Investigations into breast cancer screening participation and retention in British Columbia, Canada

by

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Abstract

Breast cancer screening programs operate across Canada and aim to reduce breast cancer mortality through early detection of breast tumours. In British Columbia (BC), a significant fraction of eligible women are not receiving regular mammograms. Research from other jurisdictions suggests that some immigrant populations participate less in screening than non-immigrants. Other research suggests that the primary care system may influence screening participation among women. Measures of primary care access, coordination and continuity in BC show recent declines, and only a small percentage of physicians are accepting responsibility for patients' ongoing primary care needs.

This thesis includes a series of population-based studies, using administrative health and other databases, to assess differences between immigrant and non-immigrant women, and among immigrant groups for: 1) breast cancer screening participation and retention; 2) breast cancer risk; and 3) differences in breast cancer stage at diagnosis. An additional study examines whether primary care factors, such as physician characteristics, or measures of physician and patient relationships, associate with screening utilization.

Breast screening participation varied markedly according to country of birth, with some immigrant groups demonstrating very low participation. Among recent immigrants, the number of primary care physician visits was consistently identified as an important predictor of participation. Both stage-specific and age-specific incidence rates, showed substantial variation by country of birth. Eastern European/Central Asian and Indian immigrants demonstrated a worse stage at diagnosis compared to non-immigrants. Several primary care factors, such as low continuity of care, few physician visits, having a male physician and short duration of affiliation with a provider were associated with lower participation. The effects of these factors were stronger within some subgroups, such as low-income and some immigrant groups. Although physician factors did not show a strong relationship with retention overall, among first-time screeners, low continuity and few physician visits were associated with lower retention. These results suggest a number of areas for potential screening promotions, interventions and future research.

Lay Summary

Breast cancer screening programs in Canada aim to reduce deaths from breast cancer by detecting breast cancer early when treatment is more effective. A significant proportion of women eligible to screen for breast cancer are not getting regular mammograms. Research suggests some groups, such as immigrant women, participate less in cancer screening.

This thesis includes several studies examining whether some groups of immigrant women in British Columbia participate less in breast cancer screening than non-immigrant women. One study included here also assesses whether family physician characteristics (such as sex or years in practice), or the relationships between women and their physicians (such as how often women see their usual physician or see different physicians), are related to regular breast screening. Other studies examine whether there is evidence that some immigrant women demonstrate higher breast cancer incidence rates and more advanced cancers at the time of diagnosis compared to non-immigrant women.

Preface

Some of the research chapters contained within this thesis have been either previously published, or submitted for review, as peer-reviewed journal articles. Others have been prepared with the intent to publish them as journal articles. As such, there is some repetition of materials across the chapters, particularly in the introductory or background sections of individual chapters and in descriptions of data sources accessed. This statement is to certify that the research presented in this thesis was conducted, analyzed, written, and disseminated by Ryan Woods.

The research contained within the chapters that follow was carried out under an approval from the University of British Columbia – British Columbia Cancer Agency Research Ethics Board (Certificate Number: H15-02792). All study data were accessed from the Population Data BC platform at the University of British Columbia upon obtaining approval of all relevant data stewards.

A version of Chapter 3 has been published as "Woods RR, McGrail KM, Kliewer EV, Kazanjian A, Mar C, Kan L, Sam J, Spinelli JJ. Breast screening participation and retention among immigrants and non-immigrants in British Columbia: A population-based study. *Cancer Med.* (2018) Aug;7(8):4044-4067." R. Woods performed the study data analysis and wrote the manuscript. All co-authors critically reviewed and revised the draft manuscript and approved the final manuscript ahead of journal submission.

Chapter 4 has been submitted for publication as a brief communication and is presently under peer-review. R. Woods performed the study data analysis and wrote the manuscript. All co-authors critically reviewed and revised the manuscript ahead of final submission to the journal.

Chapters 5 and 6 have been prepared with the intent to submit as peer-reviewed journal articles. R. Woods performed the study data analysis and wrote these chapters. Supervisory committee members have critically reviewed the chapters and provided input as to the design, analysis and interpretation of study findings.

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List of Abbreviations

ACG: Adjusted clinical groups

ADG: Aggregate diagnosis groups

AOR: Adjusted odds ratio

ARR: Adjusted rate ratio

BC: British Columbia

BCBSP: BC Cancer Breast Screening Program

BCCR: British Columbia Cancer Registry

BCVSA: BC Vital Statistics Agency

CCHS: Canadian Community Health Survey

CI: Confidence interval

CIC: Citizenship and Immigration Canada

CMHT: China, Macau, Hong Kong, Taiwan

CPAC: Canadian Partnership Against Cancer

DA: Dissemination area

ER: Estrogen Receptor

GEE: Generalized estimating equations

HER2: Human epidermal growth factor receptor 2

HR: Hormone receptor

ICD-9: International Classification of Diseases Version 9

ICD-10: International Classification of Diseases Version 10

ICDO-3: International Classification of Disease for Oncology, 3rd edition

IRCC: Immigration, Refugees, and Citizenship Canada

MSP: Medical Services Plan

NA: Not available

NC: Not calculated

NPHS: National Population Health Survey

NZ: New Zealand

ON: Ontario

OR: Odds ratio

PCP: Primary care physician

PEM: Patient enrollment model

PR: Progesterone receptor

SEER: Surveillance, Epidemiology and End-Results

SIR: Standardized Incidence Ratio

SRR: Standardized Rate Ratio

UK: United Kingdom

UPC: Usual provider of care

US: United States

USA: United States of America

USSR: Union of Socialist Soviet Republics

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My colleagues at Population Data BC have been amazing to work with throughout this study; thanks to all of you for facilitating the data application process, help on the SRE, and overall great support. A big thanks to Sandra Peterson for help getting me started unpacking some of the intimidatingly large data sets, and then for sharing her expertise on all things MSP along the way.

I was very blessed with the greatest supervisory committee I could have asked for. John (Spinelli), Kim (McGrail) and Erich (Kliewer) – you have all provided me different perspectives, interesting tangents to follow (but with cautions on getting lost on them), and a lot of encouragement and support. Unexplored tangents that have come up in our discussions will likely keep me busy for the next few years. I can't say enough how much I have enjoyed working with you all on this. I count myself very fortunate to be able to work with great people like yourselves on interesting challenges. I think I can safely promise that documents I share with you for future projects will be substantially shorter than this one. Thanks so much for everything.

My family far away from Vancouver have certainly seen less of me this past year, but your support and encouragement have been a big motivation to get this done. I look forward to spending more time with you all soon. Much love to mom and Rach, who I know both could have used more help from me this year.

My young epidemiologist sons Daragh and Niall, gave insightful comments on the tables and figures as they peered over my shoulder throughout this. I have tried to keep up with you both as I worked away at this, but I know I have missed more than a few hockey games, trips to Science World and even a family vacation together. You guys have given me some of the best breaks one could take from this work along the way. In fact, I think our quests to defeat the Ender Dragon and the Wither, and our domination of Little League tournaments around the Lower Mainland, may have delayed me finishing this.

When John asked me to get a signed waiver from my dear wife Lee, acknowledging that he would not be to blame for any pain and suffering my return to school might cause her, Lee and I both had a good laugh. Fast-forward a few years from that seemingly amusing moment, and I think it is fair to say we wouldn’t laugh quite as hard now. Sections of this document have been written on our anniversary, Christmas Eve, holidays, Hallowe’en, days of our kids’ sports games, and over many weekends and evenings that we could have spent doing anything but this. To say I couldn’t have completed this without your help and support doesn’t begin to capture how much I leaned on you to complete this (on top of all of the things I lean on you for). I owe you big…again. Thanks.

Dedication

Dedicated to two wonderfully important people to me: my pops Reg who would have loved to see this completed; and to Lee without whom this would never have been completed.

Chapter 1: Introduction

1.1 Breast Cancer and Breast Cancer Screening in Canada

1.1.1 Descriptive Epidemiology

Breast cancer is presently the most common cancer diagnosed among Canadian women with an estimated 26,500 cases diagnosed in 2017 [1]. Breast cancer is also the second most common cause of cancer death among Canadian women, second only to lung cancer, and responsible for approximately 5,000 deaths among Canadian women in 2017 [1]. Incidence rates have been stable in Canada over the past decade (2004-2013), while mortality rates have declined steadily [1]. Although breast cancer is also uncommonly, diagnosed among males, within this thesis, all discussion of breast cancer relates to cases diagnosed among females.

The risk of breast cancer among females increases with age. According to 2015 incidence data compiled by the British Columbia (BC) Cancer Registry, incidence increases from a low of approximately 11 cases per 100,000 in ages less than 40 years to 271 cases per 100,000 among those aged 50-69 years [2]. The majority (84%) of new cases diagnosed in 2015 were among women aged 50 years or older.

Prognosis after diagnosis varies markedly depending on many factors, among them cancer stage at diagnosis. Survival after a cancer diagnosis is generally measured by cancer control agencies using relative survival statistics [3]. Relative survival measures the survival experience of cancer patients relative to the general population, of similar age and sex, without cancer. Published statistics from BC report that the overall age-standardized 5-year relative survival for breast cancer is 88.0% [4]. However, relative survival is significantly higher for stage I (100.7%) or II (91.4%) cancer compared to those diagnosed at stage III (72.1%) or IV (20.9%). According to the 2018 Canadian national cancer statistical special report on cancer stage [5], almost half of breast cancers in Canada are diagnosed at stage I (46.6%) where prognosis is excellent. Stage IV disease, generally incurable, represents approximately 4.9% of all newly diagnosed breast cancer cases in Canada.

1.1.2 Breast Cancer Screening in Canada

In an effort to reduce breast cancer mortality through earlier tumour detection, all provinces in Canada have implemented population-based breast cancer screening programs [6]. In BC, average-risk women are recommended to screen biennially with mammography starting at age 50 and continuing to age 74 [7, 8]. Average-risk women may elect to start screening as early as age 40, although screening is not specifically recommended for these women by the provincial program. Women with a prior family history of breast cancer are recommended to screen annually from age 40 through to 74.

In BC, mammograms are entirely funded by the BC Cancer Breast Screening Program (BCBSP) and have no direct user fees for women who participate. Women who are eligible to screen can book mammograms directly with the program without a physician referral, however, women are required to identify a physician at the time of booking who will receive the screening results. Women who participate in the program are sent reminder letters to re-screen according to their recommended screening interval, which is by default every two years, but may be more frequent for women who identify a family history of breast cancer and are considered of higher risk of cancer.

Canadian breast cancer screening programs use a variety of indicators to monitor and evaluate the success of their programs [9]; the two most relevant to this thesis are the breast screening participation and retention rates. The participation rate is commonly reported by Canadian programs for women of average risk who are expected to screen biennially; thus it is often calculated as the fraction of eligible women who received a program mammogram over a 24- or 30-month period.

The program retention or return rate measures the success of the screening program in retaining its participants in accordance with the screening guidelines. The retention rate measures the fraction of program participants that return for a subsequent screening mammogram within a specified time window. As average risk women are recalled every two years in Canada, a 30-month retention rate is frequently used as an indicator in screening program reports.

1.1.3 Recent Performance of Breast Screening Programs in Canada

Breast cancer screening programs routinely publish program statistics including population participation and client retention rates [10-12]. Recent breast screening participation rates are presented in Table 1.1 for most Canadian provincial or territorial programs. Participation rates (Table 1.1) suggest that, in recent years, none of the programs shown have met the target of 70% set by expert advisory groups [13]. Of these programs, only two show participation rates above 60%, with BC ranking 6th out of the 11 programs with a participation rate of 54.4%.

For program retention statistics, Canadian programs generally report 30-month retention rates for first-time and subsequent clients separately. Recent rates (Table 1.1) varied from a low of 56.7% in Northwest Territories (based on first-time clients) to 87.4% in Newfoundland and Labrador (based on clients with prior screening history). Retention rates for first-time participants are particularly variable across provincial programs, however, for all of the provinces shown, retention is lower for first-time participants compared to those with prior screening history. Thus, this suggests that attention may be best placed on ensuring first-time screeners return for second screens. In BC, the 57.2% rate among first-time screeners is 18% below the national retention target of 75% [9].

1.2 British Columbia's Immigrant Population

According to the 2016 Canadian Census, BC's population included more than 1.29 million immigrants, representing 28.3% of the total population [14]. It includes more than 795,000 individuals who immigrated prior to 2001, as well as an additional 500,000 that landed between 2001 and 2016. Recent immigrants have largely originated from Asian countries, most commonly the Philippines, China, India, and the Republic of Korea [15]. The 2016 Census further illustrates the diversity of BC's total immigrant population reporting significant numbers of immigrants from Asia (>750,000), Europe (>300,000), the Americas (>110,000), Africa (>40,000), and Oceania (>30,000).

1.3 Primary Care in British Columbia

In BC, as in other parts of Canada, primary care physicians (PCPs) meet a substantial proportion of patient healthcare needs, and act as an entry point for access to specialist health services under the public healthcare system. In contrast to some other Canadian provinces, such as Ontario, the majority of PCPs in BC are paid on a fee-for-service model, rather than receiving a capitation-style remuneration for a defined patient roster. Although physicians may limit their practices to a specific set of patients whom they consider to be "their practice", this is not generally reflected in the way payment for care is delivered to these patients. Walk-in clinics are prevalent in BC, and generally provide more flexible hours than traditional practices, with locations in retail outlets and neighborhood centres. Patients may elect to, or by necessity, see more than one PCP, or visit multiple clinics, in order to meet their primary care needs. According to Statistics Canada, in 2014, approximately 15% of BC residents reported not being able to find a PCP, similar to the national average [16].

1.4 Research Objectives and Structure of Thesis

Breast cancer is clearly a significant health issue in BC and, as described above, the public healthcare system has invested in strategies (such as breast cancer screening) to reduce its associated mortality and morbidity. However, participation and retention rates have been disappointing in BC and suggest that significant numbers of eligible women are not being screened according to guidelines. This thesis investigates factors that may contribute to BC's low breast cancer screening rates, and examines other related breast cancer control indicators.

Specifically, this thesis undertakes and summarizes research with the following four primary objectives:

1. To assess whether populations of immigrant women in BC, defined by country and region of birth, demonstrate different patterns of breast screening participation and retention compared to non-immigrant women.
2. To assess variation in breast cancer risk among screening-eligible women in BC based on country and region of birth.
3. To assess breast cancer stage at diagnosis among populations of women in BC, defined by country and region of birth.
4. To assess whether primary care physician (PCP) characteristics and measures of PCP-patient relationship are associated with breast cancer participation and retention among screening-eligible women in BC.

The thesis is structured such that, following this introductory chapter that outlines the research objectives, a review of relevant literature is undertaken in Chapter 2. This includes a review of peer-reviewed literature as well as published Canadian statistical or program reports related to breast screening. Following these two chapters, are four analytic chapters, each devoted to one of the research objectives listed above.

Objective 1 is explored in the work contained in Chapter 3. This chapter describes a population-based study of screening-eligible women defined from provincial health and national immigration data. It includes an examination of both screening participation and retention rates among some of BC's largest immigrant populations, as well as an examination of factors that are associated with screening participation overall, and among recent immigrants.

Chapter 4 presents an examination of the relative incidence of breast cancer in immigrant women, defined by country and world region of birth, compared to non-immigrants in BC. This chapter aims to illustrate the considerable variation in incidence rates across groups. Although the findings from this chapter comprise a concise standalone study, the data presented aid in both justifying analytic decisions and interpreting findings from Chapter 5.

Chapter 5 presents a study designed to investigate the issue of disparities in breast cancer stage at diagnosis in common immigrant populations in BC. It assesses age- and stage-specific risks of breast cancer, in addition to examining the distribution of breast cancer stage at diagnosis, across immigrant and non-immigrant women. This study is meant to complement the work in Chapter 3 that reports on breast cancer screening disparities across these populations, and build on the work from Chapter 4, which explores the variation in breast cancer risk by country of birth.

Chapter 6 details a further study based upon the same cohort described in Chapter 3. In this chapter measures of PCP-patient relationship, such as frequency of contact, duration of patient-PCP affiliation, and continuity of care are calculated, and associations between these factors and both the participation, and retention, endpoints are assessed.

Chapter 7 is a summary chapter of the findings across these studies. This includes a discussion of the study strengths and limitations, and highlights areas of potential focus for subsequent research.

1.5 Tables

Table 1.1: Breast cancer screening participation and retention rates for Canadian breast screening programs

Province	Participation Rate	Retention Rate	
		1st Screen	Subsequent Screen
British Columbia	54.4	57.2	80.5
Alberta	58.0	62.5	79.5
Saskatchewan	43.3	64.6	83.0
Manitoba	54.1	66.7	84.0
Ontario	49.1	75.5	86.1
Quebec	62.3	67.0	81.5
New Brunswick	60.1	59.7	75.8
Nova Scotia	55.2	60.4	80.8
Prince Edward Island	59.7	68.3	86.1
Newfoundland and Labrador	36.6	78.9	87.4
Northwest Territory	31.8	56.7	72.5

Notes: 1) Participation rate is 30-month participation rate for screens performed July 1, 2012 to December 31, 2014; 2) Retention rate is 30-month rate based on women screened January 1, 2008 to December 31, 2009; 3) Source: Canadian Breast Cancer Screening Database[13]

Chapter 2: Literature Review

2.1 Overview of Chapter

This chapter is organized into four main sections. The first continues the brief review from Chapter 1 of publicly available Canadian breast cancer screening reports that include participation and retention statistics relevant to the studies undertaken in subsequent chapters. It aims to provide further data to motivate the population health relevance of the thesis. The two sections that follow this summarize peer-reviewed literature that provides a background of research upon which the present thesis builds. Finally, a summary of gaps in the literature identified from this review are discussed, with emphasis on those that this thesis will aim to address.

As noted, the peer-reviewed literature review is organized into two distinct sections, each with subsections. The first, addresses studies that have examined factors associated with breast cancer screening participation or retention in Canadian populations. Within this first section, studies were reviewed and summarized in two main groups: 1) those completed using data from Canada’s national population health surveys and; 2) a growing body of studies that used population-based Canadian administrative health data. Studies were grouped in this way, as much of the discussion regarding study approach, data availability, strengths, and limitations were common among studies within each of these two main types. Studies that utilized administrative health data have been organized into a subsection for those that focused specifically on breast cancer screening among immigrants, and a separate one for those with a focus on primary care models and PCP characteristics and screening among patients. This division of studies facilitated synthesis across these two themes.

The second main section of peer-reviewed literature reviewed in this chapter discusses studies that have examined breast cancer risk or stage at diagnosis among Canadian immigrant populations. Papers that describe differences in histo-pathologic features of breast cancers across ethnic populations, relevant to interpreting breast cancer stage differences across immigrant populations, are also discussed.

The ordering of the analytic chapters within this thesis do not follow the exact same order as the literature review in this chapter. The ordering of chapters is such that the issues of breast cancer screening (Chapter 3), incidence (Chapter 4) and stage at diagnosis (Chapter 5) among immigrants are examined in a sequence, followed by a final chapter investigating the association between breast screening and PCP factors (Chapter 6). However in the literature review, many of the studies with screening endpoints examined both immigrant and PCP-related variables within the same study, and thus for readability and to avoid repetition, the review is organized such that all screening-related studies were reviewed prior to the pieces on breast cancer risk and stage.

For all of these topics, the review focused primarily on population-based studies conducted within the Canadian population; however, there are some studies included from other jurisdictions where it was relevant. Although there is a considerable volume of smaller, single-institution or survey-based studies, these can be challenging to generalize to a Canadian population health setting. Furthermore, the review focus is on studies that examined endpoints similar to those the subsequent chapters endeavour to investigate.

2.2 Review of Breast Cancer Screening Reports

As shown in the previous chapter (Table 1.1), breast screening participation rates reported by screening programs vary considerably across provinces. The program statistics shown in Table 1.1 suggest that none of the included programs have met the target for participation of 70% set by expert advisory groups [9]. As noted in the previous chapter, BC's participation was well below this level (54.4%) and ranked 6th among the 11 programs featured.

The Canadian Partnership Against Cancer (CPAC) has further published a series of pan-Canadian cancer screening reports [6, 9] and made data available from their online cancer system performance application [17]. Table 2.1 shows provincial participation rates taken from CPAC's online data. The participation rates shown in Table 2.1 similarly indicate variation across regions in Canada. These rates were calculated using the Canadian Community Health Survey (CCHS) data [18] rather than from information provided directly from breast screening programs. CCHS screening summaries are based on self-reported information from community-dwelling samples of Canadians within each province or territory.

Despite the variation in participation rates across the provinces, CCHS rates are generally much higher than from screening program reports. According to CCHS data, 6 of 10 provinces had participation rates above the 70% participation target, whereas in Table 1.1, four of these six provinces (Manitoba, Alberta, Ontario and Newfoundland and Labrador) were below this target in recent years. These differences may be understated considering that provinces report a 30-month participation rate for program performance reports whereas the CCHS reports a 24-month rate. Screening retention is generally not reported within reports based on CCHS data.

There are few programs that report breast screening participation rates by specific ethnic subpopulations in Canada. The BC Breast Screening Program [10] reports screening participation by ethnicity for First Nations, East/South-East Asian, and South Asian women based on the self-reported ethnicity of program participants and census derived populations for these groups. According to the 2016 BC program report, all of these three subpopulations reported higher breast screening participation than the overall population. This report did not, however, include screening retention rates for these groups. Although the Manitoba Breast Screening Program included a description of program participants [19], including information on country of birth and ethnic groups, they did not publish program participation or retention statistics according to these factors.

A 2014 CPAC special report [20] provided breast screening rates for immigrant women by duration of time in Canada. Breast screening rates were based on CCHS data that included self-reported immigration status and breast screening utilization. Screening rates were generally lowest in women with shorter duration of time in Canada. This report did not further characterize the immigrant women (e.g. by region or country of birth), nor did it present data for immigrant populations by region of residence in Canada. Screening retention rates were also not featured within this report.

2.3 Review of Peer-Reviewed Literature: Factors Associated with Breast Cancer Screening Participation and Retention

2.3.1 Review of Studies Based upon Population Health Surveys

2.3.1.1 Review of Relevant Literature

Studies based upon Canadian population health surveys have examined variables associated with mammography use as early as the 1990's when programmatic screening in Canada was still being established [21, 22]. Research based on the initial wave (1994/1995) of the longitudinal National Population Health Survey (NPHS) examined an array of socio-demographic, health, lifestyle and behavioral variables for associations with prior breast screening [22]. This study identified several factors associated with higher odds of having had a prior mammogram, including: higher household income, greater education level, being a volunteer, being bilingual (compared to speaking English only), being married, having a regular primary care physician (PCP), having had a recent blood pressure check, regular or occasional physical activity, being a non-smoker, taking hormones, high self-esteem and a high sense of control. Asian place of birth was associated with lower odds of having had a mammogram (compared to North America), as was age group 40-49 or 70+ (compared to the reference age group of ages 50-69).

An update to this study based on the 1996/97 NPHS [23] restricted the study population to women aged 50-69 years, to align with the age group for which biennial screening was recommended at the time. This study examined the "no prior mammogram" endpoint as in the previous study, as well as a "time-appropriate mammogram" endpoint; the latter defined as, among women who had previously screened, whether a mammogram was reported in the past two years. The following factors were found to be associated with higher odds of "never having had a mammogram": older age (ages 55-59, 60-64, 65-69; compared to 50-54), rural residence, Asian place of birth (compared to Canada), not having a regular PCP, no recent PCP visits, no recent blood pressure check, infrequent physical activity, and being a smoker. As with the previous study, being a volunteer and taking hormone replacement were associated with lower odds of never having had a mammogram. Among women with a prior screening history, not having a regular PCP, being a smoker, no recent blood pressure check, having 0-3 recent PCP visits, and being bilingual, or French speaking, were all associated with higher odds of not having a mammogram in the past two years. Asian place of birth and taking hormone replacement therapy were associated with lower odds of not having had a mammogram in the past two years.

Further research using data from three consecutive cycles of the NPHS [24] examined factors associated with: subsequent screening two and four years after an initial screen (screening retention); or initial screening at the two- and four-year follow-up cycles (screening initiation). Only two factors were positively associated with retention at two years on multivariable analysis, namely, being a non-smoker and taking hormones. In the multivariable model for retention at four years, younger age, higher education level and being a non-smoker were associated with higher odds of continued screening.

Among women who had reported never having screened at the first cycle, variables associated with initiating screening by two or four years were not consistent at the two time points, leading to some challenges interpreting the results. Urban residence was associated with higher odds of initiating screening by two years, but not statistically significant in the model for screening initiation by four years. Non-Canadian birthplace was associated with higher odds of initiating screening prior to the four-year follow-up, however, this variable was removed from the model for the two-year endpoint with the authors citing sample size limitations. Having a recent blood pressure check was associated with higher odds of initiating screening prior to both two and four years; older age groups (compared to women aged 50-54) were associated with a lower odds of initiating screening at both time points.

Some of the more recent publications examining variables associated with breast screening participation based on iterations of the cross-sectional Canadian Community Health Survey (CCHS) [25-30] have investigated this topic more generally [25, 26, 29], whereas others have aimed to identify whether a specific health or socio-demographic variable is associated with mammography utilization [27, 28, 30]. Compared with studies based on the NPHS, these studies were conducted at a time when screening mammograms were generally universally available across Canada. Research based on the 2008 CCHS [26] identified several independent variables associated with not having had a recent mammogram among Canadian women aged 50-69. Being in age group 50-54 (compared with age group 65-69), not being married, residing in rural areas, residing in lower income neighborhoods, not having a regular family doctor, not having seen a doctor in the past year, being a smoker, being physically inactive, recent (<10 years in Canada) immigration, and a lower self-perception of one's health were all associated with higher odds of not screening in the past two years.

Kerner et al. [25] used data from the 2003, 2005, 2008 and 2012 CCHS surveys to examine whether specific socio-demographic variables were associated with cancer screening, including breast screening. More remote living was associated with lower participation, however, this pattern was not consistent across cycles of the survey. This study reported that, in most survey years, recent (<10 years in Canada) immigrants showed lower screening rates than both established immigrants (≥10 years in Canada), and non-immigrants. In the most recent survey, however, the screening rates across these groups were almost identical. Women residing in the lowest income areas consistently had lower rates than those living in higher income areas.

Further studies have used cycles of the CCHS survey to assess the role of primary care physician (PCP) contact on breast screening [29, 30]. A study based on the 2006 cycle identified that having recent contact with a regular PCP (≥1 visit in the past year) was associated with increased odds of having had a recent mammogram when adjusted for other predictors of mammography use [30]. Similar results were reported from a recent study based on the 2012 cycle [29] where having a regular PCP, recent PCP contact (<1 year since last visit), and having a recent pap smear were all associated with increased odds of having had a recent mammogram. This study also reported associations between screening utilization and socio-demographic variables such as income, education level and immigration status, consistent with what was observed in prior studies.

Other studies based on the CCHS have examined questions related to the breast screening participation of immigrant women in Canada. Sun et al. [28] examined whether Asian immigrant status was associated with ever having had a mammogram using the 2003 cycle. Immigrant respondents were divided into Asian immigrants and 'Other Immigrants' and were compared to non-immigrant women. Asian immigrants showed significantly lower odds of ever having screened compared to non-immigrants, adjusted for potential confounding variables. Other Immigrants also showed lower odds of having had a mammogram compared to non-immigrant women, however, the difference was not statistically significant. This study also examined predictors of prior screening within each of the three groups. Marital status and education level were not associated with screening in the immigrant groups, however, they showed strong associations among non-immigrant women. Other variables (e.g. Canadian language proficiency) were only considered in the analyses for immigrant populations. This suggests that in examining factors associated with screening among immigrant and non-immigrant populations, different models may need to be considered for different subpopulations. Finally, results from a recent study that utilized the 2011/2012 cycle examined the association between recency of immigration and breast screening participation among immigrants to Canada [27] and did not find a statistically significant association. It is worth noting that the survey sample included only 67 eligible-age, recent immigrant women.

2.3.1.2 Summary

Studies based on the NPHS and CCHS surveys have identified a number of relationships between mammography participation and health, behavioral and other socio-demographic factors. Although results are not consistent across all studies for each of the variables examined, several factors were consistently identified as associated with screening. Higher education, higher income level, and increased contact with a family physician have consistently been identified as associated with higher odds of screening. Rural residence, being an immigrant, and being a smoker were generally associated with lower participation. The relationship between age and screening participation was not entirely consistent across studies, however, age was generally always statistically significantly associated with screening. Several of the studies with a focus on immigrants have remarked that established correlates of breast screening from prior research in the general, or non-immigrant populations, are not always consistent with patterns observed in specific immigrant populations.

These studies also demonstrate a number of limitations of using Canada's population health surveys to investigate specific questions related to mammography participation. In studies that aimed to assess the association between immigration status and screening, the number of eligible-age, immigrant women in the survey samples was very low. Sun et al. [28] pooled immigrant women who self-identified as Arab, South-Asian, South-East Asian, Chinese, Japanese, Afghani and other Asian regions into a single category, which in total comprised only 508 respondents. The Adu et al. study examining recency of immigration and screening included only 67 recent immigrants in the sample [27]. This issue was also evident in a prior study where only 85 women out of the total respondent sample of >11,000 were recent immigrants [26].

The limited sample sizes of immigrant women captured in survey samples has led to pooling of women from diverse populations into single groups, which may limit the potential for the results to inform interventions targeting specific subpopulations. A number of the above-described studies were limited in their ability to study multiple variables for associations with screening participation due to sample size issues. In some studies, women were pooled across regions to investigate whether duration of time in Canada was associated with participation; in others, women with very different duration of time in Canada were pooled to examine screening patterns of women from a specific world region. Thus, it is challenging to simultaneously study several dimensions (e.g. duration of time in Canada, birth region, age) that might be relevant to screening behavior among immigrant women using Canada's population health surveys.

A further limitation of research based on Canadian population health surveys is the reliance on self-reported mammography use. Prior breast screening history, as well as the timing of recent mammograms, may both be subject to inaccurate reporting. Some prior research suggests that women may over-report screening [31, 32]. This is supported by the observation that screening rates from CCHS studies have been markedly higher than participation rates reported directly by screening programs in Canada. Self-report biases may also be relevant to some of the key explanatory variables examined in prior studies, including recency of physician contact, number of physician visits, and duration of time in Canada for immigrant women. A further concern with reliance on the CCHS survey could be the apparent decline in survey response rates over successive cycles of the survey [18, 33]. Non-response bias, particularly if it is differential across groups that are the focal point of specific studies of mammography participation, could result in biased study findings.

2.3.2 Breast Cancer Screening Participation: Population-based Studies Using Administrative Health Data

In this section, a diverse set of studies conducted using administrative health and other data to examine relationships between specific variables and breast cancer screening utilization are reviewed. For simplicity, these are been grouped into two main sub-sections below: 1) studies that have aimed to examine breast screening utilization among immigrant populations and; 2) studies that have assessed associations between PCP practices, characteristics, and other factors, and screening utilization.

2.3.2.1 Cancer Screening Utilization among Immigrant Populations in Canada

Recent studies from Ontario (ON), Canada have used linkages of administrative health data sets to examine cancer screening uptake among immigrant subpopulations. These include studies on cervical cancer screening [34-38], breast screening [34, 38-41] as well as colorectal cancer screening [34, 38]. Variation exists in the specific methodology used to examine screening disparities within these studies, however, the general approach has been to identify, at a population-level, individuals eligible for screening, assess the frequency with which this population has screened, and use available administrative data to identify, characterize, and compare relevant subpopulations. Recent studies that used this approach and specifically examined breast cancer screening in Canada are discussed.

The association between breast screening and the density of recent immigrants within census-defined areas in Ontario has been explored with area-based methods [34]. Administrative data were used to define the screening eligible population and to identify the receipt of mammograms within each census dissemination area. An ordinal score reflecting the density of recent (last ten years) immigrants was assigned to each dissemination area, and screening participation rates were calculated, aggregating areas with similar density of recent immigrants. A gradient of screening utilization was observed across strata, with 51.7%, 57.3% and 61.4% of eligible women receiving mammograms in areas of high, moderate and low recent immigration. This study also observed a gradient of participation across neighbourhood income quintiles with 56.1% of women in the lowest income areas having been recently screened compared to 68.1% in the highest income areas. The area-based methodology for assigning immigrant status limits the interpretability of these findings due to the potential for ecological fallacy. Further, the grouping of diverse immigrant populations into a single pooled “immigrant” group limits the utility of the information for contemplating interventions or identifying priorities for future research.

Other research from ON [41] utilized individual-level immigration data from Citizenship and Immigration Canada, linked to administrative health data, to estimate screening rates among immigrants. Screening age women identified in provincial health registration data that were not identified within the immigration records were divided into “recent registrants” (those who recently initiated provincial health coverage) and “long-term residents” (women with evidence of long-term health coverage in Ontario); women identified in the immigration data comprised the “immigrant” group. Screening rates were calculated according to these groups and further stratified by key demographic and healthcare-related variables such as age, neighbourhood income quintile, numbers of physician visits, primary care patient enrollment model, and comorbidity groups. Immigrants were further divided into “new”, “recent” and “established” based on duration of residence in Canada (durations of ≤5, 6-10, >10 years respectively).

This study reported an overall participation rate of 64%, however, both the immigrant and recent registrant groups reported lower rates (both 57%) compared to long-term residents (67%). There was a gradient of increasing breast screening with higher income quintile in all three groups. Participation was also notably higher in women who had a recent PCP visit in all groups compared to those who had not. After adjusting for potential confounders, new immigrants screened significantly less than long-term residents (Adjusted Rate Ratio (ARR) = 0.87, 95% confidence interval (CI): 0.85 to 0.88). ARRs for recent (0.90, 95% CI: 0.89, 0.91) and established (0.96, 95% CI: 0.96, 0.97) immigrants suggested that differences in screening rates between immigrants and long-term residents may narrow with duration of time in Canada. The main limitations to these findings relate to the grouping of the immigrant populations into a single immigrant group, with subpopulations only defined based on duration of residence in Canada. Further, the inability to distinguish immigrants that migrate between Canadian provinces from other Canadian-born recent health registrants in Ontario creates some misclassification in the groups examined.

Further recent research from ON [38] used linked administrative health and immigration data to examine the association between patient and physician characteristics and cancer screening (breast, colorectal, cervical) uptake; here only the breast screening outcomes are discussed. Eligible women were identified from administrative health data and linkages were established between women and PCPs. Physician characteristics such as age, sex and region of medical training, were available from a provincial physician database. Participation rates were calculated according to region of physician medical training with rates calculated for all patients together, immigrant patients, and among immigrants from the same world region as the region of their physician's medical training (this last analysis meant to assess screening in a patient population with cultural concordance with their doctor).

Within the population of all eligible patients, there were positive associations between screening participation and higher patient income quintile, Canadian-born status, female physicians, Canadian-trained physicians, length of physician practice in Ontario, and the patient enrollment model used by the physicians. Adjusted odds ratios (AORs) suggested significantly lower screening participation among most immigrant populations (based on world region of birth) compared to Canadian-born women. When restricted to only immigrant women, there was still considerable variation in the AORs according to birth region. Immigrants from South Asia

(AOR = 0.71, 95% CI: 0.64, 0.78) and Eastern Europe (0.82, 95% CI: 0.74, 0.91) screened significantly less than the reference group (women from Australia/NZ/US), whereas women from the Caribbean/Latin America (1.43, 95% CI: 1.30, 1.58), East Asia (1.11, 95% CI: 1.00, 1.23), Middle East/North Africa (1.17, 95% CI: 1.03, 1.32) and Western Europe (1.24, 95% CI: 1.12, 1.38) all participated more. Physician characteristics such as years in practice in Ontario, sex, and patient enrollment model were all significantly associated with screening among patients.

The relationship between various health and socio-demographic factors and breast screening participation within immigrants grouped by world region of birth was examined using data from Ontario [40]. Immigrant women of eligible age were identified based on linkage of health registration and federal immigration data files. Within each immigrant group, variation in participation was explored across a diverse set of socio-demographic and health variables derived from administrative data files. Consistent with prior work, this study found immigrant women from South Asia and Eastern Europe showed the lowest participation among immigrant groups; women from the Caribbean/Latin America, Western Europe and East Asia world regions demonstrated the highest rates. Some variables that were previously shown as associated with screening in the general population, such as income quintile and age, showed different associations across specific immigrant populations. Age was generally not associated with screening for most groups, however, among South Asian women, participation for women aged 60-69 was approximately 5% lower than among those aged 50-59. Among women from the Caribbean/Latin America region, the difference in participation between the highest and lowest income quintiles was <4%, however, among women from the Sub-Saharan Africa region it was almost 20%. With respect to health-related variables, a greater number of major aggregate diagnosis groups was associated with higher participation, while having no recent physician general assessment, not being part of a patient enrollment model, or having a male physician were all consistently associated with lower screening rates.

Vahabi et al. [39] similarly used linked immigration and health data to report breast screening rates among Ontario immigrants stratified by birth in a Muslim-majority country or not. The study was limited to women emigrating to Canada from five world regions where sufficient populations of Muslim women existed to permit study analyses. Among immigrants from South Asia and Sub-Saharan Africa, those born in Muslim-majority countries generally screened less than those born in non-Muslim majority countries. However, among women from the Middle East/North Africa, East Asia/Pacific and Eastern Europe/Central Asia regions, there was little difference in participation between women from Muslim and non-Muslim majority countries. A lack of a primary care patient enrollment model and having a male physician were both associated with lower participation in all groups.

2.3.2.2 PCP Characteristics and Practices and Breast Cancer Screening Utilization

The association between breast cancer screening participation and PCP characteristics, contacts and remuneration models have been examined in a number of recent population-based Canadian studies [42-49]. As with the studies described in the previous section, these studies have utilized population-based linked-administrative health data sets to explore associations between various PCP-related factors and cancer screening uptake. This section reviews studies that have aimed to assess the impact of some specific dimension of primary care on an endpoint of screening participation.

A study from Ontario used a longitudinal analysis of health data to examine the impact of recent contact (within the last two years) with a PCP on women’s propensity to screen as they age through the eligibility period [44]. Recent contact with a PCP was associated with a significantly high screening rate (compared to no recent contact), and the authors estimated this could result in a meaningful difference in the cumulative number of mammograms a woman receives throughout the eligible period for screening.

Researchers examining the association between four PCP remuneration models and preventive health practices (including breast cancer screening) in a cross-sectional study observed lower aggregate prevention scores for some payment models [45]. However, differences between models diminished after adjustment for practice characteristics (such as having a female PCP or the size of the patient roster). The authors reported a non-significant relationship between having a female PCP and participating in screening (AOR = 1.3; 95% CI: 0.8, 2.1).

Kiran et al. [42] examined how the transition to patient-centered medical homes in ON (from a largely fee-for-service payment model) affected several chronic disease prevention and management outcomes including breast screening. This study reported modestly higher participation for patients under both team-based and non-team based capitation models compared with those patients seeing fee-for-service PCPs, however, after adjustment for potential confounding variables, some of the relative difference dissipated. Furthermore, the authors identified that some of the observed difference in screening rates existed in the patients of the same PCPs prior to the implementation of the medical home models. This suggested the observed differences may relate to other unmeasured attributes of patients and physicians that enroll under specific care and remuneration models, rather than to the model itself.

A study comparing a largely fee-for-service remuneration model (called the Family Health Group) and a more capitation-based payment model (the Family Health Networks) for PCPs in Ontario found that patients of PCPs using the capitation-based model had slightly higher screening participation [46]. The higher screening rates among patients enrolled under the Family Health Networks model, represented statistically significant increases over rates among these patients prior to the implementation of these models. The authors, however, cautioned that the increase in participation observed with the Family Health Networks model, was modest in magnitude, and that screening rates in both groups were approaching benchmarks for participation in Ontario. Another longitudinal evaluation of incentive payments for PCPs who meet targets for patient cancer screening found there was little evidence of a significant effect of payment incentives on screening rates in Ontario [43].

More recently, authors in Ontario examined whether transitions from traditional to enhanced fee-for-service remuneration that occurred in the 2000s in that province had narrowed gaps in cancer screening utilization across socio-demographic groups [49]. Changes in breast cancer screening utilization were examined, stratified by income quintile and immigrant status. Over the earlier years of the transition period (e.g. 2002-2010), patients of PCPs who changed to the enhanced fee-for-service model did not show improved screening relative to the traditional fee-for-service model in any subgroup. They further noted that in some of the earlier years, post-transition breast screening rates were lower than prior to transition for immigrant women. However, transitions in later years (2011-12) were associated with improved screening in the enhanced fee-for-service model for both immigrant and non-immigrant women presenting some challenges in interpreting the study findings.

