21.4 (20.1 – 22.8)	20.5 (20.0 – 21.0)
65-69	10.7 (7.0 – 14.4)	18.0 (16.9 – 19.1)	15.7 (15.3 – 16.2)
70-74	6.8 (4.1 – 9.4)	13.2 (12.2 – 14.2)	11.1 (10.8 – 11.4)
Household Income			
No income or <$20,000	14.1 (9.0 – 19.1)	7.7 (6.7 – 8.6)	7.2 (7.0 – 7.5)
$20,000 - $39,999	13.0 (9.3 – 16.6)	17.9 (16.7 – 19.2)	16.6 (16.2 – 17.0)
$40,000 - $59,999	21.6 (15.9 – 27.2)	17.9 (16.5 – 19.2)	17.6 (17.1 – 18.0)
$60,000- $79,999	15.6 (10.4 – 20.8)	16.8 (15.5 – 18.1)	16.0 (15.5 – 16.5)
$80,000 - $99,999	11.1 (5.3 – 16.9)	12.9 (11.7 – 14.0)	12.7 (12.2 – 13.2)
$100,000 or more	24.8 (19.0 – 30.6)	26.9 (25.3 – 28.5)	29.9 (29.2 – 30.6)
Education			
Less than Secondary School	3.4 (1.7 – 5.1)	8.0 (7.2 – 8.8)	10.0 (9.7 – 10.3)
Second School Graduation	11.0 (5.9 – 16.0)	12.1 (11.0 – 13.2)	14.9 (14.4 – 15.3)
Post-Secondary School	85.7 (80.4 – 90.9)	80.0 (78.6 – 81.2)	75.2 (74.6 – 75.7)
Marital Status			
Married	82.9 (78.4 – 87.4)	74.8 (73.4 – 76.2)	65.8 (65.2 – 66.4)

Common-Law	1.2 (0.3 – 2.0)	2.8 (2.3 – 3.3)	7.9 (7.5 – 8.3)
Widowed	6.9 (3.9 – 10.0)	6.1 (5.5 – 6.7)	6.2 (5.8 – 6.5)
Separated	4.0 (1.1 – 7.0)	3.3(2.7 – 3.9)	3.0 (2.8 – 3.2)
Divorced	1.6 (0.7 – 2.4)	7.8 (6.7 – 8.8)	9.4 (9.0 – 9.7)
Single, Never Married	3.4 (1.8 – 4.9)	5.2 (4.6 – 5.8)	7.8 (7.5 – 8.1)
Self-Perceived Health			
Excellent	11.7 (8.0 – 15.3)	17.2 (15.8 – 18.6)	19.0 (18.4 – 19.5)
Very Good	37.5 (30.1 – 44.9)	31.9 (30.4 – 33.5)	37.6 (36.9 – 38.3)
Good	36.1 (29.7 – 42.4)	34.1 (32.4 – 35.7)	29.1 (28.5 – 30.0)
Fair	12.8 (8.3 – 17.3)	11.9 (10.9 – 13.0)	10.6 (10.2 – 11.0)
Poor	2.0 (0.7 – 3.2)	4.8 (3.9 – 5.8)	3.8 (3.5 – 4.0)
Province of Residence			
Maritimes	2.0 (1.1 – 3.0)	1.7 (1.4 – 1.9)	14.6 (14.2- 14.9)
Quebec	9.7 (5.0 – 13.4)	5.6 (4.8 – 6.4)	16.1 (15.6 – 16.7)
Ontario	68.3 (61.7 – 75.0)	78.3 (76.8 – 80.0)	47.2 (46.5 – 47.9)
Prairies	1.6 (0.7 – 2.4)	2.0 (1.6 – 2.4)	5.3 (5.0 – 5.5)
Western Provinces	18.3 (12.6 – 24.0)	12.4 (11.1 – 13.7)	16.7 (16.1 – 17.3)
Territories	0.1 (0.0 – 0.1)	0.1 (0.1 – 0.1)	0.2 (0.1 – 0.2)
Country of Birth			
Canada	.	.	99.1 (99.0 – 99.3)
United States	4.1 (1.5 – 6.7)	4.5 (4.0 – 5.0)	.
S&C America & Carb	10.1 (5.5 – 14.7)	13.0 (11.7 – 14.3)	.
Europe	17.5 (12.7 – 22.3)	50.9 (49.1 – 52.6)	.
Africa	7.0 (4.0 – 10.0)	4.4 (3.6 – 5.1)	.
Asia	61.3 (54.6 – 68.0)	27.2 (25.5 – 29.0)	.
Race/Cultural Origin			
White	25.5 (19.9 – 31.2)	60.0 (58.2 – 61.8)	99.3 (99.1 – 99.5)
South Asian	27.2 (21.3 – 33.2)	10.5 (9.3 – 11.7)	.
East and Southeast Asian	29.1 (22.0 – 36.1)	16.3 (14.9 – 17.8)	.
Black	5.8 (2.9 – 8.6)	6.3 (5.4 – 7.3)	.
Latin American	6.3 (2.0 – 10.6)	3.5 (2.7 – 4.3	.
Arab and Middle Eastern	6.1 (3.5 – 8.7)	3.4 (2.5 – 4.3)	.
Rurality			
Urban	96.1 (94.4 – 97.8)	91.6 (91.0 – 92.2)	73.1 (72.6 – 73.6)
Rural	3.9 (2.2 – 5.6)	8.4 (7.8 – 9.0)	26.9 (26.4 – 27.4)

All statistics are weighted
A = Chi square test shows a significant difference (P < 0.05) between recent immigrants and Canadian-born population
B = Chi square test shows a significant difference (P < 0.05) between long-term immigrants and Canadian-born population

4.2 Objective 1: Summarising Uptake of Breast, Cervical and Colorectal Cancer Screening Uptake in Canada

The first objective outlined in this study was to summarize uptake of lifetime and guideline recommended (time-appropriate) breast, cervical, and colorectal cancer screening in immigrants compared with non-immigrants across Canada, as well as to look at the effect of sociodemographic correlates of screening participation in immigrants compared with non-immigrants. To this end, age-stratified and age-adjusted screening rates were stratified by immigration status for the breast, cervical, and colorectal cancer screening subsamples. A multivariate logistic model was also used to examine the association between lifetime screening/ screening adherence with immigration status, as well as to examine the effect of other sociodemographic correlates. In all instances, the logistic regression models predict the odds of 'no screening' or 'non-adherence'. These results are presented below for each screening subsample.

Finally, a sensitivity analysis was performed to examine the effect of excluding recent immigrants having arrived in Canada within two years or less, to ensure that differences in screening participation rates among recent immigrants was not overwhelmingly due to a subset of recent immigrants having arrived in Canada too recently to begin to take advantage of preventative health care services. These results can be found in section 4.2.4.

4.2.1 Breast Cancer Screening Subsample

Age-stratified breast cancer screening rates by 5-year age group are presented in Figure 4-1, and age-standardized participation rates (using the age distribution of the Canadian-born population) and confidence internal are presented in Table 4-4. Age-standardized rates were calculated for ease of comparisons, notably with the results of the sensitivity analysis. Age-stratification demonstrates that for all ages and for all immigration groups, there was a higher proportion of lifetime breast cancer screening compared with screening adherence. Across all age groups, lifetime screening and screening adherence rates were very closely related for long-term immigrants and Canadian-born individuals, and while lifetime screening rates for these two groups appeared to increase with age, screening adherence rates plateaued and decreased after age 64. For recent immigrants, lifetime screening and adherence rates were highest among those 65 – 69 years, and otherwise presented no discernible age trends.

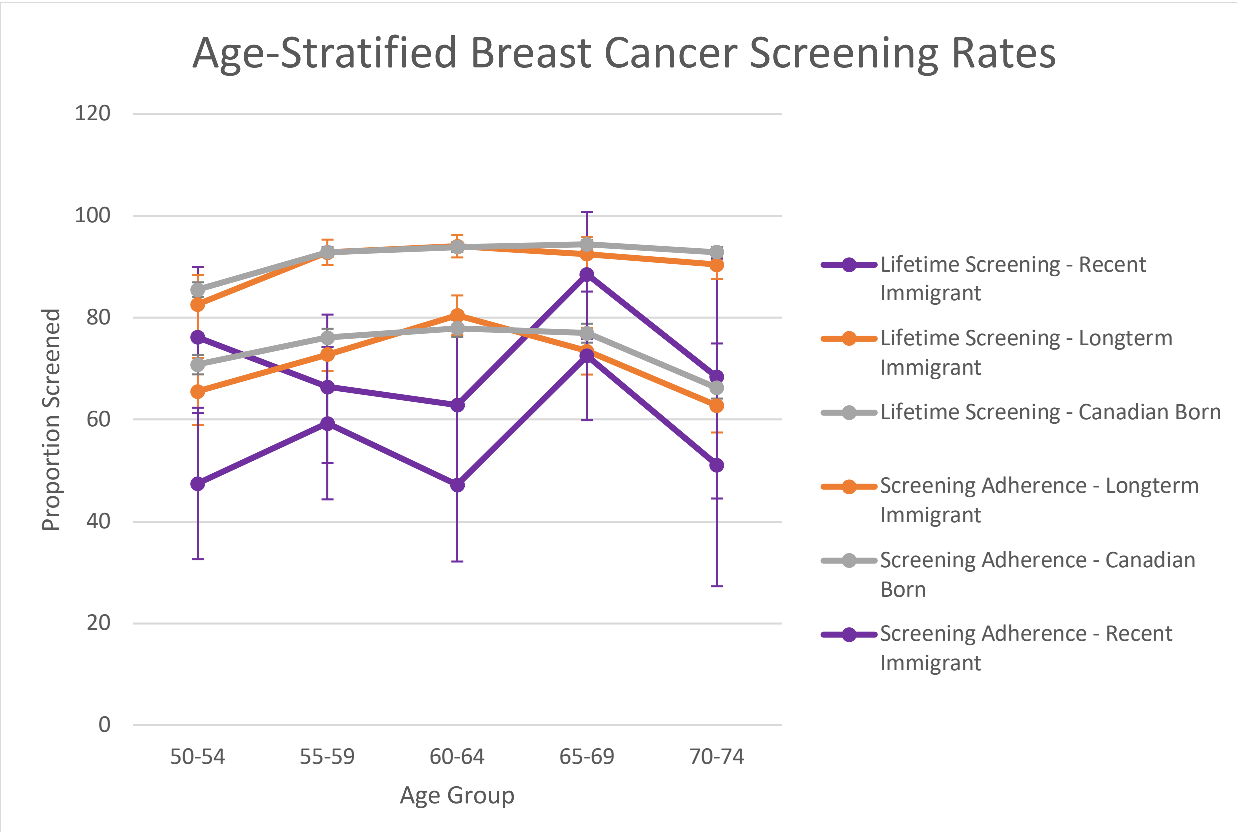


Figure 4-1 - Age Stratified Breast Cancer Screening Rates

The age-standardized screening rates were standardized according to the age distribution of the Canadian-born individuals, and are shown in Table 4-4. Age-standardized lifetime screening and screening adherence rates were very similar to crude rates for all groups. All age standardized adjustments affected crude rates by less than one percentage point, with the exception of breast cancer screening adherence rates amongst recent immigrants, which increased slightly from the crude rates (53.0% crude vs. 54.9% standardized).

Table 4-4 - Age-Standardized Mammogram Screening Rates, Breast Cancer Screening Subsample

	Recent Immigrants Unweighted n=620 Weighted N = 63,195	**Long-term Immigrants** Unweighted n=12,243 Weighted N = 636,957	**Canadian-Born** Unweighted n=72,132 Weighted N = 2,035,122
	% (95% CI)	% (95% CI)	% (95% CI)
Lifetime Breast Cancer Screening A	72.3 (63.40 -82.7)	90.1 (87.5 – 92.1)	91.5 (91.0 – 92.0)
Breast Cancer Screening Adherence A B	54.9 (43.3 – 64.9)	71.9 (68.9 – 74.3)	74.0 (73.2 – 74.9)

Standardized according to Canadian-born age structure.

All statistics are weighted

A = Chi square test shows a significant difference ($P < 0.05$) between recent immigrants and Canadian-born population

B = Chi square test shows a significant difference ($P < 0.05$) between long-term immigrants and Canadian-born population

In order to isolate the effect of immigrant status on screening uptake, a multivariate logistic regression model was fit separately for each of the independent variables and adjusted for the influence of age group, household income, educational attainment, marital status, CCHS survey year, self-perceived health, province of residence, country of birth, race/cultural origin, and rurality, and including sex for the colorectal cancer screening outcome.

Table 4-5 shows adjusted odds ratios, and associated p-values, for the association between immigration status and both lifetime breast cancer screening and screening adherence (within the guideline-recommended time period). In the model regressing lifetime screening on immigration status, recent immigrants had more than twice the odds of never screening compared to Canadian-born individuals (AOR 2.15 (95% CI 0.89 – 5.20)), and long-term immigrants had 12% lower risk of never screening compared to Canadian-born individuals (AOR 0.88 (95% CI 0.41 -1.86)). Neither of these results reached statistical significance at the $\alpha = 0.05$ level. Before adjustment, all covariates in the model were individually statistically significant predictors of screening, as demonstrated by the forward selection process. In the fully adjusted model, survey year did not have a statistically significant effect on lifetime screening, although the risk of never screening was higher in almost all years compared with 2015. Those in the youngest age group, 50 – 54, were statistically significantly more likely to never be screened with mammography compared to the oldest age group. The risk of never screening was also significantly higher for those in the lowest household income group (no income or <$20,000) compared with those in the highest income group ($100,000 or more). The risk of never screening also appeared to decrease with increasing educational attainment, and single (never married) individuals had a significantly higher risk of never being screened compared to married individuals. Those born outside of North America had a higher risk of never screening compared with North American born individuals, with individuals born in Asia demonstrating the highest risk. There were no statistically significant differences amongst racial groups, although South Asians and Latin-Americans were at increased risk compared to White women. Finally, there was statistically greater odds of never screening for those living in rural areas compared to their urban counterparts.

In regard to screening adherence, recent immigrants had 73% higher odds of screening non-adherence compared to Canadian-born individuals (AOR 1.73 (95% CI 0.90 – 3.33)), while long-term immigrants had 17% lower odds of screening non-adherence compared to Canadian – born individuals (AOR 0.83 (95% CI 0.50 – 1.38)). Again, neither of these results reached statistical significance. Every survey year was a significant predictor of screening adherence, with higher odds of non-adherence in every year compared with 2015, suggesting that screening uptake increased over time. Age was also significantly associated with screening non-adherence, and suggests that individuals in the oldest age group (70- 74 years) were at increased risk of non-adherence compared with younger ages. Screening adherence also seemed to increase with increasing household income, as well as with increased educational attainment. Married individuals had the lowest risk of breast cancer screening non-adherence, and single women the highest. Individuals with poor self-perceived health had 67% higher odds of screening non-adherence than those with excellent self-perceived health. Neither country of birth nor racial origin appeared to have a statistically significant impact on screening adherence, although those born in Asia and identifying as South Asian racial origin were at increased risk of non-adherence compared with being born in Canada and White racial origin. Finally, rurality does not appear to be a significant predictor of screening adherence.

Table 4-5 - Adjusted logistic regression, association between Immigration Status and Screening for Breast Cancer using Mammography

	Mammography					
	Never Screening			Non- Adherence		
	AOR	**(95% CI)**	**p-value**	**AOR**	**(95% CI)**	**p-value**
Immigration Status						
Recent Immigrant	2.15	(0.89 – 5.20)	0.08	1.73	(0.90 – 3.33)	0.10
Long-term Immigrants	0.88	(0.41 – 1.86)	0.73	0.83	(0.50 – 1.38)	0.47
Canadian-born	1.00	.	.	1.00	.	.
CCHS Cycle Year						
2015	1.00	.	.	1.00	.	.
2013-14	0.83	(0.59 – 1.17)	0.28	1.71	(1.35 – 2.16)	<0.01
2011-12	1.23	(0.87 – 1.75)	0.24	1.62	(1.28 – 2.04)	<0.01
2009-2010	1.13	(0.82 – 1.54)	0.45	1.50	(1.18 – 1.91)	<0.01
2007-2008	1.33	(0.95 – 1.86)	0.09	1.59	(1.26 – 2.00)	<0.01
2005	1.28	(0.95 – 1.72)	0.10	1.40	(1.14 – 1.70)	<0.01
Age Group						
50-54	2.62	(2.09 – 3.27)	<0.01	1.01	(0.87 – 1.16)	0.94
55-59	1.17	(0.94 – 1.46)	0.16	0.72	(0.63 – 0.83)	<0.01
60-64	0.94	(0.75 – 1.19)	0.61	0.59	(0.51 – 0.67)	<0.01
65-69	0.79	(0.63 – 1.00)	0.05	0.61	(0.54 – 0.71)	<0.01
70-74	1.00	.	.	1.00	.	.
Household Income						
<$20,000	1.69	(1.29 – 2.22)	<0.01	1.79	(1.51 – 2.13)	<0.01
$20,000 - $39,999	1.10	(0.85 – 1.44)	0.46	1.31	(1.13 – 1.52)	<0.01
$40,000 - $59,999	1.01	(0.79 – 1.28)	0.97	1.08	(0.93 – 1.26)	0.29
$60,000- $79,999	0.97	(0.75 – 1.25)	0.81	1.04	(0.90 – 1.22)	0.59
$80,000 - $99,999	0.85	(0.65 – 1.13)	0.26	0.93	(0.78 – 1.11)	0.43
$100,000 or more	1.00	.	.	1.00	.	.
Education						
Less than Secondary School	1.57	(1.30 – 1.89)	<0.01	1.33	(1.17 – 1.51)	<0.01
Second School Graduation	1.48	(1.25 – 1.76)	<0.01	1.20	(1.06 – 1.36)	<0.01
Post-Secondary School	1.00	.	.	1.00		.
Marital Status						
Married	1.00	.	.	1.00	.	.
Common-Law	1.19	(0.90 – 1.57)	0.23	1.06	(0.89 – 1.26)	0.53
Widowed	1.30	(1.03 – 1.65)	0.03	1.15	(1.00 – 1.32)	0.05
Separated	0.94	(0.64 – 1.38)	0.75	1.30	(0.99 – 1.70)	0.05
Divorced	1.11	(0.89 – 1.39)	0.35	1.22	(1.06 – 1.41)	<0.01
Single, Never Married	1.63	(1.32 – 2.01)	<0.01	1.39	(1.19 – 1.64)	<0.01
Self-Perceived Health						
Excellent	1.00	.	.	1.00	.	.
Very Good	1.06	(0.76 – 1.47)	0.75	0.98	(0.86 – 1.12)	0.79
Good	1.07	(0.78 – 1.46)	0.67	1.04	(0.91 – 1.19)	0.55
Fair	0.99	(0.73 – 1.34)	0.94	1.06	(0.90 – 1.25)	0.52
Poor	0.86	(0.62 – 1.20)	0.38	1.67	(1.30 – 2.14)	<0.01

Province of Residence						
Maritimes	1.00	.	.	1.00	.	.
Quebec	0.77	(0.54 – 1.08)	0.13	0.81	(0.64 – 1.02)	0.07
Ontario	0.80	(0.65 – 0.99)	0.04	0.88	(0.77 – 1.01)	0.06
Prairies	1.16	(0.87 – 1.55)	0.31	0.92	(0.75 – 1.13)	0.43
Western Provinces	0.78	(0.63 – 0.98)	0.03	1.06	(0.93 – 1.21)	0.36
Territories	1.11	(0.66 – 1.84)	0.70	1.05	(0.73 – 1.51)	0.81
Country of Birth						
Canada	1.00	.	.	1.00	.	.
Other- NA	0.98	(0.45 – 2.13)	0.96	1.24	(0.71 – 2.17)	0.46
S&C America & Carib	1.22	(0.49 – 3.01)	0.67	1.09	(0.54 – 2.17)	0.81
Europe	1.05	(0.50 – 2.22)	0.90	1.26	(0.76 – 2.11)	0.37
Africa	2.62	(0.92 – 7.46)	0.07	1.71	(0.82 – 3.57)	0.15
Asia	3.80	(1.42 – 10.17)	<0.01	1.72	(0.86 – 3.42)	0.12
Race/Cultural Origin						
White	1.00	.	.	1.00	.	.
South Asian	1.24	(0.59 – 2.63)	0.57	1.16	(0.68 – 2.00)	0.58
East and Southeast Asian	0.48	(0.22 – 1.03)	0.06	0.97	(0.57 – 1.63)	0.90
Black	0.58	(0.23 – 1.14)	0.10	0.61	(0.34 – 1.11)	0.11
Latin American	1.76	(0.53 – 5.84)	0.36	0.98	(0.40 – 2.40)	0.96
Arab and Middle Eastern	0.41	(0.12 – 1.38)	0.15	0.44	(0.18 – 1.09)	0.07
Rurality						
Urban	1.00	.	.	1.00	.	.
Rural	1.26	(1.09 – 1.45)	0.01	1.05	(0.96 – 1.15)	0.25

All statistics are weighted

4.2.2 Cervical Cancer Screening Subsample

Age-stratified screening rates, stratified by immigration status, can be seen in Figure 4-2. For all age groups and for each immigration group, the proportion of individuals having ever been screened was higher than the proportion of those that had been screened within the guideline-recommended interval. For Canadian-born individuals and long-term immigrants, lifetime screening rates increased from ages 20 – 29 years to the 30 – 39 years, and then stayed relatively constant, and relatively high (89% and above) compared to national targets. In these two groups, adherence screening rates also increased between ages 20 – 29 to ages 30 – 39, but then steadily decreased with age. Recent immigrant lifetime screening and adherence screening rates showed similar trends, peaking at the ages of 30 – 39 years (78.7% lifetime screening and 71.1% screening adherence) and then slowly decreasing with age.