The association between continuity of care with a PCP and breast screening utilization was examined using administrative health data from Winnipeg, Manitoba. Continuity of care was defined as the fraction of all PCP visits that were with a single (most common) provider. Groups of high and low continuity were created using a threshold of 75% of visits with the same provider; a sensitivity analysis used a threshold of 50% to define high and low continuity. Participation rates among women aged 50-69 years were 69% and 67% for women with low and high continuity respectively. After adjusting for other health and socio-demographic variables (such as the number of ADGs, income quintile, marital status, number of PCP visits) there was no significant association between continuity of care and participation (AOR = 1.01; 95% CI: 0.96–1.06). However, the sensitivity analysis using the 50% threshold, suggested a statistically significant association (AOR = 1.16; 95% CI: 1.08–1.24). This study also reported that women with few (1-3) PCP visits over a two-year period screened significantly less than those who had 4-12 visits; however, women with >12 visits also screened less than those with 4-12 visits.

2.3.2.3 Summary

A few themes are evident across the studies described above. The first is that there is strong evidence that breast screening participation rates vary by immigrant vs non-immigrant status, as well as among immigrant populations defined by world region of birth. Several studies also noted that income quintile and numbers of significant comorbidities were strongly associated with participation. PCP factors, such as PCP sex, were also consistently associated with screening among patients, reinforcing that both patient and PCP factors may contribute to variation in screening rates. Studies that assessed screening utilization among immigrant women, suggested that relationships between some variables and participation varied across immigrant groups, and between immigrant and non-immigrant women.

Contact with a PCP was associated with participation in several of the studies. Studies that examined screening among immigrant populations observed that women rostered to PCPs under specific patient enrollment models screened more than women who were not rostered to a regular physician. In the single Canadian study specifically focused on continuity of care and breast screening, there was an association between the number of PCP visits and participation; women with few visits screened significantly less than those with more visits. The degree to which continuity of care was associated with screening appeared to depend on the definition of high or low continuity.

Although only one Canadian study on continuity of care and breast screening was reviewed, some of the studies that aimed to compare different patient enrollment models in Ontario have some relevance to this issue. Some of the enrollment models require patients and PCPs, or teams of PCPs, to be formally rostered to one another thus creating some degree of continuity between patients and PCPs. As noted above, that studies have remarked that women who are rostered to a PCP through a patient-enrollment model generally have higher screening rates than those who are not. This was evident in both non-immigrant and immigrant women. However, studies have noted that some of the apparent higher screening rates among these women may relate to selection issues in terms of which patients and physician elect to enroll under the various models.

These studies demonstrated several strengths compared to the studies based upon the population-health surveys. The number of immigrant women identified from the administrative databases was large enough to permit the examination of several factors within immigrant populations (e.g. duration of residence in Canada, age). In several studies, the authors were able to present outcomes by region of birth, providing more granular information about patterns among specific immigrant groups. The use of administrative data also addresses the issue of self-report bias in the screening outcomes and important exposures or explanatory variables (e.g. number of PCP visits). Despite large numbers of immigrant women within several of the world region groups examined in these studies, none of the studies provided breakdowns by specific country of birth. None of the above-mentioned studies examined breast screening retention as an endpoint.

2.4 Review of Peer-Reviewed Literature: Breast Cancer Incidence and Stage at Diagnosis among Canadian Immigrant Populations

2.4.1 Breast Cancer Incidence among Canadian Immigrant Populations

Although several studies have examined breast cancer mortality among Canadian immigrant women [50-53], there are relatively fewer reports on breast cancer incidence in Canadian immigrant subpopulations. McDermott et al. [54] completed a national study of cancer incidence among Canadian immigrants using linked administrative databases. Incidence rates among both refugees and non-refugees were lower than the Canadian general population (Standardized Incidence Ratios - SIRs: 0.38 and 0.32 respectively). There was also variation in SIRs across region of birth with estimates ranging from 0.23 (South Asia) to 0.45 (Western Europe). Their study, however, did not examine age- or stage-specific rates of breast cancer in these populations. The study cohort represented immigrants who landed in Canada between 1980 and 1990 and hence, the distribution of immigrants in this cohort may not reflect those in present-day Canada. This cohort was also relatively young for a study of cancer incidence (75% of the cohort was less than 45 years of age).

An Alberta study combined place of birth information collected by the Alberta Cancer Registry with census-derived populations of Chinese immigrants [55]. The age-standardized incidence rate for Chinese immigrants were substantially lower than for the Canadian-born population (34.9 per 100,000 vs 64.8 per 100,000 respectively), but higher than the rate reported for the population of Shanghai (21.0 per 100,000). This study did not examine age- or stage-specific incidence or include stage distribution information. Although the authors pointed to the high data quality within the cancer registry, they did not comment specifically on the reliability of the location of birth information and whether this information had been validated.

An Ontario study examined colorectal and breast cancer incidence among immigrants and identified variation in age-standardized rates according to world region of birth [56]. The age-standardized incidence rate was highest among non-immigrant women (1.61 per 1,000 women) and rates varied significantly across immigrant groups, with the lowest rate observed in South Asians (1.00 per 1,000) and the highest rate among immigrants occurring among women from the Middle East/North Africa (1.49 per 1,000). For some immigrant populations (e.g. Europe/Central Asia, Australia/United States) the incidence rates were comparable to that of non-immigrants. The authors reported that the observed differences in incidence between immigrant groups persisted after adjustment for age and income quintile. This study did not explore age- or stage-specific incidence patterns.

2.4.2 Breast Cancer Stage Distribution in Canadian Immigrant Populations

Despite the above studies characterizing the breast screening behaviours of immigrant women in some Canadian jurisdictions, breast cancer stage at diagnosis among immigrant women in Canada has not been well described. Several Canadian studies have reported on breast cancer stage at diagnosis in ethnic subgroups rather than specifically examining this issue among immigrant women [57-60]. Some of these studies are institutional reports rather than population-based investigations.

Two recent population-based studies from Ontario reported breast cancer stage distribution among ethnic and immigrant subpopulations [57, 58]. The first reported on stage at diagnosis according to surname-inferred ethnicity for women diagnosed between 2005 and 2010 [58]. Newly diagnosed women were divided into three groups: Chinese, South Asian and the remaining population (termed “general population”) using surname algorithms. A lower proportion of stage I tumours, and a higher proportion of stage III tumours, were found among South Asian women compared to both the Chinese and general population groups. Chinese women were identified as having a higher proportion of stage I, and a lower proportion of both stage III and IV cases, compared to the general population.

A more recent study investigated disparities in stage at diagnosis specifically among immigrant and non-immigrant populations [57]. Similar to the previous study, surname lists were used to assign ethnicity to cohort members and a linkage to national immigration data enabled the identification of immigrant women within each group. It is important to note, that the assignment of South Asian or Chinese status among immigrants in the analysis was inferred by the surname of women, rather than from information within the immigration data. In multivariable analysis, the authors examined ethnicity and immigrant status as separate variables and each was significantly associated with stage of disease. Compared to the general population, South Asian women showed significantly lower odds of presenting with stage I disease, and Chinese women showed significantly higher odds of stage I disease. Immigrant status was also associated with lower odds of stage I disease. Thus, these two studies suggest there may be important differences in cancer stage across ethnic and immigrant groups in Canada.

Breast cancer stage at diagnosis by ethnicity was also examined among women who received breast surgery management from a single institution in Ontario [59]. This study aimed to characterize tumour characteristics for Filipino immigrant women and presented data according to three study groups: Filipino, East Asian and Caucasian women. Ethnicity was determined from medical records based on physician or patient self-report; immigration status was not considered. Compared to Caucasians, Filipino women showed a higher frequency of node-positive disease (37% vs 27%) and a lower frequency of tumours in the smallest size category (60% vs 67%). East Asian women also showed a slightly higher percentage of node-positive tumours (31%) and fewer small tumours (62%) compared to Caucasians. None of the above-noted differences, however, were statistically significant. There are challenges with interpreting findings from this study, including the small sample size of Filipino women (sample size of 60), the single institution coverage of the cohort, and inclusion criteria that eliminated women that had metastatic disease or who were not considered for breast surgery. Finally, although the stated objective of the study was to characterize tumours of “Filipino migrants”, there was no distinction made in the study between Canadian-born women of Filipino descent and foreign-born Filipino women.

Previous research from BC [60] reported breast tumour characteristics by self-reported ethnicity for all women referred for specialist oncology care at provincial cancer centres in 2006. A higher frequency of node-positive tumours was reported among South Asian women compared to Caucasians (45% vs 33%). A notable difference in the overall stage distribution was identified between South Asian and Caucasian women, characterized by a lower frequency of stage I disease in South Asian women (23% vs 41%) and a higher frequency of stage II disease (57% vs 39%). Other ethnic subpopulations (East Asian, South-East Asian, and Other groups) demonstrated stage distributions comparable to the Caucasian population. Although the number of women included in this study was large (sample size of 1829), the number of women within each of the non-Caucasian subpopulations was low (sample size ranged from 51 to 155). There was also potential for referral bias in this study as the cases represented women referred for specialist oncologist care at provincial cancer centres.

2.4.3 Breast Cancer Age at Diagnosis among Canadian Immigrant Populations

Although there is limited published data on the age-specific incidence of breast cancer among Canadian immigrant populations, several of the above studies have reported the age distribution of women diagnosed with breast cancer according to ethnicity or immigrant status [57-60]. These studies have reported that the average age at diagnosis among non-Caucasian, or immigrant populations, is younger than that of the general population. This was particularly evident in the two studies from Ontario that presented stage distributions by ethnicity or immigrant group [57, 58]. The first of these studies identified that 42% of Chinese women, and 30% of South Asian women, were diagnosed prior to age 50, the age at which women are generally recommended to start breast screening (compared to 22% in the general population). The second study reported that 44% of immigrant women were diagnosed at age <50, compared to only 19% among non-immigrants.

An earlier mean age at diagnosis for Filipino women (53 years) compared to either the Other Asian (55 years) or Caucasian patients (58 years) was identified in the single institution study from Ontario [59]. In the BC study, 50% of both the South-East Asian and Other Ethnicity groups were diagnosed prior to age 50; the median age of diagnosis was at least 5 years younger in all ethnic subpopulations compared to the Caucasian group [60].

The studies have generally not presented age-specific rates of cancer among the groups being compared. As a result, it is challenging to assess the extent to which the lower observed age at diagnosis results from differences in age distribution across these groups or differences in age-specific risks of disease.

2.4.4 Other Histopathological Differences in Breast Cancers Across Ethnic Populations

Few studies of breast cancer diagnosed in immigrant women have reported on other histopathologic features of tumours, however, some Canadian studies have described additional tumour characteristics by ethnicity. Wan et al. [60] reported that, compared to Caucasian women, cancers diagnosed in South Asians showed a lower proportion of estrogen receptor (ER)-positive tumours and more triple-negative and human epidermal growth factor receptor 2 (HER2)-positive. A higher frequency of HER2-positive tumours was also noted in South-East Asian women. This study also reported more node-positive tumours among South Asian women, and a higher frequency of grade 3 tumours among both South-East Asian and South Asian women compared to Caucasians.

Simpson et al. [59] also reported a higher frequency of HER2-positive tumours (23%) among Filipino women compared to Caucasian (15%) and other Asian (14%) women. This study also reported a higher frequencies of ER-positive, node-positive and grade 3 cancers in Filipino women compared to the other groups.

These studies point to the potential variation in several histopathologic markers across ethnic subpopulations. The variation in some of these markers may be relevant to interpreting cancer stage at diagnosis data for these populations, as they may indicate tumours that behave more aggressively and be more likely to present at later stages. As noted above, however, both of these studies were conducted on populations of patients being seen in specific institutions and thus may reflect a biased subset of the population of all breast cancer patients.

2.4.5 International Studies of Breast Cancer Incidence, Stage, and Histopathologic Features among Immigrants

A number of studies of breast cancer incidence among immigrant populations in other countries have been undertaken [61-67]. The findings from these studies are variable owing to the era in which they were undertaken, the diversity of the immigrant populations studied, and the methodological approach undertaken. Generally, studies have suggested that among most immigrant populations, breast cancer risk is lower than among non-immigrant women [62, 64, 65, 67]. These studies note particularly low risk among immigrants from East and South Asia, as well as lower rates for women from Sub-Saharan Africa. Immigrants from "westernized" countries (e.g. United States, Australia, Western Europe) at times demonstrate higher incidence rates than non-immigrant women [62, 64, 67]. Across studies, the groupings of immigrant populations are often inconsistent, with few studies reporting patterns for immigrants from individual birth countries.

Breast cancer stage at diagnosis among immigrant women has been the focus of several studies in other countries. A Swedish study reported similar stage distributions across foreign-born and Swedish-born women [68]. A limitation of the study, however, was that stage information was missing for more than 40% of each group. Among those with complete staging data, the odds of presenting with stage II disease (compared to stage I) was significantly higher among Asian immigrants compared to non-immigrants. Research from Norway also identified that stage at diagnosis was more advanced for immigrants from several regions, including Eastern Europe, the Middle East, South Asia and Sub-Saharan Africa, compared to Norwegian-born women [69].

A study of women diagnosed with breast cancer in South-east England noted that there was substantial variation in the percentage of women diagnosed with metastatic breast cancer by ethnicity, ranging from a low of 7% in white women to a high of 15% among women identifying a Black African ethnicity [70]. This study, however, also reported that the percentage of women with complete staging information by ethnic population varied (55% to 75%). A study based on data from the United States (US) Surveillance, Epidemiology and End-Results (SEER) cancer registries identified that, overall, Asian women had similar stage distributions when compared to non-Hispanic white women [71]. Black and Hispanic white women, however, had less stage I disease and more stage II and III disease compared to non-Hispanic whites. For Asian subpopulations, the study reported that some populations, such as Chinese women, had similar stage distributions to non-Hispanic whites, while others, such as Indian/Pakistani women, showed a more advanced stage distribution.

Several studies from the US have examined breast cancer subtype distribution among different ethnic subpopulations. Research using data from the SEER program showed a significantly lower frequency of ER-positive tumours among black women (62.7%) compared to whites (80.0%). Women from Asia had a slightly lower percentage of ER-positive tumours (76.9%), however, there was variation among Asian subpopulations (range from 70.2% to 81.2%). The frequency of grade 3 tumours varied among different Asian subpopulations (range from 28.9% to 45.2%). Further, a study based on data from the California Cancer Registry [72] found the frequency of hormone receptor-positive, HER2-negative tumours varied considerably across ethnic subpopulations from a low of 49% among Korean women to a high of 70% among non-Hispanic whites. The frequency of HER2-positive tumours also varied considerably (range 19% to 36%).

Finally, in the Annual Report to the Nation on the Status of Cancer [73], US researchers presented age-standardized, subtype-specific incidence rates that showed considerable variation by ethnicity. Rates of HER2-negative and hormone receptor-negative tumours were higher in non-Hispanic black women compared to other groups. Rates of hormone-positive, HER2-negative tumours were considerably higher in non-Hispanic whites (92.7 per 100,000) compared to non-Hispanic blacks (74.4 per 100,000), Asian/Pacific Islanders (63.9 per 100,000) and Hispanic women (64.0 per 100,000. This report demonstrated that there can be substantial variation in the rates of tumours exhibiting specific histopathologic features by ethnicity. This can be seen in groups with appreciably different overall breast cancer rates (e.g. Asians and non-Hispanic whites), as well as in groups that have similar rates (e.g. non-Hispanic blacks and whites).

2.4.6 Summary

There have been a limited number of Canadian studies that have examined breast cancer risk among immigrant populations. Studies have typically reported lower rates among immigrants compared to non-immigrants. Few of these studies have presented data by specific country of birth, and have instead aggregated data by world region. Recent studies have not examined age- and stage-specific risks of breast cancer among different immigrant populations. Studies have noted the age at diagnosis of breast cancer is much lower in ethnic minority populations, or among immigrant women, compared to either non-immigrants or to the general population, however, few have investigated whether this results from a higher risk of cancer at younger ages or the demographics of the populations at-risk.

Breast cancer stage at diagnosis among immigrants has not been comprehensively studied in Canada. Stage distribution by ethnicity has been reported, however, study cohorts generally did not include a strictly foreign-born population. Thus, findings may not address questions as to whether foreign-born status, or immigration from specific countries or world regions, are associated with stage at diagnosis. Several studies have identified differences between stage distributions of ethnic groups and the general population, however, there are very few reports of stage-specific incidence rates among immigrants, in Canada, or elsewhere.

Finally, a number of studies have identified differences in the distributions of subtype and other histopathologic features across women with different ethnicities. Differences in the frequency of HER2 and hormone receptor status, tumour grade, nodal invasion and tumour size across ethnic subpopulations have been reported in recent studies. As some of these factors may influence the behavior of tumours, they may be relevant to examine when comparing stage at diagnosis across different subpopulations.

2.5 Gaps in Literature to be Examined in this Thesis

This chapter highlights a number of gaps that this thesis aims to explore. Few studies overall, and none in recent years, have examined factors associated with program retention among screening-eligible women. Among studies with a focus on immigrant women, none examined whether immigrants have different patterns of screening retention compared to non-immigrants. Similarly, among studies that have examined associations between PCP factors and screening, recent studies have only included participation as a study endpoint. This thesis will explore screening retention patterns among immigrant women (Chapter 3) as well as according to various PCP factors (Chapter 6).

Despite a number of recent studies focused on breast cancer screening patterns among immigrant women in Canada, few have presented data by country of birth, resorting to summaries that aggregate data by world region, or by immigrant and non-immigrant women. BC has a number of large immigrant populations from different countries within common world regions that may exhibit distinct screening patterns. For example, East Asia (a group reported within prior studies), includes women from some of the most common source countries for

Canadian immigrants: the Philippines, China, South Korea, and Japan. These women may exhibit different barriers to screening, or have different attitudes to screening, which may result in different patterns of participation and retention. Thus, screening patterns by country of birth are explored in Chapter 3.

Studies have previously demonstrated different screening patterns among immigrant populations in Canada, however, breast cancer stage at diagnosis among these groups has not been comprehensively investigated. Although some studies have suggested that the stage distribution varies by ethnic population, and across immigrant and non-immigrant women, these studies have had significant limitations. None of the studies have considered differences in breast cancer risk or stage-specific incidence rates in their assessment of the stage distribution across groups. Studies to date, have focused largely on Chinese and South Asian women who could be identified by surname matching methodology and there has been little examination of this issue in other groups. Chapters 4 and 5 are devoted to investigating patterns of breast cancer risk and stage at diagnosis among immigrant and non-immigrant women.

A number of studies have identified associations between participation and recent contact, or number of recent visits, with a PCP, however, very few have examined whether continuity with the same provider is associated with screening. None of the studies reviewed examined duration of affiliation between provider and patient. Further, few studies have examined whether continuity and other PCP factors may be more important in some groups, based on socio-demographic or health factors, than others. These issues will be examined within the context of BC's largely fee-for-service PCP setting, in the study in Chapter 6.

2.6 Tables

Table 2.1: Screening participation rates by province/territory from 2015 Cancer System Performance Report [17]

Province/Territory	Participation Rate (%)
Quebec	74
Ontario	73
Alberta	73
Manitoba	72
New Brunswick	71
Newfoundland and Labrador	71
British Columbia	69
Nova Scotia	67
Northwest Territories	66
Saskatchewan	64
Prince Edward Island	61
Yukon	61
Nunavut	*

Based on 2012 Canadian Community Health Survey
*Nunavut data suppressed due to small numbers

Chapter 3: Breast Cancer Screening among Immigrant and non-Immigrant Women in British Columbia, Canada

3.1 Introduction

Programmatic breast cancer screening with mammography is offered across Canada in an effort to detect tumours at earlier stages and reduce mortality from breast cancer. Screening mammograms are publicly funded in all Canadian provinces for women in target age groups yet in most Canadian jurisdictions participation rates remain well below the national target level of 70% [9]. Breast screening participation rates are a composite measure of a program's ability to attract the target population to screen and their ability to retain this population throughout the duration of their screening eligibility. Recent screening retention rates in Canada have been similarly disappointing with some jurisdictions reporting declining retention [74, 75] and 30-month retention rates of first time participants below 50% [74].

Disappointing breast screening participation rates as well as a desire to assess potential health inequities in cancer screening have motivated several recent investigations into potential screening disparities among socio-demographic groups in Canada [27, 28, 34-36, 38-41]. In particular, several recent population-based studies completed in Ontario have identified that cancer screening rates of immigrant populations are generally lower than those of non-immigrants [36, 41] and that variation exists in screening attendance among immigrants from different world regions [37, 40].

Studies that specifically examined breast screening, have found screening disparities among immigrant subpopulations, as well as associations between mammography rates and duration of residence in Canada, primary care physician characteristics, primary care contacts, and other health and socio-demographic variables [27, 38-41]. Research in Ontario reports that South Asian immigrant women have the lowest breast screening rates when stratified by world region of birth [40]. These same studies reported screening rates for women from the East Asia/Pacific region (the largest group of immigrants in Ontario) that were generally higher than other immigrant populations, and markedly higher than the rates for South Asian women. Recent studies have further suggested South Asian women may have more advanced breast tumours at the time of diagnosis [57, 58].

There are also differences in screening rates within the immigrant population by length of residence in Canada, with lower participation among more recent immigrants [27, 41]. The adjusted relative screening rate for the most recent immigrants reported from a recent study from Ontario [41] was 13% lower than the rate among long-term residents of Canada and 20% lower when restricted to women aged 60-69 years. The adjusted screening rates for immigrants generally approached those of long-term residents with increased duration of residence in Canada.

The world region categorization used in prior studies [38-40] pooled women from a diverse set of countries, many of which have sizeable populations in Canada. For example, the East Asia/Pacific group included Filipino, Chinese, Korean and Japanese immigrants. These groups may face different barriers to breast screening and have different screening patterns, but these potential differences are masked when data are examined only by world region of birth.

Prior breast screening studies generally focused on screening participation as the primary endpoint. Screening retention – defined simply as repeat screening according to guidelines - is an important performance indicator for cancer screening programs and may also show disparities among immigrant populations. An examination of screening retention would provide information on whether there are disparities among subpopulations in their propensity to re-screen.

BC has several strengths as a population within which to examine cancer screening patterns among Canadian immigrants. First, the 2016 Canadian Census showed that more than 1.29 million BC residents, or 28.3% of the province's population, are foreign-born [14]. Second, BC's population is culturally diverse, with immigration data demonstrating a large number of recent Asian immigrants with the most common source countries being the Philippines, China/Macau/Hong Kong/Taiwan (CMHT), India, and the Republic of Korea [15]. The 2016 Census further illustrates the diversity of BC's total immigrant population reporting significant numbers of immigrants from Asia (>750,000), Europe (>300,000), the Americas (>110,000), Africa (>40,000) and Oceania (>30,000).

The objectives of this study were: 1) to assess both screening participation and retention rates among BC's most common immigrant subpopulations defined by country of birth; 2) to compare screening rates in these populations to those of non-immigrant women; 3) to assess how breast screening rates vary with socio-demographic and health-related variables within these populations; 4) to offer a specific focus on screening-eligible recent immigrant (<10 years in Canada) women in terms of personal and health-related characteristics and the associations between these factors and breast screening.

3.2 Methods

3.2.1 Data Sources

This study utilized several population-based administrative databases from health and other government agencies via a comprehensive research data application facilitated through Population Data BC. Approval from all data stewards was obtained prior to data access. Specific details regarding the data sources accessed are provided in Table 3.1 and include: a provincial central demographics file, vital statistics death data, provincial cancer registry cancer diagnoses, breast screening program data, fee-for-service physician payment information, in-patient hospitalization and day surgery information, and a federal government immigration database. Research ethics approval was obtained from the University of British Columbia – BC Cancer Agency Research Ethics Board. The identities of all individuals in study data sets were replaced with study-specific random numbers that permitted linkage across the various data sources while protecting confidentiality of all individuals.

3.2.2 Participation Cohort Derivation

The study cohort to examine screening participation was identified from the provincial health registration client file and consisted of all women in BC who were aged 50-69 years for the entire period from January 1, 2013 to December 31, 2014. This age group was chosen to align both with prior studies of breast screening participation as well as to reflect an age group within which average risk women have generally been recommended to screen biennially in Canada. Women were excluded if they had a diagnosis of breast cancer or mastectomy prior to January 1, 2013, were not continuously registered in the provincial health insurance plan from January 1, 2011 through the study period, or died prior to December 31, 2014. Women had to be registered over this entire period in order to characterize health-service use and other health measures over a two-year look-back period (2011-12) prior to the interval over which the study outcome was calculated (2013-14).

3.2.3 Retention Cohort Derivation

For the retention rate outcome, a cohort of all screening eligible women who received a screening mammogram (the ‘index’ screen) through the provincial breast screening program between January 1, 2010 and June 30, 2012 was identified. These dates were chosen to permit a minimum of 30 months of follow-up on each cohort member in order to determine a 30-month retention rate. A 30-month retention rate endpoint was chosen to align with the definition reported as a screening performance indicator by most provinces in Canada [9]. As with the participation cohort, women were considered eligible if they were between 50 and 69 years of age for the entire period from the date of the index mammogram to the end of follow-up (the date 30-months after their index mammogram). This group was further restricted to those who maintained provincial health coverage for the two-year period prior to the index mammogram to permit the evaluation of health service use for cohort members. Women were excluded if they died, developed breast cancer, had a mastectomy or discontinued provincial health coverage prior to the date of their next screen or the end of follow-up. For women that had two mammograms during the period within which the index mammogram was chosen, the first mammogram was chosen to be the index screen.

3.2.4 Study Outcomes and Variable Definitions

The primary study endpoints were the screening participation rate and 30-month screening retention rate. The participation rate was defined as the number of women having a screening mammogram performed through the BC Cancer Breast Screening Program (BCBSP) between January 1, 2013 and December 31, 2014 out of the number of eligible women in the cohort. The retention rate was calculated as the number of women who had a screening mammogram performed through the BCBSP within 30 months of their index mammogram out of the total number of women who were eligible to be re-screened over that period (i.e. the number of women in the retention rate cohort). Diagnostic mammograms are not performed through the BCBSP and are billed directly to the provincial health system by radiologists and can be booked only with a referral from a physician. However, it is unknown the extent to which women utilize diagnostic mammograms in the province for screening purposes. Thus, as a sensitivity analysis of the participation rate, any bilateral mammograms billed directly to the health system (henceforth termed 'diagnostic' mammograms) in the study period were included for women who did not have a screening mammogram performed within the BCBSP.

Study groups of non-immigrant and immigrant women were created through linkage of the study cohorts to the immigration data. Any cohort member that did not link to the immigration data was assumed to be a non-immigrant woman. Available immigration data included only individuals who immigrated to Canada between 1985 and 2012 and thus women who immigrated prior to 1985 cannot be distinguished from non-immigrant women. The primary study analyses aimed to present screening rates by birth country as identified in the immigration file. Geopolitical changes that have taken place over the immigration dates covered by this data file necessitated combining some countries into single groups: countries of the former Union of Socialist Soviet Republics (USSR) were assembled into a "Former USSR State" group; countries of the former Yugoslavia were aggregated into "Former Yugoslavia"; women from the People's Republic of China, Macau, Hong Kong and Taiwan were combined into a single group identified as "CMHT" in all results. World regions were based primarily on groupings of countries used by the World Bank [76] and consistent with other recent Canadian studies [37, 40]. Immigrant women from countries with less than 100 total women were pooled into an "Other Immigrant" group within each world region.

Several socio-demographic and health-related measures were generated from the data sources identified in Table 3.1 in order to characterize study cohorts and examine correlates of breast screening. These variables included age, income quintile, rural residence, prior breast screening, index mammogram result, breast cancer family history, primary care physician (PCP) visits, the number of Johns Hopkins major aggregate diagnosis groups (ADGs) [77], duration of residence in Canada, immigration class and application type, as well as Canadian language proficiency and education level at the time of landing. The full definitions of these variables can be found in Table 3.2.

3.2.5 Statistical Analysis

Age-standardized participation and retention rates were calculated according to country and world region of birth using the age-distribution of the non-immigrant women as the standard population. Rates were generated for all countries with a minimum of 100 eligible women and presented graphically with 95% confidence intervals.

For birth countries for which there were at least 2,000 women in the participation cohort, analyses examining both the characteristics of the cohorts and their screening endpoints were undertaken. This minimum sample size was chosen in order to obtain reasonable confidence interval widths for participation rates. Socio-demographic and health measures were compared across immigrant and non-immigrant groups using descriptive statistics. Screening participation and retention rates were generated by study group, both overall and stratified by other key variables, to explore the variation in screening endpoints; exact 95% confidence intervals were calculated for both endpoints.

An additional analysis was performed which examined the characteristics of screening eligible immigrants who had resided in Canada for less than ten years to better characterize this specific population of women. Descriptive statistics for socio-demographic, healthcare and immigration factors were generated by country of birth for women from the eight most common birth countries. These countries were chosen as they accounted for more than 80% of the recent immigrant population and each had a sufficient sample size to calculate participation rates. Recent immigrant women from countries other than these eight were pooled into an “Other Immigrant” category for this analysis. Participation rates were calculated according to these same variables within each birth country cohort. To identify independent predictors of screening for each birth country cohort, Poisson regression models were used with adjustment to the parameter estimate variances to permit a direct estimation of the adjusted relative risks as the endpoint of interest (screening participation) was not rare [78]. Separate models were fit for each of the immigrant groups allowing for different variables to be selected or different effect estimates to be estimated within each group. In the regression analysis, categorical variables with less than ten women within one of the categories were grouped with adjacent categories. Within each immigrant group, if a binary explanatory variable demonstrated less than ten women in one of the categories, it was not considered as a potential predictor for that immigrant group. These decisions were made to avoid difficulties with model convergence and fitting. Terms were considered in an initial model containing all predictor variables with a sequence of generalized score tests [79] used to backward eliminate variables not significantly associated with participation.

All analyses were conducted using the Statistical Analysis Software (SAS) version 9.4 (SAS Institute, Cary, NC) and the R statistical computing software version 3.3.2 (http://www.cran.r-project.org/).

3.3 Results

3.3.1 Breast Screening Participation

The participation cohort included 537,783 women of whom 85,902 (16%) were identified as immigrants. The majority of the immigrant population who were eligible for breast screening during the study period hailed from Asia with more than 59% of the immigrant population in the cohort born in CMHT, the Philippines or India (Table 3.3). Among immigrant groups, duration of residence in Canada was highly variable. For example, the majority of Vietnamese immigrants (63.7%) had resided in Canada for 20 or more years with few (2.6%) having arrived to Canada less than 5 years ago. This contrasted with the Indian immigrant group where 15.4% had immigrated in the past 5 years and only 12.6% had been in Canada 20 years or more.

Compared to non-immigrant women, the immigrant subpopulations were younger with a higher frequency of women in the 50-59 age group; the exception to this was the immigrant Indian women who were more commonly aged 60-69 (52.6%) notably higher than the frequency among other immigrant populations (21.2-33.4%) and non-immigrant women (40.4%). Most immigrant populations showed a higher frequency of urban residence compared to the non-immigrant group. Immigrant women from the United States (US), however, showed a lower frequency of urban residence compared to non-immigrants and women from the United Kingdom (UK) showed a similar frequency of urban residence.

The distribution of income quintile varied by subpopulation: the non-immigrant and Korean immigrant groups were fairly evenly distributed across the five income quintile categories while some populations (CMHT, Indian, Filipino and Vietnamese immigrants) tended to have a greater concentration of their population in the lower income quintiles, and others (immigrants from US, UK, Iran) tended toward the higher quintiles. Consistent with their older age, Indian immigrant women had a higher number of major ADGs compared to other groups and more physician visits. This same group also had the lowest prior breast screening frequency. Korean and Chinese immigrant women showed a much higher frequency (~15%) of women who had not seen a physician in the two-year look-back period.

The age-adjusted participation rates varied considerably by country and world region of birth (Figure 3.1). Women from the East Asia/Pacific region generally showed lower screening rates than the non-immigrant population, however, women from some countries, particularly South-East Asian countries (e.g Brunei, Malaysia, Indonesia) demonstrated similar rates to non-immigrants. South Asian women also had lower participation rates than the non-immigrant population. With the exception of women born in Afghanistan, Central Asian/Eastern European immigrants showed consistently lower participation, with some of the lowest rates among all countries examined. Participation rates for women from countries within the Sub-Saharan Africa, Caribbean/Latin America and Western Europe regions generally had screening participation rates comparable with the non-immigrant population, though there were a small number of countries having significantly lower rates (e.g. Ethiopia, Germany, and Switzerland). Age-standardized participation rates and confidence intervals for all countries examined can be found in supplemental Table A1.1.

Table 3.4 shows the overall participation rates for the entire population as well as for birth countries with at least 2,000 women in the cohort. The unadjusted participation rate for the entire cohort was 50.3%. Within this group of countries there was large variation in the participation rates with South Korean women reporting the lowest participation (39.0%), followed by Indian women (44.5%); women from the United Kingdom (54.9%) and Iran (53.9%) had the highest participation rates. Screening rates did not vary consistently with age across the immigrant populations as some had higher screening rates in the younger age group (Vietnam, India and Philippines), some had similar rates in both age groups (e.g. CMHT, Iran, US, UK, Other Immigrants), while older women had the higher rate among Korean immigrants. Participation in the non-immigrant population was higher in the 60-69 age group (55.1% vs

48.5% in the 50-59 age group). These patterns resulted in some age-specific disparities such as those observed for Indian women, where in the 50-59 age group, the participation rate was identical to the rate among non-immigrant women but in the 60-69 age group it was almost 13% lower.

Screening participation increased with income quintile in the non-immigrant population, however, the relationship varied across immigrant populations (Table 3.4). For example, for women from CMHT, India and Korea there appeared to be little relationship between participation and income quintile, however, others (e.g. UK, US, Other Immigrant) showed a trend more consistent with the non-immigrant population. Screening rates increased with PCP visits for almost all of the groups. Screening rates were very low (5.6% to 16.7%) for women who had no contact with a PCP in the two years prior to the start of follow-up.

Participation generally increased with duration of residence in Canada. This was most evident for women from CMHT, India, and South Korea where the absolute difference in participation between the most recent and longest-term immigrants (≥ 20 years in Canada) approached or exceeded 20%. Women from Iran and the UK showed no relationship between screening and duration of time in Canada. Screening rates for most long-term immigrant groups approached those of non-immigrant women. For completeness, and to enable comparisons with prior Canadian studies, a table of participation rates stratified by key study variables and birth world region group has been included in the supplemental materials (Table A1.2).

The sensitivity analysis, where diagnostic mammograms performed outside the screening program were included in the participation endpoint, yielded nearly identical results to the primary analysis (appendix Table A1.3). The overall participation rate for the cohort increased to 54.2% with the ordering of the various subpopulations remaining largely the same. Although the inclusion of these mammograms increased some groups' participation rates approximately in-line with the increase seen in the overall population rate (4%), the Iranian women's rate increased 8% with these additional mammograms. In contrast the rate for Indian women increased only 1.8%. Other patterns such as the declining participation rates by age in Indian, Filipino, Vietnamese women, as well as the increase in screening participation with duration of residence in Canada, remained similar to the main analysis.

3.3.2 Breast Screening Retention

The retention rate cohort included 281,052 women of which 12.8% were identified as immigrants (Table 3.5). The age distribution of the retention rate cohort closely resembled that of the participation cohort for most groups. The age distribution of Indian women was however notably younger in the retention cohort (54.0% aged 50-59 years vs 47.4% in the participation cohort). The distributions of income quintile and urban/rural residence within this cohort were nearly identical to the participation cohort. Although there was still notable variation in the number of physician contacts across study groups in the retention cohort, there were far fewer women in any study group with no PCP contacts (range 0.3% to 1.8% in the retention rate cohort vs 2.8 to 15.2% in the participation cohort). Indian women reported the lowest rate of prior screening such that the index mammogram represented the first screen for 22.7% of the Indian group compared to only 5.6% in the non-immigrant group. Women from Korea, India and Vietnam reported the lowest family history of breast cancer (4.7-6.2%), much lower than reported by non-immigrant women (14.8%). The distribution of duration of residence in Canada across immigrant groups looked similar to that of the participation cohort, the exception being a slightly lower fraction of each immigrant group in the longest-term (20+ years) category.

Figure 3.2 shows the age-standardized 30-month retention by country of birth. There was much less variation in retention rates among birth countries than in the participation rates (Figure 3.1). For example, although the Eastern European/Central Asian nations still had numerically lower retention rates compared to non-immigrants, they were much closer to the non-immigrant rates (e.g. rates within this region range from 61.6% to 74.6% vs 74.4% for non-immigrant women). Some immigrant groups that had low participation within their world region group, such as Germany or Japan, demonstrated retention rates consistent with the non-immigrant population and similar to the rate for their world region as a whole. Because retention rates by country may be influenced by the fraction of index mammograms in each group that represented women's first time screening, these additional data have been provided in the appendix (Table A1.4).

The overall 30-month retention rate for the cohort was 74.0% (44.4% for first time screeners vs 76.0% for those who had previously screened). Retention rates across immigrant groups ranged from 64.9% in Korean women to 77.4% for women from the United Kingdom (Table 3.6). Retention rates showed modest increases with age among non-immigrant and South Korean women whereas most other groups showed little association with age. Indian women who showed a decrease of approximately 7% in participation with age showed similar retention rates in both age groups (~70%). Retention had an increasing trend with income quintile in non-immigrant women however this pattern was not as clear in immigrant subgroups. All subpopulations showed much higher retention for women who had previously screened in the program compared to those who were screening for the first time. Among first-time screeners, South Korean women had the lowest retention (40.3%), while immigrants from the UK (61.2%), Iran (52.0%) and the Philippines (52.6%) had the highest. Retention rates generally increased with greater physician contact, with most groups having the lowest retention rates among women who had no contact with a primary care physician. Among women who had at least 1 PCP contact in the look-back period, the variation in retention rates across the levels of PCP visits differed by group. For example, among immigrants from the US and UK, the range in observed retention rates across levels of PCP visits was no more than 4.8% and 7.4% respectively; the range was significantly higher among women from Iran (13.8%), Vietnam (14.4%) and CMHT (16.9%). With the exception of women from the US, UK and Iran, retention rates among immigrant subpopulations tended to increase with longer duration in Canada with those living in Canada more than 10 years generally having similar rates to non-immigrant women.

3.3.3 Characteristics and Screening Participation of Recent Immigrants

Table 3.7 provides the characteristics and participation rates by birth country for immigrant women with <10 years of residence in Canada. This analysis was limited to the eight most common birth countries among recent immigrants, which represented more than 80% of all recent immigrants. Screening participation rates were not calculated for cells with <10 women, identified in the table as 'NC' (not calculated). The most common birth countries represented within this population are nearly identical to the most common countries identified among all immigrant women (Table 3.3) with the only difference being a substitution of the Former USSR in the recent immigrant group for Vietnam in the total immigrant population.

Recent immigrants were more commonly aged 50-59, with the notable exception recent Indian immigrants who were almost evenly split among age groups. Screening participation rates were lower in the older age group for several immigrant groups (women from CMHT, India, Philippines, Former USSR and Other Immigrants) however in some groups there appeared to be little relationship (women from South Korea, Iran, US, UK). More than 98% of women from

CMHT, India, the Philippines, South Korea and Iran resided in an urban area, with only recent immigrant women from the US and UK having more than 10% of the population residing in rural areas.

There was a considerable range in Canadian language fluency with women from CMHT and India having >75% with no competence in English or French, while others reported near 100% fluency (e.g. women from the US, UK). Language competence did not seem to associate with screening participation in several of the immigrant groups (CMHT, the Philippines, South Korea, Iran) while women from the India, Former USSR and Other Immigrant groups showed lower screening participation among women with no Canadian language competency.

Education level at the time of landing similarly showed strong variation across study groups. Chinese immigrants reported 50.3% having secondary school education or less, compared to nearly half of recent Indian immigrants reporting no formal education at all and an additional 34.8% reporting secondary school or less. For immigrant women from the Philippines, US and the Former USSR the percentage of women with undergraduate or graduate degrees was above 60% suggesting highly educated groups. Curiously, 11.2% of recent immigrants from the UK reported no formal education which may represent a data quality issue. The relationship between education level and screening participation was not uniform across immigrant groups with some groups showing increased participation with higher education (e.g. women from US or Other Immigrants) while others appeared to have little association (e.g. women from the UK or Iran).

Screening participation rates were higher among refugee immigrants compared to either economic or family class immigrants for immigrants from CMHT, India, and South Korea. In all three of these groups however the number of women immigrating under this class represented a very small proportion of the immigrant population with participation rates estimated from between 11 and 138 women across these groups. There were no refugee class immigrants from the US or UK and thus participation rates could not be calculated. Among immigrants from the Former USSR, refugee class immigrants showed the lowest participation rates however this group was comprised of only 22 women and thus the participation rate is highly imprecise. Among immigrant women from Iran and Other Immigrants there was little relationship between immigrant class and participation.