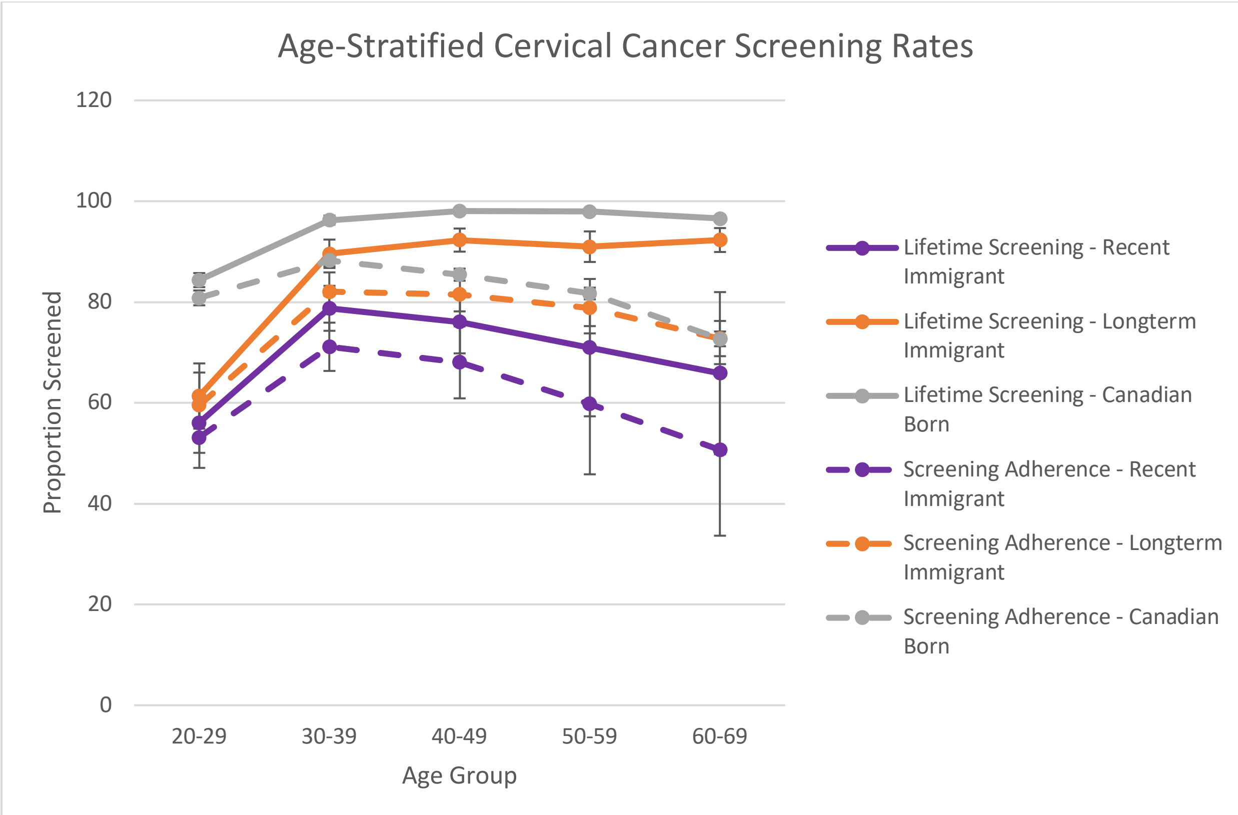


Figure 4-2– Age Stratified Cervical Cancer Screening Rates

Age standardized screening rates are shown in Table 4-6. Despite a wider screening-eligible age group, standardization again resulted in similar rates to the crude for cervical cancer screening, although recent immigrant and long-term immigrant lifetime screening rates and adherence rates did go down up to four percentage points. Age-standardized lifetime pap screening rates were 69.9% for recent immigrants, compared with 84.5% for long-term immigrants and 94.4% for Canadian-born individuals. Adherence rates were 61.5% for recent immigrants, compared with 75.1% for long-term immigrants and 82.7% for Canadian born individuals.

Table 4-6- Age-Standardized Pap Cancer Screening Rates, Cervical Cancer Screening Subsample

	Recent Immigrants Unweighted n=2125 Weighted N = 174,832	**Long-term Immigrants** Unweighted n=6635 Weighted N = 392,868	**Canadian-Born** Unweighted n=52,563 Weighted N = 1,744,107
	% (95% CI)	% (95% CI)	% (95% CI)
Lifetime Pap Screening [A B]	69.9 (66.9 – 73.0)	84.5 (83.1 – 86.0)	94.4 (94.0 – 94.8)
Pap Screening Adherence [A B]	61.5 (58.6 - 65.2)	75.1 (73.4 – 76.8)	82.7 (82.1 – 83.2)

Standardized according to Canadian-born age structure.
All statistics are weighted
A = Chi square test shows a significant difference (P < 0.05) between recent immigrants and Canadian-born population
B = Chi square test shows a significant difference (P < 0.05) between long-term immigrants and Canadian-born population

Next, two separate multivariate logistic regression models were fit to examine the effect of immigration status on never screening for cervical cancer and cervical cancer screening non-adherence. Adjusted logistic regression results can be seen in Table 4-7. In regard to lifetime screening uptake, recent immigrants had 27% higher odds (AOR 1.27 (CI 0.70 – 2.29)) of never being screened compared with Canadian-Born individuals, while long-term immigrants had 45% lower odds (AOR 0.55 (CI 0.31 – 0.99)) of never being screened compared to Canadian-born individuals. Covariates showed lower odds of never screening in every year compared with 2015, suggesting that uptake of cervical cancer screening was higher in 2005 compared to 2015. Age was also negatively associated with lifetime screening, with every age group showing statistically significant lower odds of never being screened compared to 60 – 69 year old women. Household income was also negatively associated with screening, with every income group showing a lesser risk of never screening compared with households earning $100,000 or more. Odds of never screening did decrease with increasing educational attainment, with each education bracket showing a statistically significant association with lifetime screening uptake. Women who were single (never married) had over five times the odds of never screening compared with married women, and those with poor self-perceived health also showed increased odds of never screening compared with those with excellent self-perceived health. Compared to

Maritime provinces, other provinces showed significantly greater odds of never screening, the highest being in Quebec with over four times the odds. Women of every other country of birth also had higher odds of never screening compared with Canadian-born individuals, the highest being for women from Asia, who had over five times the risk of never screening compared to Canadian born women. Additionally, every racial origin showed increased risk of never screening compared to White women, the highest again being amongst South Asian women. Finally, women living in rural settings had statistically significant higher odds of never being screened.

In regard to cervical cancer screening adherence, recent immigrants had 47% higher odds (AOR 1.47 (CI 0.98 – 2.21)) of non-adherence compared to Canadian born women, whereas long-term immigrants had 24% lower odds (AOR 0.76 (CI 0.52 – 1.12)) of non-adherence compared with Canadian born women. As with lifetime screening, odds of screening adherence were lower in all years compared to 2015. Those with the lowest income (No income or <$20,000) had significantly higher odds of non-adherence compared with those in the highest income category (AOR 1.26 (CI 1.06 – 1.49)). Self-perceived health was positively associated with screening adherence. Risk of non-adherence was once again highest in Quebec. Finally, individuals born in Asia and identifying as South Asian were at the highest risk of non-adherence compared with those born in Canada and identifying as White. Individuals of Arab or Middle Eastern origin also had almost double the risk of non-adherence compared with those that identified as White (OR 2.13 (CI 1.42 – 3.20). Lastly, those living in rural areas had 30% higher risk of non-adherence compared with those living urban areas.

Table 4-7- Adjusted logistic regression, association between Immigration Status and Screening for Cervical Cancer using Pap Smear

	Pap Test Never Screening			Non- Adherence		
	AOR	**(95% CI)**	**p-value**	**AOR**	**(95% CI)**	**p-value**
Immigration Status						
Recent Immigrant	1.27	(0.70– 2.29)	0.42	1.47	(0.98– 2.21)	0.06
Long-term Immigrant	0.55	(0.31– 0.99)	0.04	0.76	(0.52– 1.12)	0.17
Canadian-born	1.00	.	.	1.00	.	.
CCHS Cycle Year						
2015	1.00	.	.	1.00	.	.
2013-14	0.79	(0.53– 1.17)	0.25	0.96	(0.77– 1.20)	0.78
2011-12	0.60	(0.42– 0.86)	0.01	0.85	(0.69– 1.05)	0.14
2009-2010	0.53	(0.35– 0.80)	<0.01	0.81	(0.63– 1.05)	0.11
2007-2008	0.59	(0.42– 0.84)	<0.01	0.85	(0.70– 1.03)	0.11
2005	0.64	(0.47– 0.87)	0.01	0.86	(0.73– 1.03)	0.11
Age Group						
20-29	0.41	(0.33– 0.50)	<0.01	0.77	(0.68– 0.88)	<0.01
30-29	0.34	(0.28– 0.43)	<0.01	1.02	(0.90– 1.16)	0.71
40-49	0.41	(0.32– 0.52)	<0.01	1.33	(1.17– 1.51)	<0.01
50-59	0.51	(0.39– 0.65)	<0.01	1.93	(1.68– 2.20)	<0.01
60-69	1.00	.	.	1.00	.	.
Household Income						
No income or <$20,000	0.91	(0.67– 1.23)	0.54	1.26	(1.06– 1.49)	<0.01
$20,000 - $39,999	0.84	(0.66– 1.05)	0.14	1.12	(0.98– 1.28)	0.09
$40,000 - $59,999	0.84	(0.67– 1.04)	0.12	1.06	(0.92– 1.21)	0.38
$60,000- $79,999	0.86	(0.69– 1.07)	0.19	1.01	(0.89– 1.15)	0.82
$80,000 - $99,999	0.74	(0.57– 0.96)	0.03	0.83	(0.72– 0.96)	0.02
$100,000 or more	1.00	.	.	1.00	.	.
Education						
Less than Secondary School	1.56	(1.19– 2.06)	<0.01	1.70	(1.48– 1.96)	<0.01
Second School Graduation	1.28	(1.03– 1.60)	0.03	1.21	(1.08– 1.35)	<0.01
Post-Secondary School	1.00	.	.	1.00	.	.
Marital Status						
Married	1.00	.	.	1.00	.	.
Common-Law	1.27	(0.98– 1.64)	0.06	1.10	(0.97– 1.26)	0.13
Widowed	1.63	(1.08– 2.47)	0.02	1.44	(1.21– 1.72)	<0.01
Separated	1.37	(0.87– 2.15)	0.17	1.23	(1.01– 1.50)	0.03
Divorced	0.77	(0.55– 1.07)	0.12	1.09	(0.93– 1.28)	0.25
Single, Never Married	5.67	(4.73– 6.80)	<0.01	2.51	(2.25– 2.80)	<0.01
Self-Perceived Health						
Excellent	1.00	.	.	1.00	.	.
Very Good	1.10	(0.93– 1.31)	0.24	1.07	(0.97– 1.18)	0.17
Good	1.25	(1.04– 1.51)	0.02	1.29	(1.15– 1.44)	<0.01
Fair	1.10	(0.81– 1.48)	0.53	1.39	(1.17– 1.65)	<0.01
Poor	1.62	(0.87– 3.01)	0.13	1.81	(1.42– 2.30)	<0.01
Province of Residence						

Maritimes	1.00	.	.	1.00	.	.
Quebec	4.66	(3.55– 6.10)	<0.01	1.94	(1.66– 2.26)	<0.01
Ontario	1.58	(1.23– 2.03)	<0.01	1.20	(1.06– 1.37)	<0.01
Prairies	1.74	(1.3– 2.33)	<0.01	1.24	(1.05– 1.45)	0.01
Western Provinces	1.37	(1.05– 1.78)	0.02	1.20	(1.03– 1.39)	0.015
Territories	1.14	(0.78– 1.65)	0.49	1.09	(0.89– 1.34)	0.39
Country of Birth						
Canada	1.00	.	.	1.00	.	.
Other- NA	1.32	(0.67 – 2.60)	0.43	0.93	(0.60 – 1.44)	0.74
S&C America & Carib	1.48	(0.68– 3.24)	0.32	0.77	(0.45– 1.31)	0.34
Europe	3.68	(2.02– 6.72)	<0.01	1.52	(1.03– 2.24)	0.03
Africa	3.89	(1.81– 8.34)	<0.01	1.48	(0.83– 2.64)	0.18
Asia	5.53	(2.87– 10.65)	<0.01	1.70	(1.07– 2.70)	0.02
Race/Cultural Origin						
White	1.00	.	.	1.00	.	.
South Asian	3.64	(2.41– 5.50)	<0.01	2.18	(1.58– 3.01)	<0.01
East and Southeast Asian	3.12	(2.13– 4.57)	<0.01	1.98	(1.48– 2.65)	<0.01
Black	1.47	(0.86– 2.52)	0.15	1.26	(0.85– 1.86)	0.25
Latin American	2.34	(1.16– 4.70)	0.02	1.13	(0.65– 1.96)	0.66
Arab and Middle Eastern	3.08	(1.91– 4.95)	<0.01	2.13	(1.42– 3.20)	<0.01
Rurality						
Urban	1.00	.	.	1.00	.	.
Rural	1.22	(1.05– 1.42)	0.01	1.30	(1.20– 1.41)	<0.01

All statistics are weighted

4.2.3 Colorectal Cancer Screening Subsample

Finally, the Age and sex-stratified colorectal Cancer screening rates can be seen in Figure 4-3 and Figure 4-4. In Canadian-born and long-term immigrant men, lifetime screening and screening adherence rates were lowest among those 50 – 54 years, and increased steadily with age. For recent immigrants, lifetime screening and adherence screening rates were lower than either long-term immigrants or Canadian-born individuals. Recent immigrants between the ages of 50 – 54 years had lifetime and adherence screening rates of 38.6% and 35.8% respectively, which decreased to 22.9% and 21.7% respectively. From there, screening rates for recent immigrants rose steadily.

Among women, lifetime and adherence screening rates for long-term immigrants increased from ages 50 – 54 to ages 70 – 74. For recent immigrants, no discernible age trend can be seen – however, lifetime and adherence rates were closely related for all age groups.

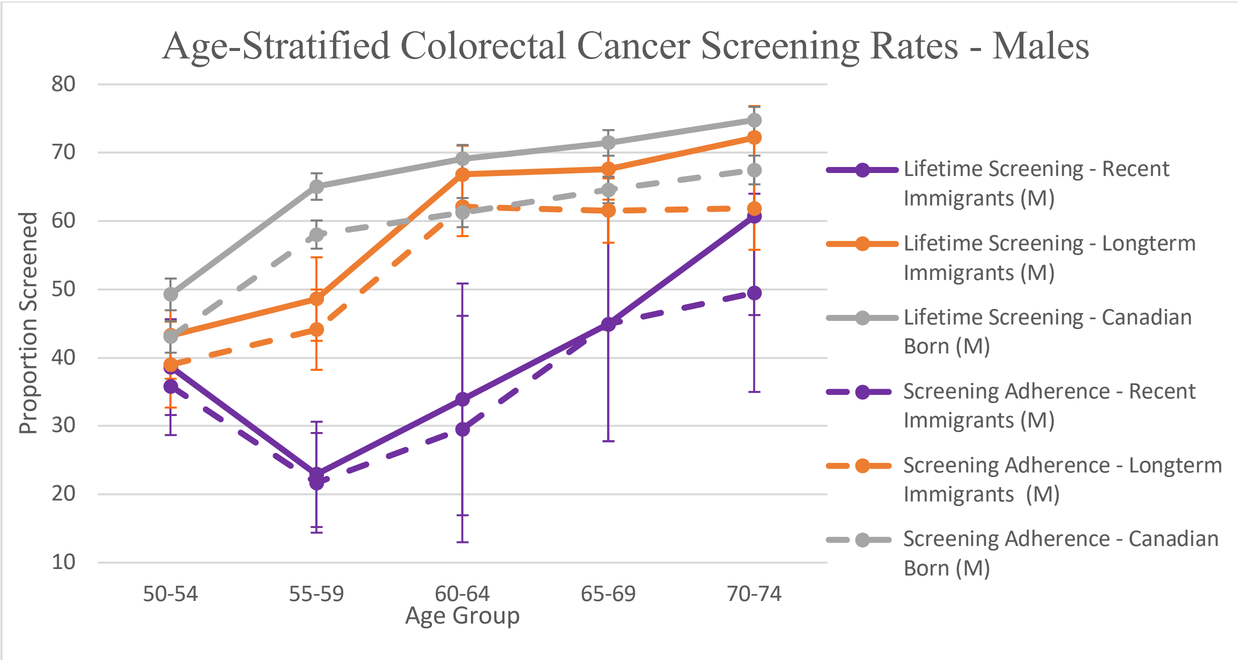


Figure 4-3– Age-Stratified Colorectal Cancer Screening Rates (Males)

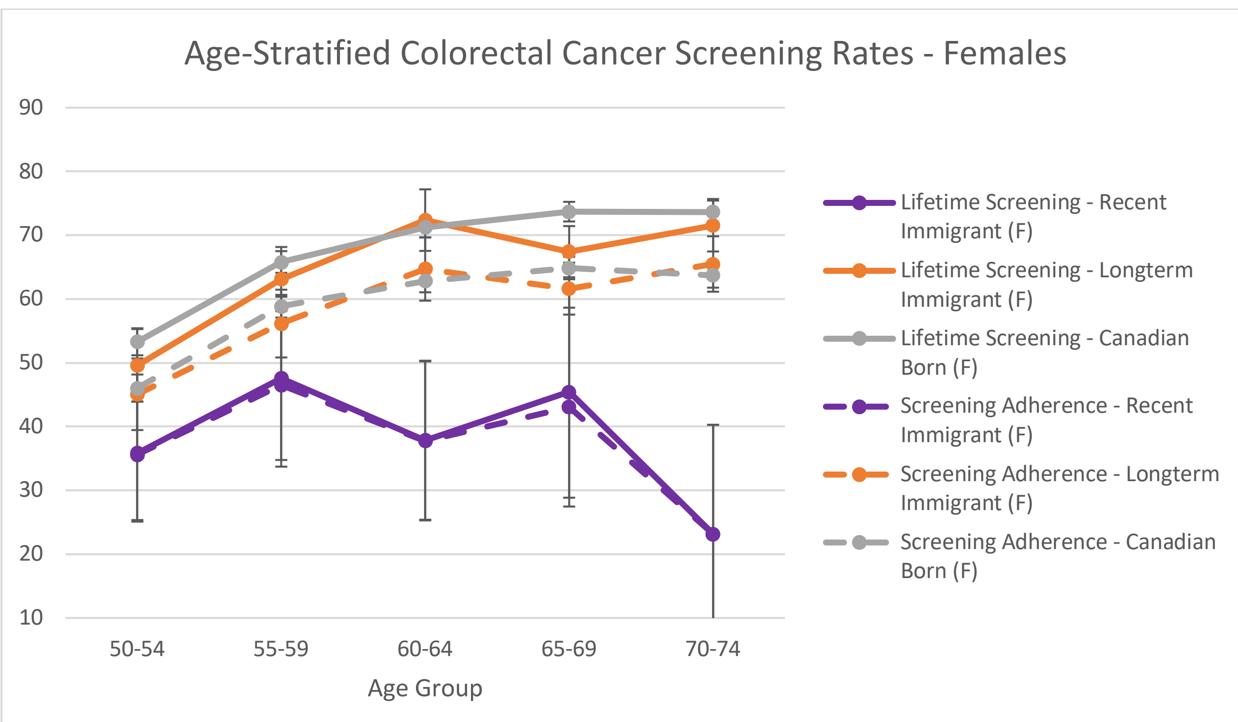


Figure 4-4 - Age-Stratified Colorectal Cancer Screening Rates (Females)

Age and Sex-Standardized rates can be found in Table 4-10. These rates, standardized according to the age and sex distribution of the Canadian-born population, were again closely related to crude rates. Recent immigrant lifetime screening rates increased from 37.1% to 37.7% from crude, while long-term immigrant lifetime rates increased from 56.4% to 61.0%. Screening adherence for both groups also increased after standardization, from 33.8% to 35.7% in recent immigrants, and from 51.0% to 55.1% in long-term immigrants. There was nevertheless still a significant difference between lifetime and adherence screening rates between recent immigrants and Canadian-born individuals, and between long-term immigrants and Canadian-born individuals.

Table 4-8– Age and Sex-Standardized Colorectal Cancer Screening Rates, Cervical Cancer Screening Subsample

	Recent Immigrants Unweighted n=620 Weighted N = 63,195	**Long-term Immigrants** Unweighted n=12,243 Weighted N = 636,957	**Canadian-Born** Unweighted n=72,132 Weighted N = 2,035,122
Lifetime Colorectal Cancer Screening **A B**	37.1 (30.5 – 43.7)	56.4 (54.1 – 57.5)	64.7 (64.0 – 65.3)
Colorectal Cancer Screening Adherence **A B**	33.8 (27.3 – 40.6)	51.0 (49.1 – 52.6)	57.2 (56.5 – 57.8)

Standardized according to Canadian-born age and sex structure.
All statistics are weighted
A = Chi square test shows a significant difference (P < 0.05) between recent immigrants and Canadian-born population
B = Chi square test shows a significant difference (P < 0.05) between long-term immigrants and Canadian-born population

Next, multivariate logistic regression was used to explore the effect of immigrant status and other correlates on screening uptake (Table 4-11). Looking first at Lifetime Screening, recent immigrants had a significantly increased risk of never screening compared with Canadian-born individuals (AOR 1.75 (CI 1.11 – 2.77)), while long-term immigrants had non-significant slightly lower odds of screening (AOR 0.96 (CI 0.69 – 1.34)). CCHS survey year was significantly associated with colorectal cancer screening uptake, with the risk of never screening decreasing every two years between 2005 and 2015. Consistent with age-stratified trends, women were significantly less likely to be screened compared to men, and risk of never screening decreased with increasing age. Lower income groups had a higher risk of never screening compared to those in the highest income bracket, and educational attainment was positively associated with lifetime screening. Ontarians had the lowest risk of never screening, and Canadian born individuals the lowest risk compared to every other world region of birth. Other racial groups were at higher risk compared with White individuals, with South Asians at the highest risk (AOR 1.88 (CI 1.26 – 2.81). There was also a significantly higher risk of never screening among rural dwellers compared with urban dwellers.

In regard to screening adherence rates, recent immigrants had 54% higher odds of non-adherence compared with Canadian born individuals (AOR 1.54 (CI 0.98 – 2.44)), while long-term immigrants had a slightly decreased risk of non-adherence (AOR 0.97 (CI 0.70 – 1.34)). Similarly to lifetime rates, screening adherence was highest in 2015 and positively associated with screening year. Adherence rates were also positively associated with educational attainment as well as with age, with the youngest age group having almost three times these odds of non-adherence compared with the oldest group (AOR 2.81 (CI 2.55 – 3.10). Screening adherence was highest among married individuals, as well as among those with excellent self-perceived health. Every other country of origin was at a higher risk of non-adherence compared with Canada, the highest risk among those born in Asia and Central and South America. Accordingly, South Asians and Latin Americans were at the highest risk of non-adherence compared with White individuals. Lastly, there was a significantly higher risk of non-adherence to colorectal cancer screening among rural dwellers compared to urban dwellers.

Table 4-9- Adjusted logistic regression, association between Immigration Status and Screening for Colorectal Cancer using FOBT or Sigmoidoscopy

	Colorectal Cancer Screening					
	Never Screening			Non- Adherence		
	AOR	**(95% CI)**	**p-value**	**AOR**	**(95% CI)**	**p-value**
Immigration Status						
Recent Immigrant	1.75	(1.11– 2.77)	0.02	1.54	(0.98– 2.44)	0.07
Non- Recent Immigrant	0.96	(0.69– 1.34)	0.81	0.97	(0.70– 1.34)	0.81
Non- Immigrant	1.00	.	.	1.00	.	.
CCHS Cycle Year						
2015	1.00	.	.	1.00	.	.
2013-14	1.34	(1.14– 1.58)	<0.01	1.14	(0.99– 1.32)	0.09
2011-12	1.74	(1.48– 2.04)	<0.01	1.47	(1.27– 1.70)	<0.01
2009-2010	2.36	(2.01– 2.76)	<0.01	1.92	(1.67– 2.22)	<0.01
2007-2008	3.18	(2.70– 3.75)	<0.01	2.63	(2.26– 3.06)	<0.01
2005	5.30	(4.30– 6.53)	<0.01	4.56	(3.73– 5.57)	<0.01
Sex						
Male	1.00	.	.	1.00	.	.
Female	1.21	(1.14– 1.28)	<0.01	1.16	(1.10– 1.23)	<0.01
Age Group						
50-54	3.23	(2.92– 3.57)	<0.01	2.81	(2.55– 3.10)	<0.01
55-59	1.85	(1.69– 2.03)	<0.01	1.65	(1.51– 1.81)	<0.01
60-64	1.33	(1.21– 1.46)	<0.01	1.26	(1.15– 1.38)	<0.01
65-69	1.15	(1.05– 1.26)	<0.01	1.09	(0.99– 1.19)	<0.01
70-74	1.00	.	.	1.00	.	.
Household Income						
<$20,000	1.34	(1.18– 1.52)	<0.01	1.50	(1.33– 1.68)	<0.01
$20,000 - $39,999	1.24	(1.13– 1.36)	<0.01	1.33	(1.21– 1.45)	<0.01
$40,000 - $59,999	1.08	(0.99– 1.19)	0.10	1.15	(1.05– 1.26)	<0.01
$60,000- $79,999	1.14	(1.03– 1.25)	0.01	1.16	(1.06– 1.27)	<0.01
$80,000 - $99,999	0.97	(0.87– 1.08)	0.52	1.01	(0.91– 1.12)	0.94
$100,000 or more	1.00	.	.	1.00	.	.
Education						
Less than Secondary School	1.40	(1.29– 1.52)	<0.01	1.37	(1.26– 1.49)	<0.01
Second School Graduation	1.27	(1.17– 1.38)	<0.01	1.23	(1.13– 1.33)	<0.01
Post-Secondary School	1.00	.	.	1.00	.	.
Marital Status						
Married	1.00	.	.	1.00	.	.
Common-Law	1.17	(1.04– 1.31)	0.01	1.19	(1.06– 1.34)	<0.01
Widowed	1.36	(1.21– 1.54)	<0.01	1.35	(1.20– 1.51)	<0.01
Separated	1.13	(0.95– 1.35)	0.18	1.13	(0.95– 1.34)	0.19
Divorced	1.24	(1.11– 1.38)	<0.01	1.27	(1.15– 1.41)	<0.01
Single, Never Married	1.30	(1.18– 1.44)	<0.01	1.33	(1.21– 1.46)	<0.01
Self-Perceived Health						

Excellent	1.00	.	.	1.00	.	.
Very Good	1.62	(1.36– 1.92)	<0.01	1.39	(1.18– 1.64)	<0.01
Good	1.45	(1.24– 1.71)	<0.01	1.26	(1.08– 1.47)	<0.01
Fair	1.37	(1.16– 1.61)	<0.01	1.23	(1.05– 1.44)	0.01
Poor	1.12	(0.94– 1.34)	0.22	1.07	(0.91– 1.27)	0.43
Province of Residence						
Maritimes	1.00	.	.	1.00	.	.
Quebec	1.39	(1.22– 1.57)	<0.01	1.17	(1.04– 1.32)	0.01
Ontario	0.46	(0.42– 0.50)	<0.01	0.43	(0.40– 0.47)	<0.01
Prairies	0.65	(0.58– 0.73)	<0.01	0.67	(0.60– 0.74)	<0.01
Western Provinces	0.70	(0.62– 0.78)	<0.01	0.70	(0.63– 0.77)	<0.01
Territories	0.99	(0.81– 1.21)	0.89	1.05	(0.86– 1.28)	0.68
Country of Birth						
Canada	1.00	.	.	1.00	.	.
Other- NA	1.21	(0.82– 1.78)	0.35	1.30	(0.89– 1.90)	0.18
S&C America & Carib	1.42	(0.90– 2.24)	0.14	1.47	(0.94– 2.32)	0.09
Europe	1.27	(0.91– 1.77)	0.16	1.19	(0.86– 1.65)	0.31
Africa	1.27	(0.75– 2.14)	0.38	1.12	(0.67– 1.86)	0.68
Asia	1.54	(0.94– 2.54)	0.09	1.50	(0.93– 2.42)	0.10
Race/Cultural Origin						
White	1.00	.	.	1.00	.	.
South Asian	1.88	(1.26– 2.81)	<0.01	1.53	(1.04– 2.24)	0.03
East and Southeast Asian	1.17	(0.77– 1.80)	0.47	1.09	(0.73– 1.62)	0.69
Black	1.15	(0.75– 1.78)	0.53	1.02	(0.67– 1.54)	0.96
Latin American	1.79	(1.05– 3.05)	0.03	1.85	(1.04– 3.28)	0.04
Arab and Middle Eastern	1.52	(0.88– 2.63)	0.14	1.52	(0.90– 2.55)	0.12
Rurality						
Urban	1.00	.	.	1.00	.	.
Rural	1.07	(1.01– 1.13)	0.03	1.06	(1.01– 1.12)	0.04

All Statistics are weighted

4.2.4 Sensitivity Analysis

The Canada Health Act (CHA), Canada's federal legislation governing the conditions with which provincial and territorial health insurance programs must conform, allows for provinces to impose a three-month waiting period before new immigrants are eligible for health care coverage (13). While not all provinces impose such a waiting period, three out of four immigrants will settle in Ontario, Quebec, and British Columbia (119), all of which do have three-month waiting period policies. This wait period, as well as many other facets related to the immigrant settlement experience, may cause a delay in seeking preventative healthcare services, especially for diseases with long latency periods such as cancer. To account for the possibility that the lower rates of cancer screening in recent immigrants is due largely to the most recently arrived immigrants not utilizing screening services due to a lack of coverage or significant barriers to healthcare within the first couple of years upon arrival, a sensitivity analysis was performed. This analysis examines the screening rates of recent immigrants while excluding those that arrived in Canada most recently – here, residing in Canada for two years or less. This analysis thus allows for a 2-year adjustment period during which new immigrants may have been attending to other settlement priorities and may not have sought preventative health services.

After removing immigrants with 0 – 2 years of residency, age-adjusted screening rates for breast and cervical cancer, and age and sex-adjusted rates for colorectal cancer, were calculated. This new group, including only immigrants with 2 – 10 years of residency in Canada, will be referred to as 'Settled Recent Immigrants'. A logistic regression model was also fit and adjusted for all previous covariates to examine any changes in the association between screening uptake and immigration status when using the New Recent Immigrants group. These adjusted rates and logistic regression results can be found in Table 4-10 and Table 4-11.

Standardized screening rates and 95% confidence intervals for settled recent immigrants (2 –10 years of residence in Canada) are included in Table 4-10 and a multivariate logistic regression model was also fit with the Settled Recent Immigrants group (Table 4-11), to examine whether there would be a change in the association between immigration status and breast, cervical and colorectal cancer screening uptake. Breast cancer lifetime and adherence screening rates did not change substantially for recent immigrants after removing the most recent arrivals. Lifetime screening decreased from 72.3% to 72.1%, while adherence rates decreased from 54.9% to 51.8%. For the cervical cancer subsample, lifetime rates for recent immigrants also rose from 69.9% to 71.7%, and adherence rates rose from 61.5% to 64.8% after removal of the most recently arrived immigrants. Lastly, age and sex-standardized lifetime colorectal cancer screening rates for recent immigrants rose marginally from 37.1% to 37.3%, and adherence rates rose from 33.8% to 34.9% after removal of the most recently arrived immigrants.

Adjusted logistic regression results can be found in Table 4-11. After removal of the most recent immigrants (0 – 2 years of residence in Canada), odds of never screening for breast cancer rose from AOR = 2.15 to AOR = 2.16, and odds of non-adherence to breast cancer screening guidelines decreased from AOR= 1.84 to AOR = 1.73, compared with Canadian-born individuals. Using the Settled Recent Immigrants group, odds of never screening for cervical cancer decreased from AOR = 1.27 to AOR = 1.24, and odds of non-adherence decreased from AOR = 1.47 to OAR = 1.43, compared with Canadian born individuals. Finally, removal of the most recently arrived immigrants resulted in higher odds of never screening for colorectal cancer from AOR = 1.65 to AOR = 1.75 and decreased the odds of non-adherence from AOR = 1.67 and AOR =1.54. There were no substantial changes in the effect of screening covariates (not shown) in the model when using the Settled Recent Immigrants group.

Table 4-10- Sensitivity Analysis, Age-Standardized Breast, Cervical, and Colorectal Cancer Screening Rates for Recent immigrants with 2 – 10 Years of Residency in Canada

	Settled Recent Immigrants (2 – 10 years of Residence in Canada)		
	Breast Cancer Unweighted N= 258 Weighted N = 26,861	Cervical Cancer Unweighted N = 2011 Weighted N = 155,387	Colorectal Cancer Unweighted N = 563 Weighted N = 53,408
	% (95% CI)	% (95% CI)	% (95% CI)
Lifetime Screening	72.1 (63.1 – 81.0)	71.7 (68.5 – 75.0)	37.3 (30.2 – 44.4)
Adherence Screening	51.8 (44.7 – 58.9)	64.8 (61.4 – 68.2)	34.9 (27.9 – 41.9)

Breast and Cervical cancer screening standardized according to Canadian-born age structure, colorectal cancer screening rates to age & sex structure
All statistics are weighted

Table 4-11– Sensitivity Analysis, Adjusted Odds Ratios; Association between Immigration Status and Cancer Screening, using Recent Immigrants Arrived in Canada 2 – 10 years ago

	Breast Cancer			
	Never Screening		Non-Adherence	
	AOR (95% CI)	p-value	AOR (95% CI)	p-value
Recent Immigrant (2-10 years)	2.16 (0.89 – 5.22)	0.95	1.84 (0.95 – 3.58)	0.07
Long-term Immigrant	0.88 (0.42 – 1.85)	0.844	0.84 (0.51 – 1.40)	0.51
Canadian Born	1.00	-	1.00	-
	Cervical Cancer			
Recent Immigrant (2-10 years)	1.24 (0.68 – 2,25)	0.48	1.43 (0.94 – 2.15)	0.09
Long-term Immigrant	0.55 (0.31 – 0.99)	0.05	0.76 (0.52 – 1.21)	0.17
Canadian Born	1.00	-	1.00	-
	Colorectal Cancer			
Recent Immigrant (2-10 years)	1.65 (1.01 – 2.68)	0.04	1.67 (1.03 – 2.71)	0.04
Long-term Immigrant	0.91 (0.65 – 1.27)	0.57	1.02 (0.73 – 1.41)	0.93
Canadian Born	1.00	-	1.00	-

All models are adjusted for the effects of CCHS Cycle Year, Age, Household Income, Educational Attainment, Marital Status, Self-Perceived Health, Province of residence, World Region of Birth, Race/Cultural Origin, and Rurality
All statistics are weighted

4.3 Objective 2: Difference in Breast and Cervical Cancer Screening Amongst Immigrant Subgroups

As described in Chapter 2 of this thesis, the relatively recent introduction of colorectal cancer screening guidelines and programs, unequal access across provinces, and the conflation between sigmoidoscopy and colonoscopy in the CCHS questionnaire, makes it difficult to accurately draw conclusions in regard to differences in screening uptake amongst different population subgroups. It was decided therefore to proceed with the analysis of Objective 2 and 3 using the breast and cervical cancer screening subsamples (BCS-SS and CCS-SS) only.

The second objective of this thesis was to explore differences in screening uptake among immigrant subgroups based on racial origin and world region of birth. To this end, stratified multivariate logistic regression models were used to first explore the difference in lifetime and adherence screening uptake between racial groups among recent immigrants and long-term immigrants separately. In all cases, 'White' racial origin was used as the reference group, and adjusted for the effects of CCHS Cycle Year, Age, Household Income, Educational Attainment, Marital Status, Self-Perceived Health, Province of residence, World Region of Birth, and Rurality. Stratified multivariate logistic regression models were also fit to explore the relationship between world region of origin and cancer screening uptake. In this case, 'North America' was used as the reference group for recent immigrants and long-term immigrants and the models were adjusted for the effects of CCHS Cycle Year, Age, Race, Household Income, Educational Attainment, Marital Status, Self-Perceived Health, Province of residence, World Region of Birth, and Rurality. While age-standardized screening rates, stratified by racial origin and world region of birth, were also evaluated, the logistic regression models allowed for the effect of race and country of origin to be isolated and are presented here instead.

BCS-SS - By racial/cultural origin

Results from the multivariate logistic regression models evaluating the effect of racial origin on breast and cancer screening uptake can be found in Figures 4-5 and 4-6.

Results are displayed as forest plots, with the vertical line representing the reference group (White racial origin).

In regard to differences in breast cancer screening between racial groups among recent immigrants, only South Asian women had higher odds of never breast cancer screening compared to White women (AOR 1.12 (CI 0.27 – 4.60, $p = 0.88$). Adherence rates similarly saw only one other group, Black women, with higher odds of non-adherence (AOR 1.09 (CI 0.52 – 2.32), $p < 0.82$). Neither of these results were statistically significant.

In contrast to recent immigrants, the only statistically significant results were seen among black long-term immigrants, who had a statistically significant decreased odds of never screening and screening non-adherence (AOR 0.32 (CI 0.14 – 0.71) and AOR 0.41 (CI 0.23 – 5.59), respectively) compared with white long-term immigrants. Among other long-term immigrant groups, both South Asian and Latin American women had higher odds of never screening (AOR 1.22 (CI 0.53 – 2.39) and (AOR 2.20 (CI 0.63 – 6.63), respectively), and South, Southeast and East Asians had higher odds of non-adherence (AOR 1.23 (CI 0.70 – 2.17), AOR 1.15 (CI 0.67 – 1.96)) and AOR 1.02 (CI 0.42 – 2.49) respectively), compared to White long-term immigrants. Again, only results among black long-term immigrants were statistically significant.

CCS-SS - By racial/cultural origin

Different trends can be seen in regard to the association between racial origin and cervical cancer screening uptake. In Figure 4-6, lifetime and adherence Pap screening was higher for all racial groups compared to white women, both among recent and long-term immigrants. Among recent immigrants, South Asian women had the highest risk of never screening and of non-adherence (AOR 3.85 (CI 2.36 – 6.29), $p < 0.01$ and AOR 2.43 (CI 1.62 – 3.62), $p < 0.01$ respectively).

Among long-term immigrants, South Asian women had the highest risk of never screening (AOR 4.87 (CI 3.15 – 7.54)) compared to white long-term immigrants, and Arab/Middle Eastern women had the highest risk of non-adherence (AOR 3.04 (CI 1.89 – 4.90)) compared to white long-term immigrants. Among racial long-term immigrant groups, black long-term immigrants had the lowest, though still elevated, risk compared to white long-term immigrants.