The median number of PCP visits was lower for women from South Korea (5.0) and CMHT (6.0) and much higher for women from India (13.0) and Iran (11.0). As with the analysis on the entire cohort, the recent immigrant analysis revealed a strong positive relationship between screening participation and number of PCP visits. In all immigrant groups, the women with no recent PCP visits had the lowest screening rates.

The analysis to identify independent predictors of breast screening participation among the most recent immigrants identified only the number of PCP visits as a significant predictor within all immigrant groups. Compared to women who had 10 or more PCP visits, those with no recent PCP visits showed adjusted relative risks (ARRs) in the range from 0.11 to 0.37 (Table 3.8) indicating much lower screening. ARRs increased in each immigrant group with the number of PCP visits. Older age (60-69 vs 50-59) was associated with less screening participation in women from CMHT, India, the Philippines, the Former USSR and Other Immigrants. Within the groups for which age was not significantly associated with screening participation, the ARRs from the initial model that considered age ranged from 0.96 to 1.08. Among women from India, US, Former USSR and Other Immigrant, those with lower education levels tended to screen less in comparison to women with graduate education. The Former USSR group had less than ten women reporting no formal education and thus this group was pooled with the “secondary school or less” group for this analysis. Thus the ARR for this group needs to be interpreted differently than for the other immigrant populations. The Former USSR group was the only group for which the immigrant class variable was significantly associated with participation with family class immigrants demonstrating greater participation compared to economic migrants (ARR = 1.57, 95% CI: 1.20, 2.05). Although not statistically significant, refugees reported lower screening in this population compared to economic immigrants (ARR = 0.73, 95% CI: 0.30, 1.77). Although considered in the analysis, Canadian language proficiency at the time of landing, rural residence and the number of major aggregate diagnosis groups (ADGs) were not identified as being significantly associated with participation in any of the immigrant groups.

3.4 Discussion

The present study demonstrates that screening participation rates in BC are lower for some immigrant subpopulations compared to non-immigrant women. Participation rates showed variation when women were grouped by both world region of birth and by individual countries of birth. Participation rates also varied within immigrant subpopulations according to age group, duration of residence in Canada as well as other socio-demographic variables. At the same time, the relationship between participation and these variables was not consistent across the immigrant populations.

This study appears to be the first large population-based study in Canada that has examined breast screening retention rates as an endpoint in comparing immigrant and non-immigrant groups. In comparison with the participation rate analysis, less variation was observed in retention rates across both world region and birth country groups. When the analysis was restricted to the women with at least one mammogram within the program prior to the index screen, the variability in retention rates was reduced further (appendix Table A1.4).

The retention rate analysis revealed less disparity with the non-immigrant population for women from the Central Asian/Eastern European region compared to what was observed in the participation analysis. Indian immigrant women showed lower participation rates compared to non-immigrant women; however, in the retention rate analysis that was restricted to those women with at least one screen prior to the index screen, the retention rates for the two groups were essentially identical. These findings of lower variation in retention rates across many of the groups examined and less disparity with the non-immigrant rate are possibly encouraging in that they may suggest that different groups of women, once attracted to programmatic screening, can be similarly retained.

The present study's participation results are consistent with prior Canadian studies that have reported lower breast cancer screening rates among immigrant women and specific immigrant subpopulations [26, 38, 40, 41]. Recent data from Ontario, Canada [40] demonstrated that among immigrant women, South Asians had the lowest breast screening utilization rate with the age 60-69 group demonstrating lower screening than those aged 50-59 years. Similar results were found for Indian immigrants in this study. Eastern European/Central Asian immigrant women in Ontario were also found to have among the lowest participation rates, consistent with the present study's findings for this population. This study provides additional detail, showing that participation rates are consistently poor among all countries in this regional group. Prior Canadian studies have also noted that breast screening participation is strongly associated with duration of residence in Canada [26, 27, 40, 41]. Although this same association was observed within many of the immigrant groups examined, immigrants from Iran and the UK did not show a clear association. Further, when screening retention was examined, the association with duration of residence in Canada was less consistent across groups examined. While it was largely true that retention rates were lower among the most recent immigrants, rates did not increase across the categories reflecting increased duration of residence in Canada in several groups.

The individual country-level analysis within this study identified some screening patterns not reported in recent studies which examined data at the regional level. Screening participation and retention among South Korean immigrant women in the present study was very low relative to non-immigrants and other immigrant populations; among recent immigrants, this group also demonstrated some of the lowest participation rates. A significant proportion of this group also had no apparent PCP visits in the look-back period (15.2% overall and 21.0% of recent immigrants) and generally low proficiency in Canadian languages. As noted in a recent review article [59], there have been limited Canadian data reporting on breast screening rates for Filipino women who are BC's second largest population of screening-age immigrant women. Thus, this study contributes important data on this population including a description of both screening patterns and characteristics of the screening-age Filipino immigrant population in BC. Although overall participation for this group was similar to the East Asia/Pacific region rate, Filipino women residing in Canada for less than ten years had an overall participation rate 14% lower than that of non-immigrants; among women aged 60-69 the rate was 19% lower. The characteristics of recent Filipino immigrants suggested a highly educated group with strong Canadian language proficiency, living almost entirely in urban areas; further, almost 95% of recent Filipino immigrants reported some PCP visits in the look-back period. Thus this information may help to support interventions and promotions within these populations.

There have been numerous studies of breast cancer screening among immigrant populations undertaken in other countries [80-86]. Comparing results between studies is challenging as the birth country composition of immigrant populations vary significantly across countries, barriers to screening for immigrants in their adopted country may be different, and the health and cancer screening systems may also differ in significant ways. Acknowledging the challenges with comparing studies, findings have generally reported that screening rates among immigrant populations are lower than those among non-immigrants. Among these studies, several have further assessed and reported a similar positive association between duration of residence in the adopted country and screening participation [80, 82, 83]. A recent population-based study from Norway reported that participation rates rose much more quickly with years of residence in Norway for women who emigrated from high-income countries compared to those that emigrated from middle- or low-income countries. Income-level of the source country does not completely explain the patterns observed in the present study, as for example, South Korea showed a gradual increase in participation with duration of residence in Canada, similar to Indian or CMHT immigrants. Among studies that have reported screening rates for immigrants by region or country of birth, there are similarities to this study's findings of lower rates of screening among women from Eastern European/Central Asian, East Asian and South Asian countries [80, 83].

Participation rates within each of the study groups generally increased with primary care physician contact; the lowest participation rates were observed in the groups of patients that reported no PCP visits within the look-back period (ranged between 2.8% and 15.2%). Further, in the analysis of predictors of screening participation among recent immigrant women, the number of PCP visits was the only variable associated with having been screened in all immigrant groups examined. For recent South Korean immigrant women with no PCP visits (21% of all recent South Korean immigrants) the participation rate was only 5.2% while for women with ten or more PCP visits it was 46.1%.The results were nearly identical for recent Chinese immigrant women and similar for other immigrant groups. Generally, the retention rates were higher for groups with more PCP contact; it is worth noting that less than 2% of each study group in the retention rate analysis had no PCP visits and thus their retention rates are highly imprecise. Despite using a number of definitions for PCP contact, the association with breast screening has been reported in a number of Canadian studies [26, 30, 38, 40, 41, 44]. Generally, they have found recent contact with a PCP was associated with increased screening participation [26, 30, 40, 44], or that a greater number of PCP visits was associated with higher participation rates [40].

In Ontario, there has been considerable work examining the specific patient enrollment model (PEM) that attaches patients to a PCP and how this correlates with breast screening [38-41]. There are a number of PEM's in use in Ontario and these provide various models of rostering patients to individual or teams of physicians with differences in the model of remuneration for care provided to patients. In a recent study of breast screening among immigrants to Ontario, only 10% of women in their population-based cohort were not enrolled in some kind of PEM [40]. In BC, primary care is typically remunerated under a fee-for-service (FFS) model, and patients and physicians are not formally rostered together as they are with the Ontario PEM approach. Thus, this study's findings cannot be directly compared to studies that have shown that screening rates are generally improved among immigrant women rostered to PCP's with a PEM compared to those who are not [40, 41]. However, recent research has attempted to better characterize the PCP population in BC by examining the variation in PCP practice style using available administrative data [87] and suggests there is variation in the level of responsibility that fee-for-service PCPs assume for patients they see. Future work could thus assess the characteristics and practice style of the PCPs that immigrant and non-immigrant women see and how these factors associate with screening uptake among eligible women.

There are a number of study strengths including the use of population-based, administrative data sets which permit the estimation of population screening rates and reduce the potential for selection bias. Thus, in contrast to studies that utilize survey methods, the present study is not affected by response or recall biases for key variables (e.g. timing of most recent mammogram, years since immigration, number of PCP visits). The data sets included information from diverse sources permitting the examination of screening rates by a variety of socio-demographic and health variables. The immigration data included the specific country of birth of each immigrant woman in the cohort permitting the examination of screening indicators by country of birth rather than aggregate world regions alone.

Reliance on administrative data does impose some limitations on study findings. Although this study aimed to compare screening participation and retention rates in immigrant and non-immigrant women, women who immigrated to Canada prior to 1985 are included in the non-immigrant group. Although the magnitude of this misclassification is not known, because long-term immigrants tend to exhibit similar screening rates to non-immigrants, the screening rates reported here among immigrants are almost certainly lower than they would be were it possible to identify immigrants that landed in Canada prior to 1985.

Immigrant women's screening, surgical and breast cancer histories prior to when they immigrated were not represented in provincial data sets. Thus, women who developed breast cancer or had mastectomy surgeries outside of BC could not be removed from the screening-eligible cohort. The unexpectedly high percentage of immigrants from the UK reporting no prior formal education may suggest that education status was not accurately captured for all women within the immigration data. As the majority of these women were identified as dependents (in place of principal applicants) in the immigration data, it is possible that this information is less relevant for this type of applicant and was not captured as accurately. Unfortunately, verifications of the data could not be performed due to the administrative nature of its collection and thus this remains a limitation of the study data.

Our ability to definitively count primary care visits for each cohort member was also limited. Although primary care in BC is mainly delivered by fee-for-service physicians, a smaller fraction of physicians are paid under an alternate payment program for which no service use data are available. The implication is some patients who appeared to have no primary care encounters may in fact have seen a physician paid through alternative payments. Only 5.9% of the total cohort had no physician visits within the look-back period and thus the affected group did not comprise a significant portion of the total cohort.

An ecological variable was used to reflect patient socioeconomic status (income quintile) and was derived from the postal code of residence which may not accurately reflect their true socioeconomic status. Prior Canadian research has however shown that, among those residing in Canadian census metropolitan areas, this variable shows strong concordance with various socioeconomic factors such as household income, home ownership, single-parent homes, unemployment and other characteristics [88]. The area-based income quintile available within study data sets was also derived using information collected from the 2006 Canadian census. It is possible that some neighborhood incomes have changed between 2006 and the study follow-up periods and thus are not accurately captured within these data sets. Finally, screening rates for many of the birth country groups examined had low statistical precision due to the small numbers of women representing these groups within the study cohort.

Despite the findings of lower screening rates among some immigrant populations in BC, it is important to also reflect on the population statistics presented here , principally that only 50% of the eligible women participated in breast screening over the two-year follow-up. Further, the 30-month retention rate for first time attendees in the present study was 44% (compared to 76% for those with prior screening). These statistics are far below targets set by Canadian cancer screening expert advisory panels [9]. Some of the observed screening disparities among immigrant subpopulations will require specific screening promotion to improve screening rates; there are strong equity rationales for such interventions. However, given the relatively small sizes of the immigrant populations within this cohort, raising the screening rates in the immigrant populations alone will not substantially improve the overall population screening rate.

Addressing observed screening disparities will be a complex task given the diversity of the BC immigrant population. The present paper was not intended as a comprehensive review of potential interventions to address disparities in breast screening, however, the literature related to screening barriers and interventions among immigrants is rich. Screening rates are generally lowest among new, or more recent, immigrants suggesting this population as an important focus for intervention. However, designing interventions will be challenging given that, as shown here, recent immigrants to BC are diverse with respect to characteristics such as language, PCP contact, age and education level. This variation exists even within groups of women that emigrate from a common world region (e.g. the Canadian language proficiency, education level and PCP contact among Chinese and Filipino immigrant women were quite different). Despite this, since a substantial proportion of un-screened recent immigrants have had PCP contact, interventions mediated through PCPs may be an approach to reach these women. In Canada, recently published studies on interventions to improve screening rates mediated through PCP's have reported positive results [89, 90]. Thus if interventions mediated through PCP practices are to be contemplated within BC, further research to better understand how recent immigrant women access primary care and more information about the PCPs they visit would be instrumental to suggest potential interventions.

3.5 Tables

Table 3.1: Details of data sources accessed for the present study

Database	Description	Years of data utilized by present study
BC Cancer Breast Screening Program (BCBSP) database [91]	Includes information on BCBSP clients including demographics, self-reported breast cancer risk factors, screening mammogram information and results. The BCBSP database has captured information on clients since the program's inception in 1988.	1988-2014
BC Cancer Registry (BCCR) [92]	A population-based registry of all cases of cancer diagnosed in BC residents since 1970. Data from BCCR can be linked to other data sources from 1985 on as this was the first year that the provincial personal health number was consistently captured across health databases in BC.	1985-2014
Medical Services Plan (MSP) physician payment file [93]	Includes all services provided by fee-for-service practitioners to individuals and billed to BC's Medical Services Plan. MSP is BC's public universal health coverage plan. Data include service dates, fee codes, and diagnoses responsible for paid physician services.	2008-2014
Consolidation file [94]	The central demographic file containing residential and health coverage information for all individuals registered with MSP or who receive health services in BC	2008-2014
Discharge Abstract Database [95]	Includes data on hospital discharges, transfers and deaths of in-patients as well as day surgery admissions to BC acute care facilities. This data set includes patient and facility information as well as clinical details (including in-hospital interventions) associated with the patient's hospital stay.	1985-2014
Immigration, Refugees, and Citizenship Canada database [96]	Includes immigration details on permanent residents who immigrated to Canada between 1985 and 2012. Includes details on countries of birth, last residence and citizenship, immigrant class, year of arrival and landing as well as socioeconomic information such as education-level, occupation skills and Canadian language proficiency.	1985-2012
BC Vital Statistics Agency database [97]	Captures all deaths registered in BC.	2010-2014

Table 3.2: Definitions of study variables

Variable	Relevant cohort and population	Definition
Age	Participation and Retention; all women	In years; calculated from date of birth to the start of cohort follow-up. Categorized into two groups: 50-59 and 60-69 years.
Income quintile	Participation and Retention; all women	Derived from postal code of residence at the start of follow-up and categorized into five quintiles.
Rural residence	Participation and Retention; all women	Derived from postal code of residence at the start of follow-up. Postal codes associated with communities with populations of less than 10,000 were assigned to rural; community sizes of ≥10,000 were assigned to urban.
Prior breast screening	Participation and Retention; all women	The presence of any mammogram performed by the BCBSP prior to the start of follow-up was taken to mean a prior history of screening; women with no documented BCBSP mammogram were assumed to have no prior screening history.
Family history of breast cancer	Retention; all women	Based on self-reported breast cancer history on the BCBSP client questionnaire. Women could indicate presence or absence of family history; women who did not complete this question were coded as unknown.
Index screen results	Retention; all women	Based on index mammogram result identified in BCBSP database. Categorized as normal or abnormal result.
Primary care physician visits	Participation and Retention; all women	The number of primary care physician office visits identified from the physician payment file within a two-year look-back window prior to the start of follow-up. Categorized into: 0, 1-4, 5-9, 10-14, 15+.
Number of major ADGs	Participation and Retention; all women	Based on the Johns Hopkins ACG/ADG system. The number of major ADGs identified was categorized into 0, 1, 2 or ≥3.
Duration of residence in Canada	Participation and Retention; immigrants only	Calculated from date of landing in Canada identified in the immigration data to the start of cohort follow-up. Categorized into four groups: <5, 5-9, 10-19 and ≥20 years.
Canadian language proficiency	Participation; recent immigrants only	Based on the immigration data and reflects proficiency at the time of landing. Proficiency in either English or French is taken as having proficiency in Canadian language(s); no reported proficiency in either language taken as "none".
Education level	Participation; recent immigrants only	Based on the immigration data and reflects highest attained education at the time of landing.
Immigration applicant type	Participation; recent immigrants only	Based on the immigration data and coded to principal, dependent or other applicant type.
Immigration class	Participation; recent immigrants only	Based on the immigration data and coded to economic, family, refugee or other class.

BCBSP = BC Cancer Breast Screening Program; ACG = adjusted clinical groups; ADG = aggregate diagnosis groups

Table 3.3: Characteristics of screening participation cohort

Variable	Subgroup	Non-immigrant (N=451,881)	CMHT (N=30,185)	Philippines (N=10,911)	India (N=9,958)	South Korea (N=4,028)	Iran (N=3,517)	United Kingdom (N=2,692)	United States (N=2,572)	Vietnam (N=2,089)	Other Immigrants (N=19,950)
Age	50-59	269217 (59.6%)	21637 (71.7%)	8597 (78.8%)	4721 (47.4%)	3075 (76.3%)	2507 (71.3%)	2020 (75.0%)	1713 (66.6%)	1579 (75.6%)	14681 (73.6%)
	60-69	182664 (40.4%)	8548 (28.3%)	2314 (21.2%)	5237 (52.6%)	953 (23.7%)	1010 (28.7%)	672 (25.0%)	859 (33.4%)	510 (24.4%)	5269 (26.4%)
Urban/Rural Residence	Urban	377369 (83.5%)	30091 (99.7%)	10675 (97.8%)	9790 (98.3%)	3953 (98.1%)	3503 (99.6%)	2315 (86.0%)	1974 (76.7%)	2083 (99.7%)	18808 (94.3%)
	Unknown	121 (0.0%)	6 (0.0%)	<5 (0.0%)	<5 (0.0%)	<5 (0.0%)	<5 (0.0%)	<5 (0.0%)	<5 (0.0%)	<5 (0.0%)	<5 (0.0%)
Income Quintile	1 (lowest)	77218 (17.1%)	8243 (27.3%)	3529 (32.3%)	2623 (26.3%)	708 (17.6%)	472 (13.4%)	301 (11.2%)	379 (14.7%)	716 (34.3%)	4787 (24.0%)
	2	82661 (18.3%)	6649 (22.0%)	3107 (28.5%)	3489 (35.0%)	720 (17.9%)	706 (20.1%)	353 (13.1%)	421 (16.4%)	640 (30.6%)	4246 (21.3%)
	3	89586 (19.8%)	5971 (19.8%)	2121 (19.4%)	2056 (20.6%)	826 (20.5%)	489 (13.9%)	501 (18.6%)	462 (18.0%)	386 (18.5%)	3921 (19.7%)
	4	97307 (21.5%)	4606 (15.3%)	1304 (12.0%)	1050 (10.5%)	867 (21.5%)	729 (20.7%)	651 (24.2%)	510 (19.8%)	224 (10.7%)	3476 (17.4%)
	5 (highest)	101004 (22.4%)	4434 (14.7%)	783 (7.2%)	732 (7.4%)	840 (20.9%)	999 (28.4%)	868 (32.2%)	767 (29.8%)	114 (5.5%)	3374 (16.9%)
	Unknown	4105 (0.9%)	282 (0.9%)	67 (0.6%)	8 (0.1%)	67 (1.7%)	122 (3.5%)	18 (0.7%)	33 (1.3%)	9 (0.4%)	146 (0.7%)
# Major ADGs	0	264682 (58.6%)	21459 (71.1%)	7279 (66.7%)	5577 (56.0%)	2851 (70.8%)	2116 (60.2%)	1722 (64.0%)	1585 (61.6%)	1337 (64.0%)	12514 (62.7%)
	1	114594 (25.4%)	5695 (18.9%)	2394 (21.9%)	2748 (27.6%)	772 (19.2%)	863 (24.5%)	650 (24.1%)	610 (23.7%)	489 (23.4%)	4761 (23.9%)
	2	40356 (8.9%)	1604 (5.3%)	671 (6.1%)	972 (9.8%)	208 (5.2%)	315 (9.0%)	175 (6.5%)	212 (8.2%)	141 (6.7%)	1505 (7.5%)
	3+	17945 (4.0%)	482 (1.6%)	221 (2.0%)	358 (3.6%)	52 (1.3%)	109 (3.1%)	60 (2.2%)	72 (2.8%)	47 (2.2%)	576 (2.9%)
	Unknown	14304 (3.2%)	945 (3.1%)	346 (3.2%)	303 (3.0%)	145 (3.6%)	114 (3.2%)	85 (3.2%)	93 (3.6%)	75 (3.6%)	594 (3.0%)
# PCP Visits	Median [IQR]	8.0 [4.0 - 14.0]	7.0 [3.0 - 13.0]	9.0 [5.0 - 14.0]	14.0 [8.0 - 21.0]	7.0 [2.0 - 12.0]	12.0 [6.0 - 18.0]	7.0 [4.0 - 12.0]	7.0 [4.0 - 12.0]	10.0 [5.0 - 16.0]	8.0 [4.0 - 14.0]
	0	24489 (5.4%)	4428 (14.7%)	578 (5.3%)	279 (2.8%)	613 (15.2%)	256 (7.3%)	174 (6.5%)	176 (6.8%)	128 (6.1%)	1404 (7.0%)
	1-4	94031 (20.8%)	6285 (20.8%)	2029 (18.6%)	837 (8.4%)	939 (23.3%)	397 (11.3%)	640 (23.8%)	641 (24.9%)	313 (15.0%)	4022 (20.2%)
	5-9	135389 (30.0%)	8050 (26.7%)	3351 (30.7%)	1910 (19.2%)	1109 (27.5%)	779 (22.1%)	861 (32.0%)	806 (31.3%)	531 (25.4%)	5545 (27.8%)
	10-14	92818 (20.5%)	5717 (18.9%)	2561 (23.5%)	2233 (22.4%)	728 (18.1%)	772 (22.0%)	524 (19.5%)	488 (19.0%)	474 (22.7%)	4053 (20.3%)
	15+	105154 (23.3%)	5705 (18.9%)	2392 (21.9%)	4699 (47.2%)	639 (15.9%)	1313 (37.3%)	493 (18.3%)	461 (17.9%)	643 (30.8%)	4926 (24.7%)
Prior Screening	Yes	339836 (75.2%)	21581 (71.5%)	7346 (67.3%)	5898 (59.2%)	2743 (68.1%)	2725 (77.5%)	2017 (74.9%)	1758 (68.4%)	1491 (71.4%)	13510 (67.7%)
Years of residence in Canada	Median [IQR]		16.7 [12.7 - 19.7]	17.8 [11.6 - 21.0]	11.5 [6.8 - 16.8]	13.8 [10.0 - 18.2]	14.4 [9.5 - 18.8]	19.5 [11.3 - 23.6]	17.4 [7.5 - 23.2]	21.5 [18.6 - 24.3]	18.3 [12.3 - 22.7]
	< 5	NA	1416 (4.7%)	930 (8.5%)	1538 (15.4%)	244 (6.1%)	295 (8.4%)	218 (8.1%)	290 (11.3%)	54 (2.6%)	1092 (5.5%)
	5 - 9		3605 (11.9%)	1399 (12.8%)	2534 (25.4%)	762 (18.9%)	635 (18.1%)	381 (14.2%)	559 (21.7%)	137 (6.6%)	2406 (12.1%)
	10 - 19		18119 (60.0%)	4981 (45.7%)	4636 (46.6%)	2347 (58.3%)	1825 (51.9%)	811 (30.1%)	723 (28.1%)	567 (27.1%)	8348 (41.8%)
	20+		7045 (23.3%)	3601 (33.0%)	1250 (12.6%)	675 (16.8%)	762 (21.7%)	1282 (47.6%)	1000 (38.9%)	1331 (63.7%)	8104 (40.6%)

IQR = Inter-quartile range; PCP = Primary care physician; ADG = aggregate diagnosis group; NA = Not Applicable; CMHT = China, Macau, Hong Kong, Taiwan

Table 3.4: Breast screening participation rates for screening eligible women by study factors

Variable	Subgroup	Population (N=537,783)	Non-immigrant (N=451,881)	CMHT (N=30,185)	Philippines (N=10,911)	India (N=9,958)	South Korea (N=4,028)	Iran (N=3,517)	United Kingdom (N=2,692)	United States (N=2,572)	Vietnam (N=2,089)	Other Immigrants (N=19,950)
All Women	All Women	50.3 [50.2, 50.4]	51.2 [51.0, 51.3]	45.7 [45.2, 46.3]	45.9 [44.9, 46.8]	44.5 [43.5, 45.5]	39.0 [37.5, 40.5]	53.9 [52.2, 55.5]	54.9 [53.0, 56.8]	46.1 [44.2, 48.1]	46.5 [44.3, 48.6]	44.5 [43.8, 45.2]
Age	50-59	48.0 [47.8, 48.2]	48.5 [48.3, 48.7]	45.3 [44.6, 46.0]	46.8 [45.7, 47.8]	48.3 [46.8, 49.7]	37.6 [35.8, 39.3]	53.8 [51.8, 55.8]	54.3 [52.1, 56.4]	45.6 [43.2, 48.0]	48.1 [45.6, 50.6]	44.2 [43.4, 45.0]
	60-69	53.9 [53.7, 54.2]	55.1 [54.9, 55.4]	46.8 [45.8, 47.9]	42.6 [40.6, 44.7]	41.1 [39.8, 42.5]	43.7 [40.5, 46.9]	54.0 [50.8, 57.1]	57.0 [53.2, 60.8]	47.1 [43.8, 50.5]	41.6 [37.3, 46.0]	45.5 [44.1, 46.8]
Urban/Rural Residence	Urban	51.2 [51.0, 51.3]	52.3 [52.2, 52.5]	45.8 [45.2, 46.3]	46.0 [45.1, 47.0]	44.7 [43.7, 45.7]	38.9 [37.4, 40.4]	53.8 [52.1, 55.5]	55.7 [53.6, 57.7]	48.5 [46.3, 50.7]	46.4 [44.2, 48.5]	44.7 [44.0, 45.4]
	Rural	45.2 [44.8, 45.5]	45.3 [45.0, 45.7]	27.3 [18.3, 37.8]	39.0 [32.7, 45.5]	36.0 [28.6, 43.8]	44.6 [33.0, 56.6]	69.2 [38.6, 90.9]	50.4 [45.2, 55.6]	38.3 [34.4, 42.3]	80.0 [28.4, 99.5]	41.4 [38.6, 44.4]
Income Quintile	1 (lowest)	43.0 [42.7, 43.3]	42.9 [42.5, 43.2]	44.5 [43.5, 45.6]	43.2 [41.5, 44.8]	43.5 [41.6, 45.4]	34.6 [31.1, 38.2]	50.4 [45.8, 55.0]	49.2 [43.4, 55.0]	42.2 [37.2, 47.4]	41.5 [37.8, 45.2]	41.4 [40.0, 42.8]
	2	48.3 [48.0, 48.6]	48.8 [48.5, 49.2]	47.8 [46.6, 49.1]	45.9 [44.1, 47.7]	44.7 [43.0, 46.4]	42.4 [38.7, 46.1]	52.1 [48.4, 55.9]	47.0 [41.7, 52.4]	43.7 [38.9, 48.6]	50.9 [47.0, 54.9]	43.7 [42.2, 45.2]
	3	51.1 [50.8, 51.4]	51.9 [51.6, 52.2]	47.4 [46.1, 48.7]	48.6 [46.5, 50.8]	45.5 [43.4, 47.7]	43.2 [39.8, 46.7]	57.1 [52.5, 61.5]	55.3 [50.8, 59.7]	44.6 [40.0, 49.3]	46.4 [41.3, 51.5]	45.1 [43.6, 46.7]
	4	52.7 [52.4, 53.0]	53.5 [53.2, 53.8]	45.0 [43.6, 46.5]	48.8 [46.0, 51.5]	43.0 [39.9, 46.0]	39.6 [36.3, 42.9]	53.9 [50.2, 57.6]	55.6 [51.7, 59.5]	47.3 [42.9, 51.7]	48.2 [41.5, 55.0]	46.3 [44.6, 47.9]
	5 (highest)	55.7 [55.4, 56.0]	56.8 [56.5, 57.1]	43.4 [41.9, 44.9]	46.1 [42.6, 49.7]	46.9 [43.2, 50.5]	36.5 [33.3, 39.9]	56.0 [52.8, 59.1]	59.9 [56.6, 63.2]	49.7 [46.1, 53.3]	49.1 [39.6, 58.7]	48.0 [46.3, 49.7]
# Major ADGs	0	48.3 [48.1, 48.4]	49.6 [49.4, 49.8]	41.1 [40.4, 41.8]	43.3 [42.1, 44.4]	41.2 [39.9, 42.5]	34.0 [32.2, 35.8]	49.4 [47.2, 51.5]	53.8 [51.4, 56.2]	44.0 [41.6, 46.5]	43.4 [40.7, 46.1]	41.7 [40.9, 42.6]
	1	54.4 [54.1, 54.6]	54.6 [54.3, 54.9]	57.6 [56.3, 58.9]	51.4 [49.4, 53.4]	48.0 [46.1, 49.8]	51.2 [47.6, 54.7]	60.4 [57.0, 63.7]	58.0 [54.1, 61.8]	50.3 [46.3, 54.4]	55.0 [50.5, 59.5]	49.2 [47.7, 50.6]
	2	53.6 [53.1, 54.0]	53.3 [52.9, 53.8]	60.3 [57.8, 62.7]	52.3 [48.5, 56.1]	51.2 [48.0, 54.4]	58.7 [51.6, 65.4]	59.4 [53.7, 64.8]	53.7 [46.0, 61.3]	50.0 [43.1, 56.9]	52.5 [43.9, 60.9]	53.0 [50.4, 55.5]
	3+	47.8 [47.2, 48.5]	47.2 [46.5, 47.9]	63.1 [58.6, 67.4]	54.3 [47.5, 61.0]	52.5 [47.2, 57.8]	53.8 [39.5, 67.8]	68.8 [59.2, 77.3]	56.7 [43.2, 69.4]	51.4 [39.3, 63.3]	31.9 [19.1, 47.1]	45.1 [41.0, 49.3]
	Unknown	50.7 [49.9, 51.4]	51.7 [50.9, 52.5]	45.7 [42.5, 49.0]	44.5 [39.2, 49.9]	43.9 [38.2, 49.7]	39.3 [31.3, 47.8]	57.9 [48.3, 67.1]	55.3 [44.1, 66.1]	40.9 [30.8, 51.5]	44.0 [32.5, 55.9]	44.3 [40.2, 48.4]
# PCP Visits	0	14.3 [13.9, 14.7]	16.4 [16.0, 16.9]	5.6 [5.0, 6.4]	10.7 [8.3, 13.5]	8.6 [5.6, 12.5]	6.4 [4.6, 8.6]	9.4 [6.1, 13.6]	16.7 [11.5, 23.1]	13.1 [8.5, 19.0]	8.6 [4.4, 14.9]	12.2 [10.5, 14.0]
	1-4	43.1 [42.8, 43.4]	44.6 [44.3, 44.9]	33.6 [32.4, 34.7]	33.8 [31.8, 35.9]	27.5 [24.5, 30.6]	30.0 [27.1, 33.1]	38.5 [33.7, 43.5]	45.5 [41.6, 49.4]	38.1 [34.3, 42.0]	33.2 [28.0, 38.7]	35.3 [33.8, 36.8]
	5-9	54.2 [54.0, 54.5]	55.1 [54.9, 55.4]	51.5 [50.4, 52.6]	47.2 [45.5, 48.9]	40.4 [38.2, 42.7]	44.7 [41.8, 47.7]	52.8 [49.2, 56.3]	60.6 [57.3, 63.9]	52.4 [48.8, 55.9]	46.0 [41.7, 50.3]	46.4 [45.1, 47.7]

Variable	Subgroup	Population (N=537,783)	Non-immigrant (N=451,881)	CMHT (N=30,185)	Philippines (N=10,911)	India (N=9,958)	South Korea (N=4,028)	Iran (N=3,517)	United Kingdom (N=2,692)	United States (N=2,572)	Vietnam (N=2,089)	Other Immigrants (N=19,950)
	10-14	57.0 [56.7, 57.3]	57.5 [57.2, 57.8]	60.5 [59.2, 61.7]	51.9 [50.0, 53.9]	45.1 [43.0, 47.2]	50.4 [46.7, 54.1]	60.2 [56.7, 63.7]	65.6 [61.4, 69.7]	55.7 [51.2, 60.2]	49.2 [44.6, 53.8]	51.8 [50.2, 53.3]
	15+	55.0 [54.8, 55.3]	54.4 [54.1, 54.7]	67.3 [66.1, 68.5]	56.3 [54.3, 58.3]	51.1 [49.6, 52.5]	60.6 [56.7, 64.4]	64.1 [61.4, 66.7]	59.4 [55.0, 63.8]	48.8 [44.2, 53.5]	58.9 [55.0, 62.8]	53.3 [51.9, 54.7]
Prior Screening	Yes	65.1 [65.0, 65.3]	65.7 [65.5, 65.8]	61.1 [60.4, 61.7]	63.3 [62.2, 64.4]	64.3 [63.0, 65.5]	53.4 [51.6, 55.3]	64.7 [62.8, 66.5]	69.5 [67.4, 71.5]	63.3 [61.0, 65.6]	61.4 [58.9, 63.9]	61.4 [60.6, 62.2]
Years of residence in Canada †	< 5	37.0 [35.8, 38.2]	NA	33.5 [31.1, 36.1]	37.2 [34.1, 40.4]	34.9 [32.5, 37.3]	25.0 [19.7, 30.9]	54.9 [49.0, 60.7]	53.7 [46.8, 60.4]	41.7 [36.0, 47.6]	48.1 [34.3, 62.2]	36.9 [34.0, 39.8]
	5 - 9	39.3 [38.5, 40.2]		35.8 [34.2, 37.3]	43.1 [40.5, 45.7]	38.6 [36.7, 40.5]	29.9 [26.7, 33.3]	55.0 [51.0, 58.9]	52.0 [46.8, 57.1]	42.4 [38.3, 46.6]	35.8 [27.8, 44.4]	39.6 [37.6, 41.6]
	10 - 19	45.9 [45.4, 46.3]		45.4 [44.6, 46.1]	45.6 [44.2, 47.0]	48.7 [47.2, 50.1]	40.8 [38.8, 42.8]	53.6 [51.3, 56.0]	54.0 [50.5, 57.5]	47.6 [43.9, 51.3]	47.4 [43.3, 51.6]	44.2 [43.1, 45.3]
	20+	50.6 [50.0, 51.2]		54.2 [53.1, 55.4]	49.6 [47.9, 51.2]	53.0 [50.1, 55.8]	48.1 [44.3, 52.0]	53.0 [49.4, 56.6]	56.6 [53.9, 59.4]	48.4 [45.3, 51.5]	47.1 [44.4, 49.8]	47.4 [46.3, 48.5]

PCP = Primary care physician; ADG = aggregate diagnosis group; CMHT = China, Macau, Hong Kong, Taiwan

† Years of residence in Canada for the "Population" column refers to the pooled group of all immigrants

Table 3.5: Characteristics of screening retention cohort

Variable	Subgroup	Non-immigrant (N=245,123)	CMHT (N=12,863)	Philippines (N=4,324)	India (N=4,054)	Iran (N=1,716)	South Korea (N=1,553)	United Kingdom (N=1,318)	United States (N=1,141)	Vietnam (N=849)	Other Immigrants (N=8,111)
Age	50-59	146034 (59.6%)	9505 (73.9%)	3566 (82.5%)	2190 (54.0%)	1289 (75.1%)	1148 (73.9%)	973 (73.8%)	797 (69.9%)	662 (78.0%)	6098 (75.2%)
	60-69	99089 (40.4%)	3358 (26.1%)	758 (17.5%)	1864 (46.0%)	427 (24.9%)	405 (26.1%)	345 (26.2%)	344 (30.1%)	187 (22.0%)	2013 (24.8%)
Urban/Rural Residence	Urban	209059 (85.3%)	12844 (99.9%)	4239 (98.0%)	3998 (98.6%)	1707 (99.5%)	1520 (97.9%)	1127 (85.5%)	905 (79.3%)	848 (99.9%)	7689 (94.8%)
	Unknown	26 (0.0%)	0 (0.0%)	0 (0.0%)	<5 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Income Quintile	1 (lowest)	35448 (14.5%)	3441 (26.8%)	1364 (31.5%)	1147 (28.3%)	221 (12.9%)	274 (17.6%)	140 (10.6%)	152 (13.3%)	274 (32.3%)	1819 (22.4%)
	2	42973 (17.5%)	2950 (22.9%)	1181 (27.3%)	1380 (34.0%)	343 (20.0%)	285 (18.4%)	173 (13.1%)	171 (15.0%)	284 (33.5%)	1760 (21.7%)
	3	48975 (20.0%)	2685 (20.9%)	872 (20.2%)	816 (20.1%)	247 (14.4%)	318 (20.5%)	258 (19.6%)	209 (18.3%)	162 (19.1%)	1582 (19.5%)
	4	54898 (22.4%)	1946 (15.1%)	550 (12.7%)	435 (10.7%)	369 (21.5%)	324 (20.9%)	304 (23.1%)	242 (21.2%)	82 (9.7%)	1441 (17.8%)
	5 (highest)	61036 (24.9%)	1768 (13.7%)	333 (7.7%)	271 (6.7%)	500 (29.1%)	338 (21.8%)	437 (33.2%)	353 (30.9%)	44 (5.2%)	1458 (18.0%)
	Unknown	1793 (0.7%)	73 (0.6%)	24 (0.6%)	5 (0.1%)	36 (2.1%)	14 (0.9%)	6 (0.5%)	14 (1.2%)	<5 (<0.6%)	51 (0.6%)
# Major ADGs	0	132370 (54.0%)	7467 (58.1%)	2497 (57.7%)	2080 (51.3%)	934 (54.4%)	863 (55.6%)	749 (56.8%)	597 (52.3%)	473 (55.7%)	4336 (53.5%)
	1	62882 (25.7%)	2944 (22.9%)	1029 (23.8%)	1104 (27.2%)	429 (25.0%)	380 (24.5%)	332 (25.2%)	283 (24.8%)	207 (24.4%)	2078 (25.6%)
	2	21292 (8.7%)	936 (7.3%)	312 (7.2%)	370 (9.1%)	154 (9.0%)	91 (5.9%)	95 (7.2%)	96 (8.4%)	67 (7.9%)	698 (8.6%)
	3+	8162 (3.3%)	323 (2.5%)	125 (2.9%)	152 (3.7%)	52 (3.0%)	36 (2.3%)	34 (2.6%)	34 (3.0%)	26 (3.1%)	219 (2.7%)
	Unknown	20417 (8.3%)	1193 (9.3%)	361 (8.3%)	348 (8.6%)	147 (8.6%)	183 (11.8%)	108 (8.2%)	131 (11.5%)	76 (9.0%)	780 (9.6%)
# PCP Visits	Median [IQR]	9.0 [5.0 - 15.0]	10.0 [6.0 - 16.0]	11.0 [6.0 - 16.0]	15.0 [10.0 - 23.0]	13.0 [9.0 - 20.0]	9.0 [6.0 - 14.0]	9.0 [5.0 - 13.0]	8.0 [5.0 - 13.0]	13.0 [8.0 - 19.0]	10.0 [6.0 - 16.0]
	0	3579 (1.5%)	177 (1.4%)	51 (1.2%)	14 (0.3%)	8 (0.5%)	27 (1.7%)	24 (1.8%)	17 (1.5%)	<5 (<0.6%)	120 (1.5%)
	1-4	44110 (18.0%)	1897 (14.7%)	576 (13.3%)	181 (4.5%)	138 (8.0%)	270 (17.4%)	261 (19.8%)	264 (23.1%)	77 (9.1%)	1289 (15.9%)
	5-9	77668 (31.7%)	3754 (29.2%)	1244 (28.8%)	726 (17.9%)	368 (21.4%)	504 (32.5%)	449 (34.1%)	391 (34.3%)	195 (23.0%)	2333 (28.8%)
	10-14	56323 (23.0%)	3195 (24.8%)	1172 (27.1%)	946 (23.3%)	419 (24.4%)	384 (24.7%)	300 (22.8%)	232 (20.3%)	211 (24.9%)	1777 (21.9%)
	15+	63443 (25.9%)	3840 (29.9%)	1281 (29.6%)	2187 (53.9%)	783 (45.6%)	368 (23.7%)	284 (21.5%)	237 (20.8%)	363 (42.8%)	2592 (32.0%)
Family History of Breast Cancer	Yes	36258 (14.8%)	1088 (8.5%)	390 (9.0%)	190 (4.7%)	148 (8.6%)	96 (6.2%)	156 (11.8%)	195 (17.1%)	53 (6.2%)	750 (9.2%)
	Unknown	16359 (6.7%)	674 (5.2%)	272 (6.3%)	269 (6.6%)	90 (5.2%)	83 (5.3%)	80 (6.1%)	59 (5.2%)	66 (7.8%)	538 (6.6%)
Prior Screening	Yes	231474 (94.4%)	12048 (93.7%)	3830 (88.6%)	3135 (77.3%)	1520 (88.6%)	1377 (88.7%)	1215 (92.2%)	1029 (90.2%)	768 (90.5%)	7242 (89.3%)
Index screen result	Abnormal	16118 (6.6%)	646 (5.0%)	370 (8.6%)	384 (9.5%)	128 (7.5%)	68 (4.4%)	89 (6.8%)	90 (7.9%)	50 (5.9%)	627 (7.7%)
Years of residence in Canada	Median [IQR]	NA	15.8 [13.1 - 18.7]	16.7 [11.6 - 19.8]	11.8 [7.6 - 16.0]	13.0 [8.6 - 18.1]	13.9 [10.5 - 17.9]	18.1 [11.1 - 21.9]	16.2 [7.0 - 21.8]	19.7 [16.6 - 22.6]	17.4 [12.0 - 21.3]
	< 5		451 (3.5%)	367 (8.5%)	571 (14.1%)	180 (10.5%)	75 (4.8%)	121 (9.2%)	195 (17.1%)	31 (3.7%)	428 (5.3%)
	5 - 9		1302 (10.1%)	516 (11.9%)	1049 (25.9%)	360 (21.0%)	271 (17.5%)	176 (13.4%)	185 (16.2%)	51 (6.0%)	1033 (12.7%)
	10 - 19		8900 (69.2%)	2429 (56.2%)	2031 (50.1%)	908 (52.9%)	975 (62.8%)	520 (39.5%)	397 (34.8%)	369 (43.5%)	3926 (48.4%)
	20+		2210 (17.2%)	1012 (23.4%)	403 (9.9%)	268 (15.6%)	232 (14.9%)	501 (38.0%)	364 (31.9%)	398 (46.9%)	2724 (33.6%)