BCS-SS By World Region of Birth

A forest plot presenting differences in screening uptake according to World Region of Birth are shown in Figure 4-7. Limitations due to small cell counts did not allow for country-level comparisons, and so countries of birth were divided into five world regions: North America (United States and Mexico), South and Central America and the Caribbean, Europe, Africa, and Asia. Two multivariate logistic models were fit, the first restricted to recent immigrants, and the second restricted to long-term immigrants, to evaluate the association between world region of birth and lifetime and adherence screening. Both models were adjusted for the effects of CCHS Cycle Year, Age, Race/cultural origin, Household Income, Educational Attainment, Marital Status, Self-Perceived Health, Province of residence, and Rurality.

In regard to breast cancer screening, recent immigrants from South and Central America (AOR 2.91 (CI 0.91 – 9.01)), Africa (AOR 2.38 (0.53 – 10.73)), and Asia (AOR 7.72 (CI 1.60 – 15.37)) had a statistically significant higher risk of never screening compared to North-American born recent immigrants. Breast cancer screening non-adherence was only significantly higher among Asian recent immigrants compared to North American recent immigrants (AOR 4.07 (CI 1.45 – 11.43)).

Among long-term immigrants, those from South and Central America, and long-term immigrants from Europe, had similar risks of never screening compared to North Americans (AOR = 1.07 (CI 0.42 – 2.68) and AOR = 1.07 (0.51 – 2.24), respectively), while long-term immigrants from Africa and Asia showed almost three times the odds of never screening compared to Canadians (AOR = 2.79 (CI 0.95 – 8.24) and AOR =2.95 (CI 1.07 – 8.12)). Non-adherence to breast cancer screening among long-term immigrants was similarly elevated in all groups compared to North Americans, and while none were statistically significant, each group had between 20 – 40% higher odds of non-adherence compared to the reference group.

CCS-SS By World Region of Birth

The Association between World Region of Birth and Cervical Cancer screening are shown in Figure 4-8. Among recent immigrants, those born in Europe showed the highest risk of never having a pap test (AOR = 5.20 (CI 2.78 – 9.75)) and non-adherence (AOR =1.82 (CI 1.19 – 2.78)) to pap screening compared to North Americans. Recent immigrants from Africa had an increased risk of never screening (AOR 2.88 (CI 1.07 – 7.78)), but a decreased risk of non-adherence (AOR 0.89 (CI 0.41 – 1.91)), compared with North Americans, while recent immigrants from Asia had both an increased risk of never screening and non-adherence.

Among long-term immigrants, all groups had higher odds of never screening compared to North Americans, with the risk among long-term immigrants from Europe, Africa and Asia being statistically significant (AOR 3.38 (CI 1.78 – 6.40), AOR 3.79 (CI 2.31 – 8.44), AOR 5.82 (CI 4.98 – 11.37), respectively, all with $p < 0.01$). Except for those from South and Central America, all other long-term immigrants had higher odds of non-adherence to pap screening compared to North Americans, though none were statistically significant.

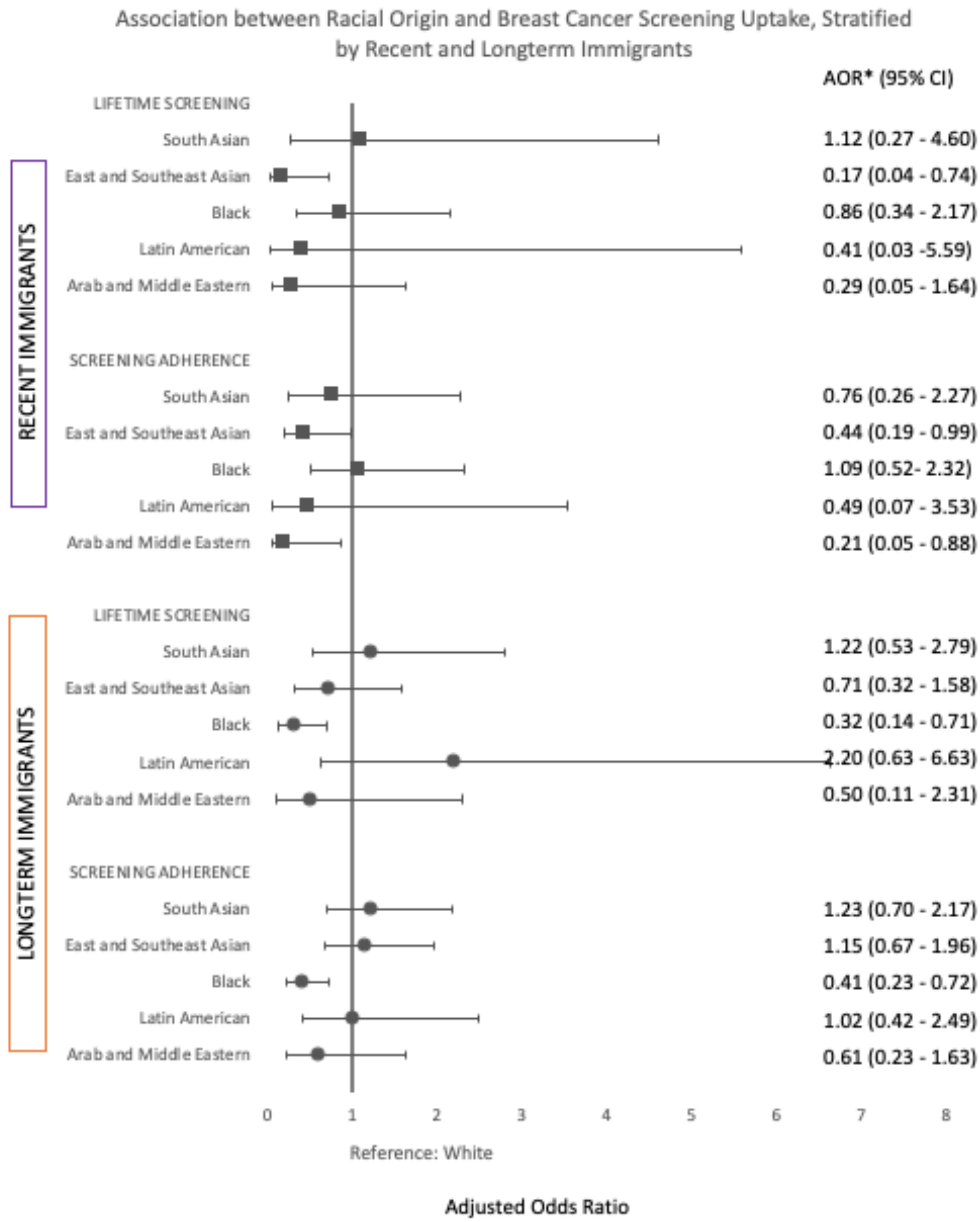


Figure 4-5 - Multivariate Logistic Regression Model, Association between Racial Origin and Lifetime Breast Cancer Screening and Screening Adherence, Stratified by Immigration Status
**Adjusted for age, income, education, marital status, self perceived health, world region of birth, year, province of residence, race/cultural origin, urban/rural dwelling*

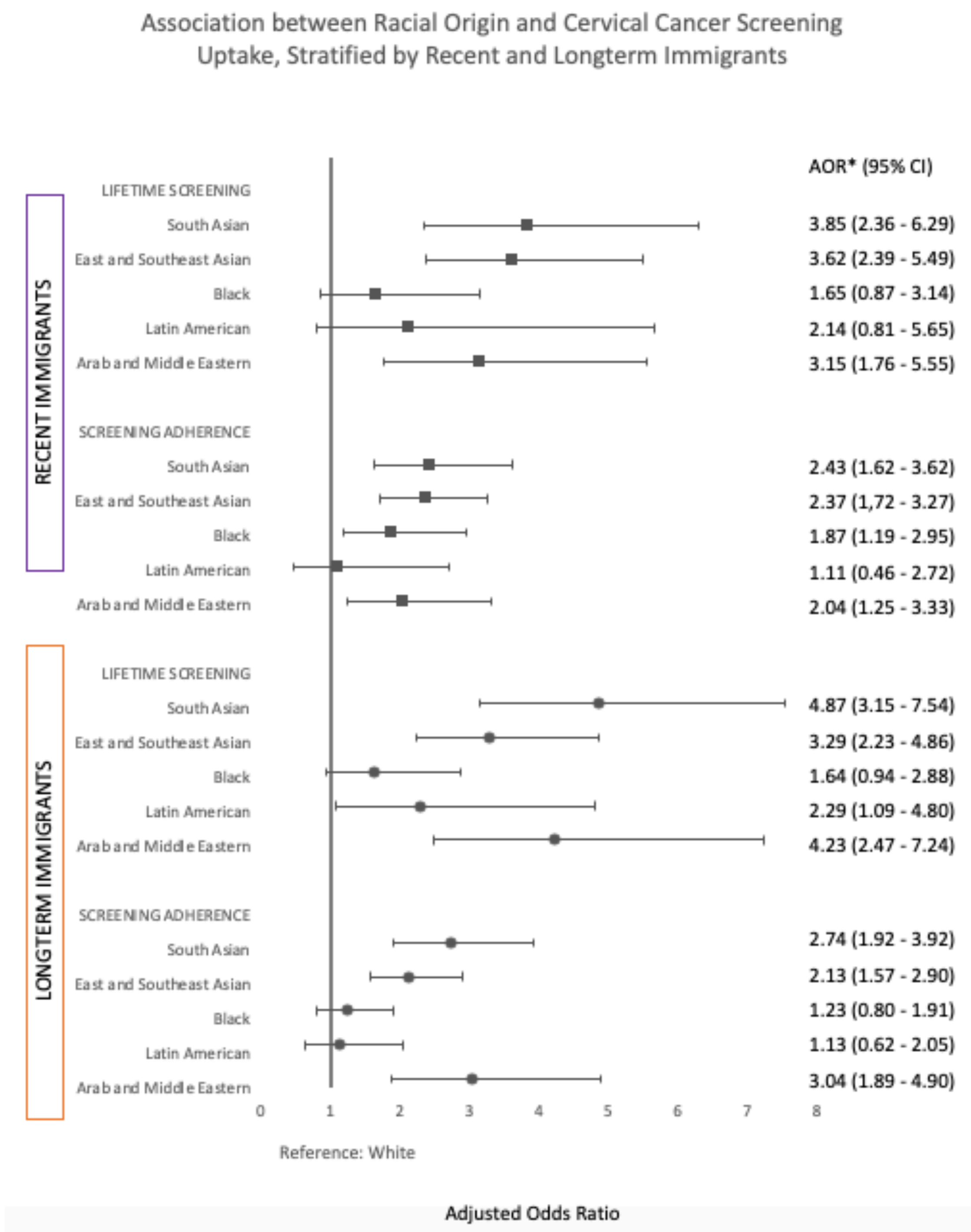


Figure 4-6 - Multivariate Logistic Regression Model, Association between Racial Origin and Lifetime Cervical Cancer Screening and Screening Adherence, Stratified by Immigration Status
**Adjusted for age, income, education, marital status, self perceived health, world region of birth, year, province of residence, race/cultural origin, urban/rural dwelling*

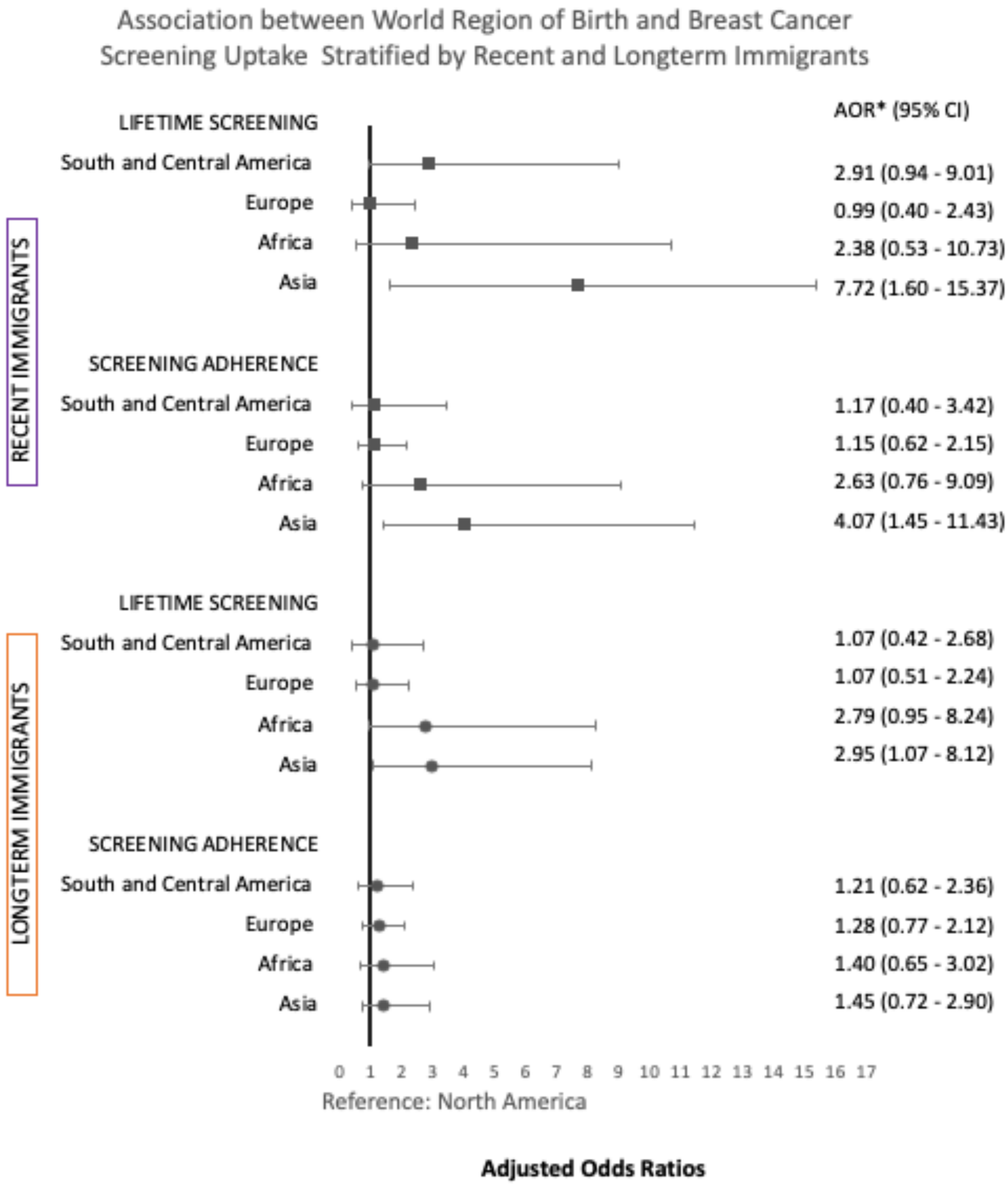


Figure 4-7 - Association between World Region of Birth and Breast Cancer Screening Uptake, Stratified by Immigration Status
**Adjusted for age, income, education, marital status, self perceived health, race, year, province of residence, race/cultural origin, urban/rural dwelling*

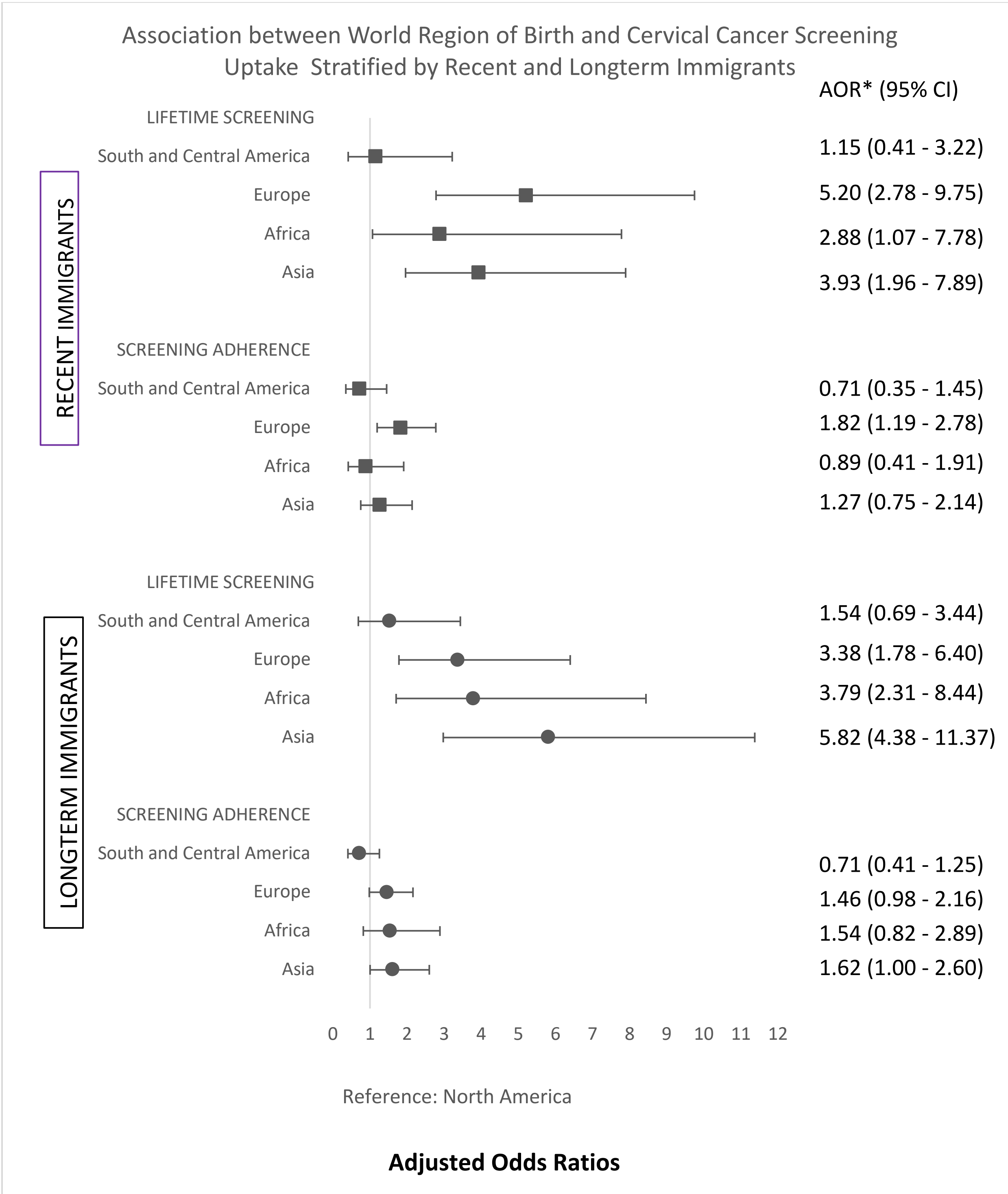


Figure 4-8 - Association between World Region of Birth and Cervical Cancer Screening Uptake, Stratified by Immigration Status

**Adjusted for age, income, education, marital status, self perceived health, race, year, province of residence, race/cultural origin, urban/rural dwelling*

4.4 Objective 3: Association between Time and Breast and Cervical Cancer Screening Uptake

As highlighted in section 4.3, Objective 3 was limited to the BCS-SS and CCS-SS. The final objective of this thesis was to examine temporal trends in breast and cervical cancer screening uptake over the ten-year period between 2005 and 2015, separately for recent immigrants, long-term immigrants, and Canadian-born individuals. Age-standardized screening rates between 2005 and 2015 were first plotted. Multivariate logistic regression models were also fit to examine the association between year and both lifetime screening and screening adherence, stratified by residency status. In order to isolate the effect of year, the models were adjusted for the effects of Age, Household Income, Educational Attainment, Marital Status, Self-Perceived Health, Province of residence, World Region of Birth, Race/cultural origin, and Rurality.

BCS-SS

Results for the age-standardized screening rates for the Breast Cancer Screening Subsample can be seen in Table 4-12. Among long-term immigrants and Canadian-born individuals, lifetime and adherence breast cancer screening rates appear to have gradually increased between 2005 and 2015. No distinct trends could be observed among recent immigrants breast cancer screening rates, although uptake appeared to peak in 2009-10. Stratified logistic regression analyses for breast cancer outcomes can be found in Figure 4-7. After adjusting for the covariates, odds of never screening among recent immigrants were lower for all years compared with 2015, though none of the odds ratios were statistically significant. Recent immigrant odds of non-adherence were lower in 2005 and 2009-10 compared with 2015, but higher in 2007-08, and 2011 to 2014. Once again, none of these results were statistically significant, and do not suggest any discernible trend in screening adherence over time among recent immigrants.

Among long-term immigrants, odds of never screening were higher in all years compared to 2015, except for in 2013-14 where long-term immigrants experienced decreased odds of never screening compared to the most recent year – suggesting that long-term immigrants were screened at higher rates in 2013-14 than in 2015. In regard to screening adherence, risk of non-adherence was the same in 2005 compared with 2015, though were higher in every other year compared to 2015. None of these results were statistically significant,and suggest that long-term immigrants did not experience any improvement in screening uptake or adherence between 2005 and 2015.

Lifetime screening among Canadian-born individuals suggests that the risk of never being screened for breast cancer were lowest risk in 2013-14 compared to 2015. In regard to breast cancer screening non-adherence of Canadian-born individuals, odds of non-adherence were consistently higher from 2005 to 2014 compared to 2015, which may suggest a positive relationship between time and breast cancer screening adherence. It is difficult to discern what events took place in 2015 for this to be the case, though it could perhaps be due to the cohorts opted-in during that CCHS survey year.

CCS-SS

Results for the age-standardized cervical cancer screening rates can be found in Table 4-13. Among Canadian-born individuals, lifetime and adherence screening rates stayed relatively constant from 2005 to 2015. While long-term immigrant lifetime cervical cancer screening and pap test adherence fluctuated, screening rates were higher in 2005 than they were in 2015. Among recent immigrants, lifetime cervical cancer and adherence screening appeared to fluctuate across the ten-year period as well, though recent immigrants were similar in 2005 as in 2015. These results do not suggest in a substantial increase in cancer screening uptake among any of the residency status groups during the ten year period.

Stratified logistic regression models assessing the relationship between time and cervical cancer outcomes can be found in Figure 4-8. Among recent and long-term immigrants, there are no discernible trends in lifetime screening or screening adherence, although the risk of never screening and non-adherence was generally non-significant but lower in all years compared to 2015.

Among Canadian-born individuals, odds of never screening and non-adherence were lower in all years compared with 2015 – suggesting that the risk of not being screened for cervical cancer, and of non-adherence to pap tests, was highest in 2015 compared to previous years. In 2013-14, odds of never screening and non-adherence were close to that of 2015 (AOR 0.73 (CI 0.47 – 1.11) and AOR 0.97 (CI 0.77 – 1.23), respectively), suggesting that screening uptake has not meaningfully increased between 2005 and 2015, even among the Canadian-born population.

Table 4-12 – Age-standardized Breast Cancer Screening Rates by Year, 2005 - 2015

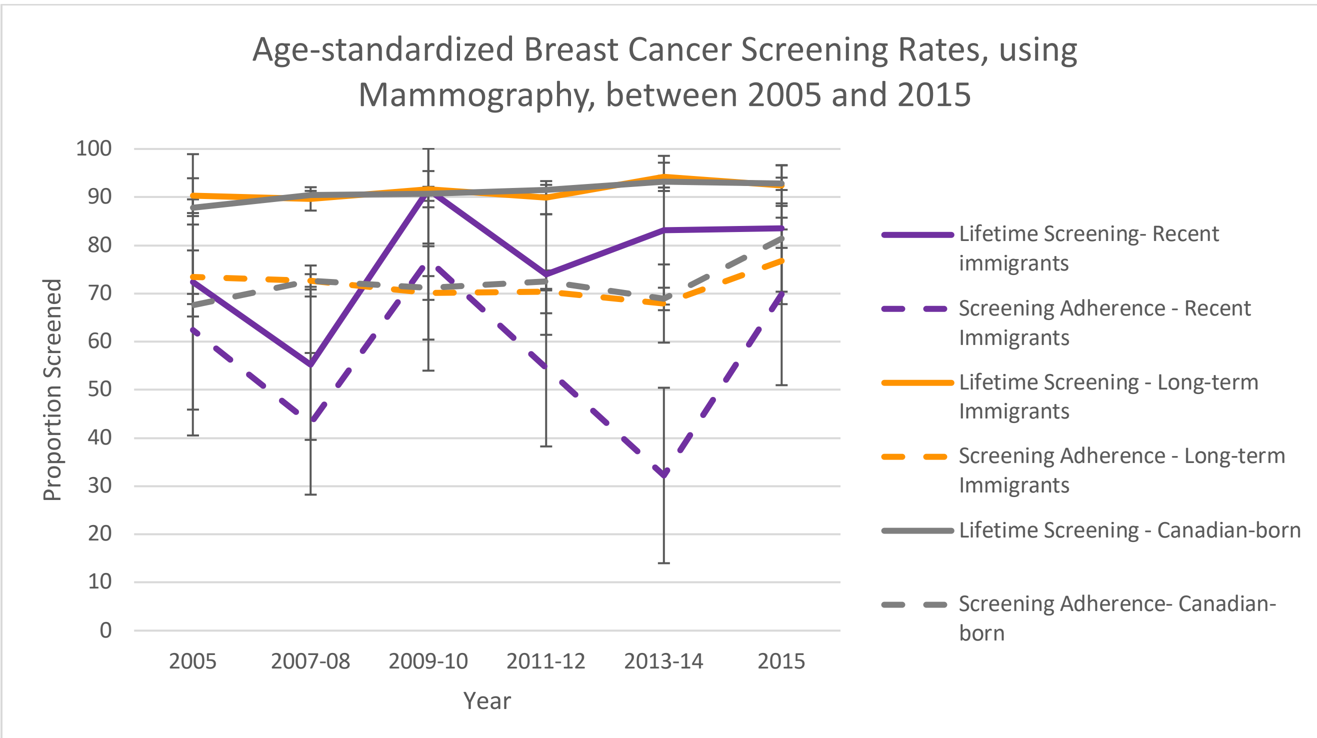
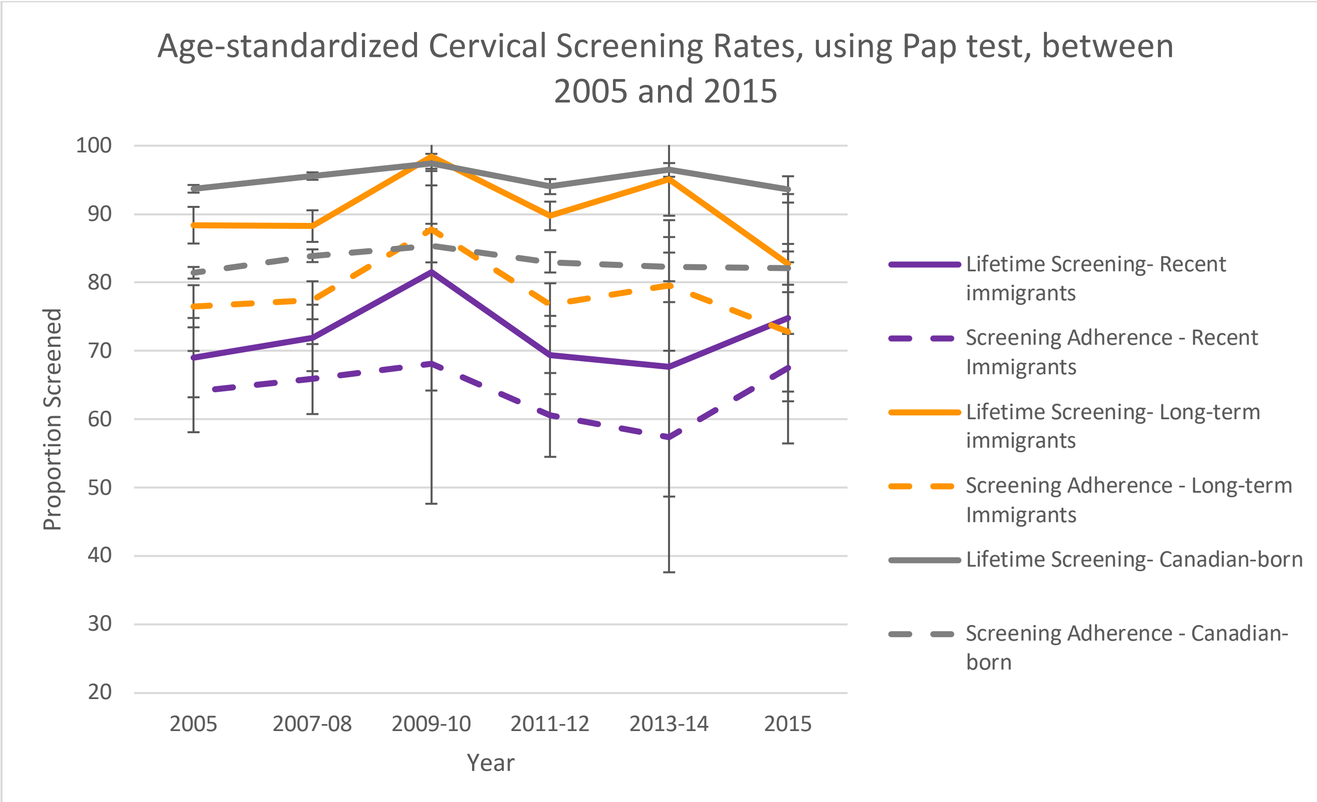


Table 4-13 - Age-standardized Cervical Cancer Screening Rates by Year, 2005 - 2015



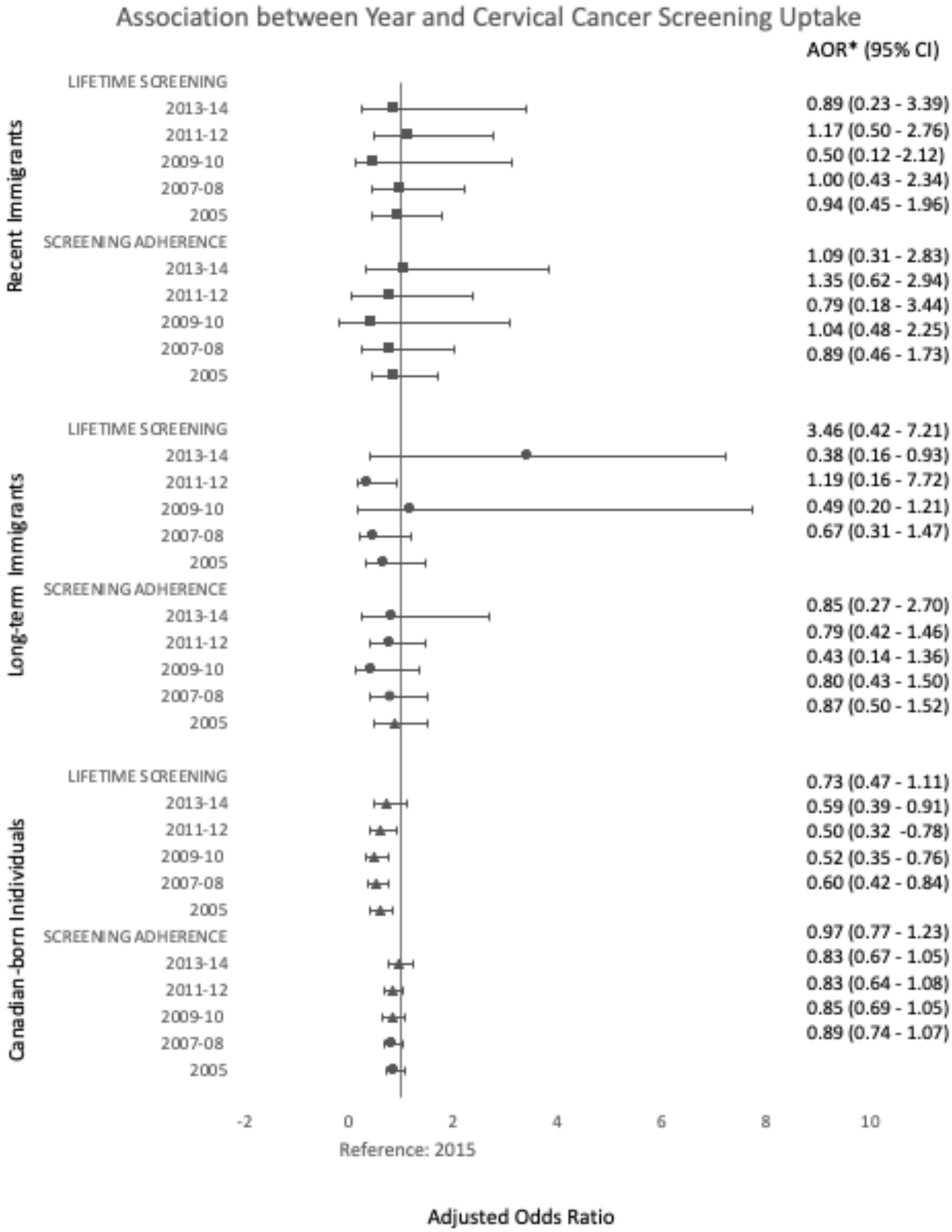


Figure 4-9 - Multivariate Logistic Regression Model, Association between Time and Lifetime Breast Cancer Screening and Screening Adherence, Stratified by Immigration Status

**Adjusted for age, income, education, marital status, self perceived health, race, world region of birth, province of residence, race/cultural origin, urban/rural dwelling*

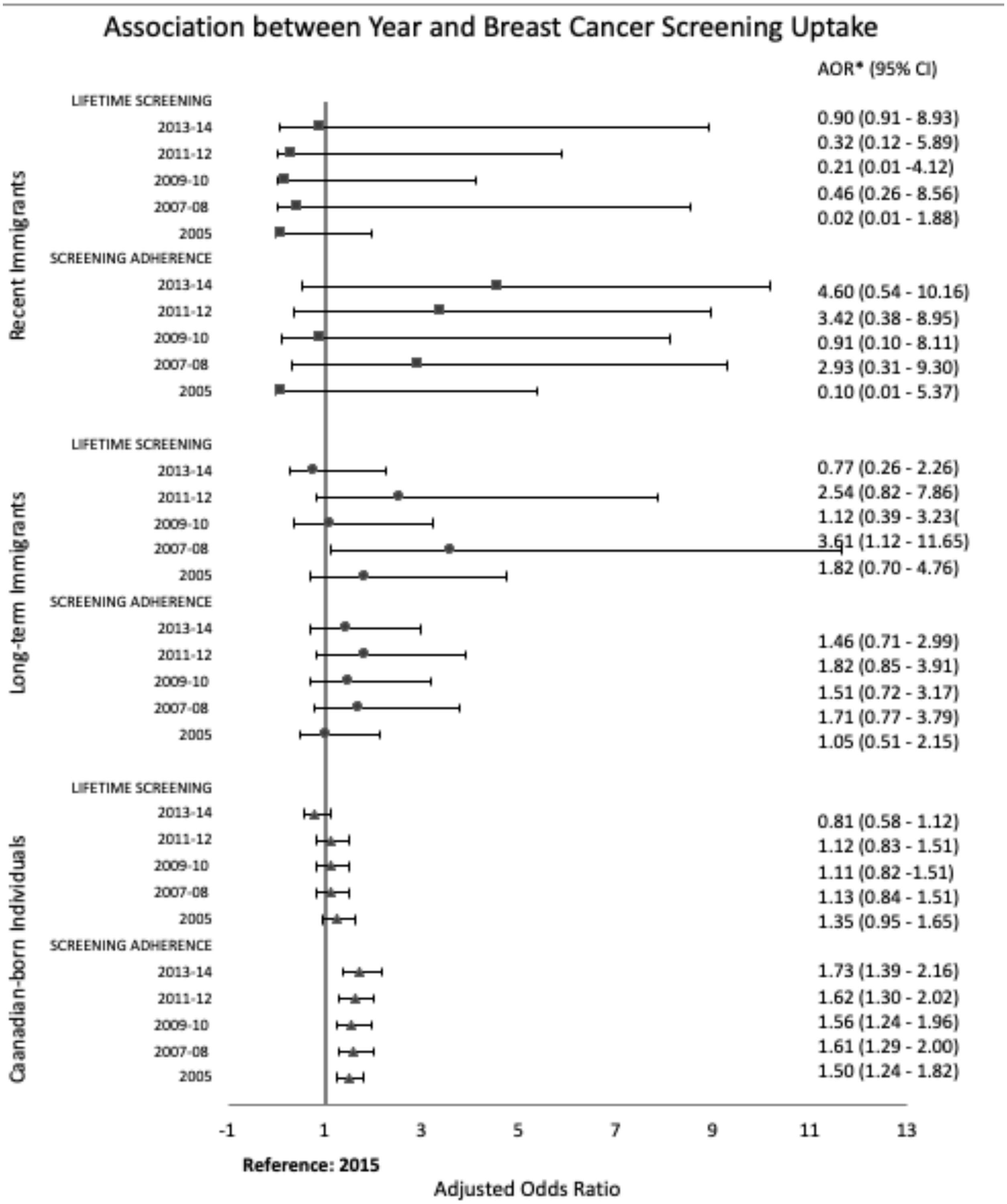


Figure 4-10- Multivariate Logistic Regression Model, Association between Time and Lifetime Cervical Cancer Screening and Screening Adherence, Stratified by Immigration Status

**Adjusted for age, income, education, marital status, self perceived health, race, world region of birth, province of residence, race/cultural origin, urban/rural dwelling*

Chapter 5: Discussion

This project uses ten years of a nationally representative cross-sectional health survey data to provide an overview of breast, cervical, and colorectal cancer screening uptake amongst age-eligible and average risk immigrants and non-immigrants in Canada. The study first used descriptive statistics, and multivariate logistic regression modelling to control for known predictors of cancer screening, to evaluate the impact of immigration status on lifetime screening and screening adherence. The study then provided an analysis of differences in breast and cervical cancer screening uptake amongst immigrant subgroups by cultural/racial origin and world region of birth. Finally, the project evaluated the effect of calendar year on breast and cervical cancer screening uptake across the 10-year time period, between 2005 and 2015, for recent and long-term immigrants, as well as for the Canadian population.

The following chapter provides a summary and discussion of the three major objectives identified in this thesis project, situating the results within the wider literature. A discussion and evaluation of the project's methodological strengths and limitations is also discussed. Finally, I will discuss policy implications as a result of these research findings and provide some recommendations for future research directions.

5.1 Summary and Discussion of Objective 1: Overview of Screening Uptake

The first objective of this thesis was to provide a descriptive overview of breast, cervical, and colorectal cancer screening uptake amongst immigrants compared to non-immigrants in Canada. To this end, age-stratified and age and sex-adjusted lifetime screening and screening adherence rates were evaluated for recent immigrants (<10 years of residency in Canada), long-term immigrants (≥10 years of residency in Canada), and Canadian-born individuals, for each of the three cancer screening subsamples (breast, cervical, and colorectal). Multivariate logistic regression models were also fit in order to evaluate the association between immigrant status and cancer screening uptake, as well as to evaluate the effect of other sociodemographic predictors of screening. In all instances, and consistent with the literature, recent immigrants had lower rates of lifetime screening and screening adherence compared to long-term immigrants and Canadian-born individuals. Long-term immigrants also consistently had lower screening rates compared to the Canadian-born population, although these differences seemed to disappear after adjusting for confounders.

5.1.1 Breast Cancer

This thesis found relatively high lifetime breast cancer screening rates among recent immigrants, long-term immigrants and Canadian-born women (69.9%, 91.5%, and 90.1%, respectively), as well as comparatively high cancer adherence rates (54.9%, 71.9%, and 74.0%, respectively). Much of the literature focuses on cancer screening adherence or retention rates as a key outcome. However, studies providing estimates of lifetime screening rates were fairly consistent with the results in this study, including a study from 2009 which reported 71.1% uptake among Asian immigrants compared to 89.0% among Canadian-born women(73). A 2011 study evaluating uptake among Chinese immigrant respondents found that 92% reported ever having a mammogram(55).

Cancer screening adherence is often used as a key outcome in order to evaluate results against national targets set by the Canadian Partnership Against Cancer (CPAC), an independent national organisation funded by the federal government to accelerate action on cancer control for all Canadian (120). The national target for screening mammography within 30 months is 70%, achieved in this study for both long-term immigrants and Canadian-born individuals within 24 months. However, screening adherence rates for recent immigrants (54.9%) remained well below national targets.

Still, set against adherence rates previously reported in the literature and through cancer oversight agencies, the findings in this thesis were relatively high. In 2014, Cancer View, a CPAC project consolidating cancer screening resources and information, found that breast screening participation rates in the general Canadian population were at their highest among women in Quebec, who reported breast cancer screening adherence rates of 62.3%, with a national average of 54.1% (121). Reported breast cancer screening adherence rates in the general population vary between 53 % to 89% in the Canadian literature reviewed for this study (71).