IQR = Inter-quartile range; PCP = Primary care physician; ADG = aggregate diagnosis group; CMHT = China, Macau, Hong Kong, Taiwan

Table 3.6: 30-month screening retention rates for screening eligible women by study factors

Variable	Subgroup	Population (N=281,052)	Non-immigrant (N=245,123)	CMHT (N=12,863)	Philippines (N=4,324)	India (N=4,054)	Iran (N=1,716)	South Korea (N=1,553)	United Kingdom (N=1,318)	United States (N=1,141)	Vietnam (N=849)	Other Immigrants (N=8,111)
All women	All women	74.0 [73.9, 74.2]	74.4 [74.2, 74.5]	73.9 [73.2, 74.7]	71.8 [70.4, 73.1]	69.8 [68.4, 71.2]	70.6 [68.4, 72.8]	64.9 [62.5, 67.3]	77.4 [75.0, 79.6]	68.6 [65.8, 71.3]	74.4 [71.4, 77.3]	70.8 [69.8, 71.8]
Age (index screen)	50-59	71.6 [71.3, 71.8]	71.6 [71.3, 71.8]	73.0 [72.1, 73.9]	72.1 [70.6, 73.5]	70.2 [68.2, 72.1]	71.1 [68.5, 73.5]	63.0 [60.1, 65.8]	76.9 [74.1, 79.5]	67.4 [64.0, 70.6]	75.2 [71.8, 78.5]	70.0 [68.9, 71.2]
	60-69	78.0 [77.7, 78.2]	78.5 [78.2, 78.7]	76.6 [75.2, 78.0]	70.3 [66.9, 73.6]	69.4 [67.3, 71.5]	69.3 [64.7, 73.7]	70.4 [65.7, 74.8]	78.8 [74.1, 83.0]	71.5 [66.4, 76.2]	71.7 [64.6, 78.0]	73.3 [71.3, 75.2]
Urban/Rural residence	Urban	74.8 [74.6, 75.0]	75.2 [75.1, 75.4]	73.9 [73.2, 74.7]	71.9 [70.5, 73.2]	70.0 [68.6, 71.4]	70.5 [68.2, 72.6]	64.8 [62.3, 67.2]	78.2 [75.6, 80.6]	70.9 [67.9, 73.9]	74.4 [71.3, 77.3]	71.1 [70.0, 72.1]
	Rural	69.1 [68.7, 69.6]	69.2 [68.7, 69.7]	84.2 [60.4, 96.6]	65.9 [54.8, 75.8]	57.4 [43.2, 70.8]	100.0 [66.4, 100.0]	69.7 [51.3, 84.4]	72.8 [65.9, 79.0]	59.7 [53.2, 66.1]	100.0 [2.5, 100.0]	66.6 [61.9, 71.1]
Income quintile	1 (lowest)	70.8 [70.4, 71.3]	70.8 [70.3, 71.3]	72.8 [71.3, 74.3]	71.0 [68.6, 73.4]	69.1 [66.4, 71.8]	71.5 [65.1, 77.3]	58.8 [52.7, 64.6]	74.3 [66.2, 81.3]	66.4 [58.3, 73.9]	71.9 [66.2, 77.1]	70.1 [68.0, 72.2]
	2	73.4 [73.0, 73.7]	73.7 [73.3, 74.1]	73.7 [72.1, 75.3]	71.5 [68.8, 74.0]	70.2 [67.7, 72.6]	73.2 [68.2, 77.8]	68.4 [62.7, 73.8]	82.7 [76.2, 88.0]	63.2 [55.5, 70.4]	74.3 [68.8, 79.3]	69.0 [66.8, 71.1]
	3	74.3 [73.9, 74.6]	74.5 [74.1, 74.9]	75.3 [73.6, 76.9]	72.7 [69.6, 75.6]	70.8 [67.6, 73.9]	68.0 [61.8, 73.8]	66.0 [60.5, 71.2]	74.8 [69.0, 80.0]	69.9 [63.1, 76.0]	80.2 [73.3, 86.1]	70.7 [68.4, 73.0]
	4	74.9 [74.6, 75.2]	75.1 [74.8, 75.5]	74.8 [72.8, 76.7]	70.9 [66.9, 74.7]	69.7 [65.1, 73.9]	69.9 [65.0, 74.6]	67.9 [62.5, 73.0]	77.6 [72.5, 82.2]	71.1 [64.9, 76.7]	76.8 [66.2, 85.4]	72.6 [70.2, 74.9]
	5 (highest)	75.9 [75.5, 76.2]	76.2 [75.9, 76.5]	73.3 [71.2, 75.4]	74.5 [69.4, 79.1]	68.3 [62.4, 73.8]	70.6 [66.4, 74.6]	63.3 [57.9, 68.5]	78.3 [74.1, 82.0]	69.4 [64.3, 74.2]	63.6 [47.8, 77.6]	72.7 [70.3, 75.0]
# Major ADGs	0	79.9 [79.7, 80.1]	80.2 [80.0, 80.4]	79.8 [78.9, 80.7]	76.8 [75.1, 78.4]	75.4 [73.5, 77.2]	77.4 [74.6, 80.1]	71.1 [68.0, 74.2]	83.4 [80.6, 86.0]	77.7 [74.2, 81.0]	79.9 [76.0, 83.4]	76.8 [75.5, 78.0]
	1	80.5 [80.2, 80.8]	80.7 [80.4, 81.0]	82.3 [80.9, 83.7]	80.3 [77.7, 82.7]	75.8 [73.2, 78.3]	77.6 [73.4, 81.5]	75.5 [70.9, 79.8]	83.1 [78.7, 87.0]	71.0 [65.4, 76.2]	83.1 [77.3, 87.9]	77.5 [75.6, 79.3]
	2	80.3 [79.8, 80.8]	80.5 [80.0, 81.0]	81.4 [78.8, 83.9]	76.9 [71.8, 81.5]	76.2 [71.5, 80.5]	71.4 [63.6, 78.4]	75.8 [65.7, 84.2]	75.8 [65.9, 84.0]	69.8 [59.6, 78.7]	86.6 [76.0, 93.7]	80.7 [77.5, 83.5]
	3+	79.7 [78.8, 80.5]	79.7 [78.8, 80.5]	81.4 [76.7, 85.5]	80.0 [71.9, 86.6]	80.9 [73.8, 86.8]	73.1 [59.0, 84.4]	72.2 [54.8, 85.8]	82.4 [65.5, 93.2]	82.4 [65.5, 93.2]	80.8 [60.6, 93.4]	78.1 [72.0, 83.4]
	Unknown	8.4 [8.0, 8.7]	8.3 [8.0, 8.7]	8.9 [7.3, 10.6]	5.5 [3.4, 8.4]	6.0 [3.8, 9.1]	5.4 [2.4, 10.4]	6.6 [3.4, 11.2]	17.6 [10.9, 26.1]	17.6 [11.5, 25.2]	3.9 [0.8, 11.1]	9.2 [7.3, 11.5]
Index screen result	Normal	74.6 [74.4, 74.7]	74.9 [74.7, 75.1]	74.3 [73.5, 75.1]	72.2 [70.8, 73.6]	70.3 [68.8, 71.8]	71.5 [69.2, 73.7]	64.9 [62.4, 67.3]	78.2 [75.8, 80.5]	68.8 [65.9, 71.6]	75.3 [72.2, 78.3]	71.4 [70.3, 72.4]
	Abnormal	66.6 [66.0, 67.3]	66.8 [66.1, 67.5]	67.0 [63.3, 70.6]	67.0 [62.0, 71.8]	65.4 [60.4, 70.1]	59.4 [50.3, 68.0]	64.7 [52.2, 75.9]	66.3 [55.5, 76.0]	66.7 [55.9, 76.3]	60.0 [45.2, 73.6]	64.8 [60.9, 68.5]
Prior screening	None	44.4 [43.6, 45.1]	43.3 [42.5, 44.2]	46.4 [42.9, 49.9]	52.6 [48.1, 57.1]	48.9 [45.6, 52.1]	52.0 [44.8, 59.2]	40.3 [33.0, 48.0]	61.2 [51.1, 70.6]	42.9 [33.5, 52.6]	44.4 [33.4, 55.9]	46.1 [42.8, 49.5]

Variable	Subgroup	Population (N=281,052)	Non-immigrant (N=245,123)	CMHT (N=12,863)	Philippines (N=4,324)	India (N=4,054)	Iran (N=1,716)	South Korea (N=1,553)	United Kingdom (N=1,318)	United States (N=1,141)	Vietnam (N=849)	Other Immigrants (N=8,111)
	Yes	76.0 [75.8, 76.2]	76.2 [76.0, 76.4]	75.8 [75.0, 76.6]	74.2 [72.8, 75.6]	76.0 [74.4, 77.5]	73.0 [70.7, 75.2]	68.0 [65.5, 70.5]	78.8 [76.4, 81.0]	71.4 [68.6, 74.2]	77.6 [74.5, 80.5]	73.8 [72.8, 74.8]
# PCP visits	0	64.4 [62.9, 65.9]	65.5 [64.0, 67.1]	50.8 [43.2, 58.4]	54.9 [40.3, 68.9]	71.4 [41.9, 91.6]	75.0 [34.9, 96.8]	44.4 [25.5, 64.7]	58.3 [36.6, 77.9]	58.8 [32.9, 81.6]	100.0 [29.2, 100.0]	59.2 [49.8, 68.0]
	1-4	70.2 [69.8, 70.6]	70.9 [70.5, 71.3]	63.2 [60.9, 65.3]	64.4 [60.3, 68.3]	64.1 [56.6, 71.1]	58.7 [50.0, 67.0]	56.3 [50.2, 62.3]	73.9 [68.2, 79.2]	65.5 [59.5, 71.2]	64.9 [53.2, 75.5]	65.7 [63.0, 68.3]
	5-9	74.7 [74.4, 75.0]	75.3 [75.0, 75.6]	71.9 [70.4, 73.3]	70.5 [67.9, 73.0]	65.0 [61.4, 68.5]	68.8 [63.7, 73.5]	65.1 [60.7, 69.2]	78.0 [73.8, 81.7]	70.1 [65.3, 74.6]	70.8 [63.8, 77.0]	69.6 [67.7, 71.5]
	10-14	76.0 [75.7, 76.3]	76.2 [75.9, 76.6]	76.7 [75.1, 78.1]	75.1 [72.5, 77.5]	71.9 [68.9, 74.7]	72.8 [68.3, 77.0]	67.2 [62.2, 71.9]	81.3 [76.5, 85.6]	70.3 [63.9, 76.1]	72.5 [66.0, 78.4]	73.7 [71.6, 75.8]
	15+	74.6 [74.3, 74.9]	74.5 [74.1, 74.8]	80.1 [78.8, 81.4]	73.9 [71.4, 76.3]	71.0 [69.1, 72.9]	72.4 [69.1, 75.5]	70.1 [65.1, 74.7]	77.1 [71.8, 81.9]	68.8 [62.5, 74.6]	79.3 [74.8, 83.4]	73.1 [71.3, 74.8]
Years of residence in Canada †	< 5	64.7 [62.8, 66.6]	NA	59.9 [55.2, 64.4]	67.8 [62.8, 72.6]	62.7 [58.6, 66.7]	67.8 [60.4, 74.5]	50.7 [38.9, 62.4]	72.7 [63.9, 80.4]	72.3 [65.5, 78.5]	67.7 [48.6, 83.3]	65.2 [60.5, 69.7]
	5 - 9	67.2 [65.9, 68.5]		65.0 [62.3, 67.6]	70.5 [66.4, 74.4]	68.6 [65.7, 71.4]	70.6 [65.6, 75.2]	57.6 [51.4, 63.5]	81.3 [74.7, 86.7]	63.2 [55.9, 70.2]	64.7 [50.1, 77.6]	66.7 [63.7, 69.6]
	10 - 19	73.3 [72.7, 73.9]		75.0 [74.1, 75.9]	72.5 [70.7, 74.3]	71.6 [69.6, 73.5]	70.5 [67.4, 73.4]	66.2 [63.1, 69.1]	77.9 [74.1, 81.4]	71.0 [66.3, 75.4]	75.9 [71.2, 80.2]	72.7 [71.3, 74.1]
	20+	73.5 [72.5, 74.4]		77.8 [76.0, 79.5]	71.9 [69.1, 74.7]	74.2 [69.6, 78.4]	73.1 [67.4, 78.3]	72.8 [66.6, 78.5]	76.6 [72.7, 80.3]	66.8 [61.7, 71.6]	74.9 [70.3, 79.1]	70.6 [68.8, 72.3]

PCP = Primary care physician; ADG = aggregate diagnosis group; CMHT = China, Macau, Hong Kong, Taiwan

† Years of residence in Canada for the "Population" column refers to the pooled group of all immigrants

Table 3.7: Characteristics of and participation rates for recent immigrants (<10 years since landing) for most common countries of birth among recent immigrants

		CMHT (N=5,021)		India (N=4,072)		Philippines (N=2,329)		South Korea (N=1,006)		Iran (N=930)	
Variable	**Subgroup**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**
Age	50-59	3956 (78.8%)	36.1 [34.6, 37.7]	2139 (52.5%)	41.9 [39.8, 44.0]	1926 (82.7%)	41.7 [39.5, 44.0]	923 (91.7%)	28.8 [25.9, 31.9]	634 (68.2%)	55.4 [51.4, 59.3]
	60-69	1065 (21.2%)	31.4 [28.6, 34.2]	1933 (47.5%)	32.0 [29.9, 34.1]	403 (17.3%)	36.0 [31.3, 40.9]	83 (8.3%)	27.7 [18.4, 38.6]	296 (31.8%)	54.1 [48.2, 59.8]
Urban/Rural residence	Urban	4998 (99.5%)	35.2 [33.9, 36.5]	4012 (98.5%)	37.3 [35.8, 38.8]	2283 (98.0%)	41.0 [38.9, 43.0]	997 (99.1%)	28.3 [25.5, 31.2]	930 (100.0%)	54.9 [51.7, 58.2]
	Rural	22 (0.4%)	22.7 [7.8, 45.4]	60 (1.5%)	30.0 [18.8, 43.2]	46 (2.0%)	30.4 [17.7, 45.8]	9 (0.9%)	NC	0 (0.0%)	NC
	Unknown	<5 (<0.1%)	NC	0 (0.0%)	NC	0 (0.0%)	NC	0 (0.0%)	NC	0 (0.0%)	NC
Income quintile	1 (lowest)	1570 (31.3%)	34.4 [32.0, 36.8]	1098 (27.0%)	37.1 [34.2, 40.0]	803 (34.5%)	40.0 [36.6, 43.5]	197 (19.6%)	24.4 [18.5, 31.0]	136 (14.6%)	50.0 [41.3, 58.7]
	2	1143 (22.8%)	37.4 [34.6, 40.3]	1489 (36.6%)	38.1 [35.6, 40.6]	697 (29.9%)	39.2 [35.5, 42.9]	178 (17.7%)	29.8 [23.2, 37.1]	186 (20.0%)	57.0 [49.5, 64.2]
	3	887 (17.7%)	35.2 [32.0, 38.4]	858 (21.1%)	37.3 [34.1, 40.6]	427 (18.3%)	43.8 [39.0, 48.6]	202 (20.1%)	35.1 [28.6, 42.2]	108 (11.6%)	58.3 [48.5, 67.7]
	4	646 (12.9%)	33.0 [29.4, 36.7]	386 (9.5%)	33.7 [29.0, 38.6]	242 (10.4%)	44.2 [37.9, 50.7]	220 (21.9%)	32.3 [26.1, 38.9]	210 (22.6%)	55.7 [48.7, 62.5]
	5 (highest)	702 (14.0%)	35.6 [32.1, 39.3]	239 (5.9%)	37.2 [31.1, 43.7]	148 (6.4%)	39.2 [31.3, 47.5]	181 (18.0%)	24.9 [18.7, 31.8]	241 (25.9%)	56.0 [49.5, 62.4]
	Unknown	73 (1.5%)	28.8 [18.8, 40.6]	<5 (<0.1%)	NC	12 (0.5%)	25.0 [5.5, 57.2]	28 (2.8%)	3.6 [0.1, 18.3]	49 (5.3%)	44.9 [30.7, 59.8]
Education level	None	48 (1.0%)	22.9 [12.0, 37.3]	2015 (49.5%)	31.2 [29.1, 33.2]	37 (1.6%)	32.4 [18.0, 49.8]	8 (0.8%)	50.0 [15.7, 84.3]	18 (1.9%)	55.6 [30.8, 78.5]
	Secondary or less	2477 (49.3%)	35.7 [33.8, 37.6]	1417 (34.8%)	41.8 [39.3, 44.5]	246 (10.6%)	31.3 [25.6, 37.5]	316 (31.4%)	26.9 [22.1, 32.1]	394 (42.4%)	55.8 [50.8, 60.8]
	Diploma/Certificate/Some University	1525 (30.4%)	36.3 [33.9, 38.8]	127 (3.1%)	47.2 [38.3, 56.3]	440 (18.9%)	40.7 [36.1, 45.4]	198 (19.7%)	28.8 [22.6, 35.6]	124 (13.3%)	62.1 [52.9, 70.7]
	Undergraduate	750 (14.9%)	33.3 [30.0, 36.8]	306 (7.5%)	48.4 [42.6, 54.1]	1453 (62.4%)	42.3 [39.7, 44.8]	368 (36.6%)	29.3 [24.7, 34.3]	262 (28.2%)	55.0 [48.7, 61.1]
	Graduate	221 (4.4%)	29.4 [23.5, 35.9]	207 (5.1%)	41.1 [34.3, 48.1]	153 (6.6%)	43.8 [35.8, 52.0]	116 (11.5%)	30.2 [22.0, 39.4]	132 (14.2%)	45.5 [36.8, 54.3]
Canadian language skill	English/French	1080 (21.5%)	35.9 [33.1, 38.9]	975 (23.9%)	42.7 [39.5, 45.8]	2171 (93.2%)	40.9 [38.8, 43.0]	513 (51.0%)	28.5 [24.6, 32.6]	616 (66.2%)	54.2 [50.2, 58.2]
	None	3941 (78.5%)	34.9 [33.4, 36.4]	3097 (76.1%)	35.5 [33.8, 37.2]	158 (6.8%)	39.2 [31.6, 47.3]	493 (49.0%)	29.0 [25.0, 33.2]	314 (33.8%)	56.4 [50.7, 61.9]

		CMHT (N=5,021)		India (N=4,072)		Philippines (N=2,329)		South Korea (N=1,006)		Iran (N=930)	
Variable	**Subgroup**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**
Applicant type	Principal	2017 (40.2%)	36.7 [34.6, 38.9]	925 (22.7%)	35.0 [32.0, 38.2]	1725 (74.1%)	39.7 [37.3, 42.0]	292 (29.0%)	30.5 [25.3, 36.1]	336 (36.1%)	52.4 [46.9, 57.8]
	Dependent	3004 (59.8%)	34.1 [32.4, 35.8]	3147 (77.3%)	37.8 [36.1, 39.5]	604 (25.9%)	43.9 [39.9, 47.9]	714 (71.0%)	28.0 [24.7, 31.5]	594 (63.9%)	56.4 [52.3, 60.4]
Immigration class	Economic	3126 (62.3%)	33.8 [32.1, 35.5]	372 (9.1%)	42.5 [37.4, 47.7]	1775 (76.2%)	41.9 [39.6, 44.3]	847 (84.2%)	29.0 [26.0, 32.2]	537 (57.7%)	54.2 [49.9, 58.5]
	Family	1682 (33.5%)	37.0 [34.7, 39.4]	3647 (89.6%)	36.6 [35.0, 38.1]	519 (22.3%)	36.8 [32.6, 41.1]	133 (13.2%)	27.1 [19.7, 35.5]	272 (29.2%)	56.3 [50.1, 62.2]
	Refugee	138 (2.7%)	41.3 [33.0, 50.0]	35 (0.9%)	48.6 [31.4, 66.0]	7 (0.3%)	NC	11 (1.1%)	36.4 [10.9, 69.2]	92 (9.9%)	57.6 [46.9, 67.9]
	Other	75 (1.5%)	37.3 [26.4, 49.3]	18 (0.4%)	33.3 [13.3, 59.0]	28 (1.2%)	50.0 [30.6, 69.4]	15 (1.5%)	20.0 [4.3, 48.1]	29 (3.1%)	48.3 [29.4, 67.5]
# Major ADGs	0	3693 (73.6%)	32.1 [30.6, 33.6]	2427 (59.6%)	34.8 [32.9, 36.7]	1624 (69.7%)	38.5 [36.2, 41.0]	759 (75.4%)	24.9 [21.9, 28.1]	570 (61.3%)	51.1 [46.9, 55.2]
	1	892 (17.8%)	44.6 [41.3, 48.0]	1088 (26.7%)	39.7 [36.8, 42.7]	478 (20.5%)	46.9 [42.3, 51.4]	160 (15.9%)	38.1 [30.6, 46.1]	221 (23.8%)	59.3 [52.5, 65.8]
	2	229 (4.6%)	44.1 [37.6, 50.8]	314 (7.7%)	42.7 [37.1, 48.4]	126 (5.4%)	46.0 [37.1, 55.1]	47 (4.7%)	48.9 [34.1, 63.9]	88 (9.5%)	58.0 [47.0, 68.4]
	3+	56 (1.1%)	37.5 [24.9, 51.5]	120 (2.9%)	47.5 [38.3, 56.8]	35 (1.5%)	42.9 [26.3, 60.6]	8 (0.8%)	NC	20 (2.2%)	75.0 [50.9, 91.3]
	Unknown	151 (3.0%)	39.1 [31.2, 47.3]	123 (3.0%)	37.4 [28.8, 46.6]	66 (2.8%)	39.4 [27.6, 52.2]	32 (3.2%)	34.4 [18.6, 53.2]	31 (3.3%)	74.2 [55.4, 88.1]
# PCP visits	Median [IQR]	6.0 [2.0 - 11.0]		13.0 [7.0 - 19.0]		8.0 [5.0 - 13.0]		5.0 [1.0 - 9.0]		11.0 [6.0 - 17.0]	
	0	769 (15.3%)	6.1 [4.5, 8.0]	129 (3.2%)	10.9 [6.1, 17.5]	120 (5.2%)	10.8 [5.9, 17.8]	211 (21.0%)	5.2 [2.6, 9.1]	57 (6.1%)	8.8 [2.9, 19.3]
	1-4	1310 (26.1%)	27.4 [25.0, 29.9]	425 (10.4%)	22.8 [18.9, 27.1]	442 (19.0%)	29.4 [25.2, 33.9]	271 (26.9%)	26.2 [21.1, 31.9]	119 (12.8%)	37.0 [28.3, 46.3]
	5-9	1425 (28.4%)	42.5 [39.9, 45.1]	847 (20.8%)	33.4 [30.2, 36.7]	772 (33.1%)	43.3 [39.7, 46.8]	279 (27.7%)	33.7 [28.2, 39.6]	219 (23.5%)	57.1 [50.2, 63.7]
	10+	1517 (30.2%)	49.6 [47.0, 52.1]	2671 (65.6%)	41.9 [40.1, 43.8]	995 (42.7%)	47.4 [44.3, 50.6]	245 (24.4%)	46.1 [39.8, 52.6]	535 (57.5%)	63.0 [58.7, 67.1]

IQR = Inter-quartile range; PCP = Primary care physician; NC = Not calculated due to sample size < 10; PR = Participation rate; N = Sample size; ADG = aggregate diagnosis group; CMHT = China, Macau, Hong Kong, Taiwan

		United States (N=849)		United Kingdom (N=599)		Former USSR State (N=473)		Other Immigrants (N=3,216)	
Variable	**Subgroup**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**
Age	50-59	543 (64.0%)	41.3 [37.1, 45.5]	465 (77.6%)	52.5 [47.8, 57.1]	347 (73.4%)	38.0 [32.9, 43.4]	2362 (73.4%)	40.4 [38.4, 42.4]
	60-69	306 (36.0%)	43.8 [38.2, 49.6]	134 (22.4%)	53.0 [44.2, 61.7]	126 (26.6%)	27.0 [19.5, 35.6]	854 (26.6%)	36.2 [33.0, 39.5]
Urban/Rural residence	Urban	636 (74.9%)	44.2 [40.3, 48.1]	496 (82.8%)	52.8 [48.3, 57.3]	451 (95.3%)	34.6 [30.2, 39.2]	3027 (94.1%)	39.3 [37.6, 41.1]
	Rural	213 (25.1%)	36.2 [29.7, 43.0]	103 (17.2%)	51.5 [41.4, 61.4]	22 (4.7%)	45.5 [24.4, 67.8]	188 (5.8%)	38.8 [31.8, 46.2]
	Unknown	0 (0.0%)	NC	0 (0.0%)	NC	0 (0.0%)	NC	<5 (<0.2%)	NC
Income quintile	1 (lowest)	144 (17.0%)	43.1 [34.8, 51.6]	61 (10.2%)	62.3 [49.0, 74.4]	136 (28.8%)	28.7 [21.3, 37.1]	943 (29.3%)	38.3 [35.2, 41.5]
	2	151 (17.8%)	41.7 [33.8, 50.0]	70 (11.7%)	37.1 [25.9, 49.5]	109 (23.0%)	39.4 [30.2, 49.3]	708 (22.0%)	38.8 [35.2, 42.5]
	3	153 (18.0%)	39.9 [32.1, 48.1]	104 (17.4%)	47.1 [37.2, 57.2]	92 (19.5%)	32.6 [23.2, 43.2]	587 (18.3%)	41.2 [37.2, 45.3]
	4	162 (19.1%)	39.5 [31.9, 47.5]	151 (25.2%)	51.7 [43.4, 59.9]	77 (16.3%)	42.9 [31.6, 54.6]	480 (14.9%)	37.5 [33.2, 42.0]
	5 (highest)	231 (27.2%)	44.6 [38.1, 51.2]	211 (35.2%)	58.3 [51.3, 65.0]	51 (10.8%)	35.3 [22.4, 49.9]	470 (14.6%)	43.0 [38.5, 47.6]
	Unknown	8 (0.9%)	NC	<5 (<0.8%)	NC	8 (1.7%)	NC	28 (0.9%)	14.3 [4.0, 32.7]
Education level	None	10 (1.2%)	20.0 [2.5, 55.6]	67 (11.2%)	55.2 [42.6, 67.4]	<5 (<1.1%)	NC	231 (7.2%)	32.0 [26.1, 38.5]
	Secondary or less	169 (19.9%)	35.5 [28.3, 43.2]	156 (26.0%)	48.7 [40.6, 56.8]	37 (7.8%)	21.6 [9.8, 38.2]	1161 (36.1%)	36.6 [33.8, 39.5]
	Diploma/Certificate/Some University	160 (18.8%)	36.3 [28.8, 44.2]	239 (39.9%)	53.1 [46.6, 59.6]	121 (25.6%)	27.3 [19.6, 36.1]	799 (24.8%)	39.8 [36.4, 43.3]
	Undergraduate	260 (30.6%)	43.8 [37.7, 50.1]	94 (15.7%)	51.1 [40.5, 61.5]	217 (45.9%)	41.0 [34.4, 47.9]	688 (21.4%)	43.0 [39.3, 46.8]
	Graduate	250 (29.4%)	49.6 [43.2, 56.0]	43 (7.2%)	62.8 [46.7, 77.0]	97 (20.5%)	36.1 [26.6, 46.5]	337 (10.5%)	44.8 [39.4, 50.3]
Canadian language skill	English/French	845 (99.5%)	42.1 [38.8, 45.5]	597 (99.7%)	52.6 [48.5, 56.7]	252 (53.3%)	38.5 [32.5, 44.8]	2408 (74.9%)	40.6 [38.6, 42.6]
	None	<5 (<0.6%)	NC	<5 (<0.8%)	NC	221 (46.7%)	31.2 [25.2, 37.8]	808 (25.1%)	35.4 [32.1, 38.8]
Applicant type	Principal	608 (71.6%)	43.1 [39.1, 47.1]	291 (48.6%)	47.8 [41.9, 53.7]	268 (56.7%)	40.3 [34.4, 46.4]	1867 (58.1%)	38.5 [36.3, 40.8]

		United States (N=849)		United Kingdom (N=599)		Former USSR State (N=473)		Other Immigrants (N=3,216)	
Variable	**Subgroup**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**
	Dependent	241 (28.4%)	39.8 [33.6, 46.3]	308 (51.4%)	57.1 [51.4, 62.7]	205 (43.3%)	28.3 [22.2, 35.0]	1349 (41.9%)	40.4 [37.8, 43.1]
Immigration class	Economic	421 (49.6%)	44.7 [39.8, 49.5]	422 (70.5%)	52.8 [48.0, 57.7]	252 (53.3%)	33.7 [27.9, 39.9]	1243 (38.7%)	40.3 [37.6, 43.1]
	Family	381 (44.9%)	40.9 [36.0, 46.1]	153 (25.5%)	52.3 [44.1, 60.4]	176 (37.2%)	40.3 [33.0, 48.0]	1263 (39.3%)	38.1 [35.4, 40.8]
	Refugee	0 (0.0%)	NC	0 (0.0%)	NC	22 (4.7%)	18.2 [5.2, 40.3]	561 (17.4%)	40.1 [36.0, 44.3]
	Other	47 (5.5%)	29.8 [17.3, 44.9]	24 (4.0%)	50.0 [29.1, 70.9]	23 (4.9%)	26.1 [10.2, 48.4]	149 (4.6%)	38.3 [30.4, 46.6]
# Major ADG's	0	500 (58.9%)	39.8 [35.5, 44.2]	387 (64.6%)	52.7 [47.6, 57.8]	333 (70.4%)	33.0 [28.0, 38.4]	2090 (65.0%)	36.4 [34.3, 38.5]
	1	228 (26.9%)	46.9 [40.3, 53.6]	151 (25.2%)	57.0 [48.7, 65.0]	91 (19.2%)	44.0 [33.6, 54.8]	722 (22.5%)	44.3 [40.7, 48.0]
	2	65 (7.7%)	52.3 [39.5, 64.9]	28 (4.7%)	42.9 [24.5, 62.8]	29 (6.1%)	27.6 [12.7, 47.2]	226 (7.0%)	50.0 [43.3, 56.7]
	3+	20 (2.4%)	25.0 [8.7, 49.1]	13 (2.2%)	61.5 [31.6, 86.1]	11 (2.3%)	45.5 [16.7, 76.6]	84 (2.6%)	36.9 [26.6, 48.1]
	Unknown	36 (4.2%)	36.1 [20.8, 53.8]	20 (3.3%)	25.0 [8.7, 49.1]	9 (1.9%)	NC	94 (2.9%)	41.5 [31.4, 52.1]
# PCP visits	Median [IQR]	7.0 [4.0 - 12.0]		7.0 [3.0 - 11.0]		7.0 [3.0 - 12.0]		8.0 [3.0 - 14.0]	
	0	51 (6.0%)	15.7 [7.0, 28.6]	43 (7.2%)	23.3 [11.8, 38.6]	45 (9.5%)	15.6 [6.5, 29.5]	292 (9.1%)	14.4 [10.6, 18.9]
	1-4	216 (25.4%)	31.9 [25.8, 38.6]	156 (26.0%)	41.0 [33.2, 49.2]	127 (26.8%)	28.3 [20.7, 37.0]	688 (21.4%)	31.4 [27.9, 35.0]
	5-9	263 (31.0%)	46.8 [40.6, 53.0]	203 (33.9%)	58.6 [51.5, 65.5]	133 (28.1%)	35.3 [27.3, 44.1]	846 (26.3%)	40.8 [37.4, 44.2]
	10+	319 (37.6%)	49.5 [43.9, 55.2]	197 (32.9%)	61.9 [54.8, 68.7]	168 (35.5%)	45.2 [37.6, 53.1]	1390 (43.2%)	47.6 [44.9, 50.2]

IQR = Inter-quartile range; PCP = Primary care physician; NC = Not calculated due to sample size < 10; PR = Participation rate; N = Sample size; USSR = Union of Soviet Socialist Republics; ADG = Aggregate diagnosis group; CMHT = China, Macau, Hong Kong, Taiwan

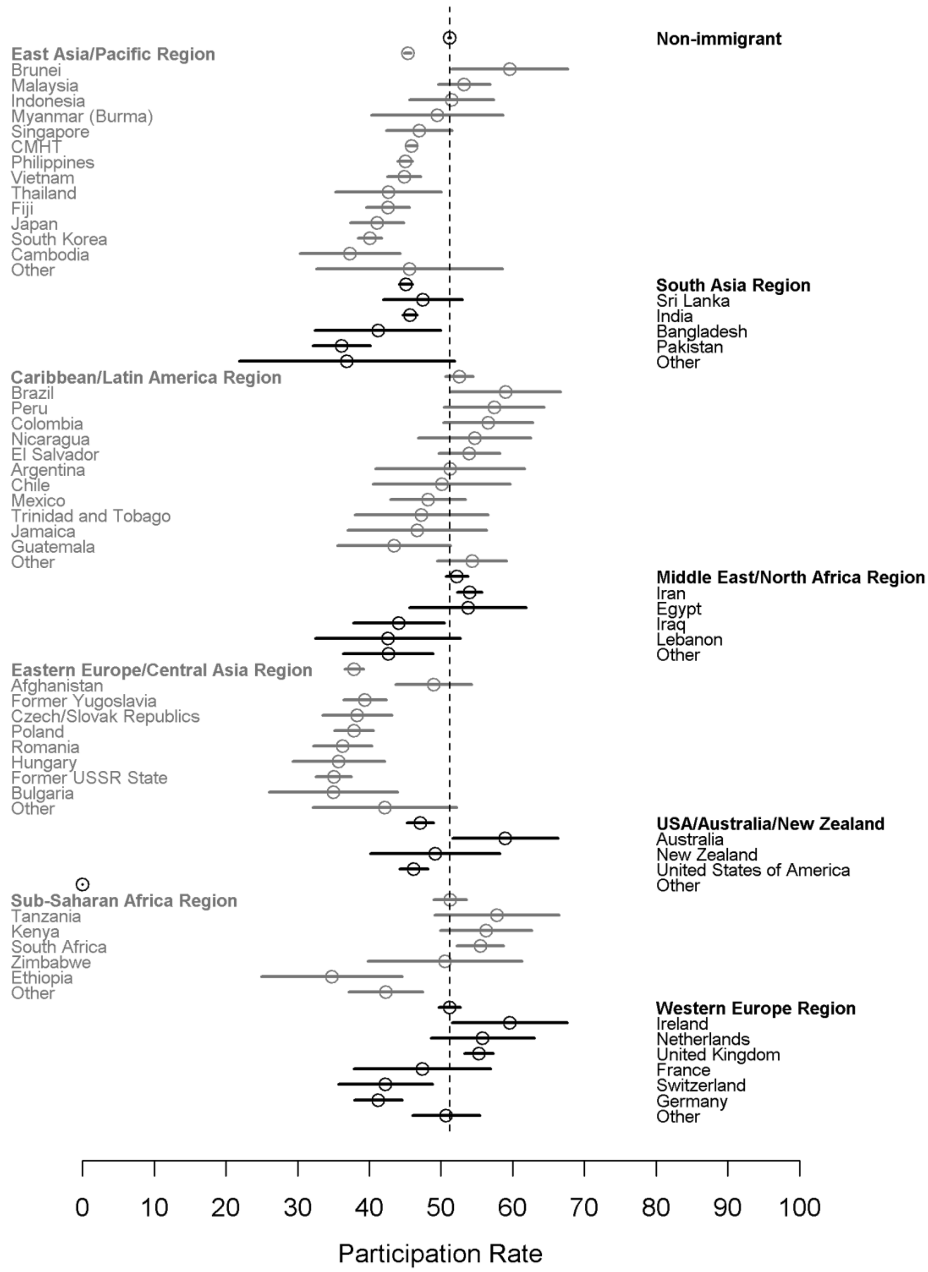
Table 3.8: Adjusted rate ratios for identified predictors of screening among recent immigrants (<10 years since landing)

Variable	Subgroup	CMHT	India	Philippines	South Korea	Iran	US	UK	Former USSR	Other Immigrants
Age	60-69 vs 50-59	0.76 (0.69,0.84)	0.79 (0.72,0.85)	0.83 (0.73,0.96)	-	-	-	-	0.54 (0.38,0.75)	0.90 (0.81,0.99)
Income quintile	Q1 (Lowest) vs Q5	-	-	-	-	-	-	1.09 (0.88,1.35)	-	-
	Q2 vs Q5	-	-	-	-	-	-	0.64 (0.47,0.88)	-	-
	Q3 vs Q5	-	-	-	-	-	-	0.82 (0.66,1.03)	-	-
	Q4 vs Q5	-	-	-	-	-	-	0.87 (0.72,1.06)	-	-
# PCP visits	None vs 10+	0.12 (0.09,0.16)	0.25 (0.15,0.41)	0.23 (0.14,0.38)	0.11 (0.06,0.20)	0.14 (0.06,0.32)	0.32 (0.17,0.60)	0.37 (0.22,0.65)	0.33 (0.16,0.66)	0.29 (0.22,0.39)
	1-4 vs 10+	0.54 (0.48,0.59)	0.52 (0.43,0.62)	0.61 (0.52,0.72)	0.57 (0.45,0.72)	0.59 (0.46,0.75)	0.64 (0.51,0.80)	0.65 (0.52,0.8)	0.58 (0.42,0.79)	0.63 (0.56,0.71)
	5-9 vs 10+	0.83 (0.77,0.90)	0.78 (0.70,0.86)	0.91 (0.82,1.01)	0.73 (0.59,0.90)	0.91 (0.79,1.03)	0.92 (0.78,1.09)	0.93 (0.79,1.08)	0.76 (0.57,1.00)	0.83 (0.75,0.91)
Immigrant class	Family vs Economic	-	-	-	-	-	-	-	1.57 (1.20,2.05)	-
	Refugee vs Economic	-	-	-	-	-	-	-	0.73 (0.30,1.77)	-
	Other vs Economic	-	-	-	-	-	-	-	0.99 (0.51,1.91)	-
Education level	None vs Graduate	-	0.76 (0.64,0.90)	-	-	-	0.41 (0.12,1.46)	-	-	0.66 (0.53,0.83)
	Secondary or less vs Graduate	-	1.00 (0.84,1.19)	-	-	-	0.72 (0.57,0.91)	-	0.67* (0.36,1.25)	0.77 (0.67,0.88)
	Diploma/Certificate/Some University vs Graduate	-	1.22 (0.96,1.55)	-	-	-	0.73 (0.58,0.92)	-	0.65 (0.44,0.98)	0.87 (0.76,1.01)
	Undergraduate vs Graduate	-	1.2 (0.99,1.46)	-	-	-	0.88 (0.73,1.05)	-	1.12 (0.83,1.51)	0.93 (0.81,1.07)

PCP = Primary care physician; Q = Quintile; CMHT = China, Macau, Hong Kong, Taiwan; UK = United Kingdom; US = United States of America; vs = versus; '-' indicates no estimate available for this variable as this term was not retained in final model
Notes: * Within Former USSR education categories "secondary or less" and "none" were grouped together due to small sample size. Other variables considered that were not predictive for any immigrant population were # of major aggregate diagnosis groups, rural residence and Canadian language ability at time of immigration. Some variables could not be considered in all groups due to sample sizes including rural residence within Korean immigrants and Canadian language ability among immigrants from US and UK.

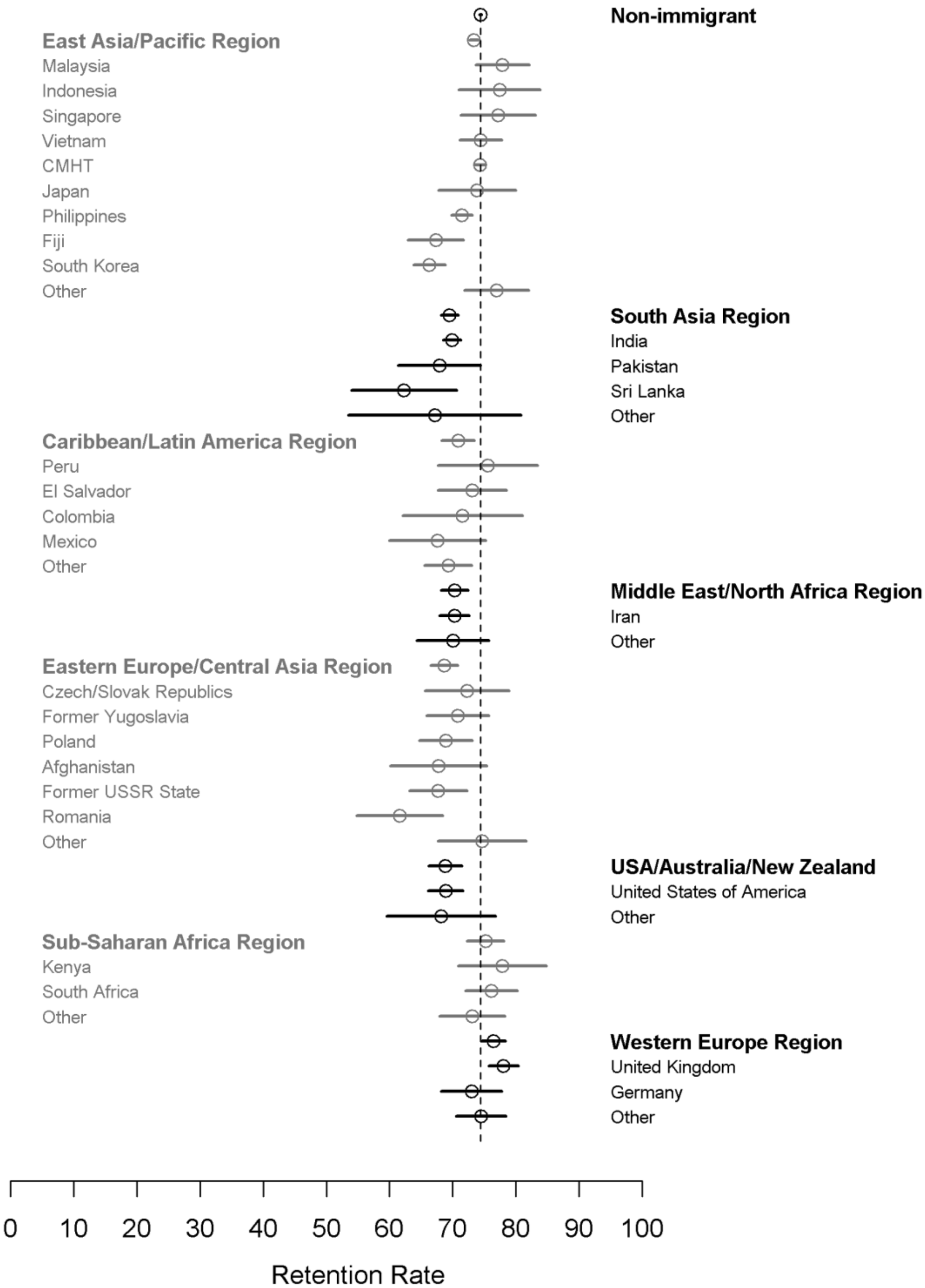
3.6 Figures

Figure 3.1: Age-standardized screening participation rates by country of birth for countries with 100 or more women in the participation cohort



Vertical dashed line represents the non-immigrant participation rate.
NZ = New Zealand; USA = United States of America; USSR = Union of Soviet Socialist Republics; CMHT = China, Macau, Hong Kong, Taiwan

Figure 3.2: Age-standardized 30-month screening retention rates by country of birth for countries with 100 or more women in the retention cohort



Vertical dashed line represents the non-immigrant retention rate.

NZ = New Zealand; USA = United States of America; USSR = Union of Soviet Socialist Republics; CMHT = China, Macau, Hong Kong, Taiwan

Chapter 4: Breast Cancer Incidence among Immigrant and non-Immigrant Women in BC

4.1 Introduction

Studies comparing breast cancer incidence rates between immigrant and non-immigrant populations span several decades. Studies of breast and other cancers among migrants can offer insights into cancer etiology and contribute data to support cancer prevention and control strategies. Early work in the United States reported that Japanese Americans had breast cancer incidence rates that were lower than among Caucasian women, but higher than in Japan [61]. Research into breast cancer patterns among immigrants has expanded considerably with studies having examined incidence patterns in several countries with different historical immigration patterns and studies describing incidence by their specific world region or country of birth [54, 56, 62-64].

British Columbia (BC) is Canada's third largest province and home to a diverse population of more than 1.29 foreign-born residents out of a population of 4.65 million, including more than 750,000 immigrants from Asian countries [14]. Breast cancer is the most common malignancy diagnosed in BC women with 3,500 new cases diagnosed annually [1]. The size and diversity of the BC immigrant population present an opportunity to contribute unique data on breast cancer incidence among migrant populations from many different countries, a number of which have not been widely examined in recent studies. Thus, this study sought to examine breast cancer incidence among immigrant women by world region and country of birth and to compare their rates to non-immigrants.

4.2 Methods

4.2.1 Data Sources

This study utilized linked population-based administrative databases from health and other government agencies. These data sets were previously described in Chapter 3, however, a description summarizing the specific data sets used for this chapter's work are provided in appendix Table A2.1. Briefly, data sets included a provincial health registration file, vital statistics death data, provincial cancer registry data, in-patient and day surgery hospital information, and a national immigration database. Personal identifiers were replaced with study-specific random numbers permitting the linkage of data files while protecting confidentiality of all individuals. Research ethics approval was granted prior to data access.

4.2.2 Cohort Derivation and Follow-up

The study cohort included all women registered in the BC health system age 40 years or older on any date between January 1, 2005 and December 31, 2014. Women were excluded if they had a prior breast cancer or prior mastectomy surgery. Further exclusions where made for women who were not registered in the BC health system prior to December 31, 2012, as this was the last date for which immigrants could accurately be identified based on available data.

Birth country was determined from immigration records for all women who immigrated to Canada between 1985 and 2012. Several territories had to be pooled into single countries owing to geopolitical events which occurred during the immigration data date range: China, Macau, Hong Kong and Taiwan were pooled into a common "CMHT" group; all countries of the former Soviet Union and the former Yugoslavia had to remain aggregated as such. Countries were grouped into world regions consistent with the work of Chapter 3 and similar to prior

Canadian immigrant studies [40, 56]. Within each world region, individual countries with fewer than five incident breast cancers observed over the follow-up period were pooled into an "Other Countries" group.

Women were considered at-risk on the later of either January 1, 2005 or the date of their fortieth birthday. Person-years at-risk were accrued until the earliest date of any of the following events: breast cancer diagnosis, mastectomy, death, termination of provincial health coverage or end of follow-up (December 31, 2014).

4.2.3 Study Measures

Incident breast cancers were obtained from the population-based BC Cancer Registry. Breast cancer age-standardized incidence ratios (SIRs) and exact 95% confidence intervals were calculated by country and world region of birth using the non-immigrant rates as the standard. The non-immigrant age-specific breast cancer incidence rates and age-distribution are provided in the appendix (Table A2.1).

To characterize the study cohort, several demographic variables were generated from available data sets. Age was calculated at the start of follow-up for each woman. The postal code of residence from the health registration database was used to assign a census (neighbourhood)-based measure of income status as in Chapter 3. For immigrant women, the duration of time in Canada was calculated, in years, from the date of landing in the immigration data to the start of follow-up and categorized into three groups (<5 years, 5-9 years, ≥10 years).

4.3 Results

The study cohort consisted of 1,448,572 women of which 260,794 (18.0%) immigrated to Canada between 1985 and 2012. The majority of the immigrant population originated from the

East Asia/Pacific (59.4%) and South Asia (13.9%) world regions. Detailed demographic information by region and country of birth is presented in Table 4.1. Briefly, immigrant women were generally younger than non-immigrants. There was considerable variability in the neighbourhood income status of women by birth country. Many groups showed income quintile distributions similar to, or more favourable than, non-immigrants (e.g. “westernized” countries, Singapore, Japan, South Korea, Iran), however, many groups showed a higher percentage of women in the lower quintiles (e.g. Philippines, Vietnam, India, Pakistan). There was considerable variation in the duration of residence in Canada across groups with some populations showing a very high percentage of women residing in Canada for more than 10 years (e.g. Fiji, Vietnam, Poland) while others showed a much smaller proportion of long-term immigrants (e.g. South Korea, Iran, former USSR).

A total of 26,403 cancers were diagnosed, 2,969 (11.2%) among immigrant women. Incident case counts were sufficient to enable 46 countries to be presented individually (Table 4.2). There was considerable variation in the SIRs by world region. SIRs were elevated for immigrants from Western Europe (SIR = 1.15) and Australia/New Zealand/United States (1.22) compared to the non-immigrant population. In contrast, women from South Asia (SIR = 0.52), East Asia/Pacific (0.75) and the Caribbean/Latin America (0.80) showed lower SIRs.

Within most regions there was substantial heterogeneity in risk by birth country. SIRs among East Asia/Pacific immigrants ranged from 0.37 (Vietnam) to 1.21 (Japan). Within the Eastern Europe/Central Asia region, SIRs varied by birth country group from 0.45 (Czech/Slovak Republics) to 1.37 (Romania), but were estimated with low statistical precision. Within the Middle East/North Africa region, immigrants from Egypt showed a significantly elevated SIR (2.75), while women from Iran, the fifth largest immigrant population in the cohort, showed rates consistent with non-immigrants (SIR = 0.95). Women from both the United Kingdom and U.S. showed significantly higher rates than non-immigrants (SIR = 1.21 for both groups). South Asia was the one region from which immigrants had consistently low ratios (e.g. India 0.52, Pakistan 0.61).

4.4 Discussion

This is the first population-based study providing breast cancer incidence data for numerous specific immigrant populations from some of Canada's most common source countries for immigrants. Within most world regions, considerable variation in SIRs was identified among birth countries, which is not observable when data are aggregated at a regional level. The East Asia/Pacific region contained four of BC's most common source countries for immigrant women, and whilst women from CMHT, Korea and Vietnam demonstrated significantly lower rates compared to non-immigrants, Filipino women showed rates consistent with non-immigrants. Within this region, immigrant women from Japan and Korea had similar age and income distributions, but markedly different SIRs (1.21 and 0.76 respectively).

Prior studies in Canada and elsewhere have also generally shown lower rates of breast cancer among immigrants from South and East Asia [54, 56, 62-64] and have suggested similar or higher rates for immigrants from Western Europe, North America and other western countries [62-64]. A number of studies have also looked at some of the specific populations reported here. In Canada, a prior research study using surname lists and census populations found breast cancer risk to be 15% lower in Iranian migrants [98], though not statistically different from the general population. Surname lists have also been used to identify South Asian migrants in the United

Kingdom and demonstrate this population's low breast cancer rates [66]. A Canadian study used birthplace information captured by the Alberta cancer registry in addition to census populations to demonstrate lower cancer risk among Chinese immigrants [55]. Research in the U.S. has noted significantly lower breast cancer incidence among Korean immigrants, consistent with the present study [65]. It is important to note that differences in the methods used to identify migrant populations may result in the inclusion of different generations of migrants across studies. The approaches also may have different limitations in their ability to identify migrant populations.

The strengths of this study include the use of population-based cancer registry data with coverage for an entire province of more than 4.6 million people. Immigrant status was determined by record linkage to national immigration data and included details on country of birth and date of landing in Canada. Women at-risk were tracked via the study data sets for death, emigration from BC, mastectomy, and cancer diagnosis enabling the appropriate enumeration of a population at-risk for breast cancer.

There are several limitations to study findings. The number of incident cancers in several groups was low leading to statistically imprecise SIRs and requiring aggregation into "Other" groups. Women who immigrated prior to 1985 cannot be distinguished from non-immigrant women due to the date range of available immigration data. Further, medical histories for women who immigrated to BC are not available prior to immigration to enable accurate study exclusions for all women. Finally, the cohort was established to examine population breast screening rates and was thus limited to women aged 40 and over throughout the study follow-up period. As such, the study SIRs presented must be interpreted accordingly.

The observation of significant variation in SIRs among countries from a common world region suggests there is value in “de-aggregating” data from regional groups into specific populations (ie specific birth countries) where feasible. Further research utilizing national linkages of cancer registry and immigration data could yield more precise estimates of breast cancer rates by country of birth and improve comparisons across populations. It is important to note that results also reflect the breast cancer risk of the current BC immigrant population; these patterns may evolve as risks change in source countries for Canadian immigrants. Other research suggests that patterns of breast cancer risk in some populations that are significant source countries for Canadian immigrants are changing [99-101]. These and other studies point to rising breast cancer incidence across several Asian populations in recent years with rates converging to the traditionally higher rates of western countries. Thus, to inform future cancer prevention and control strategies, continued surveillance of cancer incidence among immigrant populations is warranted.

4.5 Tables

Table 4.1: Cohort sample size and demographics by country of birth

World Region	Country	Number of Women	Age Group (%) 40-49	50-59	60-69	70+	Income Quintile (%) Lowest	Highest	Years Since Landing (%) < 5	5-9	10+
Non-immigrant	**Region Demographics**	**1187778**	**44.6**	**22.9**	**14.3**	**18.3**	**18.6**	**20.3**	**NA**		
East Asia/Pacific	**Region Demographics**	**154792**	**68.9**	**16.2**	**7.7**	**7.2**	**28.7**	**13.1**	**32.4**	**26.9**	**40.7**
	Japan	4098	84.0	8.5	4.0	3.5	19.1	21.0	24.4	32.6	43.0
	Indonesia	982	66.1	17.2	10.8	5.9	20.8	18.2	38.7	24.3	37.0
	Philippines	29089	74.6	14.5	6.0	4.9	32.7	9.3	36.3	21.8	41.9
	Malaysia	1830	59.6	22.8	10.4	7.1	21.4	14.8	23.9	12.0	64.2
	Singapore	1243	67.6	20.7	6.1	5.6	18.2	21.8	30.2	16.5	53.3
	South Korea	11840	76.6	15.7	4.8	2.9	19.2	19.5	49.7	26.0	24.3
	Thailand	915	85.4	11.3	1.9	1.5	26.1	15.1	42.1	23.9	34.0
	Fiji	3016	58.6	19.9	15.5	6.0	32.3	4.4	17.9	11.2	71.0
	CMHT	93840	65.7	17.1	8.5	8.6	28.9	13.9	31.4	30.8	37.9
	Vietnam	6525	71.1	13.0	8.0	7.8	35.0	4.4	12.5	10.2	77.3
	Other Regional Country	1414	68.7	17.3	6.8	7.1	34.9	6.3	20.9	10.7	68.5
South Asia	**Region Demographics**	**36202**	**49.6**	**23.6**	**17.7**	**9.1**	**28.7**	**6.4**	**36.1**	**19.2**	**44.7**
	Sri Lanka	1161	67.4	14.5	9.8	8.3	32.3	7.5	35.1	23.7	41.2
	India	32219	47.4	24.7	18.5	9.4	28.2	6.4	35.9	18.1	46.0
	Pakistan	2191	64.3	15.0	14.4	6.3	30.6	6.3	36.3	31.4	32.3
	Other Regional Country	631	79.2	12.5	5.7	2.5	41.8	4.0	46.4	26.3	27.3
Caribbean/Latin America	**Region Demographics**	**9184**	**74.5**	**14.5**	**6.0**	**5.0**	**26.9**	**12.6**	**30.7**	**17.6**	**51.7**
	Mexico	1889	83.0	9.4	4.7	3.0	21.1	17.6	37.6	26.0	36.4
	El Salvador	1377	67.9	18.1	7.1	6.9	35.8	4.5	10.0	7.1	82.9
	Jamaica	344	71.2	16.3	5.8	6.7	26.2	10.8	34.0	12.2	53.8
	Argentina	316	72.5	14.9	6.3	6.3	19.0	22.8	34.5	23.1	42.4
	Brazil	629	80.6	12.6	4.3	2.5	21.0	17.2	44.5	20.5	35.0
	Peru	717	72.1	12.8	7.8	7.3	24.0	13.9	34.6	17.2	48.3
	Other Regional Country	3912	72.8	16.0	6.2	5.0	28.8	11.3	31.1	16.9	52.1
Middle East/North Africa	**Region Demographics**	**11789**	**68.3**	**18.7**	**8.4**	**4.6**	**23.5**	**19.9**	**42.1**	**27.1**	**30.8**
	Egypt	384	66.7	17.4	9.6	6.3	27.1	16.4	36.5	22.7	40.9
	Israel	266	73.7	14.7	8.6	3.0	13.5	24.4	46.2	22.2	31.6
	Iran	8871	66.8	20.0	8.4	4.8	19.9	22.6	41.4	29.0	29.6
	Iraq	965	66.8	17.6	10.6	5.0	50.4	5.8	60.0	17.5	22.5
	Other Regional Country	1303	79.4	12.0	5.8	2.8	29.2	12.4	34.4	23.6	42.0
Eastern Europe/Central Asia	**Region Demographics**	**18072**	**72.4**	**14.9**	**7.1**	**5.6**	**32.0**	**12.2**	**28.0**	**26.7**	**45.3**
	Hungary	638	67.1	21.6	6.4	4.9	24.5	14.1	18.3	15.2	66.5
	Poland	3105	66.8	21.4	5.8	6.0	25.6	13.4	8.6	7.9	83.5
	Bulgaria	521	77.7	11.3	6.0	5.0	30.1	12.9	38.2	34.4	27.4
	Romania	2302	77.7	10.1	6.6	5.6	31.6	10.9	27.8	30.6	41.6
	Afghanistan	1014	70.5	17.9	7.1	4.4	59.2	2.7	43.6	23.0	33.4
	Former USSR State	5486	72.4	12.6	8.5	6.5	32.5	12.4	44.1	34.8	21.1
	Czech/Slovak Republics	1267	74.7	17.2	4.9	3.2	22.3	19.8	16.5	19.7	63.9
	Former Yugoslavia	3240	72.7	14.0	7.6	5.6	35.3	11.3	16.5	33.7	49.8
	Other Regional Country	499	79.2	8.8	7.4	4.6	26.1	13.2	46.7	23.4	29.9
Australia/NZ/USA	**Region Demographics**	**8270**	**63.6**	**22.0**	**8.2**	**6.1**	**13.6**	**27.4**	**37.3**	**16.1**	**46.6**
	Australia	939	83.1	11.3	3.0	2.7	11.1	31.7	30.5	18.6	50.9
	New Zealand	482	80.1	12.9	4.1	2.9	12.7	25.1	25.3	17.0	57.7
	United States of America	6835	59.8	24.2	9.2	6.8	14.0	26.9	39.1	15.7	45.2
	Other Regional Country	14	50.0	7.1	14.3	28.6	0.0	64.3	50.0	7.1	42.9
Sub-Saharan Africa	**Region Demographics**	**6460**	**70.5**	**15.4**	**8.0**	**6.0**	**23.7**	**20.1**	**31.5**	**21.5**	**47.0**
	South Africa	2710	66.3	17.5	9.1	7.1	10.1	31.5	32.0	27.8	40.3
	Tanzania	297	43.8	23.2	15.2	17.8	17.2	13.5	13.5	13.1	73.4

			Age Group (%)				Income Quintile (%)		Years Since Landing (%)		
World Region	**Country**	**Number of Women**	**40-49**	**50-59**	**60-69**	**70+**	**Lowest**	**Highest**	**< 5**	**5-9**	**10+**
	Kenya	696	60.3	19.5	10.8	9.3	18.2	17.8	20.5	14.2	65.2
	Ethiopia	598	85.6	9.4	3.8	1.2	48.3	5.0	17.4	11.0	71.6
	Other Regional Country	2159	78.6	11.9	6.1	3.4	36.5	11.7	40.9	20.0	39.1
Western Europe	**Region Demographics**	**16025**	**68.4**	**14.9**	**7.0**	**9.7**	**12.8**	**26.3**	**31.0**	**17.7**	**51.2**
	United Kingdom	8855	67.4	14.7	6.3	11.6	11.2	27.9	35.2	15.7	49.1
	Austria	222	68.0	16.2	8.6	7.2	16.2	23.0	26.6	18.0	55.4
	Belgium	139	77.0	9.4	6.5	7.2	15.1	24.5	33.8	25.9	40.3
	France	598	82.3	10.9	3.7	3.2	14.4	22.6	26.9	21.2	51.8
	Ireland	452	71.2	15.9	6.9	6.0	9.1	28.1	23.0	10.8	66.2
	Netherlands	682	71.0	13.8	7.3	7.9	11.4	28.7	34.5	19.6	45.9
	Switzerland	675	68.4	18.1	8.1	5.3	17.0	22.4	21.5	25.5	53.0
	Germany	3033	68.1	16.0	8.9	7.0	15.3	24.5	26.3	21.8	51.9
	Other Regional Country	1369	66.3	15.0	7.5	11.2	15.5	22.5	22.4	16.9	60.8

CMHT = China, Macau, Hong Kong, Taiwan; USSR = Union of Soviet Socialist Republics; USA = United States of America; NZ = New Zealand

Table 4.2: Breast cancer age-standardized incidence ratios for the years 2005-2014 by country of birth for immigrant women

World Region	**Country**	**Number of Cases**	**SIR [95% CI]**
East Asia/Pacific	**Regional Rate**	**1672**	***0.75 [0.72, 0.79]***
	Japan	50	1.21 [0.90, 1.60]
	Indonesia	16	1.15 [0.66, 1.87]
	Philippines	394	0.99 [0.89, 1.09]
	Malaysia	27	0.89 [0.59, 1.29]
	Singapore	21	1.16 [0.72, 1.77]
	South Korea	112	*0.76 [0.62, 0.91]*
	Thailand	6	0.64 [0.23, 1.38]
	Fiji	34	*0.67 [0.47, 0.94]*
	CMHT	972	*0.70 [0.65, 0.74]*
	Vietnam	35	*0.37 [0.26, 0.51]*
	Other Regional Countries	5	*0.24 [0.08, 0.55]*
South Asia	**Regional Rate**	**313**	***0.52 [0.47, 0.59]***
	Sri Lanka	9	0.56 [0.26, 1.06]
	India	282	*0.52 [0.46, 0.58]*
	Pakistan	19	*0.61 [0.37, 0.96]*
	Other Regional Countries	<5	0.50 [0.10, 1.46]
Caribbean/Latin America	**Regional Rate**	**93**	***0.80 [0.65, 0.98]***
	Mexico	14	0.73 [0.40, 1.22]
	El Salvador	17	0.79 [0.46, 1.26]
	Jamaica	5	1.09 [0.35, 2.54]
	Argentina	5	1.22 [0.40, 2.85]
	Brazil	16	*2.47 [1.41, 4.00]*
	Peru	7	0.74 [0.30, 1.53]
	Other Regional Countries	29	*0.57 [0.38, 0.82]*
Middle East/North Africa	**Regional Rate**	**161**	**1.02 [0.87, 1.19]**
	Egypt	14	*2.75 [1.51, 4.62]*
	Israel	6	1.76 [0.65, 3.84]
	Iran	119	0.95 [0.79, 1.14]
	Iraq	6	0.58 [0.21, 1.26]
	Other Regional Countries	16	1.15 [0.65, 1.86]
Eastern Europe/Central Asia	**Regional Rate**	**245**	**0.99 [0.87, 1.12]**
	Hungary	9	1.05 [0.48, 2.00]
	Poland	41	0.83 [0.59, 1.12]
	Bulgaria	8	1.35 [0.58, 2.66]
	Romania	39	1.37 [0.98, 1.88]
	Afghanistan	13	0.93 [0.50, 1.60]
	Former USSR State	71	0.98 [0.77, 1.24]
	Czech/Slovak Republics	7	*0.45 [0.18, 0.93]*
	Former Yugoslavia	49	1.01 [0.75, 1.34]
	Other Regional Countries	8	1.48 [0.64, 2.91]
Australia/NZ/USA	**Regional Rate**	**137**	***1.22 [1.03, 1.45]***
	Australia	11	1.20 [0.60, 2.14]
	New Zealand	8	1.44 [0.62, 2.85]
	United States of America	117	*1.21 [1.00, 1.45]*
	Other Regional Countries	<5	4.20 [0.11, 23.41]
Sub-Saharan Africa	**Regional Rate**	**97**	**1.11 [0.90, 1.36]**
	South Africa	53	1.31 [0.98, 1.72]
	Tanzania	6	0.99 [0.36, 2.16]
	Kenya	19	*1.68 [1.01, 2.62]*
	Ethiopia	5	0.85 [0.28, 1.99]
	Other Regional Countries	14	0.59 [0.32, 0.99]
Western Europe	**Regional Rate**	**251**	***1.15 [1.01, 1.30]***

World Region	Country	Number of Cases	SIR [95% CI]
	United Kingdom	145	*1.21 [1.02, 1.42]*
	Austria	5	1.60 [0.52, 3.72]
	Belgium	5	2.92 [0.95, 6.81]
	France	6	1.01 [0.37, 2.20]
	Ireland	6	0.96 [0.35, 2.09]
	Netherlands	10	1.06 [0.51, 1.96]
	Switzerland	9	0.90 [0.41, 1.71]
	Germany	49	1.12 [0.83, 1.48]
	Other Regional Countries	16	0.84 [0.48, 1.37]

SIR = standardized incidence ratio; CI = confidence interval; CMHT = China, Macau, Hong Kong, Taiwan; USSR = Union of Soviet Socialist Republics; USA = United States of America; NZ = New Zealand

Estimates in *italics* denote a statistically significant SIR

Chapter 5: Breast Cancer Risk and Stage at Diagnosis among Immigrant and non-Immigrant Women

5.1 Introduction

Breast cancer incidence rates vary substantially globally, as well as across ethno-cultural groups within countries [56, 62, 63, 102, 103]. Studies of breast cancer incidence rates, some several decades ago, were conducted in populations with different historical immigration patterns [54-56, 61-63, 104-106]. Generally, studies within western countries have reported lower incidence among immigrants, particularly for those originating from East and South Asian regions, compared to non-immigrants [54, 62, 104].

A number of studies have also reported a lower age at breast cancer diagnosis among certain ethno-cultural groups, including immigrant populations, compared to the general population [57-60, 71, 72] and differences in the distribution of breast cancer stage at diagnosis across immigrant or ethnic groups [57, 58, 69, 70]. Several of these studies note a significant proportion of cancers diagnosed within ethnic or immigrant populations prior to age 50, the age at which average risk women are recommended to start breast screening in many countries [9, 107, 108]. These reports complement a growing number of studies that demonstrate lower breast screening participation among immigrant populations compared to non-immigrants [80-86] in addition to the work presented in Chapter 3.

Although several of the aforementioned studies describe and compare age and stage distributions of breast cancers diagnosed among immigrant and non-immigrant populations, few describe age- and stage-specific incidence patterns within these groups. Some authors have suggested that observed differences in average age at diagnosis across populations may be relevant to setting screening policy [59]. Differences in the mean age at diagnosis across groups, however, may reflect differences in age-specific disease rates, the age distributions of the underlying populations, or possibly age-specific breast screening patterns. Age-specific rates would better inform whether the lower age at diagnosis commonly reported among immigrant women reflects a higher risk of cancer at younger ages, which is the relevant issue for setting screening policy. Further, stage-specific incidence rates may support interpretation of differences in cancer stage distributions across populations, particularly those with much different risks of breast cancer.

British Columbia (BC) is Canada's third largest province by population with the 2016 national census reporting an immigrant population that exceeds 1.29 million individuals (out of >4.6 million total inhabitants) with significant numbers of immigrants originating from Asia (>750,000), Europe (>300,000), the Americas (>110,000), Africa (>40,000) and Oceania (>30,000) [14]. Similar to most developed nations, breast cancer is the most commonly diagnosed cancer in both Canadian and BC females [1]. BC also has a universal public health care system that includes a provincial cancer control program with responsibility for cancer prevention, screening, and treatment. Thus, BC is a natural population within which to examine breast cancer incidence patterns among immigrants and non-immigrants to examine questions related to disparity in breast cancer stage across populations.

The objectives of this study were: 1) to estimate age- and stage-specific breast cancer incidence rates for common immigrant populations within BC, defined by country and world region of birth; 2) to compare these rates to those of non-immigrant women; and 3) to compare breast cancer stage-distribution across immigrant and non-immigrant groups.

5.2 Methods

5.2.1 Data Sources

This study utilized linked and de-identified population-based administrative databases from health and other government agencies. Further details regarding the various data sources are provided in Appendix Table A3.1, however, they are described in brief here: a provincial central health registration file, vital statistics death data, provincial cancer registry data, provincial breast screening program data, in-patient and day surgery hospital information, and a national government immigration database.

Research ethics approval, and the approval of all relevant data stewards, were obtained prior to data access. The identities of all individuals in data sets were replaced with study-specific random numbers that permitted linkage across data sources while protecting confidentiality of all individuals.

5.2.2 Cohort Selection

Women aged 40 years and older are eligible to self-refer to the provincial breast screening program which recommends average-risk women begin screening at age 50. Thus, this study examined a cohort at-risk for breast cancer that was aged 40 years and older to reflect a population that had access to screening. Women aged 40 years or older at any point between January 1, 2010 and December 31, 2014, as identified from the provincial heath registration file, were eligible to be included in the cohort. January 1, 2010 was chosen as the cohort entry date as this coincided with the date that the BC Cancer Registry began collecting population-based cancer stage. The cohort was restricted to women who were registered in the provincial health plan prior to December 31, 2012, as this was the last date of immigration records contained in the immigration database. Considering only women registered within the BC health system prior to this date better enabled the accurate identification of immigrant and non-immigrant women among cohort members. Women with a prior history of breast cancer or having had a mastectomy (both as identified within study databases) were excluded.

5.2.3 Breast Cancer Incidence and Study Outcomes

Incident invasive breast cancers were identified between 2010 and 2014 from the BC Cancer Registry with International Classification of Disease for Oncology, third edition, site code of C50 [109]; hematopoietic cancers and sarcomas were excluded. Breast cancer stage at diagnosis was captured according to the Collaborative Stage system, version 02/04 [110] and summarized into four categories (I, II, III, IV); a further categorization of early stage (stage I) and later stage (stages II-IV) was also created.

5.2.4 Cohort Follow-up

Person-years of risk were counted from January 1, 2010 until end of follow-up (December 31, 2014). Women who were not age 40 on January 1, 2010 were not counted as at-risk until their 40th birthday. Person-years at-risk were accrued until the earliest date of any of the following events: breast cancer diagnosis, mastectomy, death, termination of provincial health coverage, or end of follow-up.

5.2.5 Study Groups and Variable Definitions

The immigration data file was used to identify women who immigrated to BC between January 1, 1985 and December 31, 2012. Two classifications of immigrant groups were created based on the birth country identified in immigration records: the first was to report by specific birth country for countries with at least 100 incident breast cancers reported over the follow-up period. This number was chosen to ensure that sufficient events existed to enable the calculation of stage-specific and age-standardized incidence rates. Women from the People's Republic of China, Macau, Hong Kong and Taiwan were combined into a single group referred to as "CMHT" in all data summaries; this was necessitated by the way birth country was recorded in the database over time for women born in these areas. All countries that could not be presented separately due to group sizes were pooled into an "Other Immigrant" group. The second approach to grouping immigrant populations was based on the classification of countries into world regions used by the World Bank [76], Chapters 3 and 4, and other prior research into cancer screening outcomes among Canadian immigrants [37, 40].

Age groups at the start of follow-up were created using 10-year bands (40-49, 50-59, ..., 80+). For incident cancers, age at diagnosis was calculated using similar groupings. Income quintile and urban/rural status were assigned using the postal code of residence of the women at the start of follow-up. Duration of time in Canada for immigrants was calculated from the date of landing within the immigration data, to the start of follow-up; this was categorized into <5, 5-9 and 10+ years. Prior breast screening in BC was assessed by the presence of a mammogram in the provincial screening program database prior to any diagnosis of cancer.

Breast cancer subtype was defined based on the estrogen receptor (ER), progesterone receptor (PR), and human epidermal growth factor receptor 2 (HER2) site-specific factors captured within the Collaborative Staging system. Tumours were presented according to whether they were hormone receptor (HR) positive (ER+ or PR+), or negative (both ER- and PR-), as well as HER2 positive or negative. These data were used to further derive four subtypes defined as: (HR+, HER2-), (HR+, HER2+), (HR-, HER2+) and (HR-, HER2-).

5.2.6 Statistical Methods

Age-specific breast cancer incidence rates and exact 95% confidence intervals were calculated by study group. Overall and stage-specific (stage I, II-IV) age-standardized incidence rates (ASIRs) were also computed for each group using the 2011 Canadian population as the standard [111]. Rate ratios (SRRs) of the age-standardized rates for each immigrant group relative to the non-immigrant population were prepared with 95% confidence intervals calculated according to the methods of Breslow and Day [112]. Breast cancer ASIRs and SRRs were also calculated for each immigrant group by years since immigration (<10 vs 10+ years). Cohort characteristics were presented using descriptive statistics such as the median and inter-quartile range for continuous variables and frequencies and percentages for categorical variables.

Characteristics of incident cancer cases including histo-pathological tumour features such as nodal status, tumour size, subtype and stage, were similarly described by immigrant group, as well as by age group at diagnosis. Poisson regression models were used to estimate relative risks (ARRs) of later-stage (stage II-IV) tumours for immigrant groups (relative to non-immigrants), while adjusting for age, rural residence and income quintile. The approach of Zou [78] was used to obtain robust variances for model parameter estimates. Poisson regression models were repeated further stratifying immigrant groups according to years since immigration (<10, 10+ years) to assess stability of the ARRs according to duration of residence in Canada.

All analyses were conducted using the Statistical Analysis Software (SAS) version 9.4 (SAS Institute, Cary, NC) or the R statistical computing software version 3.3.2 (http://www.cran.r-project.org/).

5.3 Results

5.3.1 Cohort Characteristics

The study included a total of 1,342,317 women of which 18.6% were identified as immigrants. The most common immigrant source countries were CMHT (N=88,077), India (N=31,187) and the Philippines (N=28,764), accounting for 59.3% of the immigrant population in the cohort. These three countries were the only ones that met inclusion criteria to be presented separately; results for all other birth countries are reported in the "Other Immigrant" group. Immigrant women were generally younger than non-immigrants (Table 5.1). The proportion of women aged 40-49 was much higher in each of the immigrant groups (range 43.2% to 61.0%) than in the non-immigrant group (34.6%) and there were relatively fewer women in the age 80 and over category. Immigrants were more commonly represented in the lower income quintiles. The immigrant populations resided almost entirely in urban centres (94.2-99.7%), higher than the percentage among non-immigrants (84.6%). Duration of residence in Canada was similar among the immigrant populations with a majority in each group (55.7% to 60.2%) having resided in Canada for more than 10 years. Non-immigrants showed a much higher frequency of prior breast screening (56.2%) compared to all immigrant groups (range 29.9-40.7%); only 29.9% of Indian immigrants had previously screened for breast cancer in BC.

5.3.2 Breast Cancer Incidence

A total of 14,153 incident invasive breast cancers were diagnosed over the 5,910,041 person-years of follow-up time, the majority (87.3%) among non-immigrant women. Figure 5.1 shows the age-specific breast cancer incidence rates by immigrant group. Breast cancer incidence increased with age among non-immigrant women to a peak rate in the 70-79 age group before slightly declining in the 80+ group. Incidence rates among Indian immigrants were very low relative to all other groups in the 40-49 years age group. CMHT and Indian immigrant women appeared similar to the non-immigrant women in the 50-59 years age group, however, these groups did not exhibit the pattern of increasing incidence with age seen in non-immigrant women; rates for these two groups only declined slightly across older age groups. Immigrants from the Philippines showed higher incidence rates in ages 40-49 and 50-59 compared to non-immigrant women with lower rates in the 70-79 and 80+ age groups. Among “Other Immigrant” women, the age specific incidence rates were slightly than lower than those among non-immigrant women, except in ages 40-49.

Overall and stage-specific age-standardized rates of breast cancer were lower among immigrant groups compared to non-immigrants (Figure 5.2). CMHT and Indian immigrants had much lower incidence rates than non-immigrants (SRRs 0.65 and 0.59 respectively), whereas rates among immigrants from the Philippines and Other Immigrants were more similar to non-immigrants (SRRs 0.94 and 0.88 respectively).

The rate of stage I tumours among Indian immigrants was less than half (SRR = 0.44, 95% CI: 0.50, 0.65) the rate among non-immigrants; their rate of later-stage tumours was also lower (SRR = 0.73, 95% CI: 0.60, 0.89). CMHT immigrant women showed very low rates of stage II-IV cancers compared to non-immigrants (SRR = 0.57, 95% CI: 0.50, 0.65). Overall and stage-specific incidence rates for Filipino immigrants were consistently similar to those of non-immigrant women. Other Immigrants showed a slightly lower rate of stage I tumours compared to non-immigrants with rates of later-stage tumours more similar to those of non-immigrants (SRR = 0.92, 95% CI: 0.83, 1.03). Overall and stage-specific incidence rates for all groups can be found in appendix Table A3.2 and SRRs by group in appendix Table A3.3.

SRRs derived from stage-specific incidence rates showed the rate of stage I cancers among recent (<10 years in Canada) Indian immigrants was very low (SRR = 0.33, 95% CI: 0.20, 0.57) compared to non-immigrants (Figure 5.2); the rate of stage II-IV cancers among recent immigrants from CMHT was also very low compared to non-immigrants (SRR: 0.38, 95% CI: 0.28, 0.50) and all other groups. Among recent Other Immigrants, the rate of stage II-IV breast cancer was higher than among non-immigrants (SRR = 1.18, 95% CI: 0.99, 1.41), whereas it was lower among more established immigrants from this region (SRR = 0.82, 95% CI: 0.72, 0.94). In terms of overall risk, immigrants from CMHT, India and the Philippines who had resided in Canada for ten or more years generally had incidence rates closer to non-immigrants compared to more recent immigrants (<from these same countries. The pattern among Other Immigrants was reversed in that rates among recent immigrants were similar to non-immigrants, however, longer-term immigrants had lower rates.

5.3.3 Characteristics of Cancer Cases and Stage at Diagnosis

The characteristics of women diagnosed with breast cancer are provided in Table 5.2. Immigrant women in each group were diagnosed at younger ages (median age from 53 to 59 years) compared to non-immigrant women (64 years) reflecting the younger average age of the immigrant cohort members. In particular, among CMHT, Filipino and Other Immigrant women, one third of cases were diagnosed at ages 40 to 49 years compared to only 12.5% in the non-immigrant women.

The hormone receptor status of the incident cancers was similar across immigrant groups (Table 5.3, 81.4-85.7%) and non-immigrants (84.9%). The variation in HER2 status was more substantial with 25.3% of tumours testing positive among Filipino immigrants compared to only 13.4% among non-immigrants and 12.0% among Indian immigrants. The subtype distribution also showed differences across groups driven in part by the strong differences in the frequency of HER2-positive tumours. Indian women had a lower frequency of tumours in the smallest size category (44.6%) compared to the other groups (52.6% to 58.1%). Indian immigrants also showed the highest proportion of node-positive tumours (41.7%) among birth-country groups, more than 9% higher than among CMHT immigrants (32.5%).