There are a number of factors that may have contributed to the higher-than-average findings in this study compared to previously reported participation rates. First, in the BCS-SS alone, a total of 14,116 observations were dropped due to invalid or non-responses to questions regarding covariates – a majority of these due to missing information on income, educational attainment, and race and region of origin. It is possible that the over-estimation of screening rates is in relation to missing observations due to the sensitive nature of the questions – especially in relation to income or educational attainment. Higher-than average screening rates could also be due to acquiescence bias, in which respondents 'say yes' or agree to all questions during long surveys or interviews. Finally, the CCHS interviewers do attempt to have surveys interviewed when a non-English speaker is selected for the survey, but translation relies heavily upon other members in the household being able and available for translation. It is possible that there was a loss of non-English speaker respondents due to non-response or misunderstanding of survey questions associated to language barriers.

Using the breast cancer screening subsample, two multivariate logistic regression models were also fit for two key outcomes of interest: lifetime breast cancer screening (a binary outcome variable defined as having ever or never been screened using mammography, and mammography screening adherence (a binary outcome variable defined as having had been screened within two years or less, or not). Adjusted logistic regression results suggest that recent immigrants had 73% higher odds of never screening, and long-term immigrants had 17% lower odds of never screening, compared to Canadian-born women. These results are in contrast with the gap in age-adjusted rates between long-term immigrants and the Canadian-population, and suggest that after controlling for sociodemographic factors, long-term immigrants actually have a decreased risk of non-adherence compared to Canadian-born individuals.

Our study suggests that individuals in the youngest age group, in the lowest income bracket, with the lowest educational attainment, and those who had never married were at the highest risk of never having a breast mammogram and breast cancer screening non-adherence. This is consistent with past studies that have found that unmarried women with lower education and income demonstrate lower mammography use (122,123), though our findings are contrasted by many studies that have found that older individuals are at higher risk of non-adherence than younger age groups (124). Among all residents, individuals from Quebec were at the lowest risk of never screening and non-adherence, which is consistent with national reports (121). Rural residents were also at increased risk of never being screened for breast cancer and screening mammography non-adherence. Urban-rural differences in breast cancer screening uptake have been studied in the population, and lifetime screening and screening adherence has been found to be significantly lower among rural women (125). In this study, the majority of immigrants were found to live in urban areas. It is possible that rural immigrants have experience an increased risk of never screening using mammography and mammography screening non-adherence, but this question has not been examined in the literature. However, an interaction term between immigration/residency status and rural/urban residence was non-significant, suggesting that the effect of urban/rural residency on lifetime screening and screening adherence does not depend on immigration status.

5.1.2 Cervical Cancer

The results from this thesis show relatively high lifetime cervical cancer screening rates for recent immigrants, long-term immigrants, and Canadian-born women (69.9%, 84.5%, 94.4%, respectively). Findings from this study suggest a rather large differential exists between immigrant and non-immigrant groups - a 24-point gap in lifetime screening uptake between recent immigrants and the Canadian population, and a 10-point gap between long-term immigrant women and Canadian-born women. Previous findings have reported similar gaps in lifetime Pap screening, with one 2013 study reporting 52.0% of individuals in a low income and high immigration group had ever been screened, compared with 63.4% in the general population (12).

Cervical cancer screening adherence rates, defined as having been screened within 3 years or less, were 61.5% for recent immigrants, 75.1% for long-term immigrants, and 82.7% for Canadian-born women. The CPAC report a national target of ≥80% for women 21 to 69 years of age within 42 months (three years plus six months)(126), which was only achieved, though within 36 months, in our study by the Canadian-born group. Age-adjusted adherence rates remained high compared to past studies, including reports by CPAC which have reported age-standardized Pap test adherence rates across Canadian provinces to be between 62.9% and 71.3%, the highest found amongst women in Newfoundland and Labrador. Past studies evaluating Pap screening adherence have also found lower estimates than that reported in this study, with one 2007 study reporting adherence rates as low as 36.9% among recent immigrants versus 60.9% among long-term residents (although provincial health insurance registration was used as a proxy for immigration status in this study)(59).

Using the cervical cancer screening subsample (CCS-SS), two multivariate logistic regression models were fit to examine the effect of immigration status on cervical cancer screening uptake, as well as to analyse the effect of other sociodemographic predictors. Similar to the findings using the breast cancer screening subsample, after adjusting for confounders, recent immigrants were at higher risk of never being screened (AOR = 1.27) and non-adherence (AOR = 1.47), compared with Canadian-born individuals, while long-term immigrants had a lower risk of never screening (AOR = 0.55) and of non-adherence (AOR = 0.76) compared with Canadian-born women. These results again suggest that while age-adjusted rates are lower among long-term immigrants compared to Canadian born women, adjusting for sociodemographic predictors reveals that long-term immigrants are actually at decreased risk of non-screening.

These results are consistent with other findings in the literature. Indeed, one study by Khadilkar et al. in 2013 similarly found that recent immigrant women (less than 10 years in Canada) were statistically significantly less likely to have a Pap test within the past 3 years compared with Canadian born women (PR =0.77 (CI 0.71 – 0.84), while long-term immigrants (10 years or more in Canada) showed similar compliance with the recommended Pap testing intervals compared to non-immigrants (PR = 0.98 (CI 0.94 – 1.02)) (62). This is to be expected given that the study also used data from the 2007-08 Canadian Community Health Survey (CCHS).

Our study suggests that older age, lower income, and the lowest educational attainment were significantly associated with higher odds of non-adherence. Being single also put women at significantly higher risk of never screening and non-adherence. All provinces were at higher risk of never screening and non-adherence compared to women in the Maritimes or eastern provinces, which in this study included Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland and Labrador. Unfortunately, the nature of the CCHS's optional screening module did not allow for comparisons across individual provinces. However, CPAC screening reports have reported that cervical cancer screening is highest among women in Newfoundland and Labrador (126), which is consistent with the results from the current study. Risk of never screening and pap test non-adherence was also highest in Quebec (AOR 4.66 (CI 3.55 – 6.10)). Given that Quebec is the only province without a formal cervical cancer screening program, women being at higher risk of never screening and pap test non-adherence is expected. Never having a pap screening test and cervical cancer screening non-adherence was significantly lower in rural areas as compared to urban areas (AOR 1.07 (CI 1.01 – 1.13) and AOR 1.06 (1.01 – 1.12), respectively). This is consistent with past studies that have found that women living in rural areas are at increased risk of non-adherence to cervical cancer screening(127) . It is likely that lower cervical cancer screening uptake in rural areas has to do a lack of access to specialists due to population sparseness, though the effect of immigrant status and rurality do not appear to intersect.

Findings in the literature evaluating differences in screening uptake amongst immigrants generally also support these conclusions. One 2013 study found that Pap test non-adherence was associated with older age groups (40 – 69), being single, having low education, having low income (58). Another 2007 study by Lofters et al. also found that recent immigration (but not long-term), visible minorities, low income, and low education were all associated with significantly lower 3-years Pap screening rates.

5.1.3 Colorectal Cancer

As mentioned in Chapter 1 of this thesis, population-based colorectal cancer programs are relatively new in Canada, and hence the results are less interpretable compared to the more established breast and cervical cancer screening programs. In this study, age and sex-standardized colorectal cancer screening rates were the lowest among all cancer outcomes, with recent immigrants reporting 37.1% lifetime rates and 33.8% adherence rates, long term immigrants reporting 56.4% lifetime rates and 51.0% screening adherence rates, and Canadian-born individuals reported 64.7% lifetime rates and 57.2% adherence rates. None of the residency groups reached the CPAC's national targets for colorectal cancer screening in a 30-month period (≥ 60%). Reported colorectal cancer lifetime and adherence rates in the literature vary substantially. The CPAC reports the highest provincial colorectal cancer screening adherence rates in Saskatchewan, at 53.0%. One study done in 2013, relying on data from Ontario alone, found that the proportion of men who had received at least one FOBT or endoscopy in their lifetime was 61.6%, and decreased to 55.1% among women (12).

To explore the effect of sociodemographic determinants, as well as the main effect of immigration status, on colorectal cancer screening uptake, two multivariate logistic regression models were fit. For both lifetime colorectal cancer screening and screening adherence, recent immigrants had higher odds of never screening and non-adherence compared with Canadian-born individuals (AOR = 1.75 and AOR = 1.54, respectively). As seen with the last two cancer subsamples, long-term immigrants also had lower odds of never screening (AOR = 0.96) and non-retention (AOR = 0.97).

Being a woman, being among the youngest age group, being among the lowest income and education group, being screened prior to 2015, being single (never married), not being born in Canada, being non-white, and being of rural residence were all associated with higher risk of never being screened and screening non-adherence. Ontario appeared to have the highest lifetime and adherence colorectal cancer screening rates, likely due to the province having implemented the first population colorectal cancer screening program in Canada, *ColonCancerCheck*, in 2007(128). Quebec had the highest risk of never screening and non-adherence to colorectal cancer screening guidelines.

In this study, year was positively associated with lifetime screening and colorectal cancer screening retention, which may reflect the progressive implementation of colorectal cancer screening programs in the last decade. The odds of never screening in 2005 were five times that of 2015, decreasing to 34% higher odds in 2013-14 compared to 2015. Among racial/cultural groups, all non-white racial groups had an elevated risk of never screening and non-adherence to colorectal cancer screening guidelines, with South Asians at the highest risk (Never screening

AOR 1.88 (CI 1.26 – 2.81), non-adherence AOR 1.53 (CI 1.04 – 2.24)). Being born in any other region of origin was also associated with a higher risk of never screening and non-adherence to colorectal cancer screening compared with Canada, with immigrants from Asia having the highest odds of never screening (AOR 1.54 (CI 0.94 – 2.54)) and non-adherence (AOR 1.50 (CI 0.93 – 2.42)). Those living in rural areas were also at higher risk of never screening for colorectal cancer and colorectal cancer non-adherence. While specialists who can perform sigmoidoscopies may still be difficult to access in rural areas, the further development of colorectal cancer screening programs and the availability of mail-out fecal test kits(128), should allow for superior equity in colorectal cancer screening provision compared to breast or cervical cancer screening.

While very few studies in the literature have explored differences in colorectal cancer screening uptake between immigrants and non-immigrants in Canada, one study by Borkhoff et al. did find that that the lowest uptake in colorectal cancer screening in Canada was among those living in low-income and high-immigration areas(12), compared with individuals in high income and low-immigration areas. As population colorectal cancer programs continue to be rolled out, further research will be needed to determine whether disparities persist upon the implementation of population colorectal cancer screening coverage.

5.1.4 Screening uptake - conclusions

The nature of Canada's provincial jurisdiction over healthcare services has meant that cancer prevention efforts have not necessarily been rolled-out equitably, with some provinces more advanced in their screening and information efforts than others. However, national guidelines set by bodies like the CPAC and CTFPHC exist in order for provinces to strive to the same screening standards, and for the most part, provinces have been consistent in their efforts to follow updated guidelines and provide population screening coverage. Nevertheless, inconsistent results relating to lifetime and adherence cancer screening rates are to be expected when reviewing the literature, given that rates can vary widely based on many different factors (e.g. provincial focus, data source, study design, year or years being assessed, and various exclusion criteria, etc).

Some clear trends from this analysis did emerge and were consistent with previous findings in the literature. First, for breast, cervical, and colorectal cancers, recent immigrants were at increased risk of both never being screened and non-adherence to national screening guidelines, with screening rates well below national targets set by CPAC. Conversely, for each cancer outcome, long-term immigrants had decreased odds of never screening and non-adherence. The results from this study thus suggest that while recent immigrants are at increased risk of not being screened, at least for the first 9 years upon arrival in Canada, increased years of immigration may narrow the gap in screening utilisation, to the point where immigrants utilise preventative cancer screening services to the same degree, or possibly to a higher degree, as Canadian-born individuals.

Second, as would be expected given the history of cancer screening guidelines and organized programs in Canada, the proportion of the population being screened for colorectal cancer was lowest among all screening outcomes, and highest for cervical cancer screening. Cervical cancer screening using Pap smears has been the standard in Canada since the 1960s, and it is likely that knowledge about the need for screening is well established in the general population, especially in comparison to colorectal cancer screening. It is difficult to determine if the controversy around elevated false positive rates using mammography (21,129) has affected breast cancer screening adherence across the country, though it is possible that cervical cancer screening is simply more accessible and easier to adhere to (given the three year interval, as opposed to two for mammograms).

Third, for each of the main outcomes, a sensitivity analysis adjusting for the effect of very recent immigration (residency for two years or less) did not significantly change the screening proportion or adjusted odds ratios. This indicates that recent immigrants are not only at higher risk due to the effects of their first few years in Canada, but remain at risk for almost a decade after arrival in the country.

Finally, these results suggest that sociodemographic correlates have a significant impact on differences in screening uptake among population subgroups. While crude rates suggest that long-term immigrants are at elevated risk of never screening and screening non-adherence, adjusting for the effects of various confounders suggests that long-term immigrants do not exhibit any increased risk. This study confirms that in general, age, income, education, marital status, province of residence, and urban geography are important predictors of screening uptake and adherence. This suggests that socioeconomic status is still an important determinant of health seeking and preventative behaviours, and that steps need to be taken to remedy inequities across social classes to improve population cancer screening. While some of these inequities are beyond the scope of Canada's health care system, these results point to a need for targeted interventions for under-screened communities and a holistic approach to preventative health care.

Screening rates reported in this study were consistently higher than what has been found in the literature, as well as what has been reported by cancer oversight organisations like the Canadian Partnership Against Cancer (CPAC). As mentioned before, it is possible that non-response and missing data (answers including 'Don't know', 'Refusal', or 'Not Stated') to questions regarding income, educational attainment, race, and country of origin contributed to a loss of vulnerable individuals from the study, resulting in an overestimation lifetime and adherence screening rates. While past studies have shown good concordance between self-reported screening histories and administrative data (107), it has been suggested that individuals of low socioeconomic status are more likely to overreport screening histories (70). This may also have inflated lifetime screening and adherence estimates. Higher overall rates in this study may also be due to acquiescence bias, wherein respondents tend to agree with all the questions or say 'yes' due to the long and drawn-out nature of surveys, like that of the CCHS. Lastly, while the CCHS attempts to provide translation to individuals unable to speak English or French, interviewers are limited to either the languages spoken amongst themselves, or else rely on another person in the household for translation. While the response rate for the CCHS is quite high, it is possible that vulnerable Canadians who are not able to speak the official languages – and thus likely face other barriers to health care utilisation and information – could have been systematically excluded from the study.

5.2 Summary and Discussion of Objective 2: Screening Differences Amongst Immigrant Subgroups

5.2.1 Breast Cancer

To examine screening differences among immigrant subgroups, stratified logistic regression models were fit to isolate the effect of cultural/racial origin and world region of birth on cancer screening uptake among recent immigrants and long-term immigrants seperately. Two logistic regression models were fit to each the recent immigrant and long-term immigrant groups, first with the key independent variable ‘Racial/Ethnic Origin’, and then with the independent variable ‘World Region of Birth’. In all instances, the models were adjusted for the effect of CCHS Cycle Year, Age Group, Household Income, Educational Attainment, Marital Status, Self-Perceived Health, Province of Residence, World Region of Birth or Race/Cultural Origin (depending on the key independent variable), and Rurality.

Among recent immigrants, East and Southeast Asian women had a statistically significant lower risk of non-screening and never screening compared with white recent immigrant women. In regard to screening adherence, Arab and Middle Eastern recent immigrant women had significantly lower odds of screening non-adherence compared to white women. Otherwise, almost all groups had non-significant and lower odds of breast screening non-adherence compared to white recent immigrant women. These results suggest that among recent immigrants, East and Southeast Asian women had the lowest risk of never screening for breast cancer, while Arab and Middle Eastern women had the lowest risk of non-adherence to breast cancer screening. Conversely, the association between world region of birth and breast cancer screening uptake amongst recent immigrant women suggests that immigrants from South and Central America, Africa, and Asia are at increased risk of never screening and screening non-adherence compared with immigrants from North America.

In regard to long-term immigrants, the only significant results were among Black long-term immigrants, who had the lowest risk of never screening and non-adherence compared to all groups, and significantly lower risk compared to white long-term immigrants (AOR = 0.32 (CI 0.14 – 0.71) and AOR = 0.41 (CI 0.23 – 0.72)). In contrast, logistic regression results exploring the effect of world region of birth on breast cancer screening uptake suggest that long-term immigrants born in Africa and Asia have higher odds of never screening and non-adherence compared to those born in North America. The risk among South and Central American and European women more closely matched the risk of North American long-term immigrants.

The categorisations used in this study are very broad, as small sample sizes did not allow for a more nuanced evaluation. It is important therefore not to associate racial groups with world regions of origin – these categories do not ever perfectly match up, and less so in this study where very broad categorisations were used. Still, this study provides a unique perspective on the relative risk between immigrant subgroups, whereas few studies in the literature have done this before. For example, many studies have reported Asian and South Asian immigrants to be at higher risk of never screening and mammography non-adherence (73)(130), although these previous studies have contrasted immigrant subgroups against rates in Canada's general population. The current study is among the first to look at differences among immigrants only.

In regard to the significant results finding black long-term immigrants to be at lower risk of never having a mammography and mammography non-adherence, these results are contrasted by results in the literature. A considerable amount of literature from the United States has suggested that black women have both increased odds of developing breast cancer, as well as increased risk of never being screened(131). However, findings from the United States, where racial demographics, geographical segregation, and access to medical insurance are unique, cannot be directly compared with the sociodemographic realities in Canada. It is possible that in Canada, physicians are aware of the increased risk of breast cancer among black women and thus refer them more frequently to screening than they might other racial groups. In a Canadian context, a recent study by Woods et al. found that immigrants from Sub-Saharan Africa had mean breast cancer screening participation rates similar to the rates of non-immigrants, findings that support the results in this study (54). The findings from the current study suggesting that long-term black immigrants are at lower risk of never screening and breast cancer screening non-adherence may again have more to do with an increased risk among white long-term immigrants.

Immigrant women are likely affected by a confluence of different sociodemographic and immigration-related factors. While many were adjusted for in this study, there remains many factors that could not be controlled for. It is possible that a cohort effect, in which more recent immigrant groups are selected for factors that may include better health or better knowledge of healthcare, is being seen among non-white recent immigrants compared to their white counterparts. A recent paper by Woods et al. found that Eastern European women had lower screening rates when compared to several other world regions of birth(54), and this may help understand the increased risk among racially white recent immigrants compared to others. Still, more information is needed about the class of immigrant cohorts – whether they are economic, family, or refugee class immigrants – as this may inform health seeking practices.

5.2.2 Cervical Cancer

Differences in cervical cancer screening among immigrant subgroups were examined by isolating the effect of racial/cultural origin and world region of birth using logistic regression and stratified by recent or long-term immigration. In all instances, the models were adjusted for the effect of CCHS Cycle Year, Age Group, Household Income, Educational Attainment, Marital Status, Self-Perceived Health, Province of Residence, World Region of Birth or Race/Cultural Origin (depending on the key independent variable), and Rurality.

Among recent immigrants, all racial groups had a higher risk of never screening and screening non-adherence compared to white recent immigrants. The highest risk for both never screening and non-adherence was among South Asian women, followed closely by East and Southeast Asian women and Arab and Middle Eastern women. In examining the effect of world region of birth, all regions had a higher risk of never screening compared with North American recent immigrants, though women from South and Central America, and Africa, had a non-significant decreased risk of non-adherence compared with North American recent immigrants.

Among long-term immigrants, all racial groups had increased odds of never screening for cervical cancer and non-adherence to Pap screening guidelines compared to White long-term immigrants, although significantly higher odds were found only among South Asian, East and Southeast Asian, and Arab and Middle Eastern women. When comparing odds across world regions of birth, long-term immigrants from all regions were at increased risk of never screening compared to North Americans, although the risk among South and Central Americans was non-significant. The risk of Pap test non-adherence was also higher among long-term immigrants from Europe, Africa, and Asia compared to North American long-term immigrants, although the risk of non-adherence was actually lower among South and Central Americans compared to North American long-term immigrants.