Compared to the other groups, the stage distribution was markedly different in the Indian immigrants with a much lower proportion of stage I cases and a higher proportion of stage II cases. The frequency of Stage IV at diagnosis ranged from 2.3% among CMHT immigrants to 6.8% among Other Immigrants. In the analysis stratified by age at diagnosis, (appendix Table A3.4) stage II-IV disease was more frequent among women age 40-49 than age ≥50 years for all groups. However, the frequency of later stage tumours among Indian women aged ≥50 years was higher (61.6%) than among women of the same age in the other groups (42.4 to 53.4%). The percentage of later-stage tumours among CMHT immigrants was notably lower than the non-immigrants in both age groups.

Among women diagnosed with breast cancer, there was a significantly lower rate of stage II-IV cancers in CMHT immigrants (ARR = 0.88, 95% CI: 0.80, 0.96) compared to non-immigrants (Table 5.4). Indian immigrant women showed a significantly higher rate of later-stage cancers (ARR = 1.18, 95%: 1.05, 1.33) compared to non-immigrants. Immigrants from the Philippines and Other Immigrants showed no significant differences compared to non-immigrants. When stratified by years since immigration (Table 5.4), Indian immigrant women in both groups (< 10 years and 10+ years in Canada) showed elevated rates of later-stage tumours compared to non-immigrants, however, the difference was most notable in those with shorter duration in Canada (ARR = 1.31, 95% CI: 1.09, 1.57).

5.3.4 Incidence and Cancer Stage by World Region of Birth

Compared to non-immigrant women, both South Asian (SRR = 0.59) and East Asian (SRR = 0.70) immigrants demonstrated lower breast cancer incidence when grouped according to world region of birth (Figure 5.3; appendix Table A3.3). SRRs were not significantly different than 1 in any of the other populations. East Asian, South Asian and Eastern European/Central Asian immigrants showed significantly lower rates of stage I cancers compared to non-immigrants. For stage II-IV cancers, the rates among Eastern European/Central Asian immigrants were similar to non-immigrants while for South and East Asian immigrants they were significantly lower.

Immigrant women from the Caribbean/Latin America region showed the highest proportion of tumours in the smallest tumour size category as well as the highest proportion of node-positive cancers (Table 5.5). Immigrant women from South Asia showed the lowest percentage of tumours in the smallest size category (43.7%). The percentage of stage I tumours was lower among women from the South Asia (35.0%) and Eastern Europe/Central Asia (37.1%) compared to other groups (range 41.0 – 50.5%). Although based on few cases, the percentage of stage IV cancers at diagnosis was 15.7% among immigrants from Sub-Saharan Africa, much higher than the percentage among non-immigrants (4.9%). The percentage of stage I tumours within this group (47.1%), however, was comparable to non-immigrants (45.3%) and among the highest of all groups. The East Asia/Pacific group, which when taken as a single world region group represented the largest immigrant group, showed a stage distribution very similar to that of non-immigrants.

5.4 Discussion

The present study reports breast cancer incidence patterns and histo-pathologic features of incident breast cancer cases, including stage at diagnosis, among common immigrant populations to BC, Canada. This is the first population-based study to examine age- and stage-specific breast cancer incidence patterns among immigrant populations in Canada. This study reports incidence rates and cancer stage information according to country of birth for the most common immigrant source countries, as well as by world region of birth. The former provides important incidence data on Filipino women for whom cancer incidence information in Canada has been scarce. Breast cancer incidence patterns vary markedly across some of BC's most common immigrant groups, and differ from the patterns observed among non-immigrants. These findings demonstrate the value of presenting data, where feasible, by specific country of birth as very different incidence patterns were observed for Filipino and Chinese immigrant populations, who have been grouped together in prior studies of breast cancer incidence or screening among immigrant populations [40, 56]. Some populations, such as Indian and Eastern European/Central Asian immigrants, demonstrated a significantly lower proportion of early stage (stage I) tumours compared to the non-immigrant population.

The present study's observation that overall breast cancer incidence rates are generally lower among immigrant populations compared to non-immigrants is consistent with other studies in Canada [54-56] and elsewhere [62, 104-106]. Breast cancer rates among more established immigrants from certain countries/regions were observed to be higher than those among more recent immigrants; this observation has been described in other recent studies of breast cancer incidence among immigrants [56, 63] and past research on breast cancer mortality [50]. Prior research has suggested this may relate to a process of acculturation among immigrants whereby with increased duration in an adopted country, risk factor profiles among immigrants approach those of non-immigrants [50, 113].

The differences in age-specific risk patterns observed among some Asian immigrant women and non-immigrants have been discussed in recent studies from the United States (US) [100, 101]. These studies found that when data are analyzed in a cross-sectional approach, like in the present study, the breast cancer risk relationship with age appears flat in Asian women whereas the US Caucasian population rates show a strong increase with age. They note that when data are analyzed controlling for birth cohort effects, the pattern of risk with age appears more similar across these populations. The studies also suggest that more recent birth cohorts in some Asian nations are demonstrating higher breast cancer risks than prior birth cohorts and show rates converging to those of US Caucasians. Thus, continued surveillance of cancer incidence patterns among immigrant populations will be important to assess how these risk patterns change over time.

Several prior studies have observed a lower age at diagnosis for breast cancer among different ethno-cultural groups compared to either Caucasian or general populations [59, 60, 71, 72, 100]. Authors have noted that this might originate from differences in screening patterns with age [71] or have implications for setting screening guidelines [59]. This study similarly observed a younger median age at diagnosis among immigrant populations compared to non-immigrants. These analyses show lower cancer rates in age 40-49 for CMHT and Indian immigrants compared to non-immigrants, however, the median age at diagnosis in these groups was 11 and 5 years younger respectively. The younger age at diagnosis is thus driven by a very different immigrant age distribution rather than a higher risk of breast cancer at younger ages. This does not provide a strong rationale for recommending earlier initiation of screening for these women.

Filipino women showed a numerically higher incidence rate in the age 40-49 group, although the relatively small number of events leads to an imprecise estimate of risk. Examining the age-specific risk of breast cancer among Filipino women in other larger populations, perhaps by linking the immigration database to the national Canadian Cancer Registry, would be worthwhile to more precisely quantify risks.

Indian immigrant women were diagnosed with a lower proportion of stage I tumours than any of the other groups examined. As shown in Chapter 3, Indian immigrants have lower screening rates than the general population in BC, particularly among women aged 60-69 years which may explain part of the observed disparity in stage distribution for these immigrants. These findings are consistent with results from Ontario, Canada which similarly identified South Asian women being diagnosed with a low percentage of stage I tumours [57, 58] and with data from Norway showing this population had higher odds of late-stage disease [69]. However, in interpreting the stage data, one must consider the strong differences in overall breast cancer risk across groups. Adjusted for age, Indian immigrant women had an overall breast cancer risk lower than all other groups examined. The stage-specific incidence rates for early and later-stage tumours were also very low compared to other groups; the incidence of stage II-IV tumours in Indian women was 0.73 times the incidence in the non-immigrant women. Thus, this group demonstrates both a lower population risk of later-stage tumours, as well as a higher proportion of late-stage tumours among women diagnosed with cancer.

It is possible, given the very different breast cancer risk profiles of Indian immigrants and non-immigrants, that differences in risk factors between these populations might explain some of the difference in stage at diagnosis. For example, if specific risk factors that associate with less aggressive disease are not present to the same extent in Indian women, this could result in fewer low-risk tumours. This study's data however, do not contain information on potential breast cancer risk factors.

Over-diagnosis has received considerable attention in the discussion around breast cancer screening [114-116] and may also explain part of the difference in stage distribution for the Indian immigrant population. Given that this group has shown both lower breast screening and lower incidence rate of stage I, it is possible that over-diagnosed cases are present in other groups, but not to the same extent in the Indian immigrants. It is also possible that the disparity in the early diagnosis of breast cancer between this population and non-immigrants results from other factors not specifically examined in the present study. For example, there may be differences in timely follow-up of breast abnormalities or abnormal screening findings that contribute to the observed disparities.

The analysis of stage distribution by world region (Table 5.5) suggested that early-stage tumours are also less frequent among immigrants from Eastern Europe/Central Asia compared to non-immigrants. As shown in the findings from chapter 3, this population has been shown to have the lowest screening rates among BC immigrants grouped by world region of birth, and similarly low screening rates have been reported in other Canadian research [40]. Eastern European immigrants were also identified as having higher odds of late-stage breast cancer compared to Norwegian-born women [69]. The stage presentation for this group is of interest as the overall breast cancer risk is similar to that of the non-immigrant population and the difference appears driven entirely by differences in the risk of stage I tumours (Figure 5.3). Over-diagnosis is a possible contributor to the lower stage I rate in this population given their lower breast screening participation. Although the frequency of stage II disease was similar between this population and non-immigrants, the frequencies of both stage III and stage IV cases were higher (stage III: 19.6% vs 12.4%; stage IV: 8.4% vs 4.9%) and thus may warrant further study.

This study has several strengths, including the use of population-based cancer registry data with case-coverage for an entire province of more than 4.5 million people. Immigrant status was determined by record linkage to national immigration data and included details such as country of birth and duration of residence in Canada. Using administrative data, cohort members were tracked for death, emigration from BC, cancer diagnosis or breast surgery enabling the appropriate identification of the population at-risk for breast cancer over the study follow-up.

The study's reliance on administrative data imposes some limitations on the findings. Women who immigrated prior to 1985 cannot be identified within the immigration data and thus cannot be distinguished from non-immigrant women. Further, women who immigrated into BC from outside of Canada, or other Canadian provinces, may have had medical histories that would have excluded them from the study, however, these are not identifiable within provincial data. Despite using five-years of cancer incidence data, small sample sizes prevented the presentation of data by country of birth for all but the three most common immigrant populations. Finally, the population at-risk was limited to women aged 40 and over as this study cohort was originally constructed to examine population breast screening rates and was thus limited to ages where women in BC are eligible for screening. The cancer incidence rates must thus be interpreted accordingly.

In conclusion, this study found variable patterns of breast cancer risk across immigrant populations in BC, and between immigrant and non-immigrant women. Generally, rates among immigrant women were lower than among non-immigrants, and both age- and stage-specific risks differed across group. Among some specific populations of immigrant women diagnosed with breast cancer disparities in stage at diagnosis were also identified. A number of factors could contribute to differences in stage distribution across immigrant and non-immigrant groups, however, quantifying the potential impact of these various factors will require further study. Given the potential harm of late-stage diagnosis, continued evaluation of the breast cancer diagnostic pathways for immigrant and non-immigrant women is warranted. Further efforts may elucidate potential system inequities that contribute to late stage presentation of breast cancer in these populations. This study highlights a need for continued surveillance of cancer incidence among Canada's immigrant populations.

5.5 Tables

Table 5.1: Characteristics of cohort at-risk by birth country

Variable	Statistic	Non-immigrant (N=1,092,606)	CMHT (N=88,077)	India (N=31,187)	Philippines (N=28,764)	Other Immigrant (N=101,683)
Age (Start of follow-up)	Median [IQR]	55.7 [46.4 - 67.0]	48.6 [42.3 - 58.1]	54.1 [41.7 - 64.5]	47.3 [41.6 - 54.1]	47.3 [41.4 - 55.4]
	40-49	377,648 (34.6%)	47,817 (54.3%)	13,466 (43.2%)	17,543 (61.0%)	60,826 (59.8%)
	50-59	283,534 (26.0%)	21,066 (23.9%)	6,365 (20.4%)	7,149 (24.9%)	23,499 (23.1%)
	60-69	206,152 (18.9%)	8,890 (10.1%)	6,851 (22.0%)	2,167 (7.5%)	9,866 (9.7%)
	70-79	121,178 (11.1%)	6,591 (7.5%)	3,296 (10.6%)	1,287 (4.5%)	4,720 (4.6%)
	80+	104,094 (9.5%)	3,713 (4.2%)	1,209 (3.9%)	618 (2.1%)	2,772 (2.7%)
Income quintile	1 (lowest)	202,999 (18.6%)	25,847 (29.3%)	8,629 (27.7%)	9,406 (32.7%)	22,405 (22.0%)
	2	208,784 (19.1%)	19,042 (21.6%)	10,577 (33.9%)	7,886 (27.4%)	20,928 (20.6%)
	3	214,843 (19.7%)	16,985 (19.3%)	6,268 (20.1%)	5,531 (19.2%)	19,221 (18.9%)
	4	224,954 (20.6%)	12,608 (14.3%)	3,414 (10.9%)	3,466 (12.0%)	18,767 (18.5%)
	5 (highest)	228,867 (20.9%)	12,776 (14.5%)	2,242 (7.2%)	2,256 (7.8%)	19,260 (18.9%)
	Unknown	12,159 (1.1%)	819 (0.9%)	57 (0.2%)	219 (0.8%)	1,102 (1.1%)
Duration of residence in Canada (years)	Median [IQR]	NA	12.2 [6.2 - 15.9]	13.1 [5.7 - 17.7]	11.5 [4.4 - 16.5]	12.3 [5.9 - 17.8]
	< 5 years		18,454 (21.0%)	7,424 (23.8%)	7,936 (27.6%)	22,020 (21.7%)
	5-9 years		17,094 (19.4%)	4,982 (16.0%)	4,811 (16.7%)	19,748 (19.4%)
	10+ years		52,529 (59.6%)	18,781 (60.2%)	16,017 (55.7%)	59,915 (58.9%)
Rural residence	Urban	924,347 (84.6%)	87,797 (99.7%)	30,572 (98.0%)	28,109 (97.7%)	95,759 (94.2%)
	Rural	166,286 (15.2%)	265 (0.3%)	604 (1.9%)	651 (2.3%)	5,903 (5.8%)
	Unknown	1,973 (0.2%)	15 (0.0%)	11 (0.0%)	<5 (0.0%)	21 (0.0%)
Prior breast screening	Yes	613,734 (56.2%)	35,854 (40.7%)	9,311 (29.9%)	10,410 (36.2%)	37,665 (37.0%)

CMHT = China, Macau, Hong Kong, Taiwan ; IQR = Inter-quartile range; NA = not applicable

Table 5.2: Characteristics of women diagnosed with breast cancer, 2010-2014, by birth country

Variable	**Statistic**	**Non-immigrant (N=12,352)**	**CMHT (N=566)**	**India (N=175)**	**Philippines (N=269)**	**Other Immigrant (N=791)**
Age at diagnosis	Median [IQR]	64.0 [55.0 - 73.0]	53.0 [48.0 - 63.0]	59.0 [50.0 - 67.0]	52.0 [47.0 - 59.0]	54.0 [47.0 - 64.0]
	40-49	12.5%	32.2%	21.1%	34.9%	35.1%
	50-59	23.1%	34.8%	29.1%	43.1%	29.8%
	60-69	29.8%	17.8%	30.3%	16.7%	20.0%
	70-79	21.0%	10.4%	14.9%	4.1%	9.9%
	80+	13.5%	4.8%	4.6%	<1.9%	5.2%
Income quintile	1 (lowest)	18.4%	26.0%	29.1%	29.4%	19.3%
	2	19.1%	20.1%	33.7%	27.9%	18.8%
	3	19.0%	19.3%	17.7%	21.6%	19.1%
	4	20.1%	17.7%	12.6%	13.8%	20.0%
	5 (highest)	22.5%	15.7%	6.9%	6.3%	21.9%
	Unknown	0.9%	1.2%	0.0%	<1.9%	0.9%
Urban residence	Urban	84.6%	99.6%	98.3%	98.5%	94.1%
	Unknown	0.1%	0.0%	0.0%	0.0%	0.0%
Duration of residence in Canada (years)	Median [IQR]	NA	16.5 [11.3 - 19.5]	15.2 [8.3 - 20.7]	16.2 [9.0 - 19.6]	14.9 [8.4 - 20.3]
	<5 years		8.5%	14.9%	14.5%	13.4%
	5-9 years		12.5%	14.3%	13.4%	16.8%
	10+ years		79.0%	70.9%	72.1%	69.8%
Prior screening	Yes	74.5%	70.3%	67.4%	67.3%	64.6%

CMHT = China, Macau, Hong Kong, Taiwan; IQR = Inter-quartile range; HR = hormone receptor; HER2 = human epidermal growth factor receptor 2; NA = not applicable

Table 5.3: Histo-pathological features and stage at diagnosis of incident breast cancer cases, 2010-2014, by birth country

Variable	**Statistic**	**Non-immigrant (N=12,352)**	**CMHT (N=566)**	**India (N=175)**	**Philippines (N=269)**	**Other Immigrant (N=791)**
Hormone receptor (HR)	Positive	10,483 (84.9%)	461 (81.4%)	150 (85.7%)	224 (83.3%)	666 (84.2%)
	Unknown	258 (2.1%)	19 (3.4%)	<5 (<2.9%)	<5 (<1.9%)	8 (1.0%)
HER2	Positive	1,650 (13.4%)	105 (18.6%)	21 (12.0%)	68 (25.3%)	138 (17.4%)
	Unknown	382 (3.1%)	27 (4.8%)	<5 (<2.9%)	10 (3.7%)	18 (2.3%)
Subtype	HR+, HER2-	9,193 (74.4%)	383 (67.7%)	135 (77.1%)	174 (64.7%)	564 (71.3%)
	HR+, HER2+	1,165 (9.4%)	70 (12.4%)	12 (6.9%)	43 (16.0%)	92 (11.6%)
	HR -, HER2-	1,120 (9.1%)	49 (8.7%)	14 (8.0%)	17 (6.3%)	71 (9.0%)
	HR -, HER2+	489 (4.0%)	36 (6.4%)	9 (5.1%)	25 (9.3%)	46 (5.8%)
	Unknown	385 (3.1%)	28 (4.9%)	5 (2.9%)	10 (3.7%)	18 (2.3%)
Tumour size	Tis/T0/T1	6,732 (54.5%)	329 (58.1%)	78 (44.6%)	143 (53.2%)	416 (52.6%)
	T2	4,044 (32.7%)	175 (30.9%)	72 (41.1%)	100 (37.2%)	267 (33.8%)
	T3/T4	1,235 (10.0%)	40 (7.1%)	22 (12.6%)	22 (8.2%)	93 (11.8%)
	TX	341 (2.8%)	22 (3.9%)	<5 (<2.9%)	<5 (<1.9%)	15 (1.9%)
Nodal status	Positive	4,232 (34.3%)	184 (32.5%)	73 (41.7%)	102 (37.9%)	314 (39.7%)
	NX	415 (3.4%)	30 (5.3%)	<5 (<2.9%)	5 (1.9%)	15 (1.9%)
Stage	I	5,595 (45.3%)	275 (48.6%)	63 (36.0%)	117 (43.5%)	338 (42.7%)
	II	4,215 (34.1%)	193 (34.1%)	72 (41.1%)	106 (39.4%)	269 (34.0%)
	III	1,535 (12.4%)	55 (9.7%)	26 (14.9%)	33 (12.3%)	115 (14.5%)
	IV	604 (4.9%)	13 (2.3%)	11 (6.3%)	7 (2.6%)	54 (6.8%)
	Unknown	403 (3.3%)	30 (5.3%)	<5 (<2.9%)	6 (2.2%)	15 (1.9%)

CMHT = China, Macau, Hong Kong, Taiwan; IQR = Inter-quartile range; HR = hormone receptor; HER2 = human epidermal growth factor receptor 2;

Table 5.4: Adjusted risk ratios from Poisson regression models examining predictors of stage II-IV breast cancer diagnosis, 2010-2014

Variable	**Level**	**ARR (95% CI) – No Stratification by Duration of Residence**	**ARR (95% CI) – Groups Stratified by Duration of Residence: < 10 years**	**ARR (95% CI) – Groups Stratified by Duration of Residence: 10+ years**
Immigrant group	CMHT vs non-immigrant	*0.88 (0.80,0.96)*	*0.82 (0.67,1.01)*	*0.89 (0.81,0.99)*
	India vs non-immigrant	*1.18 (1.05,1.33)*	*1.31 (1.09,1.57)*	1.13 (0.98,1.30)
	Philippines vs non-immigrant	0.99 (0.88,1.10)	1.14 (0.95,1.35)	0.93 (0.81,1.07)
	Other immigrants vs non-immigrant	1.03 (0.96,1.10)	1.09 (0.98,1.22)	1.00 (0.92,1.08)
Rural residence	Rural vs urban	*1.06 (1.01,1.11)*	*1.06 (1.01,1.11)*	
Income quintile	Q1 (lowest) vs Q5 (highest)	*1.10 (1.05,1.16)*	*1.10 (1.05,1.16)*	
	Q2 vs Q5 (highest)	*1.08 (1.02,1.13)*	*1.08 (1.02,1.13)*	
	Q3 vs Q5 (highest)	1.04 (0.99,1.09)	1.04 (0.99,1.09)	
	Q4 vs Q5 (highest)	1.03 (0.98,1.08)	1.03 (0.98,1.08)	
Age group	50-59 vs 40-49	*0.92 (0.88,0.96)*	*0.92 (0.88,0.97)*	
	60-69 vs 40-49	*0.80 (0.76,0.84)*	*0.80 (0.76,0.84)*	
	70-79 vs 40-49	*0.79 (0.75,0.84)*	*0.79 (0.75,0.84)*	
	80+ vs 40-49	1.12 (1.07,1.18)	1.12 (1.07,1.18)	

ARR = adjusted risk ratio; CI = confidence interval; CMHT = China, Macau, Hong Kong, Taiwan; Q = quintile
Estimates in italics are statistically significant at the 5% significance level.

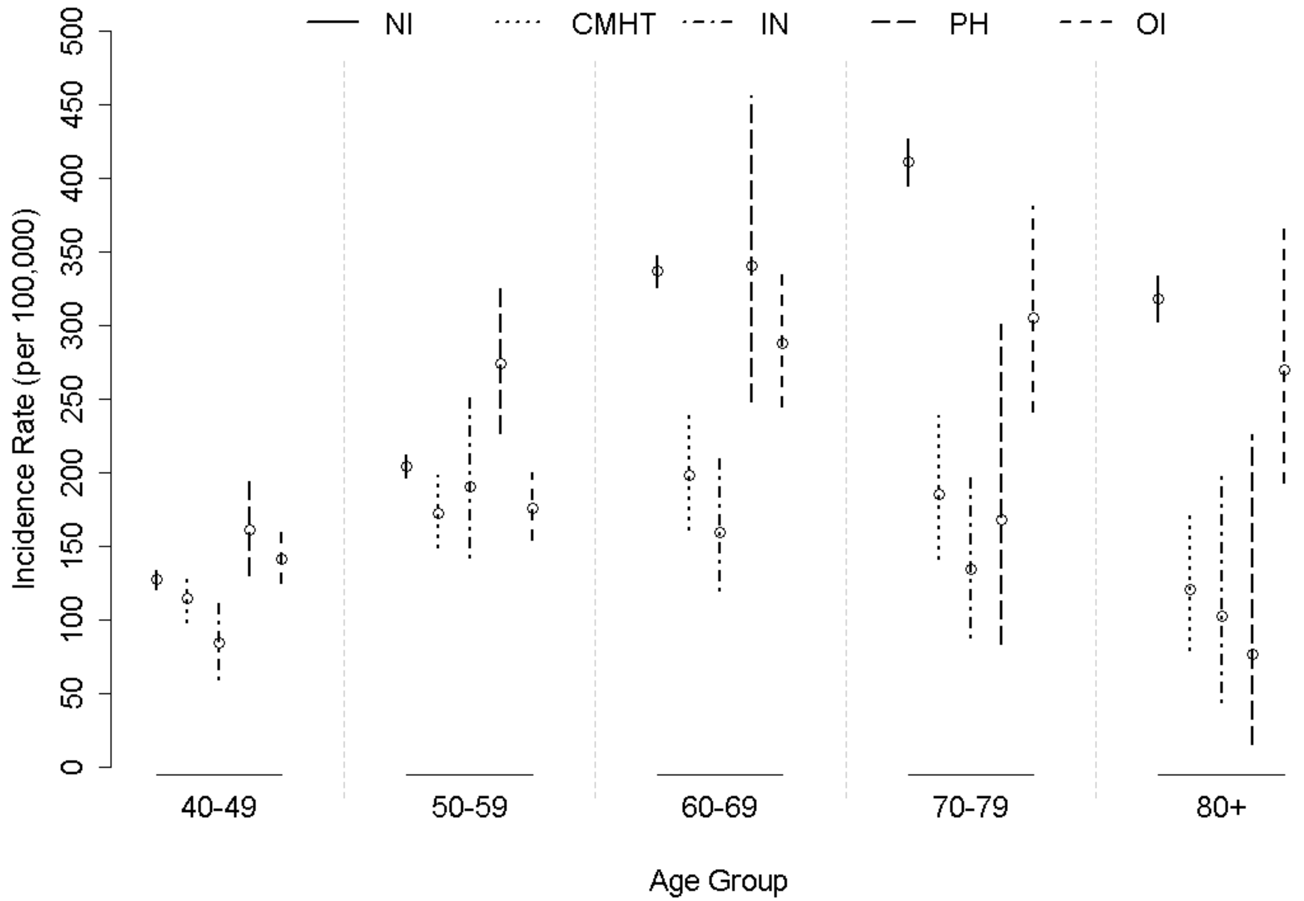
Table 5.5: Histo-pathological features and stage at diagnosis of incident breast cancer cases, 2010-2014, by world region

Variable	Statistic	Non-immigrant (N=12,352)	East Asia/ Pacific (N=1,012)	South Asia (N=197)	Caribbean/ Latin America (N=61)	Middle East/ North Africa (N=107)	Eastern Europe/ Central Asia (N=143)	Australia/ NZ/ USA (N=76)	Sub-Saharan Africa (N=51)	Western Europe (N=154)
Hormone receptor (HR)	Positive	10,483 (84.9%)	832 (82.2%)	169 (85.8%)	55 (90.2%)	93 (86.9%)	117 (81.8%)	69 (90.8%)	44 (86.3%)	122 (79.2%)
	Unknown	258 (2.1%)	23 (2.3%)	<5 (<2.5%)	0 (0.0%)	0 (0.0%)	<5 (<3.5%)	<5 (<6.6%)	0 (0.0%)	<5 (<3.2%)
HER2	Positive	1,650 (13.4%)	203 (20.1%)	27 (13.7%)	16 (26.2%)	17 (15.9%)	30 (21.0%)	10 (13.2%)	7 (13.7%)	22 (14.3%)
	Unknown	382 (3.1%)	40 (4.0%)	<5 (<2.5%)	0 (0.0%)	<5 (<4.7%)	<5 (<3.5%)	<5 (<6.6%)	<5 (<9.8%)	<5 (<3.2%)
Subtype	HR+, HER2-	9,193 (74.4%)	683 (67.5%)	149 (75.6%)	41 (67.2%)	78 (72.9%)	98 (68.5%)	59 (77.6%)	39 (76.5%)	109 (70.8%)
	HR+, HER2+	1,165 (9.4%)	133 (13.1%)	17 (8.6%)	14 (23.0%)	12 (11.2%)	17 (11.9%)	9 (11.8%)	<5 (<9.8%)	11 (7.1%)
	HR-, HER2-	1,120 (9.1%)	84 (8.3%)	16 (8.1%)	<5 (<8.2%)	8 (7.5%)	11 (7.7%)	5 (6.6%)	<5 (<9.8%)	19 (12.3%)
	HR-, HER2+	489 (4.0%)	71 (7.0%)	10 (5.1%)	<5 (<8.2%)	5 (4.7%)	13 (9.1%)	<5 (<6.6%)	<5 (<9.8%)	11 (7.1%)
	Unknown	385 (3.1%)	41 (4.1%)	5 (2.5%)	0 (0.0%)	<5 (<4.7%)	<5 (<3.5%)	<5 (<6.6%)	<5 (<9.8%)	<5 (<3.2%)
Tumour size	Tis/T0/T1	6,732 (54.5%)	557 (55.0%)	86 (43.7%)	37 (60.7%)	64 (59.8%)	70 (49%)	43 (56.6%)	28 (54.9%)	81 (52.6%)
	T2	4,044 (32.7%)	345 (34.1%)	82 (41.6%)	20 (32.8%)	29 (27.1%)	47 (32.9%)	26 (34.2%)	16 (31.4%)	49 (31.8%)
	T3/T4	1,235 (10.0%)	81 (8.0%)	26 (13.2%)	<5 (<8.2%)	12 (11.2%)	22 (15.4%)	5 (6.6%)	6 (11.8%)	21 (13.6%)
	TX	341 (2.8%)	29 (2.9%)	<5 (<2.5%)	0 (0.0%)	<5 (<4.7%)	<5 (<3.5%)	<5 (<6.6%)	<5 (<9.8%)	<5 (<3.2%)
Nodal status	Positive	4,232 (34.3%)	349 (34.5%)	79 (40.1%)	33 (54.1%)	39 (36.4%)	62 (43.4%)	26 (34.2%)	19 (37.3%)	66 (42.9%)
	NX	415 (3.4%)	39 (3.9%)	<5 (<2.5%)	0 (0.0%)	<5 (<4.7%)	<5 (<3.5%)	0 (0.0%)	<5 (<9.8%)	5 (3.2%)
Stage	I	5,595 (45.3%)	467 (46.1%)	69 (35.0%)	25 (41.0%)	54 (50.5%)	53 (37.1%)	37 (48.7%)	24 (47.1%)	64 (41.6%)
	II	4,215 (34.1%)	366 (36.2%)	84 (42.6%)	23 (37.7%)	29 (27.1%)	47 (32.9%)	28 (36.8%)	11 (21.6%)	52 (33.8%)
	III	1,535 (12.4%)	106 (10.5%)	29 (14.7%)	10 (16.4%)	17 (15.9%)	28 (19.6%)	8 (10.5%)	7 (13.7%)	24 (15.6%)
	IV	604 (4.9%)	33 (3.3%)	12 (6.1%)	<5 (<8.2%)	5 (4.7%)	12 (8.4%)	<5 (<6.6%)	8 (15.7%)	10 (6.5%)
	Unknown	403 (3.3%)	40 (4.0%)	<5 (<2.5%)	0 (0.0%)	<5 (<4.7%)	<5 (<3.5%)	<5 (<6.6%)	<5 (<9.8%)	<5 (<3.2%)

NZ = New Zealand; USA = United States of America; HR = hormone receptor; HER2 = human epidermal growth factor receptor 2

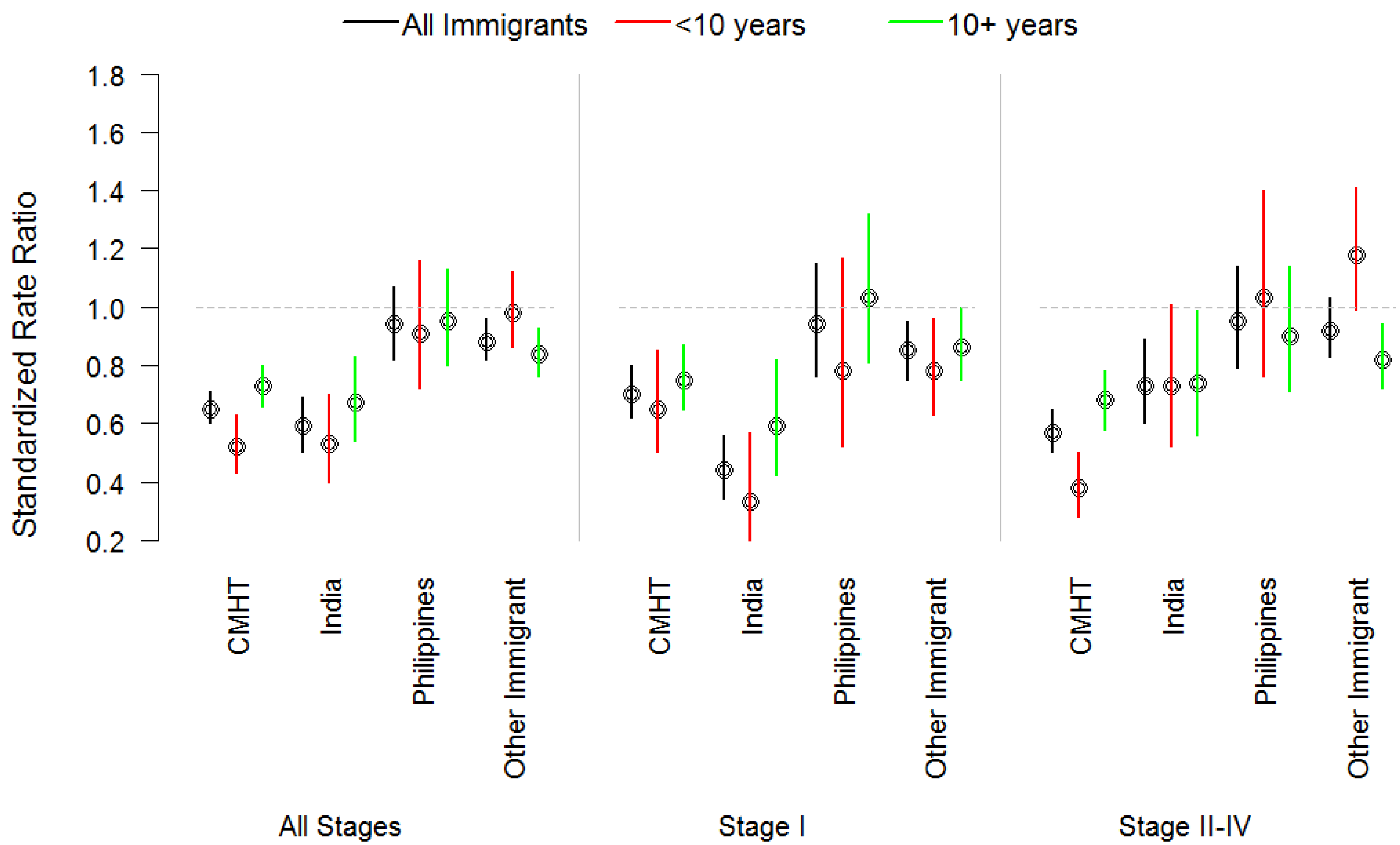
5.6 Figures

Figure 5.1: Age-specific breast cancer incidence rates and 95% confidence intervals, 2010-2014, by country of birth



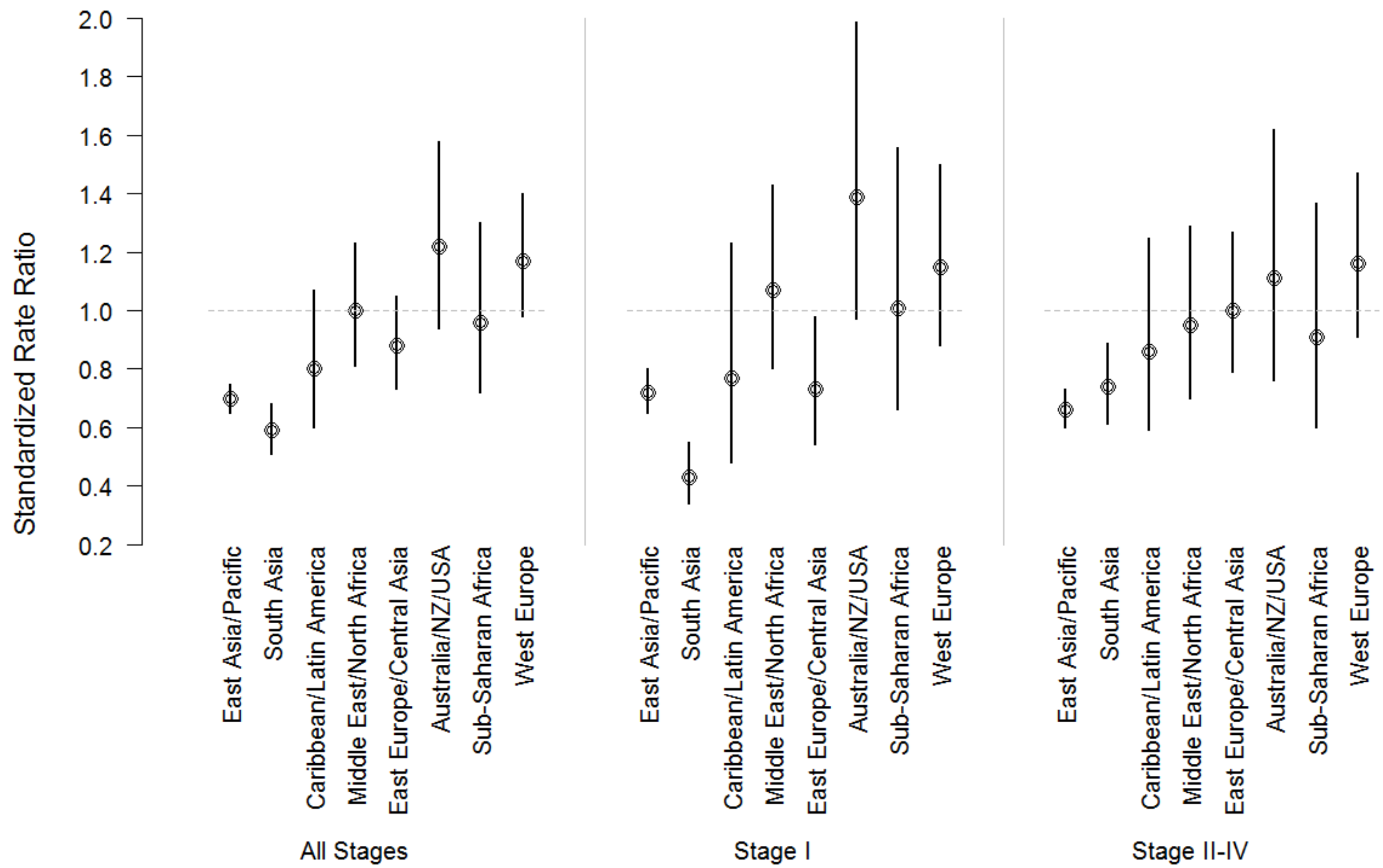
NI=Non-immigrant, CMHT=China, Macau, Hong Kong, Taiwan, IN = India, PH=Philippines, OI=Other Immigrant

Figure 5.2: Age-standardized breast cancer incidence rate ratios and 95% confidence intervals, 2010-2014, by country of birth (relative to non-immigrant rates) and years since immigration (<10 years, 10+ years)



CMHT=China, Macau, Hong Kong, Taiwan

Figure 5.3: Age-standardized breast cancer incidence rate ratios and 95% confidence intervals, 2010-2014, by world region of birth (relative to non-immigrant rates)



NZ = New Zealand; USA = United States of America

Chapter 6: Primary Care Physician Contact, Continuity and Characteristics and Breast Cancer Screening

6.1 Introduction

A number of factors may affect an individual's attitude toward, and decision to participate in, breast cancer screening. Individual characteristics such as age, education level, cultural or ethnic group, economic position and other factors may all be relevant to one's decision to screen; several of these factors and their association with participation and retention were explored in Chapter 3. In addition to individual factors, characteristics of the health system itself may impact the likelihood that women participate in screening. For example, access to screening services may vary regionally, or across urban and rural settings, and impact one's ability to obtain timely mammograms. The extent to which mammography is promoted, and the program's ability to identify eligible women, and make them aware of their eligibility, may also impact participation.

Primary care system factors may also be important in shaping women's attitudes toward or decisions to screen for cancer. In prior research, immigrant women and their primary care physicians (PCPs) have both reported a lack of time within medical appointments to discuss screening as a barrier to participation [117, 118]. PCP encouragement has been consistently identified as a factor that positively affects women's decision to screen for breast cancer [117, 119, 120]. Some screening programs, such as the Ontario Breast Screening Program, use PCP-linked correspondence, such as notifications of eligibility or reminder letters, to encourage women to screen, and these have been shown to increase participation or retention rates within organized cancer screening programs [89, 121, 122]. Some PCP office electronic medical record systems in Canada have functionality to identify eligible or overdue women from within patient rosters [121, 123]. Decision aids and tools have been made available from the Canadian Preventive Health Taskforce's breast screening recommendation website to better communicate the potential benefits and harms of screening to possible participants [123]. Some of these materials specifically advise patients to discuss the screening recommendations for different age groups with their PCPs to help inform their decision to screen. A number of the above examples suggest that the relationship between patients and PCPs may be important to screening participation and retention among patients; this is the focus of the present chapter.

A number of prior studies have been undertaken to assess and establish associations between breast screening participation and PCP contact, numbers of visits, and characteristics. Recent contact with a PCP has consistently been positively associated with breast cancer screening participation across a number of studies in Canada [26, 29, 30, 44]. Other studies have reported a positive association between the number of recent PCP visits and higher breast screening participation (Chapter 3) [23, 124] and retention (Chapter 3). Various PCP characteristics have also been associated with breast screening participation including physician sex [38, 125, 126] as well as years in practice and country of medical training [38, 40].

Continuity of care with a PCP has also been the focus of several recent studies examining health outcomes for women across the breast cancer care continuum. Research has examined measures of primary care continuity throughout the breast cancer diagnosis period [127, 128] and after diagnosis, including among breast cancer survivors [128]. There are variable results from several studies investigating continuity of care and breast cancer screening in different populations in the United States, such as Medicaid-insured seniors [129], urban minorities [130, 131], and a private group insured population [132]. There is relatively sparse research on measures of continuity of care with a PCP and breast cancer screening within Canada's universal public health system. A study examining the urban population of Winnipeg, identified a positive association between continuity and breast screening [47] after adjusting for known predictors of mammography utilization. However the findings in this study varied depending on the definition of continuity used.

Across these studies, a variety of study designs, definitions of continuity, and populations of focus have been used and may all contribute to the lack of consistency in findings. These studies have generally considered several preventive health measures as endpoints, including mammography, however, none of the above studies examined the impact of continuity measures on screening retention or examined associations within subgroups of the screening-eligible population that may have different screening patterns.

British Columbia (BC) has a single-payer public health care system with the majority of primary care physicians working under a fee for service payment model. Although many patients may largely see a single provider for their primary care needs, others may need to visit several physicians based on appointment availability, urgency of need, lack of other available options, convenience, or other reasons. As in other parts of Canada, walk-in clinics are prevalent and may be used periodically for care by patients that have regular PCPs, or exclusively by some patients for all of their primary care needs [133]. Several authors have described a changing landscape in Canadian primary care with physicians seeking alternatives to traditional general practice employment to achieve an improved work-life balance, PCPs providing fewer hours of clinical care, and demographic shifts in the physician population [87, 134, 135]. Research findings from BC have suggested that there has been a recent decline in measures of physician-patient relational continuity, and other indicators of full-service primary care [134]. Further, recent research has identified that a very low percentage (24%) of fee-for-service PCPs in BC provide care characterized as “high responsibility”, meaning their practice patterns suggest they manage and coordinate the majority of all care for their patients.

This setting offers an opportunity to examine variability in continuity of primary care and preventive health measures, such as cancer screening. Breast cancer screening utilization in BC is low, and well below targets established by expert advisory panels [9]. In particular, the provincial BC Cancer Breast Screening Program reports a 30-month screening retention rate for first-time participants of only 45% compared to a national target of 75% [10]. Thus, there is motivation to better understand potential determinants of low screening utilization, including factors related to primary care accessed by eligible women.

Having established that more frequent contact (i.e. number of visits) with a PCP is associated with higher breast cancer screening participation in the BC population (Chapter 3), the study within this chapter seeks to identify if other PCP factors, independent of number of visits, are associated with screening utilization. The specific factors that this study aims to assess include: continuity of office visits with a PCP; duration of affiliation with a provider; and PCP sex and years since medical training graduation. The results from Chapter 3 demonstrated associations between PCP visits and screening utilization among immigrant groups and substantial variation in screening rates across these same groups. This chapter aims to assess if the effects of the PCP factors described above on screening utilization vary across several immigrant populations (including non-immigrants). As prior studies have focused largely on screening participation, and given BC’s low screening retention rates, this study aimed to further expand the existing literature by including breast screening retention as an endpoint. As screening utilization has been shown to vary by some key variables such as age, income quintile, and other factors, and to potentially motivate the development of specific interventions, the consistency of associations across some additional pre-defined subgroups was assessed.

6.2 Methods

6.2.1 Data Sources

This study utilized several population-based administrative health databases accessed via a comprehensive research data application facilitated through Population Data BC. Approval to access study data was granted by all data stewards and research ethics approval was obtained from the University of British Columbia – BC Cancer Agency Research Ethics Board. Specific details regarding the data sources accessed are provided in Appendix Table A4.1; these sources include: a provincial central demographics file, vital statistics death data, provincial cancer registry cancer diagnoses, breast screening program data, fee-for-service physician payment information, in-patient hospitalization and day surgery information, a provincial medical provider database, and a national government immigration database.

The identities of all individuals in data sets were replaced with study-specific random numbers that permitted linkage across data sets while protecting confidentiality of all individuals.

6.2.2 Cohort Selection

Separate cohorts were generated to examine the main study endpoints of breast screening participation and retention. The inclusion and exclusion criteria for each cohort are described below.

The breast screening participation cohort was identified from the provincial health registration file by selecting all women in BC who were aged 50-69 years for the entire period from January 1, 2013 to December 31, 2014. This age group was chosen both to align with prior studies of breast screening participation, and to reflect an age group within which average risk women have generally been recommended to screen biennially in Canada. Women were excluded if they had a diagnosis of breast cancer or mastectomy prior to January 1, 2013, were not continuously registered in the provincial health insurance plan from January 1, 2011 throughout the study period, or died prior to December 31, 2014. Women had to be registered over this entire period in order to characterize comorbidity status at the time of cohort entry and health service use throughout the study follow-up (2013-14). Women were required to have had a minimum of three visits to a PCP during the follow-up period in order to assess measures of patient-physician relationship.

The retention cohort included all screening eligible women who received a screening mammogram (the 'index' screen) through the provincial breast screening program between January 1, 2010 and June 30, 2012. These dates were chosen to permit adequate follow-up on each cohort member to enable the calculation of a 30-month screening retention rate which is a standard breast screening program performance indicator in Canada [9]. Women were considered eligible if they were between 50 and 69 years of age for the entire period from the date of the index mammogram to the end of follow-up (30-months after their index mammogram). This group was further restricted to those who maintained provincial health coverage for the two-year period prior to the index mammogram and to women with at least three PCP visits over the follow-up period. Women were excluded if they died, developed breast cancer, had a mastectomy or discontinued provincial health coverage prior to the date of their next screen or the end of follow-up. In the event women had two screening mammograms in the period within which the index screen was to be selected, the first mammogram was chosen as the index screen.

6.2.3 Study Outcomes and Variable Definitions

The primary study endpoints were the screening participation and 30-month screening retention rates. The participation rate was defined as the number of women having a screening mammogram performed through the provincial breast screening program between January 1, 2013 and December 31, 2014 out of the number of eligible women in the cohort. The retention rate was calculated as the number of women who had a screening mammogram performed through the breast screening program within 30 months of their index mammogram out of the total number of women who were eligible to be re-screened over that period (i.e. the number of women in the retention cohort). In BC, diagnostic mammograms are not performed through the breast screening program and can only be booked with a referral from a physician. The present analysis does not include diagnostic mammograms in the participation or retention endpoint definitions.

Two measures of physician-patient relational continuity were calculated. The concentration of PCP visits among different providers was measured using the Usual Provider of Care (UPC) index, calculated as the proportion of PCP office visits over the follow-up period that were with the patient's usual PCP (see below). The duration of affiliation between PCP and patient (in years) was also calculated by examining the earliest identified visit date within the range of study data for each patient and their usual PCP. For the participation analysis, duration of affiliation was categorized into three groups: <5, 5-9 and 10+ years. For retention, the year range of available physician data (2001-2014) necessitated categorizing into two groups: <5 and 5+ years. This is because the earliest cohort entry date for retention was earlier (as early as Jan 1,

2010) than for participation (Jan 1, 2013) to ensure a reasonable sample size and a minimum 30-month window to observe the retention endpoint. Thus, it was impossible to assess 10-year affiliation for all retention cohort members. Further details on the definitions of study variables are provided in Table 6.1.

Calculation of the above described continuity measures required patients and PCPs to be explicitly linked and thus PCP and patient pairings were determined according to the following sequential rules. In BC, fee-for-service PCPs can bill incentive fees annually if they commit to being responsible for the majority of the primary care needs for patients with eligible chronic diseases or who require complex care as a result of specific conditions. Thus, if a PCP billed an incentive fee to a patient during the follow-up period, the patient was assigned to that PCP. In the event that more than one PCP billed an incentive to a single patient, or for patients who did not have an incentive code billed to them, the majority of total office visits with a specific physician was used to assign patients. In the event of a tie, the total dollar amount of PCP services provided to the patient over the follow-up period was used to assign the final PCP.

Several socio-demographic and additional health-related measures were generated to better characterize study cohorts and examine for relationships with breast screening. These variables included age, income quintile, rural residence, prior breast screening, index mammogram result, breast cancer family history, primary care physician (PCP) visits, the number of unique PCPs seen by patients, PCP sex, the number of years since medical training graduation (for the PCP), and the number of Johns Hopkins major aggregate diagnosis groups (ADGs) [77]. Additional details related to these variables can also be found in Table 6.1. For convenience, within sections below the term “PCP factors” is used to refer to the set of PCP characteristics, PCP-patient continuity measures, and numbers of PCPs seen and total.

Immigrant women within each study cohort were identified by linkage of cohort members to the immigration database. Any cohort members not identified in the immigration database were assumed to be non-immigrants. As described in Chapter 3, this means a percentage of each cohort, representing women that immigrated prior to the first year covered by the immigration database (1985), are misclassified. Time since immigration to Canada was calculated as the difference (in years) between the date of landing in the immigration database and the start date of follow-up and categorized in <5, 5-9. 10-19, 20+ years.

Information from the immigration records was used to create immigrant groups by country or world region of birth. Within this chapter, non-immigrants and 5 groups of immigrant women were created for subgroup analyses. Women from China, Macau, Hong Kong and Taiwan (CMHT), India and the Philippines were presented as three separate populations as they were the largest in BC and comprised the majority (59%) of the eligible immigrant population. Women from Eastern European countries were presented as a combined fourth group, as this large set of women was found to have the lowest screening utilization in Chapter 3 when analyses were conducted by world region of birth. Thus, this chapter provides an opportunity to further characterize this population. Any remaining immigrants were pooled into an "Other Immigrant" group.

6.2.4 Statistical Methods

Categorical variables described above were summarized using descriptive statistics such as frequencies and percentages. Screening rates were calculated (participation and retention), both overall and stratified by key study variables, to explore the variation in screening endpoints; exact 95% confidence intervals were calculated for both endpoints. These descriptive analyses were repeated stratified by age group (50-59, 60-69) as well as immigrant group.

To examine the effect of various PCP factors on both participation and retention, Poisson regression models were used to estimate adjusted relative risks (ARRs). ARRs were chosen as the effect measure because of the cohort study design and the use of study endpoints that are not rare. Generalized estimating equations (GEE) for the Poisson model were fit with a physician cluster effect in order to address the potential clustering of patients within a single physician and obtained robust standard errors for model parameters according to established methods [78, 136]. Each PCP factor (number of office visits, number of PCPs seen by a patient, duration of affiliation, UPC index, PCP sex, years since graduation) was assessed in separate models, adjusted for other known predictors of screening participation or retention. PCP factors were subsequently included in a single multivariable model, adjusted for other predictors of outcome. In the multivariable model, the number of unique PCPs was not included due to high structural correlation with other variables that were included include, namely the number of PCP visits and UPC index.

To explore the consistency of effect measures, several pre-determined subgroup analyses were performed. For the screening participation endpoint, four sets of subgroup analyses were performed creating strata defined by age (50-59, 60-69 years), income quintile (highest and lowest quintiles), number of PCP visits, and immigrant populations (6 groups total, as described above). The subgroup based on the number of PCP visits included only those women who had a minimum of 10 visits with a PCP over the follow-up period. The rationale for examining this group was to assess whether the associations between the measures of relational continuity and outcome would be similar in a population of women with high PCP contact. For the retention analysis, these same subgroups were examined, as well as an additional analysis which stratified women based on whether their index mammogram was the first screen within the program, or a subsequent screen. This last analysis was undertaken as retention for first-time breast cancer screeners is generally dramatically lower than it is for women with prior screening history [10].

The examination of duration of PCP affiliation within immigrant subgroups required a special model parameterization for both the participation and retention outcomes to address structural dependence between this variable and time since immigration (e.g. women who had not been in Canada more than 5 years could not have a duration of affiliation greater than 5 years). For the participation analysis, a categorical variable was created based on values of both variables with the following 6 levels: {<5 years in Canada, < 5 years with PCP}, {5-9 years in Canada, <5 years with PCP}, {5-9 years in Canada, 5-9 years with PCP}, {10+ years in Canada, <5 years with PCP}, {10+ years in Canada, 5-9 years with PCP}, {10+ years in Canada, 10+ years with PCP}. This was entered into regression models as a categorical variable and contrast statements were used to estimate relative risks across levels of duration of affiliation, for women with similar duration of time in Canada. An identical approach was used for the retention analysis, however, only five levels were present in the variable as duration of affiliation could only be measured as <5 years and 5+ years for retention (see above).

All analyses were conducted using the Statistical Analysis Software (SAS) version 9.4 (SAS Institute, Cary, NC) and the R statistical computing software version 3.3.2 (http://www.cran.r-project.org/).

6.3 Results

6.3.1 Participation

The final study cohort included 455,680 women, the majority (60.0%) of whom were aged 50-59 years at the start of follow-up (Table 6.2). The overall breast screening participation for the cohort was 54.8% and was higher among women aged 60-69 years (57.9%) compared to those in ages 50-59 (52.7%). The majority of the cohort (85.9%) resided in urban areas and was distributed fairly evenly across the five income quintiles. Screening participation increased from 47.8% in the lowest income quintile to 60.2% in the highest quintile and was higher in urban areas (55.7%) compared to rural areas (49.1%). More than half of the women (56.1%) reported no major ADGs with only 4.3% having 3 or more; screening participation was slightly lower among women reporting 3 or more major ADGs (48.5%) than those that reported fewer (range 54.2 - 55.6%).

Participation was slightly lower among women with 3-6 PCP visits compared to women with >6 visits (Table 6.3); this pattern was consistent across both age groups examined. The relatively small group of women who saw more than ten PCPs over the follow-up period had much lower participation (42.5%) compared to those who saw fewer providers (e.g. 56.2% for women who saw one provider). Participation was lower (48.6%) among women in the lowest quartile of the UPC index compared to women with higher values (range 55.5-58.1%); this pattern was evident in the cohort as a whole as well as within both age strata. Participation rates increased with increasing duration of affiliation with a PCP. Women who had been with their usual PCP for ten or more years had a participation rate 7.9% higher (58.9%) than those who had been with their provider for less than 5 years. The majority of women in the cohort (60.1%) were attached to a male PCP and participation for women with a male PCP was 6.4% lower than among those with female providers. Years since graduation for the PCP was not associated with participation overall, or in either age group.

Table 6.4 contains ARRs for associations between PCP factors and the participation endpoint; these estimates are derived from models that include only one PCP factor at a time, while adjusting for other potential confounding variables (age, income, rural residence, number of ADGs). The findings from these models are consistent with the descriptive data shown in Table 6.3. Factors that demonstrated the strongest associations with lower participation included having 3-6 PCP visits (ARR = 0.89, 95% CI: 0.88, 0.89), seeing 11 or more PCPs over the follow-up period (ARR = 0.86, 95% CI: 0.84, 0.89), being in the lowest quartile of the UPC continuity measure (ARR = 0.91, 95% CI: 0.90, 0.92), having shorter (<5 years) duration of affiliation with a provider (ARR = 0.87, 95% CI: 0.87, 0.88), or having a male PCP (ARR = 0.89, 95% CI: 0.88, 0.90). The association between years since PCP graduation and participation among patients was not strong (ARRs 1.03-1.04), but suggested screening was slightly lower for women attached to PCPs from the highest quartile (representing those who graduated in the earliest years).

Results from the multivariable analysis are shown in Table 6.5. Results were similar to those shown in Table 6.4 with respect to the associations of the various PCP factors and participation. Specifically, women with few (3-6) PCP visits, lower UPC index, shorter duration of affiliation with their provider, and who had a male PCP showed significantly lower participation. Table 6.5 also includes the ARRs estimated from the pre-specified subgroup analyses based on age, income quintile and number of PCP visits. The effect of fewer PCP visits was consistent across age groups (ARRs = 0.87 and 0.86), however, the effect was stronger in women residing in neighbourhoods with the lowest incomes (ARR = 0.82) compared to those with higher incomes (ARR = 0.91). Women residing in the lowest income areas with 7-9 PCP visits screened 10% lower than those with 16+ visits, however, among women in high income areas, participation was not significantly different across these groups. Women with the lowest UPC continuity values consistently screened less than those with the highest continuity within the various subgroups, however, the effect was weakest in the subgroup of women with ten or more PCP visits (ARR = 0.94, 95% CI: 0.92,0.95). Women with <5 years affiliation with their provider showed consistently lower screening within the subgroups compared to those with ten or more years of affiliation (ARR range: 0.85-0.91). Compared to having a female provider, having a male PCP was associated with 10-15% lower participation across subgroups. Participation was slightly higher among patients who saw PCPs in the first quartile of years since medical school graduation (ARR range: 1.03-1.07); the association between this variable and participation was fairly consistent across subgroups.

Table 6.6 includes the ARRs from models for screening participation fit separately to immigrant subgroups. In all groups, less contact with a PCP was associated with lower participation, particularly among immigrants; the ARRs for 3-6 PCP visits (compared to 16 or more visits) ranged from 0.64 among Indian immigrants to 0.89 among non-immigrants. Non-immigrants, Eastern European immigrants and Other Immigrants showed significantly lower participation in the lowest UPC quartile compared to the highest quartile. In contrast, among immigrants from CMHT, India and the Philippines, participation appeared to be lower in the group of women with the highest UPC values compared to for example, women in the third quartile (ARRs ranged 1.06 to 1.08). Among non-immigrants and immigrants who had resided in Canada for ten years or more, women with short duration of affiliation with their PCP (<5 years) screened less than those with the longest duration (ARRs ranged from 0.84 to 0.92). Among immigrant women who had resided in Canada between 5 and 9 years, shorter duration of PCP affiliation was associated with significantly lower participation among immigrants from CMHT (ARR = 0.87) and Other Immigrants (ARR = 0.91); although ARRs associated with shorter affiliation were < 1 for the other immigrant groups, none of these estimates were statistically significant. Women seeing male PCPs screened between 11% and 14% lower than women with female providers. Years of PCP active practice did not show a strong association with participation in any of the groups. Demographic, health and PCP factors for the participation cohort, stratified by immigrant group are summarized in Appendix Tables A4.2 and A4.4; crude participation rates according to these same factors are provided in Appendix Tables A4.3 and A4.5.

6.3.2 Retention

The retention cohort included 258,753 women and the overall 30-month retention rate was 74.7%. Retention was generally lower for younger women, those living in rural or lowest income areas, or women with 3 or more ADGs (Table 6.7). Retention was significantly lower for first-time participants (45.4%) compared to those with prior program screening (76.6%). Women whose index screen result was abnormal had lower retention (67.1%) compared to those with normal screen results (75.3); these latter two findings were consistent across age groups.

Retention rates ranged from 72.9% to 76.1% across the categories of numbers of PCP visits (Table 6.8). Women who saw a single PCP over the follow-up had higher retention (76.9%) compared to those who saw several different PCPs (e.g. retention was 65.1% among women who saw 11 or more different PCPs); only 21.4% of women in the cohort saw a single PCP during the follow-up period. Women in the lowest quartile of continuity of care (UPC < 0.54) had the lowest retention (70.7%) compared to women in higher quartiles (range 74.3% to 76.9%). Retention was slightly higher in women with a longer duration of affiliation with their provider, overall, and within both age groups. Retention rates were comparable for women who had male or female providers. There was a slight increase in retention with duration of time in practice for the PCP; retention ranged from 72.9% in the lowest quartile to 76.2% in the highest.

ARRs for associations between PCP factors and retention are shown in Table 6.4. After adjustment for age, income quintile, rural residence, family history, index screen result and prior screening, there were few strong associations visible between retention and the various PCP factors. Retention was lower for women who had seen 6-10 (ARR = 0.94, 95% CI: 0.93, 0.94) or eleven or more different PCPs (ARR = 0.87, 95% CI: 0.85, 0.90) compared to those with only 1 PCP, and among women in the lowest quartile of continuity (ARR = 0.94, 95% CI: 0.93, 0.94) compared to those in the highest quartile.

Table 6.9 presents ARRs from multivariable models examining the associations between PCP and other factors and retention, for the cohort overall, and among subgroups. In the overall cohort, women with 3-6 PCP visits showed slightly lower retention than those women with 16 or more visits (ARR = 0.96, 95% CI: 0.96, 0.97). Women in the lowest quartile of continuity were retained 7% less compared to those in the highest quartile (ARR = 0.93, 95% CI: 0.92, 0.94). Duration of affiliation between patient and PCP, PCP sex and years since PCP medical graduation were not strongly associated with screening retention, after adjustment for other factors. The association between number of PCP visits and retention was generally consistent across the various analyses, however, it appeared to be stronger among women for whom the index mammogram represented their first screen. In this group, screening was lower for those women reporting 3-6 visits (ARR = 0.90, 95% CI: 0.85, 0.95) compared to those with 16 or more. The ARR associated with the lowest quartile of continuity was also lower among first-time screeners (ARR = 0.86) compared to those who had screened before and the cohort as a whole (ARR = 0.93 for both).

Among first-time screeners some variables exhibited a different relationship with retention compared to the analysis of the overall cohort. Having an abnormal result on the index mammogram did not associate with worse retention in this group (ARR = 1.01, 95% CI: 0.97, 1.06) compared to within the cohort as a whole, and within those with a prior screening history; in these groups, a false-positive mammogram was generally associated with a 6-8% relative reduction in retention. Women in rural areas generally showed lower retention (ARRs ranged from 0.93 to 0.96), however, among first-time screeners, this was not the case (ARR = 1.04, 95% CI: 0.99, 1.09).

Among non-immigrant women, fewer PCP visits was not associated with a substantially lower retention compared to those with 16 or more visits (ARR = 0.97, 95% CI: 0.97, 0.98), however, immigrants from CMHT (ARR = 0.87, 95% CI 0.84, 0.90), the Philippines (ARR = 0.89, 95% CI: 0.84, 0.94) and Other Immigrants (ARR = 0.90, 95% CI: 0.87, 0.93) with few PCP visits all showed significantly lower retention (Table 6.10). Low continuity with a PCP showed modest associations with retention among non-immigrants (ARR = 0.93, 95% CI: 0.92, 0.93), immigrants from the Philippines (ARR = 0.90, 95% CI: 0.85, 0.96), and Other Immigrants (ARR = 0.95, 95% CI: 0.91, 0.98). Duration of affiliation with a PCP, PCP sex and PCP years in active practice were not strongly associated with retention in any of the immigrant subgroups. Across immigrant groups, first-time screeners were retained between 14 and 23% lower than women with prior screening history. Appendix Tables A4.6 to A4.9 include demographic, health, and PCP factors according to immigrant group and corresponding retention rates by these same variables.

6.3.3 Distribution of PCP Factors Associated with Lower Screening Utilization

Within the overall participation cohort, four PCP factors (PCP sex, duration of affiliation, number of PCP visits and continuity of care) were identified as significantly associated with lower participation. These categorical factors demonstrated a relative difference in screening across extreme categories of 10% or more (e.g. lowest quartile of UPC vs highest quartile). Table 6.11 presents the distribution of the number of these PCP factors for women in the participation cohort and the corresponding participation rate for each group. 87.5% of cohort members had one of the PCP factors associated with lower screening; a proportionally smaller group (2.4%), but representing more than 10,000 women, had all four of these factors with a corresponding participation rate that was very low (36.6%). Relative to women with none of these factors, women with all four screened almost 40% less (ARR = 0.61, 95% CI: 0.60, 0.63). A similar summary is provided for first-time screeners within the retention cohort as within this subgroup, associations between two PCP factors (low continuity and few PCP visits) and retention were identified. In the overall retention cohort, there were no strong associations with PCP factors noted. More than 40% of the first-time screening cohort had one or more of these PCP factors; retention for those with both of these PCP factors (6% of the cohort) was 20% lower than for women with neither factor (ARR = 0.80, 95% CI: 0.73, 0.87).

6.4 Discussion

The present study observed several associations between PCP factors and screening endpoints. Women with few (3-6) physician visits had participation rates approximately 5% lower than women with more visits; adjusted for other factors, these women screened about 14% less than women who had frequent visits (16+ visits) to their PCP. This is consistent with several other studies in Canada and elsewhere that have observed infrequent PCP contact is associated with either lower recommendation to screen [137] or lower breast screening participation [23, 30, 47, 124]. The effect of fewer PCP visits, however, was significantly stronger among immigrant subgroups corresponding to participation rates between 22% and 36% less than among women in these same populations with frequent PCP contact. This study suggests that the number of PCP visits may be less relevant for screening retention among the general population and non-immigrant women, however, among first-time screeners as well as select immigrant populations, those with few visits had relative retention rates approximately 10-13% lower than those with the most PCP visits. This information may support interventions to improve retention in these specific populations of women.

Two measures of relational continuity between PCPs and patients were examined in this study. Both a low percentage of PCP visits with the usual provider (<54%), and a shorter affiliation between patient and PCP (<5 years), were associated with significantly lower participation. These findings align with a prior Canadian study that found women with less than 50% of visits with their usual provider had a significantly lower odds (odds ratio = 0.86) of having had a recent mammogram, compared to women with >50% of visits with the same provider. Their study noted that when the cut-point used to identify low/high continuity was shifted to 75%, no difference in screening rates was observed, which suggests the group with the lowest continuity scores in their cohort likely had the lowest screening, similar to this study's findings. The association observed here between continuity and screening retention among first-time screeners (ARR = 0.86, 95% CI: 0.81, 0.91) may support identifying populations of women most at-risk of program loss for interventions and future research.

When analyses were stratified by immigrant population, the association between continuity of care (UPC index) and both participation and retention varied across these groups. In non-immigrants, Eastern European/Central Asian immigrants and Other Immigrants, women with the lowest continuity demonstrated significantly lower participation (ARRs ranged 0.85 to 0.93) compared to women with the highest continuity. Among CMHT, Indian and Filipino immigrants, there was no significant difference between those with the highest and lowest continuity. Interestingly, the association between participation and duration of affiliation between patient and PCP was much more consistent across immigrant groups than the association observed for the UPC index. Among non-immigrants and immigrants with more than 10 years since immigration, the ARRs ranged from 0.84 to 0.92 and all were statistically significant. Although these two measures aim to assess patient and PCP relational continuity, and are derived from the same physician payment data, they do measure different constructs. UPC measures the intensity of visits with the most commonly seen provider; it is possible a cohort member could see a PCP many times for a specific issue during a brief period and have a high UPC index, but a very low duration of affiliation. The consistency of the effect of duration of affiliation across these various groups suggests the population of women who have recently changed providers may benefit from further study or intervention to improve participation.

Studies conducted within different populations in the United States (US) have had inconsistent findings with respect to the association between continuity of care and breast cancer screening [130, 132]. A study conducted with data collected by a private insurer in Washington state used a similar definition of low continuity to this study (UPC <50%) but found no difference in the percentage of women in both groups that were screened [132]. A survey study conducted in a US multi-ethnic population asked respondents about their breast screening utilization and physician contacts, and found that those who identified having a usual provider screened more than those who had no regular provider [130]. A separate survey study of women enrolled in the US Medicaid program found no association between mammography screening and the duration of affiliation between women and providers [129]. There were a number of differences in methodology between that study and the present one, including the inclusion of a population strictly older than 65 years of age with no upper limit of age.

Several studies in Ontario have assessed whether the specific patient enrollment models used to pair women and PCPs, or teams of PCPs, are associated with screening participation [38, 40, 42]. Although these are not studies specifically on continuity measures such as those from the present study, they do contrast primary care enrolment models, some of which explicitly create continuity of care through the rostering of patients to PCPs or clinics. Some of these studies have described lower participation for patients who are not attached to a PCP through an enrollment model [38, 40] which may be concordant with this study's findings of lower participation among those with low continuity. It is important to note that the higher participation observed among patients within the Ontario enrollment models may be attributable to other factors associated with the models other than just continuity of care (e.g. incentive or other physician payment differences).

The present study's observation that women who have a male PCP screen less for breast cancer than those with a female provider is consistent with several prior studies from Canada [38, 40] and elsewhere [124-126]. Among women who had previously screened, this factor appeared to be less important for retention. A prior study from Ontario noted a significant positive relationship between breast screening participation and a physician's years in active medical practice in Ontario [38]. No association was found between years since graduation and breast screening retention in this work, but a small association with participation was found (e.g. ARR =1.05, 95% CI: 1.03, 1.07 for most recent vs earliest graduates). The effect measures across these two studies are not entirely comparable as, firstly, the variables analyzed to measure PCP experience (years since graduation and years in active practice), although surely correlated, are not the same, and secondly, the effect measures reported in the studies (odds ratios and relative risks) are not the same. Other studies in Canada have noted that the country or region of medical training for PCPs was associated with breast cancer screening participation or overall better preventive care [38, 40, 138]. This information was not available within this study's data sources and thus could not be investigated or adjusted for in analyses.

An interesting result was observed within the subgroup of first-screeners with respect to the effect of an abnormal first mammogram. In all other subgroups, and within the cohort as a whole, retention was lower for women following an abnormal index mammogram (ARRs ranged 0.92 to 0.94), however, among first-time screeners, an abnormal result did not appear associated with worse retention (ARR = 1.01, 95% CI: 0.97, 1.06). This has been previously observed within the BC breast screening program [10]. Within this same population of first-time screeners, the lower retention generally associated with rural residence was not observed (ARR = 1.04, 95% CI: 0.99, 1.09). It is not clear exactly why these factors would have different associations with retention within this specific subgroup, however, the significant difference in retention of first time (45.4%) and subsequent (76.6%) screeners may offer a suggestion. It could be that first-time screeners are lost for a variety of reasons and rural residence and screen result are not overly represented among those that are lost in this initial heavy loss of participants; it could be many women do not like the overall experience of a mammogram and choose not to re-screen. However, among those that were amenable to continuing to participate, the access issues associated with rural residence, and the negative experience of a false-positive, become more dominant reasons for not continuing to return.

This study has several strengths, including the use of population-based databases for breast screening, cancer registration, physician payment, patient demographics and health registration, vital statistics and hospitalization. Using administrative data, cohort members were able to be tracked for death, emigration from BC, cancer diagnosis or breast surgery enabling the identification and enumeration of a population eligible for breast screening. The use of such data help mitigate issues associated with inaccurate self-reported health services utilization [139, 140] and cancer screening [32, 141]. Further, the study data allowed for the calculation of two different measures of relational continuity (i.e. the UPC index and the duration of affiliation between PCP and patient) in addition to enabling the enumeration of both the number of unique PCPs seen by patients and the total number of PCP visits. This study further utilized a limited set of PCP characteristics (sex, years since graduation) available on the entire PCP population present in study databases permitting the examination of associations between both patient and physician characteristics and breast screening. The study's large sample size also enabled the examination of associations between screening and other factors within subgroups which can be challenging to do within survey designs.

The study's reliance on administrative data imposes some limitations on findings. Several study measures required the attachment of physicians and patients and this was determined based on patterns observed in administrative data; the pairings of PCPs and patients may not reflect the patient's own perception of who their regular PCP is. The year range of available physician payment data was from 2001 to 2014 and thus limited how far back in time the affiliation between providers and patients could be evaluated. For the retention cohort this meant that there was not a minimum of 10 years of look-back period on all cohort members and thus affiliation was categorized into <5, ≥ 5 years; for the participation cohort, more than ten years of records for each patient were observed. However, in both cohorts, the true first visit pairing between the PCP and patient may not have been observed due to data truncation. This limited the examination of screening variation associated with longer-term affiliation. Finally, the observational nature of the data make drawing causal inferences from the findings challenging. It could be that women who demonstrate certain patterns of primary care utilization and continuity are more likely to screen based on personal preferences or beliefs. Thus, increasing continuity, for example, through intervention may not yield improved participation or retention for all women.

The study measures of continuity are, by definition and study methodology, between patient and PCP. It is possible that some patients see a team of physicians from a common clinic and the data do not permit an assessment of the extent to which this occurs. The implication is that this study could assess whether screening outcomes are different among women who see different PCPs from a common clinic, compared to women who see different PCPs in different clinics. Further, a small percentage of physicians in the province work under an alternative payment plan rather than receiving fee for service payment; these physicians are not included in the study cohort. The inclusion criteria required patients to have had a minimum of three fee-for-service PCP visits in the physician payment file over the study period. Thus, only women with a minimum degree of fee for service physician visit activity were included in the study, which must be considered when interpreting the findings. The study data did not contain some PCP characteristics such as region of medical training that have been included in other studies which may have resulted in residual confounding.

In summary, this study identified that some PCP factors were significantly associated with either screening participation or retention. These findings build on the extensive literature that identifies strong associations between PCP contacts and breast cancer screening, and add support to the notion that strong relationships between PCPs and patients associate with better screening utilization. Additional investigation of the PCPs and their practice patterns may also offer valuable insights, as research from BC suggests that the PCP population exhibits diverse practice styles [87]. This may support understanding whether some of the observed associations between PCP factors and screening depend on the practice styles of the PCPs and the specific clinical services they generally provide. Among immigrant populations, factors such PCP sex and duration of affiliation showed similar effects to within the general population. However, others, such as continuity of care and number of PCP visits, showed very different effect estimates suggesting this issue may warrant further research. Screening retention of first-time screeners was very low in this study (45.4%) -- well below the national target of 75% [6] -- and suggests a potential priority area for intervention. Women with infrequent physician contact and poor continuity in this population have particularly low retention. This information is important to consider as some interventions to encourage re-screening among women overdue for mammograms, have been mediated through PCPs in BC [89]. However, the population of women at highest risk of loss may be more difficult to reach by such interventions if they don't have a PCP that they see regularly or identify as their usual provider. Future research might include further investigation into the populations of patients who have low continuity and infrequent physician visits to examine in greater detail the socio-demographic characteristics, geographic distribution, and other health utilization of these women. This might provide insights to support interventions to improve screening outcomes among these women and motivate further research.

6.5 Tables

Table 6.1: Definitions of study variables

Variable	**Relevant cohort**	**Definition**
Age	Participation and Retention	In years; calculated from date of birth to the start of cohort follow-up. Categorized into two groups: 50-59 and 60-69 years.
Income quintile	Participation and Retention	Derived from postal code of residence at the start of follow-up and categorized into five quintiles.
Rural residence	Participation and Retention	Derived from postal code of residence at the start of follow-up. Postal codes associated with communities with populations of less than 10,000 were assigned to rural; community sizes of ≥10,000 were assigned to urban.
Prior breast screening	Participation and Retention	The presence of any mammogram performed by the BCBSP prior to the start of follow-up was taken to mean a prior history of screening; women with no documented BCBSP mammogram were assumed to have no prior screening history. In the retention cohort this represents whether a woman's index mammogram was the first screen or a subsequent screen.
Family history of breast cancer	Retention	Self-reported breast cancer history on the BCBSP client questionnaire. Women could indicate presence or absence of family history; women who did not complete this question were coded as unknown.
Index screen result	Retention	Based on index mammogram result identified in BCBSP database. Categorized as normal or abnormal result.
Number of major ADGs	Participation and Retention	Based on the Johns Hopkins ACG/ADG system. The number of major ADGs identified was categorized into 0, 1, 2 or 3+.
Primary care physician visits	Participation and Retention	The number of primary care physician (PCP) office visits identified from the physician payment file during two-year follow-up period. Categorized into quartiles (3-6, 7-9, 10-15, 16+)
Number of primary care physicians seen	Participation and Retention	The number of unique PCPs seen by a patient during the two-year follow-up period. Categorized into 1, 2, 3-5, 6-10, 11+
Usual Provider of Care (UPC) index	Participation and Retention	Calculated as the proportion of all PCP visits in the follow-up period identified in the physician payment data that were with the patient's assigned PCP. Categorize into quartiles.
Duration of PCP-patient relationship	Participation and Retention	The time (in years) from the date of the first visit between the patient and their assigned PCP and the start date of follow-up. Categorized into: <5, 5-9, 10+ years for the participation cohort; <5, 5+ years for the retention cohort.
PCP sex	Participation and Retention	Determined from College of Physician and Surgeons of BC database.
PCP years since medical school	Participation and Retention	The number of years between the year of medical degree graduation, identified on the College of Physician and Surgeons

graduation		of BC database and the start of cohort follow-up. Categorized into quartiles (<19, 19-25, 26-35, >35).