These results are generally consistent with the evidence from the literature. Several studies have found that immigrant women of South Asian and Arab or Middle Eastern background have lower likelihoods of being up-to-date on Pap testing compared to the general population(59,62,65,66). Many of these studies have proposed factors that may contribute to the lower screening uptake among these women, including lack of knowledge and prevalence of cervical cancer screening in their home countries (65). Islam is a prevalent religion among these racial/cultural groups, and it is also feasible that religion and corresponding ideas of modesty, plays a role in these screening inequities. There is evidence, especially in studies based in the United States, that ideas of modesty and access to a female physician may play an important role in Pap screening uptake among Muslim women (47) (132)(133). The results of this study suggest that recent and long-term white immigrants have lower risk of never screening and cervical cancer screening non-adherence.

It is unclear the reason for white recent immigrant women to be at higher risk of never screening and non-adherence to breast cancer, but at lower risk of cervical cancer screening compared to other groups. Again, this may have to do with a cohort effect in which some groups are selected for better knowledge of health or the healthcare system – which may be due to the class of immigrants (economic, family, refugee) –not captured in the current study. It is also possible that this is due to the fact that the underlying sample composition of recent immigrants in the BCS-SS and CCS-SS is not the same, given that younger recent immigrants from ages 20-50 are included in the CCS-SS and excluded elsewhere. Given the many unmeasured immigration-related factors that may affect screening uptake, the groups are not directly comparable, even when adjusting for the effect of age and year.

5.3 Summary and Discussion of Objective 3: Immigrant Screening Uptake across CCHS Study Years

5.3.1 Breast Cancer

To explore differences in screening years, age-standardized screening rates were plotted and multivariate logistic regression was used to isolate the effect of year on breast and cervical cancer screening uptake among recent immigrants, long-term immigrants, and Canadian-born individuals, separately. The resulting odds ratios were again controlled for the effects of Age Group, Household Income, Educational Attainment, Marital Status, Self-Perceived Health, Province of Residence, World Region of Birth, Race/Cultural Origin, and Rurality.

Age-standardized breast cancer screening rates and adherence rates amongst recent immigrants did not show any discernible time trends. This was confirmed after adjusting for covariates using multivariate logistic regression, which suggested that there was no statistically significant higher odds of never screening and breast cancer screening non-adherence in the years prior to 2015, compared with this most recent year. While age-standardized breast cancer screening rates and adherence rates suggested a very gradual increase in screening rates between 2005 and 2015 amongst long-term immigrants and Canadian-born individuals, logistic regression suggests that there were no statistically significant differences in lifetime screening among long-term immigrants and Canadian-born individuals between the years prior to 2015 and this most recent year, and no statistically increased odds of non-adherence among long-term immigrants during this time period.

The results do suggest that the only marked improvements in breast cancer screening uptake over time were among Canadian-born individuals, whose risk of non-adherence to breast cancer screening guidelines seemed to increase further with every year from 2005 to 2013/14 compared with 2015, suggesting that mammography screening adherence has been increasing significantly over time among Canadian-born women.

These results suggest that that breast cancer screening rates have not been markedly different between 2005 and 2015 for immigrant users. The first breast cancer screening program was introduced in 1988, and between then and 2003, breast cancer screening uptake increased markedly (134). From 2003 until at least 2008, studies suggest that the percentage of guideline-recommended mammography use stabilised(135). This suggests that while breast cancer screening uptake has stabilised, disparities amongst immigrants persist. The results of this study support immigrant-targeted interventions in order to improve uptake and adherence.

As described in Chapter 2 of this thesis, over the last decade the use of mammography for regular breast cancer screening has come under scrutiny. And while the International Agency for Research on Cancer (IARC) concluded that mammography does significantly reduce the risk of breast-cancer related mortality and morbidity and recommended its continued use (23), it is difficult to measure how the controversy around false positive results has tarnished the reputation of mammography amongst both physicians and the public. The CTFPC is set to release its updated breast cancer screening guidelines to the Canadian public in 2018, and changes are likely to reflect the most recent evidence available for the effectiveness of mammography, and could further impact Canadians' views on the benefits and limitations of breast cancer screening, and thus on national cancer screening rates.

5.3.2 Cervical Cancer

In regard to cervical cancer screening uptake, age-standardized rates between 2005 and 2015 did not demonstrate any trends in lifetime or adherence cervical cancer screening uptake. Logistic regression results suggest that recent immigrants had lower odds of non-retention to Pap test 2005 - 2012 compared to the most recent year, suggesting that recent immigrants had lower risk of non-adherence and never screening for cervical cancer in earlier years compared to 2015. Pap screening retention among long-term immigrants was also lower in all years compared to 2015, again suggesting that there was no improvement in screening retention among long-term immigrants over time. Finally, among Canadian-born individuals, odds of never screening and screening non-retention were also lower in all years compared with 2015. None of these results were statistically significant, which suggests that cervical cancer screening uptake amongst recent immigrants, long-term immigrants, and Canadian-born women has not increased between 2005 and 2015.

While screening rates were found to be quite high amongst non-immigrants, immigrant screening remained well below the national targets, and increases across the 10 years examined in this study were expected. Cervical cancer screening is well-established in Canada; the first cervical cancer screening program dates back to 1960, when the province of British Columbia introduced a provincial cervical cancer screening program with the use of a Pap test. The results in this study suggest that population screening programs have not seen improvements to uptake across years, and that more efforts are needed to commit women and physicians to following the national recommendations on cervical cancer screening. Efforts for increasing immigrant uptake are especially needed and targeted intervention for new immigrants may help address disparities.

In addition to screening, prevention efforts are also under way in Canada – with school-based programs offering Human papillomavirus (HPV) vaccines for teens before they become sexually active(136), so there remains the possibility that the introduction of the HPV vaccine has had an impact on rates of Pap screening, or the views of patients and physicians on the necessity for screening. However, HPV vaccines do not protect against all strains of HPV, and because not everyone is systematically inoculated, it is important to address misconceptions that the HPV vaccine removes the need for screening or should have any impact on screening behaviours.

5.4 Methodological Strengths

This study has a number of noteworthy strengths. This is one of the first studies to examine differences in immigrant and non-immigrant uptake amongst average-risk individuals for breast, cervical, and colorectal cancer screening together. While past studies have looked at individual cancer screening outcomes, the use of self-reported CCHS data here allows for a comparison of rates across groups, provinces, and time with all respondents answering the same questions. This study was uniquely able to apply consistent methodologies across the sample, including consistent inclusions and exclusions and adjustments. This study's use of several cycles of a nationally representative survey, as opposed to comparing provincial screening data from different provincial jurisdictions which are often collected and adjusted differently, allows for a more complete national overview of cancer screening uptake.

This large sample size used in this study through the combination of survey cycles, greatly improved the external validity of the results to the overall screening-eligible Canadian population. Additionally, while the response rate to the CCHS has decreased over time, it remained quite high even through to 2015 (60.1%). The use of Bootstrap Resampling Technique also provided optimal estimates of the true variance given the complex survey design used in the CCHS (137).

The use of repeated cross-sectional studies has also been shown to be beneficial in several respects. One example from the literature, which used both cohort and repeated cross-sectional study data to examine breast cancer screening rates, suggested that the use of repeated cross-sectional data is advantageous due to the fact that it does not suffer cumulative losses to follow-up, and that it better reflected the community-level changes over time (e.g. age demographics) (138), and thus avoids issues of sample attrition classically found in cohort and longitudinal designs. The authors also reported that between the cohort and repeated cross-sectional methods, responses to breast cancer screening behaviour were comparable. The use of standardized rates and logistic regression techniques also allowed for comparisons while adjusting for known confounders.

5.5 Study Limitations and Methodological Concerns

Several limitations inherent to the Canadian Community Health Survey (CCHS) data and study design must be mentioned. Firstly, this study relies on set quantitative characteristics and methods of analysis, which may miss the intersecting effect of important macro-level factors and other parts of an individuals' experience that may affect preventative health care use. It was beyond the scope of this study to qualitatively evaluate factors related to recent immigrants' experience accessing health services, language and cultural barriers to information, acculturation, and other beliefs affecting use of preventative health care services.

The second limitation to using the CCHS data was a result of the survey's limiting the cancer screening modules as optional content for provinces, which meant that during each cycle different provinces chose to opt in or out to the cancer screening questions. The CCHS provides this option so as not to repeat work already done by provincial-level health agencies. As outlined in the second chapter of this thesis, health care is a provincial responsibility and practices and programs can differ significantly from one province to the next. And while most provinces have a federally consolidated immigration plan (except in Quebec, which has an agreement with the Government of Canada to select its own immigrants), immigrants from different countries are not accepted to Canada in the same ratio every year, and immigration experiences may differ from one province to the next. So, while the effect of province of residence was controlled for in the regression analysis, the results of this analysis may be skewed by the specific immigrant cohorts surveyed in the CCHS's optional content as well as by province-specific health determinants or integration efforts. This also obscures the interpretation of the results, in that factors related to provincial health policy, and its effect on patient and physician knowledge and acceptability of screening practices, physician recommendation, and screening availability could not be accurately assessed.

This study relied on self-reported cancer screening histories, and as such is susceptible to response, recall, acquiescence, and social desirability biases. Many validation studies have documented fairly good levels of concordance between self-reported survey data and administrative data (patient charts, laboratory records) (107) (139) (70). One meta-analysis from 2008 that examined the accuracy of self-reported data from the United-States found high sensitivity for mammogram, pap smear, and FOBT (95%, 93%, and 82% respectively), but relatively low specificity for mammogram (61%) and pap (48%), and high specificity for FOBT (78%) (107). In this study, sensitivity was defined as the probability that a history documented as positive was reported as positive (number of true positives divided by the number of true positives and false negatives), and specificity was defined as the probability that a history documented as negative was reported as negative (number of true negatives divided by the number of true negatives plus false positives). This and other Canadian-focused studies (70) suggest that people do have a tendency to over-report their cancer screening histories. Importantly, in the meta-analysis cited above, sensitivity and specificity estimates tended to be lower among Black and Latin American samples compared to predominantly White samples. This may explain the higher screening rates reported in this study when compared to the literature or other cancer screening oversight bodies like the Canadian Partnership Against Cancer (CPAC).

Respondents who indicated ‘Don’t know’, ‘Refusal’, or ‘Not Stated’ to any of the covariates in this study were excluded from the sample. This likely could have meant that more vulnerable individuals, perhaps refusing to answer questions regarding health practices, income, or education due to social desirability bias, being excluded at higher rates. This could have artificially inflated screening rates and may have biased some results toward the null. Importantly, during the survey interviews, if a respondent did not speak English or French, an attempt was made to schedule an interview with an interviewer who could speak the respondent’s native language. If this was not possible, the interviewer asked to get someone in the household to translate. If translation efforts were unsuccessful, it is possible that the study suffered from response bias that may have disproportionately affected vulnerable demographics, biasing results towards the null.

From its inception until the latest cycle in 2015, the annual response rate to the CCHS survey has declined. Statistics Canada offers some possible contributing factors, including fewer households with landlines, the more current universality and availability of call display, general distrust of government, and too many telemarketing or phishing calls(140). These factors may have contributed to the exclusion of some vulnerable populations, namely homeless and transient individuals.

Adherence rates were susceptible to some errors due to the nature of the CCHS survey. All survey designs are subject to recall bias and misclassification bias. Respondents asked whether they had been screened within the time frame could have overestimated or underestimated the time period, especially for the longer intervals (like for endoscopy, with was recommended once within 10 years), and this could have biased odds ratios towards or away from the null. Many studies also allow for 6-month grace periods for individuals to be screened within the guideline recommended frame. In this study, the CCHS’s pre-categorisations for screening questions did not allow for the grace period, meaning that individuals who had been screened a few months past the interval would have been classified as ‘non-adherent’.

The regression analyses were also limited by small sample sizes for some outcomes, which led to loss of precision and wider confidence intervals and limited the interpretation of the effect estimate. Small sample sizes amongst immigrant subgroups also limited this analysis to rather broad regions of birth and racial categories. For example, having ‘Africa’ as a categorization for region of origin works to conceal the vast number of different ethnic, cultural, religious, and socioeconomic particularities between dozens of African nations, and even between large and distinct areas such as the majority Arab and Muslim nations in North Africa and majority Black and Christian nations in Sub-Saharan Africa. These categorisations also do not account for levels of acculturation. This study’s inability to differentiate between more specific countries of origin limits the conclusions made in comparing ‘World Region of Origins’ and have biased results towards the null.

It is also possible that screening knowledge based on country of birth had an effect on immigrant uptake upon arrival to Canada. Although it was beyond the scope of this study to evaluate and synthesize differences in the existence of breast, cervical, and colorectal cancer screening norms or programs in each of the world regions assessed for this study, it is possible that screening practices and norms prior to immigration obscures the interpretation of these findings. For example, Japan, Korea, and Singapore have either initiated or currently have fairly robust breast cancer screening programs, while the majority of other Asian countries (141) – including Nepal, Pakistan, Mongolia, and Iraq - are low-income countries where cancer diagnosis and treatment facilities are extremely scarce (142). This is likely true across the different cancer outcomes, and further supports the need for country-level, as opposed to continent-level, research on preventative cancer practices amongst immigrants. Grouping countries of origin by low-, middle-, or high- income could also control for some of this effect.

Finally, while this study was able to control for many variables identified in the literature to be confounders in the relationship between immigration status and cancer screening uptake, there remains the possibility of bias arising from unmeasured confounders. One noteworthy variable known to be an important predictor of screening behaviour, ‘having a regular doctor’, was not included in this study due to changes in this question across CCHS survey years – making it incompatible for comparison across the 10-year period. Other confounders, such as macro-level characteristics including the effect of varying provincial screening recommendations and practices compared to national guidelines, patient and provider attitudes and beliefs towards screening practices due to the media or other suggestions, and possible immigrant cohort effects, could compromise the interpretation of the effect estimates. As mentioned before, cohort effects and type of immigration (economic vs family vs refugee, for example) may have had an unmeasured effect on various immigrant groups and the association with cancer screening uptake. It was also impossible the measure the effect of acculturation across groups. Ten years of data in regards to immigration and screening uptake is perhaps not long enough to see significant population trends, and long-term studies are needed to examine these effects on preventative health care use.

5.6 Conclusions and Policy Implications

This study sought to explore differences in uptake in cancer screening of immigrants as compared to the general population in Canada, and found evidence of hampered breast, cervical, and colorectal cancer screening uptake amongst recent immigrants. Sociodemographic factors, such as high income, high educational attainment, and being married were found to be statistically significant predictors of lifetime and adherence screening across outcomes. Recent immigrants from South and Central America, Africa, and Asia showed higher risk of never screening for breast cancer, and breast cancer screening non-adherence, compared with recent immigrants from North America. Recent immigrants from Europe, Africa, and Asia were also at higher risk of never screening for cervical cancer compared to North American recent immigrants, although those from South and Central America and Africa showed lower odds of cervical cancer screening non-adherence compared to their North America counterparts. These findings have the potential to contribute to the field of cancer prevention amongst immigrant communities, and to be used for policy and advocacy efforts. There is relatively little research available on historically marginalized and vulnerable communities, and the current study adds evidence for the need for representation of immigrant demographics in research, especially given that these demographics are only expected to grow. While this study provides some evidence of differential uptake based on racial and cultural origin as well as world region of birth, more research, using larger cohorts to enable studies of more specific subpopulations, is necessary. Qualitative research and interviews evaluating immigrant patient experiences and their own evaluations of barriers to preventative health care use would also help elucidate the reasons for disparities among different immigrant subgroups.

When the Canadian government ended preferential treatment towards European immigrants in 1967, and began accepting large cohorts of immigrants from all over the world, ethnic and cultural demographics in Canada began to change drastically. Despite the existence of population screening programs, the results from this study suggest that the provinces need to do more to address the many types of sociodemographic, cultural and linguistic barriers that may lead to hampered uptake among recent immigrants in Canada. To this end, a federal policy or national funding outlining reasonable accommodations or interventions for newcomers navigating the health care system is warranted.

The research evaluating screening promotion interventions currently provides some evidence about what can be done to increase participation in population-based screening programs, including peer-support programs(123). However, an intervention which works for the demographics of one province is unlikely to be perfectly reproducible in another. Likely an approach that would be most effective would be for provinces to adapt evidence-based screening promotion interventions to their own particular demographics and under-served populations, which could be delivered through provincial screening programs.

While we were unable to confirm the findings in this study, the literature suggests that having a regular family doctor is highly predictive of adherence to cancer screening guidelines. While everyone should have regular appointments with a general practitioner, it is possible that increasing screening uptake among marginalized populations could lie in expanding interventions beyond primary care physician offices, and into more accessible forms of organized screening -including more access to mail out colorectal cancer screening tests, and mobile Pap and Mammography units(143), as well as expanding training to non-physicians to conduct screenings. It is likely that some combination of these approaches would be necessary to increase uptake among at risk populations, though more research is needed to evaluate the possible interventions.

Lastly, this thesis provides evidence that sociodemographic inequities in the population persist and are strong predictors of cancer screening and chronic disease prevention. To address these inequities, and to achieve the broadest policy reforms, interventions that target income and educational disparities in the population would help increase screening uptake across cancer screening outcomes. Some of these policies may require to look beyond healthcare provision and demand educational and political reforms, without which structural barriers to health and to

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Appendices

Appendix A - Provinces Opted-In to CCHS Cancer Screening Modules (Optional Content)

Table 0-1 - Provinces Opted-In to CCHS Breast Cancer Screening Module by Survey Year

	Newf & Lab	PEI	NS	NB	QC	ON	MAN	SASK	ALB	BC	YUK	NWT	Nunavut
2005	**X**	**X**	**X**	**X**	**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**
2007-08	**X**		**X**	**X**		**X**		**X**				**X**	
2009-10	**X**		**X**	**X**					**X**			**X**	
2011-12	**X**					**X**			**X**				**X**
2013-14			**X**	**X**					**X**			**X**	
2015	**X**				**X**				**X**				

Table 0-2- Provinces Opted-In to CCHS Cervical Cancer Screening Module by Survey Year

	Newf &Lab	PEI	NS	NB	QC	ON	MAN	SASK	ALB	BC	YUK	NWT	Nunavut
2005	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
2007-08				**X**		**X**		**X**				**X**	
2009-10		**X**	**X**								**X**		**X**
2011-12						**X**							
2013-14		**X**		**X**							**X**	**X**	
2015	**X**				**X**				**X**				

Table 0-3 - Provinces Opted-In to CCHS Colorectal Cancer Screening Module by Survey Year

	Newf &Lab	PEI	NS	NB	QC	ON	MAN	SASK	ALB	BC	YUK	NWT	Nunavut
2005	**X**	**X**	**X**	**X**		**X**					**X**	**X**	**X**
2007-08	**X**	**X**				**X**		**X**				**X**	**X**
2009-10	**X**	**X**	**X**	**X**		**X**		**X**			**X**	**X**	**X**
2011-12	**X**	**X**				**X**			**X**				**X**
2013-14	**X**	**X**		**X**	**X**		**X**		**X**			**X**	
2015	**X**	**X**		**X**					**X**				

Appendix B - Canadian Community Health Survey (CCHS) and Derived Variables used in the Analysis

Canadian Community Health Survey (CCHS) and Derived variables used in the analysis				
	Variable Name (Cycle Year or indication of derived variable)	**Concept and Question**	**Type**	**Code**
1.	**GEO_PRV** (2015) **GEO_PRV** (2007-08, 2009-10, 2011-12, 2013-14) **GEO_PRV** (2005)	**Concept**: Province of residence of respondent **Question**: Province of residence of respondent	Categorical	10 = Newfoundland and Labrador 11= Prince Edward Island 12 = Nova Scotia 13 = New Brunswick 24 = Quebec 35 = Ontario 46 = Manitoba 47 = Saskatchewan 48 = Alberta 59 = British Columbia 60 = Yukon 61 = Northwest Territories 62= Nunavut
2.	**PRV** (Derived)	Province of residence - regrouped	Categorical	10= Maritimes (Newfoundland & Labrador, PEI, Nova Scotia, New Brunswick) 24 = Quebec 35 = Ontario 46 = Prairies (Manitoba and Saskatchewan)

				48 = Western Provinces (Alberta and British Columbia) 60 = Territories (Yukon, Northwest Territories, and Nunavut)
3.	**DHH_AGE** (2015) **DHH_AGE** (2007-08, 2009-10, 2011-12, 2013-14) **DHHE_AGE** (2005)	**Concept:** Age (Years) **Question:** What is your age?	Numeric	012-102
4.	**DHHGAGE** (Derived)	Age by 5-year age grouping	Categorical	1 = 0 – 9 years 2 = 10 – 14 years 3 = 15 – 19 years 4 = 20 – 24 years 5 = 25 – 29 years 6 = 30 – years 7 = 35 – 39 years 8 = 40 – 44 years 9 = 45 – 49 years 10 = 50 – 54 years 11 = 55 – 59 years 12 = 60 – 64 years 13 = 65 – 69 years 14 = 70 – 74 years 15 = 75 + years
5.	**DHH_SEX** (2015)	**Concept:** Sex **Question:** Interviewer: Enter the respondent's sex.	Categorical	1 = Male 2 = Female

	DHH_SEX (2007-08, 2009-10, 2011-12, 2013-14) **DHHE_SEX** (2005)	If necessary, ask: Is respondent male or female?		
6.	**GEODVUR** (2015) **GEODUR2** (2007-08, 2009-10, 2011-12, 2013-14) **GEOEDUR2** (2005)	**Concept:** Population center or rural area classification (grouped). **Question:** Population center or rural area classification (grouped). All cycles renamed to **GEODUR2**	Categorical	1 = Urban 2 = Rural
7.	**GEN_005** (2015) **GEN_01** (2007-08, 2009-10, 2011-12, 2013-14) **GENE_01** (2005)	**Concept:** Self-perceived Health. **Question:** In general, would you say your health is…? All cycles renamed to **GEN_01**	Categorical	1 = Excellent 2 = Very Good 3 = Good 4 = Fair 5 = Poor 7 = Don't Know 8 = Refusal 9 = Not Stated
8.	**CCC_130** (2015) **CCC_131** (2007-08, 2009-10, 2011-12, 2013-14) **CCCE_131** (2005	**Concept:** Has Cancer. **Question:** Do you have cancer?	Categorical	1 = Yes 2 = No 7 = Don't Know 8 = Refusal 9 = Not Stated

9.	**PAP_005** (2015) **PAP_020** (2007-08, 2009-10, 2011-12, 2013-14) **PAPE_020** (2005)	**Concept:** Ever had a Pap Smear Test –Lifetime. **Question:** Have you ever had a PAP smear test? All cycles renamed to **PAP_020**	Categorical	1 = Yes 2 = No 7 = Don't Know	8 = Refusal 9 = Not Stated
10.	**PAP_022** (2015) **PAPE_022** (2007-08, 2009-10, 2011-12, 2013-14) **PAPE_022** (2005)	**Concept:** Last time had a Pap Smear Test **Question:** When was the test time?	Categorical	1 = Less than 6 months ago 2 = 6 months to less than 1 year ago 3= 1 year to less than 2 years ago	4 = 2 years to less than 5 years ago 5 = 5 years ago or more 6 = Not applicable 7 = Don't know 8 = Refusal 9 = Not Stated
11.	**PAPT**	Had Pap within guideline recommended period	Categorical	1 = Yes (Last pap within the last three years) 2= No (Last pap three years or more ago)	
12.	**MAM_005** (2015) **MAM_030** (2007-08, 2009-10, 2011-12, 2013-14)	**Concept:** Ever had Mammogram **Question**: Have you ever had a mammogram, that is, a breast x-ray?	Categorical	1 = Yes 2 = No 7 = Don't Know 8 = Refusal 9 = Not Stated	

	MAME_030 (2005)			
13.	**MAM_010** (2015) **MAM_032** (2007-08, 2009-10, 2011-12, 2013-14) **MAME_032** (2005)	**Concept:** Last time mammogram was done **Question:** When was the last time?	Categorical	1 = Less than 6 months ago 2 = 6 months to less than 1 year ago 3= 1 year to less than 2 years ago 4 = 2 years to less than 5 years ago 5 = 5 years ago or more 6 = Not applicable 7 = Don't know 8 = Refusal 9 = Not Stated
14.	**MAMT (Derived)**	Had mammogram scan within guideline recommended period		1 = Yes (Last mam within the last two years) 2= No (Last mam two years or more ago)
15.	**SDCDVCB** (2015) **SDCGCB10** (2007-08, 2009-10, 2011-12, 2013-14) **SDCEGCB10** (2005) Renamed for all cycles: **WRB**	**Concept:** Country of birth – grouped	Categorical	1 = Canada 2 = Other – North America 3 = South and Central America, Bermuda and Caribbean 4 = Europe 5 = Africa 6 = Asia 7 = Oceania 8 = Antarctica and Adjacent Islands 9 = Not Stated

16.	**SDCDVIMM** (2015) **SDCFIMM** (2007-08, 2009-10, 2011-12, 2013-14) **SDCEFIMM** (2005)	**Concept**: Immigrant Flag	Categorical	1 = Landed Immigrant/ Non-permanent resident 2 = Non-Immigrant (Canadian born) 3 = Not Stated
17.	**SDCT** (Derived)	Length of Time in Canada since Immigration	Categorical	1 = 0-10 years 2 = 11 + years 3 = Not Stated
18.	**SDC_025** (2015) **SDC_5A_1** (2011-12, 2013-14)	**Concept**: Knowledge of Official Languages. **Question**: Of English or French, which Language(s) do you speak well enough to conduct a conversation? Is it...? All cycles available renamed to **SDC_5A_1**	Categorical	1 = English Only 2 = French On.ly 3 = Both English and French 4 = Neither English nor French
19.	**FLAG** (Derived)	CCHS Cycle Survey Year Flag	Categorical	1= 2015 4= 2009-10 2 = 2013-14 5 = 2007-08 3=2011-12 6= 2005
20.	**EDUDHR04** (2015) **EDUDR04** (2007-08, 2009-10, 2011-12, 2013-14)	**Concept:** Highest level of education	Categorical	1 = Less than Secondary School Graduation 2= Secondary School Graduation 3 = Some Post-Secondary Education 4= Post-Secondary certificate/diploma or degree

	EDUEDR04 (2005)			9 = Not stated
21.	**EDU** (Derived)	Education- regrouped	Categorical	1 = Less than Secondary school 2= Secondary School Graduation 3= Some or Graduation from Post-Secondary School
22.	**DHH_MS**	**Concept**: Marital Status **Question:** What is your marital status? Are you married, living common-law, widowed, separated, divorced, or single, never married?	Categorical	1 = Married 2= Common-Law 3 = Widowed 4 = Separated 5 = Divorced 6= Single, Never Married 97 – Don't Know 98 – Refusal 99 – Not Stated
23.	**SDCDCGT** (2015) **SDC_43** (2007-08, 2009-10, 2011-12, 2013-14) **SDCE_43** (2005)	**Concept:** Cultural/racial origin **Question:** You may belong to one or more racial or cultural groups on the following list...? (Excludes Indigenous Peoples)	Categorical	A = White B = Chinese C= South Asian D = Black E =Filipino F = Latin American G= South East Asian H = Arab I = West Asian K= Korean J= Japanese M = Other
24.	**RACE** (Derived)	Racial or Cultural Origin - Regrouped	Categorical	1 = White 2 = South Asian 3 = East and South East Asian (Chinese, Korean, Japanese, Filipino) 4 = Black 5 = Latin American 6 = Arab and Middle Eastern 7 = Other

25.	**INCDHH**	Concept: Household Income	Categorical	1= No Income 2 = Less than $5,000 3 = $5,000 to $9,999 4 = $10,000 to $14,999 5 = $15,000 to $19,999 6 = $20,000 to $29,999 7 = $30,000 to $39,999 8 = $40,000 to $49,999	9 = $50,000 to $59,999 10 = $60,000 to $69,999 11 = $70,000 to $79,999 12 = $80,000 to $89,999 13 = $90,000 to $99,999 14 = $100,000 to less than $150, 000 15 = $150, 000 or more
26.	**INCT (**Derived)	Household Income	Categorical	1 = No income- $19,999 2 = $20,000 – $39,999 3 - $40,000- $59,999	4 - $60,000 - $79,999 5 – 80,000 - $99,999 6 - $100,000 or more

Appendix C - Provincial Population Cancer Screening Programs and Screening Guideline

	Breast	Cervical	Colorectal
Alberta	**Test:** Mammography(144) **Population:** Asymptomatic women ages 50-74 without a family history of breast cancer **Periodicity:** Once every two years **Start of Program:** 1990	**Test:** Pap test (144) **Population:** Starting at age 25 or 3 years after becoming sexually active, until age 70 **Periodicity:** Once every 3 years **Start of Program:** 2000	**Test:** Fecal Immunochemical Test (FIT). If FIT shows abnormal results, followed up with colonoscopy (145) **Population:** Asymptomatic men and women ages 50 to 74 **Periodicity:** Once a year **Start of Program:** 2007
British Columbia	**Test:** Mammography (146) **Periodicity:** Once every two years **Population:** Asymptomatic women ages 50-74 without a family history of breast cancer **Start of Program:** 1988	**Test:** Pap test (80) **Population:** Women ages 25-69 **Periodicity:** Once every 3 years **Start of Program:** 1960	**Test:** Fecal Immunochemical Test (FIT). If FIT shows abnormal results, followed up with colonoscopy **Population:** Asymptomatic men and women ages 50 to 74 **Periodicity:** Once every two years **Start of Program:** 2014

Ontario	**Test:** Mammography(148) **Periodicity:** Once every two years **Population:** Asymptomatic women ages 50-74 without a family history of breast cancer **Start of Program:** 1990	**Test:** Pap test (149) **Population:** Women ages 21-70 **Periodicity:** Once every 3 years **Start of Program:** 2000	**Test**: Fecal occult blood test (FOBT). If FOBT shows abnormal results, followed up with colonoscopy within 8 weeks **Population:** Asymptomatic men and women ages 50 to 74 **Periodicity:** Once every two years **Start of Program:** 2007
Quebec	**Test:** Mammography(150) **Periodicity:** Once every two years **Population:** Asymptomatic women ages 50-69 without a family history of breast cancer **Start of Program:** 1998	**Test:** Pap test **Population:** Women ages 21-65 **Periodicity:** Once every 2-3 years **Start of Program: -**	**Test:** Fecal Immunochemical Test (FIT). If FIT shows abnormal results, followed up with colonoscopy **Population:** Asymptomatic men and women ages 50 to 74 **Periodicity:** Once every two years **Start of Program:** 2019 (estimated)
New Brunswick	**Test:** Mammography(151) **Periodicity:** Once every two years	**Test:** Pap test (152) **Population:** Starting at age 21 or 3 years after becoming sexually	**Test:** Fecal Immunochemical Test (FIT). If FIT shows abnormal results, followed up with colonoscopy (153) **Population:** Asymptomatic men and women ages 50 to 74

	Population: Asymptomatic women ages 50-69 without a family history of breast cancer **Start of Program:** 1995	active (whichever is later), until age 69 **Periodicity:** Once every 3 years **Start of Program: -**	**Periodicity:** Once every two years **Start of Program: -**
Nova Scotia	**Test:** Mammography(154) **Periodicity/Population:** Once a year for asymptomatic women age 40-49 Once every two years for asymptomatic women ages 50-69 without a family history **Start of Program** : 1991	**Test:** Pap test **Population:** Starting at age 21 or 3 years after becoming sexually active, until age 70 **Periodicity:** Once every 3 years **Start of Program:** 1991	**Test:** Fecal Immunochemical Test (FIT). If FIT shows abnormal results, followed up with colonoscopy **Population:** Asymptomatic men and women ages 50 to 74 **Periodicity:** Once every two years **Start of Program:** 2014
Prince Edward Island	**Test:** Mammography(155) **Periodicity:** Once a year **Population:** Asymptomatic women ages 40-75 without a family history of breast cancer	**Test:** Pap test **Population:** Women ages 21 to 65 **Periodicity:** Once every 2 years **Start of Program:** 2001	**Test:** Fecal Immunochemical Test (FIT). If FIT shows abnormal results, followed up with colonoscopy **Population:** Asymptomatic men and women ages 50 to 74 **Periodicity:** Once every two years

	Start of Program: 1998		**Start of Program:** 2014
Newfoundland and Labrador	**Test:** Mammography(148) **Periodicity:** N/A **Population:** Asymptomatic women ages 50-74 without a family history of breast cancer **Start of Program:** 1996	**Test:** Pap test **Population:** Women ages 20 to 69 **Periodicity:** Once a year until there are 3 consecutive negative Pap tests. Then once every 3 years. **Start of Program:** 2003	**Test:** Fecal Immunochemical Test (FIT). If FIT shows abnormal results, followed up with colonoscopy **Population:** Asymptomatic men and women ages 50 to 74 **Periodicity:** Once every two years **Start of Program:** 2014

Appendix D - Assessing Model Assumptions and Model Fit

Table 0-4 - Assessing model fit; Association between Immigration Status and Breast Cancer Screening

Lifetime Screening			Screening Adherence		
Variables	**AIC**	**LRT**	**Variables**	**AIC**	**LRT**
Intercept (MAMEVER)	767228.26	*p<0.001*	*Intercept (MAMT)*	1458888.7	*p<0.001*
MAM_030 + DHHGAGE	748770.99	*p<0.001*	*MAMT + INCT*	1443221.8	*p<0.001*
MAM_030 + DHHGAGE + RACE	740227.82	*p<0.001*	*MAMT + INCT + DHHGAGE*	1429919.7	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT	732297.31	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG*	1418223.8	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT + SDCT	729087.64	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG + SDCT*	1413694.1	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT + SDCT + EDU	725865.81	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG + SDCT + GEN_01*	1410476.3	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT + SDCT + EDU + WRB	723777.16	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG + SDCT + GEN_01 + RACE*	1407661.1	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT + SDCT + EDU + WRB + FLAG	721662.63	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG + SDCT + GEN_01 + RACE + DHH_MS*	1405525.6	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT + SDCT + EDU + WRB + FLAG + DHH_MS	719944.12	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG + SDCT + GEN_01 + RACE + DHH_MS + EDU*	1403576.9	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT + SDCT + EDU + WRB + FLAG + DHH_MS + GEODUR2	718864.29	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG + SDCT + GEN_01 + RACE + DHH_MS + EDU + PRV*	1402133.2	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT + SDCT + EDU + WRB + FLAG + DHH_MS + GEODUR2 + PRV	718249.20	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG + SDCT + GEN_01 + RACE + DHH_MS + EDU + PRV + WRB*	1401579.2	*p<0.001*
MAM_030 + DHHGAGE + RACE + INCT + SDCT + EDU + WRB + FLAG + DHH_MS + GEODUR2 + PRV + GEN_01	717890.34	*p<0.001*	*MAMT + INCT + DHHGAGE + FLAG + SDCT + GEN_01 + RACE + DHH_MS + EDU + PRV + WRB + GEODUR2*	1401453.9	*p<0.001*

AIC – Akaike information criterion. Estimator of the relative quality of statistical models for a given set of data. A good model is the one that has the minimum AIC among all the other models

LRT – Likelihood Ratio Test. Compares goodness of fit between two statistical models. A small p value provides evidence against the intercept-only model and in favour of the current model

Table 0-5 - Assessing model fit; Association between Immigration Status and Cervical Cancer Screening

Lifetime Screening			Screening Adherence		
Variables	**AIC**	**LRT**	**Variables**	**AIC**	**LRT**
Intercept (PAPT)	2297826.7	*p<0.001*	*Intercept (PAP_020)*	1327103.5	*p<0.001*
PAP + RACE	2247933.7	*p<0.001*	*PAP + RACE*	1198371.6	*p<0.001*
PAP + RACE + DHH_MS	2207299.0	*p<0.001*	*PAP + RACE + DHH_MS*	1075594.4	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE	2178601.8	*p<0.001*	*PAP + RACE + DHH_MS + SDCT*	1052013.2	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE + SDCT	2165555.6	*p<0.001*	*PAP + RACE + DHH_MS + SDCT + DHHGAGE*	1034201.7	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE + SDCT + EDU	2154394.3	*p<0.001*	*PAP + RACE + DHH_MS + SDCT + DHHGAGE + PRV*	1018871.0	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE + SDCT + EDU + PRV	2147490.0	*p<0.001*	*PAP + RACE + DHH_MS + SDCT + DHHGAGE + PRV + WRB*	1010426.3	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE + SDCT + EDU + PRV + GEN_01	2140308.3	*p<0.001*	*PAP + RACE + DHH_MS + SDCT + DHHGAGE + PRV + WRB + EDU*	1008150.1	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE + SDCT + EDU + PRV + GEN_01 + WRB	2135962.7	*p<0.001*	*PAP + RACE + DHH_MS + SDCT + DHHGAGE + PRV + WRB + EDU + FLAG*	1006730.0	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE + SDCT + EDU + PRV + GEN_01 + WRB + INCT	2132704.8	*p<0.001*	*PAP + RACE + DHH_MS + SDCT + DHHGAGE + PRV + WRB + EDU + FLAG + GEN_01*	1005429.0	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE + SDCT + EDU + PRV + GEN_01 + WRB + INCT + GEODUR2	2129778.4	*p<0.001*	*PAP + RACE + DHH_MS + SDCT + DHHGAGE + PRV + WRB + EDU + FLAG + GEN_01 + INCT*	1004370.9	*p<0.001*
PAP + RACE + DHH_MS + DHHGAGE + SDCT + EDU + PRV + GEN_01 + WRB + INCT + GEODUR2 + FLAG	2129368.0	*p<0.001*	*PAP + RACE + DHH_MS + SDCT + DHHGAGE + PRV + WRB + EDU + FLAG + GEN_01 + INCT + GEODUR2*	1003858.0	*p<0.001*

AIC - Akaike information criterion. Estimator of the relative quality of statistical models for a given set of data. A good model is the one that has the minimum AIC among all the other models

LRT – Likelihood Ratio Test. Compares goodness of fit between two statistical models. A small p value provides evidence against the intercept-only model and in favour of the current model

Table 0-6- Assessing model fit; Association between immigration status and lifetime colorectal cancer screening

Lifetime Colorectal Cancer Screening			Colorectal Cancer Screening Adherence		
Variables	**AIC**	**LRT**	**Variables**	**AIC**	**LRT**
Intercept (CCSEVER)	3585674.3	*p<0.001*	*Intercept (CCST)*	3736670.9	*p<0.001*
CCST + DHHGAGE	3495703.9	*p<0.001*	*CCST + DHHGAGE*	3664249.6	*p<0.001*
CCST + DHHGAGE + FLAG	3454868.1	*p<0.001*	*CCST + DHHGAGE + FLAG*	3630055.2	*p<0.001*
CCST + DHHGAGE + FLAG + PRV	3421271.8	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV*	3593539.8	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE	3390304.8	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE*	3571134.4	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE + EDU	3379359.5	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE + INCT*	3554295.6	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE + EDU + SDCT	3371824.1	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE + INCT + DHH_MS*	3548270.4	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE + EDU + SDCT + DHH_MS	3364574.6	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE + INCT + DHH_MS + EDU*	3543125.7	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE + EDU + SDCT + DHH_MS + GEN_01	3358988.9	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE + INCT + DHH_MS + EDU + SDCT*	3538261.3	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE + EDU + SDCT + DHH_MS + GEN_01 + DHH_SEX	3354711.9	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE + INCT + DHH_MS + EDU + SDCT + GEN_01*	3534739.3	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE + EDU + SDCT + DHH_MS + GEN_01 + DHH_SEX + INCT	3350347.2	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE + INCT + DHH_MS + EDU + SDCT + GEN_01 + DHH_SEX*	3531524.6	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE + EDU + SDCT + DHH_MS + GEN_01 + DHH_SEX + INCT + WRB	3349804.2	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE + INCT + DHH_MS + EDU + SDCT + GEN_01 + DHH_SEX + WRB*	3530551.3	*p<0.001*
CCST + DHHGAGE + FLAG + PRV + RACE + EDU + SDCT + DHH_MS + GEN_01 + DHH_SEX + INCT + WRB + GEODUR2	3349437.6	*p<0.001*	*CCST + DHHGAGE + FLAG + PRV + RACE + INCT + DHH_MS + EDU + SDCT + GEN_01 + DHH_SEX + WRB + GEODUR2*	3530255.0	*p<0.001*

AIC - Akaike information criterion. Estimator of the relative quality of statistical models for a given set of data. A good model is the one that has the minimum AIC among all the other models

LRT – Likelihood Ratio Test. Compares goodness of fit between two statistical models. A small p value provides evidence against the intercept-only model and in favour of the current model

Appendix E - Flowchart for scoping review study selection