BC = British Columbia; BCBSP = BC Cancer Breast Screening Program; ACG = adjusted clinical groups; ADG = aggregate diagnosis group; UPC = Usual provider of care; PCP = primary care physician;

Table 6.2: Select demographic and health characteristics of participation cohort and their participation rates

				Age Groups			
		Cohort		50-59		60-69	
Variable	**Subgroup**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**
All women	All women	455,680 (100.0%)	54.8 [54.6, 54.9]	273,461 (100.0%)	52.7 [52.5, 52.9]	182,219 (100.0%)	57.9 [57.7, 58.1]
Urban/rural residence	Urban	391,597 (85.9%)	55.7 [55.5, 55.9]	236,461 (86.5%)	53.7 [53.5, 53.9]	155,136 (85.1%)	58.7 [58.5, 59.0]
	Rural	63,990 (14.0%)	49.1 [48.8, 49.5]	36,943 (13.5%)	46.1 [45.6, 46.6]	27,047 (14.8%)	53.3 [52.7, 53.9]
	Unknown	93 (0.0%)	38.7 [28.8, 49.4]	57 (0.0%)	42.1 [29.1, 55.9]	36 (0.0%)	33.3 [18.6, 51.0]
Income quintile	Q1 (lowest)	83,175 (18.3%)	47.8 [47.4, 48.1]	50,160 (18.3%)	45.8 [45.3, 46.2]	33,015 (18.1%)	50.8 [50.2, 51.3]
	Q2	87,887 (19.3%)	52.7 [52.4, 53.0]	52,459 (19.2%)	51.1 [50.7, 51.5]	35,428 (19.4%)	55.1 [54.5, 55.6]
	Q3	90,412 (19.8%)	55.5 [55.2, 55.9]	54,727 (20.0%)	53.6 [53.2, 54.0]	35,685 (19.6%)	58.5 [58.0, 59.0]
	Q4	93,953 (20.6%)	57.0 [56.7, 57.3]	56,775 (20.8%)	54.7 [54.3, 55.1]	37,178 (20.4%)	60.5 [60.0, 61.0]
	Q5 (highest)	96,368 (21.1%)	60.2 [59.9, 60.5]	56,966 (20.8%)	57.7 [57.3, 58.1]	39,402 (21.6%)	63.7 [63.2, 64.2]
	Unknown	3,885 (0.9%)	48.1 [46.5, 49.6]	2,374 (0.9%)	45.3 [43.3, 47.4]	1,511 (0.8%)	52.3 [49.8, 54.9]
Prior screening	None	100,170 (22.0%)	9.8 [9.6, 10.0]	67,395 (24.6%)	10.9 [10.7, 11.1]	32,775 (18.0%)	7.6 [7.4, 7.9]
	Yes	355,510 (78.0%)	67.4 [67.3, 67.6]	206,066 (75.4%)	66.4 [66.2, 66.6]	149,444 (82.0%)	68.9 [68.7, 69.2]
# Major ADGs	0	255,544 (56.1%)	54.9 [54.7, 55.1]	161,120 (58.9%)	53.0 [52.8, 53.3]	94,424 (51.8%)	58.2 [57.9, 58.5]
	1	127,783 (28.0%)	55.6 [55.3, 55.8]	74,115 (27.1%)	53.2 [52.9, 53.6]	53,668 (29.5%)	58.8 [58.4, 59.2]
	2	45,436 (10.0%)	54.2 [53.7, 54.6]	24,100 (8.8%)	51.3 [50.7, 52.0]	21,336 (11.7%)	57.4 [56.7, 58.0]
	3+	19,639 (4.3%)	48.5 [47.8, 49.2]	9,779 (3.6%)	45.5 [44.5, 46.5]	9,860 (5.4%)	51.4 [50.4, 52.4]
	Unknown	7,278 (1.6%)	56.0 [54.8, 57.1]	4,347 (1.6%)	53.8 [52.3, 55.3]	2,931 (1.6%)	59.1 [57.3, 60.9]

N = Sample size; PR = Participation rate; ADG = Aggregate diagnosis group; Q = quintile

Table 6.3: PCP characteristics and measures of PCP-patient continuity for participation cohort and their participation rates

				Age Groups			
		Cohort		50-59		60-69	
Variable	**Subgroup**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**	**N (%)**	**PR (%)**
# PCP visits	3-6	127,055 (27.9%)	50.8 [50.6, 51.1]	82,747 (30.3%)	49.2 [48.8, 49.5]	44,308 (24.3%)	54.0 [53.5, 54.4]
	7-9	93,297 (20.5%)	55.5 [55.2, 55.8]	56,490 (20.7%)	53.7 [53.3, 54.1]	36,807 (20.2%)	58.2 [57.7, 58.8]
	10-15	126,126 (27.7%)	57.5 [57.3, 57.8]	72,800 (26.6%)	55.5 [55.1, 55.9]	53,326 (29.3%)	60.3 [59.9, 60.7]
	16+	109,202 (24.0%)	55.6 [55.3, 55.9]	61,424 (22.5%)	53.2 [52.8, 53.6]	47,778 (26.2%)	58.7 [58.2, 59.1]
# PCPs seen	1	96,468 (21.2%)	56.2 [55.8, 56.5]	55,180 (20.2%)	54.5 [54.0, 54.9]	41,288 (22.7%)	58.4 [57.9, 58.9]
	2	117,037 (25.7%)	56.3 [56.0, 56.6]	69,272 (25.3%)	54.3 [53.9, 54.7]	47,765 (26.2%)	59.2 [58.7, 59.6]
	3-5	187,060 (41.1%)	54.5 [54.3, 54.7]	113,937 (41.7%)	52.3 [52.1, 52.6]	73,123 (40.1%)	57.9 [57.6, 58.3]
	6-10	50,176 (11.0%)	50.8 [50.3, 51.2]	31,728 (11.6%)	48.6 [48.1, 49.2]	18,448 (10.1%)	54.5 [53.7, 55.2]
	11+	4,939 (1.1%)	42.5 [41.1, 43.9]	3,344 (1.2%)	40.2 [38.6, 41.9]	1,595 (0.9%)	47.3 [44.8, 49.8]
UPC quartiles	<0.54 (QRT1)	101,703 (22.3%)	48.6 [48.3, 49.0]	66,480 (24.3%)	46.9 [46.5, 47.3]	35,223 (19.3%)	52.0 [51.4, 52.5]
	0.54-0.78 (QRT2)	139,850 (30.7%)	55.5 [55.3, 55.8]	85,538 (31.3%)	53.5 [53.2, 53.9]	54,312 (29.8%)	58.7 [58.3, 59.1]
	0.78-0.99 (QRT3)	117,659 (25.8%)	58.1 [57.8, 58.3]	66,263 (24.2%)	55.9 [55.6, 56.3]	51,396 (28.2%)	60.8 [60.4, 61.2]
	1.00 (QRT4)	96,468 (21.2%)	56.2 [55.8, 56.5]	55,180 (20.2%)	54.5 [54.0, 54.9]	41,288 (22.7%)	58.4 [57.9, 58.9]
Duration with PCP	<5 years	190,748 (41.9%)	51.0 [50.8, 51.2]	115,627 (42.3%)	48.7 [48.4, 49.0]	75,121 (41.2%)	54.5 [54.2, 54.9]
	5-9 years	100,465 (22.0%)	55.2 [54.9, 55.5]	59,016 (21.6%)	53.1 [52.7, 53.5]	41,449 (22.7%)	58.2 [57.7, 58.7]
	10+ years	164,467 (36.1%)	58.9 [58.7, 59.2]	98,818 (36.1%)	57.1 [56.8, 57.4]	65,649 (36.0%)	61.6 [61.3, 62.0]
PCP sex	Female	181,713 (39.9%)	58.6 [58.4, 58.9]	112,310 (41.1%)	56.6 [56.3, 56.9]	69,403 (38.1%)	62.0 [61.6, 62.3]
	Male	273,967 (60.1%)	52.2 [52.0, 52.4]	161,151 (58.9%)	50.0 [49.7, 50.2]	112,816 (61.9%)	55.4 [55.1, 55.7]
PCP years since graduation	<19 (QRT1)	129,647 (28.5%)	54.2 [53.9, 54.5]	78,006 (28.5%)	51.6 [51.3, 52.0]	51,641 (28.3%)	58.0 [57.6, 58.4]
	19-25 (QRT2)	99,539 (21.8%)	55.0 [54.7, 55.3]	60,243 (22.0%)	52.9 [52.5, 53.3]	39,296 (21.6%)	58.2 [57.7, 58.7]
	26-35 (QRT3)	124,277 (27.3%)	55.5 [55.3, 55.8]	75,186 (27.5%)	53.7 [53.3, 54.0]	49,091 (26.9%)	58.4 [57.9, 58.8]
	36+ (QRT4)	102,217 (22.4%)	54.4 [54.1, 54.7]	60,026 (22.0%)	52.6 [52.2, 53.0]	42,191 (23.2%)	57.0 [56.5, 57.4]

N = Sample size; PR = participation rate; PCP = primary care physician; UPC = Usual Provider of Care Index; QRT = quartile

Table 6.4: GEE Poisson regression adjusted risk ratios (ARRs) for PCP factors and associations with breast screening participation and retention

Variable	Subgroup	ARR [95% CI]	
		Participation	**Retention**
# PCP visits	3-6 vs 16+	0.89 (0.88,0.89)	0.98 (0.97,0.99)
	7-9 vs 16+	0.96 (0.95,0.97)	1.01 (1.00,1.02)
	10-15 vs 16+	1.00 (0.99,1.01)	1.02 (1.01,1.02)
# PCPs seen	2 vs 1	1.01 (1.01,1.02)	0.99 (0.98,1.00)
	3-5 vs 1	1.01 (1.00,1.02)	0.97 (0.97,0.98)
	6-10 vs 1	0.97 (0.96,0.98)	0.94 (0.93,0.94)
	11+ vs 1	0.86 (0.84,0.89)	0.87 (0.85,0.90)
UPC index (quartiles)	QRT1 vs QRT4	0.91 (0.90,0.92)	0.94 (0.93,0.94)
	QRT2 vs QRT4	1.01 (1.00,1.01)	0.98 (0.97,0.98)
	QRT3 vs QRT4	1.05 (1.04,1.06)	1.00 (0.99,1.00)
Duration with PCP (years) - Participation	<5 vs 10+	0.87 (0.87,0.88)	NA
	5-9 vs 10+	0.94 (0.93,0.95)	
- Retention	<5 vs 5+	NA	0.98 (0.97,0.98)
PCP sex	M vs F	0.89 (0.88,0.90)	1.00 (1.00,1.01)
PCP years since graduation (quartiles)	QRT1 vs QRT4	1.03 (1.01,1.05)	0.98 (0.97,0.98)
	QRT2 vs QRT4	1.04 (1.02,1.06)	0.99 (0.98,0.99)
	QRT3 vs QRT4	1.04 (1.02,1.07)	0.99 (0.98,1.00)

ARR = relative risk; CI = confidence interval; PCP = primary care physician; UPC = usual provider of care; M = male; F = female; QRT = quartile; GEE = generalized estimating equations

Participation models adjusted for: age, rural residence, income quintile, number of major ADGs; Retention models include the same terms as participation in addition to family history of breast cancer, whether the index mammogram was the first screen and index screen result.

Table 6.5: GEE Poisson regression adjusted risk ratios for associations with breast screening participation by models fit to select participation cohort subgroups

		ARR [95% CI]					
			Stratified Models				
		Full Model	Age		Income Quintile		# PCP Visits
Variable	**Subgroup**	**All Cohort**	**50-59**	**60-69**	**Lowest**	**Highest**	**10+**
# PCP visits	3-6 vs 16+	0.86 (0.85,0.87)	0.87 (0.86,0.88)	0.86 (0.85,0.87)	0.82 (0.80,0.84)	0.91 (0.90,0.93)	NA
	7-9 vs 16+	0.94 (0.93,0.94)	0.94 (0.93,0.95)	0.93 (0.92,0.94)	0.90 (0.88,0.92)	0.98 (0.96,1.00)	
	10-15 vs 16+	0.98 (0.97,0.99)	0.99 (0.98,1.00)	0.98 (0.97,0.99)	0.97 (0.95,0.99)	1.01 (0.99,1.02)	0.99 (0.98,1.00)
UPC index (quartiles)	QRT1 vs QRT4	0.89 (0.88,0.90)	0.88 (0.87,0.89)	0.90 (0.88,0.91)	0.89 (0.87,0.92)	0.88 (0.86,0.89)	0.94 (0.92,0.95)
	QRT2 vs QRT4	0.97 (0.97,0.98)	0.97 (0.96,0.98)	0.98 (0.97,0.99)	1.00 (0.98,1.02)	0.96 (0.94,0.97)	1.02 (1.01,1.03)
	QRT3 vs QRT4	1.00 (1.00,1.01)	1.00 (0.99,1.01)	1.01 (1.00,1.02)	1.02 (1.00,1.05)	0.99 (0.98,1.01)	1.03 (1.02,1.04)
Duration with PCP (years)	<5 vs 10+	0.88 (0.88,0.89)	0.88 (0.87,0.89)	0.88 (0.87,0.89)	0.85 (0.83,0.86)	0.90 (0.89,0.91)	0.91 (0.90,0.92)
	5-9 vs 10+	0.94 (0.94,0.95)	0.94 (0.93,0.95)	0.94 (0.93,0.95)	0.93 (0.91,0.95)	0.95 (0.94,0.96)	0.96 (0.95,0.97)
PCP sex	M vs F	0.88 (0.87,0.89)	0.88 (0.87,0.89)	0.89 (0.88,0.90)	0.85 (0.83,0.87)	0.90 (0.89,0.92)	0.90 (0.89,0.91)
PCP years since graduation (quartiles)	QRT1 vs QRT4	1.05 (1.03,1.07)	1.03 (1.01,1.05)	1.07 (1.04,1.09)	1.05 (1.02,1.08)	1.05 (1.02,1.07)	1.03 (1.01,1.05)
	QRT2 vs QRT4	1.02 (1.01,1.04)	1.01 (0.99,1.04)	1.03 (1.01,1.05)	1.02 (0.99,1.05)	1.03 (1.00,1.05)	1.01 (0.99,1.03)
	QRT3 vs QRT4	1.02 (1.00,1.04)	1.01 (0.99,1.03)	1.02 (1.00,1.04)	1.00 (0.97,1.03)	1.03 (1.01,1.05)	1.01 (0.99,1.03)
# Major ADGs	1 vs 0	0.98 (0.98,0.99)	0.98 (0.98,0.99)	0.99 (0.98,1.00)	0.97 (0.96,0.99)	1.00 (0.99,1.01)	0.98 (0.98,0.99)
	2 vs 0	0.94 (0.93,0.95)	0.94 (0.92,0.95)	0.95 (0.94,0.96)	0.93 (0.90,0.95)	0.96 (0.94,0.98)	0.94 (0.93,0.95)
	3+ vs 0	0.84 (0.83,0.86)	0.84 (0.82,0.86)	0.85 (0.83,0.86)	0.79 (0.76,0.82)	0.89 (0.86,0.92)	0.86 (0.84,0.87)
Age	60-69 vs 50-59	1.09 (1.08,1.09)	NA	NA	1.10 (1.08,1.11)	1.09 (1.08,1.10)	1.09 (1.08,1.10)
Urban/rural residence	Rural vs Urban	0.94 (0.93,0.96)	0.92 (0.91,0.94)	0.95 (0.93,0.96)	1.03 (1.00,1.05)	0.88 (0.86,0.90)	0.92 (0.91,0.94)
Income quintile	Q1 vs Q5	0.82 (0.81,0.82)	0.81 (0.80,0.82)	0.82 (0.81,0.83)	NA	NA	0.83 (0.82,0.84)
	Q2 vs Q5	0.89 (0.88,0.90)	0.89 (0.88,0.90)	0.88 (0.87,0.89)			0.90 (0.89,0.91)
	Q3 vs Q5	0.93 (0.92,0.94)	0.93 (0.92,0.94)	0.93 (0.92,0.94)			0.94 (0.93,0.95)
	Q4 vs Q5	0.95 (0.95,0.96)	0.95 (0.94,0.96)	0.95 (0.94,0.97)			0.95 (0.94,0.96)

ARR = adjusted relative risk; CI = confidence interval; PCP = primary care physician; UPC = usual provider of care; M = male; F = female; ADG = Aggregate diagnosis group; QRT = quartile; Q = quintile; GEE = generalized estimating equations

Table 6.6: GEE Poisson regression adjusted rate ratios for associations with screening participation from models stratified by immigrant groups within the participation cohort

Variable	Subgroup	ARR (95% CI)					
		Non-immigrants	CMHT	India	Philippines	Eastern Europe	Other Immigrants
# PCP visits	3-6 vs 16+	0.89 (0.88,0.90)	0.69 (0.66,0.72)	0.64 (0.59,0.70)	0.72 (0.68,0.77)	0.72 (0.65,0.79)	0.78 (0.75,0.81)
	7-9 vs 16+	0.95 (0.95,0.96)	0.82 (0.79,0.85)	0.77 (0.72,0.83)	0.84 (0.79,0.89)	0.87 (0.79,0.95)	0.88 (0.85,0.91)
	10-15 vs 16+	0.99 (0.98,1.00)	0.93 (0.90,0.95)	0.90 (0.86,0.94)	0.94 (0.90,0.99)	0.94 (0.86,1.02)	0.96 (0.94,0.99)
UPC index (quartiles)	QRT1 vs QRT4	0.87 (0.86,0.88)	1.01 (0.97,1.06)	1.04 (0.95,1.12)	0.94 (0.88,1.00)	0.85 (0.77,0.94)	0.93 (0.89,0.97)
	QRT2 vs QRT4	0.96 (0.95,0.97)	1.06 (1.02,1.10)	1.05 (0.98,1.12)	1.00 (0.94,1.06)	0.98 (0.89,1.08)	1.00 (0.96,1.04)
	QRT3 vs QRT4	0.99 (0.98,1.00)	1.08 (1.05,1.12)	1.06 (1.00,1.13)	1.07 (1.02,1.13)	0.95 (0.86,1.04)	1.03 (0.99,1.07)
Duration with PCP (years) Non-immigrants	<5 vs 10+	0.89 (0.89,0.90)	NA	NA	NA	NA	NA
	5-9 vs 10+	0.95 (0.94,0.96)					
Immigrants (5-9 years in Canada)	<5 vs 5-9	NA	0.87 (0.81,0.95)	0.91 (0.83,1.02)	0.89 (0.78,1.01)	0.99 (0.80,1.22)	0.91 (0.85,0.98)
Immigrants (10+ years in Canada)	<5 vs 10+		0.87 (0.84,0.91)	0.92 (0.86,0.99)	0.84 (0.78,0.89)	0.87 (0.79,0.96)	0.89 (0.86,0.92)
	5-9 vs 10+		0.92 (0.89,0.95)	1.00 (0.95,1.06)	0.92 (0.87,0.98)	0.93 (0.84,1.02)	0.96 (0.93,1.00)
PCP sex	M vs F	0.89 (0.88,0.90)	0.89 (0.86,0.93)	0.86 (0.80,0.93)	0.88 (0.84,0.93)	0.86 (0.80,0.93)	0.88 (0.85,0.91)
PCP years since graduation (quartiles)	QRT1 vs QRT4	1.04 (1.02,1.06)	1.06 (1.00,1.12)	1.05 (0.95,1.16)	1.08 (1.00,1.17)	1.00 (0.89,1.13)	1.02 (0.98,1.07)
	QRT2 vs QRT4	1.02 (1.00,1.04)	1.04 (0.98,1.09)	0.99 (0.89,1.09)	1.00 (0.93,1.08)	1.06 (0.95,1.18)	1.02 (0.97,1.06)
	QRT3 vs QRT4	1.02 (1.00,1.03)	1.06 (1.01,1.12)	1.00 (0.90,1.10)	1.01 (0.94,1.08)	1.01 (0.91,1.13)	1.03 (0.99,1.08)
# Major ADGs	1 vs 0	0.98 (0.98,0.99)	1.00 (0.97,1.02)	1.02 (0.97,1.07)	1.01 (0.97,1.06)	0.97 (0.91,1.04)	1.00 (0.98,1.03)
	2 vs 0	0.93 (0.93,0.94)	0.98 (0.94,1.02)	1.03 (0.97,1.10)	0.97 (0.90,1.04)	1.02 (0.91,1.15)	0.99 (0.95,1.03)
	3+ vs 0	0.83 (0.82,0.85)	1.00 (0.94,1.07)	1.06 (0.96,1.17)	1.00 (0.88,1.13)	0.96 (0.81,1.14)	0.88 (0.82,0.95)
Age	60-69 vs 50-59	1.11 (1.10,1.11)	0.95 (0.92,0.97)	0.81 (0.78,0.84)	0.89 (0.85,0.93)	0.98 (0.91,1.06)	1.00 (0.97,1.03)
Urban/rural residence	Rural vs Urban	0.94 (0.93,0.95)	0.65 (0.47,0.89)	0.92 (0.75,1.12)	0.87 (0.73,1.03)	0.95 (0.77,1.18)	0.96 (0.91,1.01)
Income quintile	Q1 vs Q5	0.80 (0.79,0.81)	0.96 (0.92,1.01)	0.95 (0.87,1.04)	0.91 (0.84,0.99)	0.94 (0.85,1.04)	0.88 (0.85,0.91)
	Q2 vs Q5	0.89 (0.88,0.89)	1.01 (0.96,1.06)	0.98 (0.91,1.07)	0.94 (0.86,1.02)	0.90 (0.81,1.00)	0.93 (0.89,0.96)
	Q3 vs Q5	0.93 (0.92,0.94)	1.01 (0.97,1.05)	1.02 (0.93,1.11)	1.00 (0.92,1.09)	0.98 (0.88,1.09)	0.95 (0.92,0.99)
	Q4 vs Q5	0.95 (0.94,0.96)	1.00 (0.96,1.05)	0.93 (0.85,1.03)	1.02 (0.93,1.11)	1.02 (0.92,1.13)	0.98 (0.94,1.01)

CMHT = China, Macau, Hong Kong, Taiwan; ARR = adjusted relative risk; CI = confidence interval; PCP = primary care physician; UPC = usual provider of care; M = male; F = female; ADG = Aggregate diagnosis group; QRT = quartile; Q = quintile; GEE = generalized estimating equations

Table 6.7: Select demographic and health characteristics of retention cohort and their retention rates

				Age Groups			
		Cohort		50-59		60-69	
Variable	**Subgroup**	**N (%)**	**Retention (%)**	**N (%)**	**Retention (%)**	**N (%)**	**Retention (%)**
All women	All women	258,753 (100.0%)	74.7 [74.6, 74.9]	156,431 (100.0%)	72.4 [72.1, 72.6]	102,322 (100.0%)	78.4 [78.1, 78.7]
Urban/rural residence	Urban	225,213 (87.0%)	75.5 [75.3, 75.7]	137,111 (87.6%)	73.1 [72.9, 73.4]	88,102 (86.1%)	79.1 [78.8, 79.4]
	Rural	33,517 (13.0%)	69.8 [69.3, 70.3]	19,304 (12.3%)	66.7 [66.0, 67.4]	14,213 (13.9%)	74.0 [73.2, 74.7]
	Unknown	23 (0.0%)	69.6 [47.1, 86.8]	16 (0.0%)	68.8 [41.3, 89.0]	7 (0.0%)	71.4 [29.0, 96.3]
Income quintile	Q1 (lowest)	41,173 (15.9%)	71.6 [71.2, 72.1]	24,754 (15.8%)	69.4 [68.8, 69.9]	16,419 (16.0%)	75.1 [74.4, 75.7]
	Q2	47,783 (18.5%)	74.0 [73.6, 74.4]	29,006 (18.5%)	71.7 [71.2, 72.3]	18,777 (18.4%)	77.5 [76.9, 78.1]
	Q3	51,732 (20.0%)	75.0 [74.6, 75.4]	31,837 (20.4%)	72.7 [72.3, 73.2]	19,895 (19.4%)	78.6 [78.0, 79.2]
	Q4	55,598 (21.5%)	75.6 [75.2, 75.9]	33,773 (21.6%)	73.2 [72.7, 73.7]	21,825 (21.3%)	79.2 [78.7, 79.7]
	Q5 (highest)	60,638 (23.4%)	76.6 [76.3, 76.9]	35,960 (23.0%)	73.9 [73.5, 74.4]	24,678 (24.1%)	80.5 [80.0, 81.0]
	Unknown	1,829 (0.7%)	70.0 [67.9, 72.1]	1,101 (0.7%)	67.2 [64.4, 70.0]	728 (0.7%)	74.3 [71.0, 77.5]
# Major ADGs	0	148,927 (57.6%)	75.0 [74.8, 75.2]	94,442 (60.4%)	72.8 [72.5, 73.1]	54,485 (53.2%)	78.8 [78.4, 79.1]
	1	73,702 (28.5%)	74.9 [74.6, 75.3]	42,933 (27.4%)	72.2 [71.7, 72.6]	30,769 (30.1%)	78.8 [78.3, 79.3]
	2	24,719 (9.6%)	74.3 [73.7, 74.8]	13,064 (8.4%)	71.6 [70.8, 72.4]	11,655 (11.4%)	77.3 [76.5, 78.1]
	3+	9,232 (3.6%)	71.0 [70.0, 71.9]	4,699 (3.0%)	67.5 [66.1, 68.8]	4,533 (4.4%)	74.5 [73.2, 75.8]
	Unknown	2,173 (0.8%)	73.0 [71.1, 74.8]	1,293 (0.8%)	70.8 [68.3, 73.3]	880 (0.9%)	76.1 [73.2, 78.9]
Family history	None	222,714 (86.1%)	74.2 [74.0, 74.3]	135,810 (86.8%)	71.8 [71.5, 72.0]	86,904 (84.9%)	77.9 [77.6, 78.2]
	Yes	36,039 (13.9%)	78.3 [77.9, 78.7]	20,621 (13.2%)	76.2 [75.6, 76.7]	15,418 (15.1%)	81.2 [80.6, 81.8]
Index screen	First screen	15,469 (6.0%)	45.4 [44.7, 46.2]	11,653 (7.4%)	44.8 [43.9, 45.7]	3,816 (3.7%)	47.5 [45.9, 49.1]
	Subsequent	243,284 (94.0%)	76.6 [76.4, 76.8]	144,778 (92.6%)	74.6 [74.3, 74.8]	98,506 (96.3%)	79.6 [79.3, 79.8]
Index screen result	Normal	241,315 (93.3%)	75.3 [75.1, 75.5]	145,218 (92.8%)	72.9 [72.7, 73.1]	96,097 (93.9%)	78.9 [78.6, 79.1]
	Abnormal	17,438 (6.7%)	67.1 [66.4, 67.8]	11,213 (7.2%)	65.0 [64.1, 65.9]	6,225 (6.1%)	71.1 [69.9, 72.2]

ADG = Aggregate diagnosis group; Q = quintile

Table 6.8: PCP characteristics and measures of PCP-patient continuity for retention cohort and their retention rates

				Age Groups			
		Cohort		**50-59**		**60-69**	
Variable	**Subgroup**	**N (%)**	**Retention (%)**	**N (%)**	**Retention (%)**	**N (%)**	**Retention (%)**
# PCP visits	3-6	64,785 (25.0%)	72.9 [72.6, 73.3]	42,737 (27.3%)	70.9 [70.4, 71.3]	22,048 (21.5%)	76.9 [76.3, 77.4]
	7-9	52,639 (20.3%)	75.5 [75.1, 75.9]	32,300 (20.6%)	73.1 [72.7, 73.6]	20,339 (19.9%)	79.2 [78.6, 79.8]
	10-15	75,483 (29.2%)	76.1 [75.8, 76.4]	44,230 (28.3%)	73.8 [73.3, 74.2]	31,253 (30.5%)	79.4 [79.0, 79.9]
	16+	65,846 (25.4%)	74.4 [74.0, 74.7]	37,164 (23.8%)	71.7 [71.2, 72.1]	28,682 (28.0%)	77.9 [77.4, 78.3]
# PCPs seen	1	55,445 (21.4%)	76.9 [76.5, 77.2]	32,045 (20.5%)	74.6 [74.1, 75.1]	23,400 (22.9%)	79.9 [79.4, 80.5]
	2	68,357 (26.4%)	75.7 [75.4, 76.1]	40,939 (26.2%)	73.3 [72.9, 73.7]	27,418 (26.8%)	79.4 [78.9, 79.9]
	3-5	105,684 (40.8%)	74.3 [74.0, 74.5]	64,697 (41.4%)	71.9 [71.6, 72.3]	40,987 (40.1%)	77.9 [77.5, 78.3]
	6-10	26,979 (10.4%)	70.6 [70.0, 71.1]	17,225 (11.0%)	68.2 [67.5, 68.9]	9,754 (9.5%)	74.7 [73.9, 75.6]
	11+	2,288 (0.9%)	65.1 [63.1, 67.1]	1,525 (1.0%)	63.7 [61.2, 66.1]	763 (0.7%)	68.0 [64.6, 71.3]
UPC quartiles	<0.54 (QRT1)	50,840 (19.6%)	70.7 [70.3, 71.1]	33,530 (21.4%)	68.7 [68.2, 69.2]	17,310 (16.9%)	74.8 [74.1, 75.4]
	0.54-0.78 (QRT2)	79,814 (30.8%)	74.3 [74.0, 74.6]	49,566 (31.7%)	72.2 [71.8, 72.6]	30,248 (29.6%)	77.7 [77.3, 78.2]
	0.78-0.99 (QRT3)	72,654 (28.1%)	76.4 [76.1, 76.7]	41,290 (26.4%)	73.7 [73.3, 74.2]	31,364 (30.7%)	79.9 [79.4, 80.3]
	1.00 (QRT4)	55,445 (21.4%)	76.9 [76.5, 77.2]	32,045 (20.5%)	74.6 [74.1, 75.1]	23,400 (22.9%)	79.9 [79.4, 80.5]
Duration with PCP	<5 years	105,458 (40.8%)	72.6 [72.4, 72.9]	63,906 (40.9%)	70.0 [69.6, 70.3]	41,552 (40.6%)	76.7 [76.3, 77.1]
	5+ years	153,295 (59.2%)	76.2 [76.0, 76.4]	92,525 (59.1%)	74.0 [73.7, 74.3]	60,770 (59.4%)	79.5 [79.2, 79.9]
PCP sex	Female	104,544 (40.4%)	74.8 [74.6, 75.1]	65,718 (42.0%)	72.7 [72.4, 73.1]	38,826 (37.9%)	78.4 [78.0, 78.8]
	Male	154,209 (59.6%)	74.7 [74.5, 74.9]	90,713 (58.0%)	72.1 [71.8, 72.4]	63,496 (62.1%)	78.4 [78.1, 78.7]
PCP years since graduation	<19 (QRT1)	61,542 (23.8%)	72.9 [72.5, 73.2]	37,210 (23.8%)	70.2 [69.7, 70.7]	24,332 (23.8%)	77.0 [76.4, 77.5]
	19-25 (QRT2)	55,839 (21.6%)	74.7 [74.3, 75.0]	33,891 (21.7%)	72.4 [71.9, 72.8]	21,948 (21.4%)	78.3 [77.7, 78.8]
	26-35 (QRT3)	73,265 (28.3%)	75.0 [74.7, 75.3]	44,706 (28.6%)	72.5 [72.1, 73.0]	28,559 (27.9%)	78.8 [78.3, 79.3]
	36+ (QRT4)	68,107 (26.3%)	76.2 [75.9, 76.5]	40,624 (26.0%)	74.1 [73.7, 74.5]	27,483 (26.9%)	79.3 [78.9, 79.8]

PCP = primary care physician; UPC = Usual Provider of Care Index; QRT = quartile

Table 6.9: GEE Poisson regression adjusted risk ratios for associations with breast screening retention by models fit to select retention cohort subgroups

		ARR [95% CI]							
			Stratified Models						
		Full Model	Age		Income Quintile		Index Screen		# PCP Visits
Variable	**Subgroup**	**All Cohort**	**50-59**	**60-69**	**Lowest**	**Highest**	**First**	**Subsequent**	**10+**
# PCP visits	3-6 vs 16+	0.96 (0.96,0.97)	0.97 (0.96,0.97)	0.97 (0.95,0.98)	0.96 (0.94,0.98)	0.97 (0.95,0.98)	0.90 (0.85,0.95)	0.97 (0.96,0.97)	NA
	7-9 vs 16+	1.00 (0.99,1.00)	1.00 (0.99,1.01)	1.00 (0.99,1.01)	1.00 (0.98,1.02)	1.00 (0.99,1.02)	0.94 (0.89,1.00)	1.00 (0.99,1.01)	
	10-15 vs 16+	1.01 (1.00,1.01)	1.01 (1.00,1.02)	1.00 (1.00,1.01)	1.02 (1.00,1.04)	1.01 (1.00,1.02)	0.98 (0.93,1.03)	1.01 (1.00,1.02)	1.01 (1.00,1.01)
UPC index (quartiles)	QRT1 vs QRT4	0.93 (0.92,0.94)	0.93 (0.92,0.94)	0.94 (0.93,0.95)	0.94 (0.92,0.95)	0.94 (0.93,0.96)	0.86 (0.81,0.91)	0.93 (0.93,0.94)	0.93 (0.92,0.94)
	QRT2 vs QRT4	0.97 (0.96,0.97)	0.97 (0.96,0.98)	0.97 (0.96,0.98)	0.97 (0.95,0.99)	0.97 (0.96,0.98)	0.94 (0.90,0.99)	0.97 (0.96,0.98)	0.97 (0.96,0.98)
	QRT3 vs QRT4	0.99 (0.98,0.99)	0.98 (0.97,0.99)	0.99 (0.98,1.00)	0.99 (0.97,1.01)	0.98 (0.97,1.00)	0.99 (0.94,1.04)	0.99 (0.98,0.99)	0.98 (0.97,0.99)
Duration with PCP (years)	<5 vs 5+	0.99 (0.98,0.99)	0.98 (0.98,0.99)	0.99 (0.98,1.00)	0.97 (0.95,0.98)	1.00 (0.99,1.01)	1.04 (1.00,1.08)	0.99 (0.98,0.99)	0.99 (0.98,0.99)
PCP sex	M vs F	0.99 (0.99,1.00)	0.99 (0.98,1.00)	1.00 (0.99,1.01)	0.98 (0.97,1.00)	1.00 (0.99,1.01)	0.98 (0.94,1.02)	0.99 (0.99,1.00)	0.99 (0.98,1.00)
PCP years since graduation (quartiles)	QRT1 vs QRT4	0.98 (0.97,0.99)	0.97 (0.96,0.98)	0.99 (0.98,1.00)	0.99 (0.97,1.01)	0.97 (0.96,0.99)	0.99 (0.94,1.05)	0.98 (0.97,0.99)	0.97 (0.96,0.99)
	QRT2 vs QRT4	0.99 (0.98,0.99)	0.98 (0.97,0.99)	0.99 (0.98,1.00)	0.99 (0.97,1.01)	0.99 (0.98,1.00)	0.98 (0.93,1.04)	0.99 (0.98,0.99)	0.98 (0.97,0.99)
	QRT3 vs QRT4	0.99 (0.98,1.00)	0.98 (0.97,0.99)	1.00 (0.99,1.01)	0.99 (0.97,1.01)	0.99 (0.98,1.01)	1.00 (0.94,1.05)	0.99 (0.98,1.00)	0.99 (0.98,0.99)
Index screen	First vs Subsequent	0.78 (0.78,0.79)	0.78 (0.78,0.79)	0.78 (0.77,0.80)	0.79 (0.77,0.80)	0.79 (0.77,0.81)	NA	NA	0.79 (0.78,0.80)
Index screen result	Abnormal vs normal	0.93 (0.92,0.94)	0.93 (0.92,0.94)	0.93 (0.91,0.94)	0.92 (0.90,0.95)	0.92 (0.91,0.94)	1.01 (0.97,1.06)	0.92 (0.91,0.93)	0.94 (0.92,0.95)
Family history of breast cancer	Yes vs None	1.05 (1.04,1.06)	1.06 (1.05,1.07)	1.04 (1.03,1.05)	1.04 (1.03,1.06)	1.05 (1.04,1.07)	1.08 (1.02,1.14)	1.05 (1.04,1.06)	1.04 (1.04,1.05)
# Major ADGs	1 vs 0	0.99 (0.99,1.00)	0.99 (0.98,1.00)	1.00 (0.99,1.00)	0.99 (0.98,1.01)	0.99 (0.98,1.00)	0.97 (0.93,1.01)	0.99 (0.99,1.00)	0.99 (0.98,1.00)
	2 vs 0	0.98 (0.97,0.99)	0.98 (0.97,0.99)	0.98 (0.97,0.99)	0.97 (0.95,0.99)	0.98 (0.97,1.00)	0.90 (0.84,0.96)	0.98 (0.97,0.99)	0.98 (0.97,0.99)
	3+ vs 0	0.94 (0.93,0.95)	0.93 (0.91,0.95)	0.95 (0.93,0.96)	0.91 (0.88,0.94)	0.94 (0.91,0.97)	0.90 (0.82,0.99)	0.94 (0.93,0.95)	0.94 (0.92,0.95)
Age	60-69 vs 50-59	1.06 (1.06,1.07)	NA	NA	1.06 (1.05,1.07)	1.07 (1.06,1.08)	1.05 (1.00,1.09)	1.06 (1.06,1.07)	1.06 (1.06,1.07)
Urban/rural residence	Rural vs urban	0.95 (0.94,0.95)	0.94 (0.93,0.95)	0.95 (0.94,0.96)	0.96 (0.95,0.98)	0.93 (0.91,0.95)	1.04 (0.99,1.09)	0.94 (0.93,0.95)	0.93 (0.92,0.95)
Income quintile	Q1 vs Q5	0.95 (0.94,0.96)	0.95 (0.94,0.96)	0.94 (0.93,0.96)	NA	NA	0.94 (0.89,0.99)	0.95 (0.94,0.96)	0.95 (0.94,0.96)
	Q2 vs Q5	0.97 (0.97,0.98)	0.98 (0.97,0.99)	0.97 (0.96,0.98)			0.95 (0.90,1.00)	0.98 (0.97,0.98)	0.97 (0.97,0.98)
	Q3 vs Q5	0.98 (0.98,0.99)	0.99 (0.98,1.00)	0.98 (0.97,0.99)			0.97 (0.91,1.02)	0.99 (0.98,0.99)	0.98 (0.98,0.99)
	Q4 vs Q5	0.99 (0.98,1.00)	0.99 (0.98,1.00)	0.99 (0.98,1.00)			0.96 (0.91,1.02)	0.99 (0.99,1.00)	0.99 (0.98,1.00)

ARR = adjusted relative risk; CI = confidence interval; PCP = primary care physician; UPC = usual provider of care; M = male; F = female; ADG = Aggregate diagnosis group; QRT = quartile; Q = quintile; GEE = generalized estimating equations

Table 6.10: GEE Poisson regression adjusted risk ratios for associations with breast screening retention by models fit to immigrant groups within the retention cohort

Variable	Subgroup	ARR (95% CI)					
		Non-immigrants	CMHT	India	Philippines	Eastern Europe	Other Immigrants
# PCP Visits	3-6 vs 16+	0.97 (0.97,0.98)	0.87 (0.84,0.90)	0.92 (0.84,1.00)	0.89 (0.84,0.94)	0.97 (0.88,1.06)	0.90 (0.87,0.93)
	7-9 vs 16+	1.00 (1.00,1.01)	0.92 (0.89,0.96)	1.02 (0.95,1.09)	0.94 (0.89,1.00)	0.98 (0.90,1.07)	0.96 (0.93,0.99)
	10-15 vs 16+	1.01 (1.01,1.02)	0.98 (0.95,1.00)	0.99 (0.94,1.04)	0.99 (0.95,1.04)	1.02 (0.95,1.10)	0.97 (0.95,1.00)
UPC Index (quartiles)	QRT1 vs QRT4	0.93 (0.92,0.93)	0.99 (0.96,1.03)	1.01 (0.95,1.08)	0.90 (0.85,0.96)	0.97 (0.88,1.07)	0.95 (0.91,0.98)
	QRT2 vs QRT4	0.96 (0.96,0.97)	0.99 (0.97,1.01)	1.00 (0.94,1.06)	0.97 (0.93,1.02)	1.00 (0.92,1.10)	0.96 (0.93,0.99)
	QRT3 vs QRT4	0.98 (0.98,0.99)	1.02 (0.99,1.04)	1.02 (0.97,1.08)	0.96 (0.92,1.01)	1.00 (0.92,1.09)	0.98 (0.95,1.02)
Duration with PCP (years) Non-immigrants	<5 vs 5+	0.99 (0.98,1.00)	NA	NA	NA	NA	NA
Immigrants (5-9 years in Canada)	<5 vs 5+	NA	0.96 (0.88,1.03)	0.93 (0.86,1.01)	0.94 (0.83,1.06)	1.10 (0.94,1.30)	1.00 (0.94,1.06)
Immigrants (10+ years in Canada)	<5 vs 5+		0.96 (0.93,0.99)	0.96 (0.90,1.01)	1.00 (0.96,1.06)	0.93 (0.87,1.00)	0.98 (0.95,1.00)
PCP sex	M vs F	0.99 (0.99,1.00)	1.01 (0.98,1.03)	0.99 (0.95,1.04)	1.00 (0.96,1.05)	1.01 (0.95,1.08)	1.00 (0.98,1.03)
PCP years since graduation (quartiles)	QRT1 vs QRT4	0.98 (0.97,0.99)	0.97 (0.94,1.01)	1.01 (0.95,1.07)	0.97 (0.91,1.03)	0.98 (0.89,1.08)	0.99 (0.95,1.03)
	QRT2 vs QRT4	0.99 (0.98,0.99)	0.99 (0.96,1.02)	1.03 (0.97,1.09)	1.02 (0.96,1.07)	0.92 (0.83,1.01)	0.99 (0.96,1.03)
	QRT3 vs QRT4	0.99 (0.98,1.00)	0.98 (0.96,1.01)	1.03 (0.97,1.09)	0.95 (0.90,1.00)	0.95 (0.88,1.04)	0.97 (0.94,1.00)
Index screen	First vs Subsequent	0.78 (0.77,0.78)	0.80 (0.77,0.83)	0.80 (0.77,0.83)	0.86 (0.82,0.89)	0.77 (0.71,0.83)	0.82 (0.79,0.84)
Index screen result	Abnormal vs normal	0.93 (0.91,0.94)	0.95 (0.90,1.00)	1.03 (0.96,1.11)	0.97 (0.90,1.03)	0.90 (0.80,1.02)	0.94 (0.90,0.99)
Family history of breast cancer	Yes vs None	1.05 (1.04,1.06)	1.06 (1.03,1.10)	1.05 (0.97,1.14)	1.02 (0.96,1.09)	0.93 (0.82,1.06)	1.06 (1.03,1.10)
# Major ADGs	1 vs 0	0.99 (0.99,1.00)	1.00 (0.98,1.03)	0.99 (0.95,1.04)	1.00 (0.96,1.05)	0.96 (0.90,1.03)	0.97 (0.94,0.99)
	2 vs 0	0.98 (0.97,0.99)	0.99 (0.96,1.03)	1.00 (0.95,1.06)	1.02 (0.95,1.09)	1.00 (0.90,1.10)	0.97 (0.93,1.01)
	3+ vs 0	0.94 (0.93,0.95)	0.99 (0.93,1.05)	1.00 (0.91,1.10)	0.92 (0.82,1.05)	0.96 (0.82,1.13)	0.87 (0.80,0.94)
Age	60-69 vs 50-59	1.07 (1.06,1.07)	1.02 (0.99,1.04)	0.98 (0.94,1.03)	0.96 (0.92,1.01)	1.03 (0.96,1.10)	1.01 (0.98,1.04)
Urban/rural residence	Rural vs urban	0.95 (0.94,0.95)	1.12 (0.90,1.41)	0.83 (0.65,1.06)	0.95 (0.81,1.13)	1.06 (0.88,1.29)	0.95 (0.90,1.00)
Income quintile	Q1 vs Q5	0.95 (0.94,0.95)	0.99 (0.96,1.02)	1.05 (0.97,1.14)	0.95 (0.89,1.02)	0.98 (0.90,1.07)	0.98 (0.94,1.02)
	Q2 vs Q5	0.97 (0.97,0.98)	0.99 (0.96,1.02)	1.06 (0.98,1.15)	0.96 (0.89,1.02)	0.97 (0.88,1.06)	0.99 (0.96,1.02)
	Q3 vs Q5	0.98 (0.98,0.99)	1.01 (0.97,1.04)	1.06 (0.98,1.15)	0.99 (0.92,1.06)	1.01 (0.91,1.10)	0.99 (0.96,1.03)
	Q4 vs Q5	0.99 (0.98,1.00)	1.01 (0.97,1.04)	1.06 (0.96,1.18)	0.95 (0.88,1.03)	0.95 (0.86,1.06)	1.02 (0.98,1.05)

ARR = adjusted relative risk; CI = confidence interval; PCP = primary care physician; UPC = usual provider of care; M = male; F = female; ADG = Aggregate diagnosis group; QRT = quartile; Q = quintile; GEE = generalized estimating equations

Table 6.11: Distribution of PCP factors associated with lower screening for the participation and retention cohorts

Cohort	Number of PCP Factors	# Cohort Members	% of Cohort	Observed Participation/ Retention Rate	Adjusted Relative Screening Rates (95% CI)
Participation cohort [Factors considered: 3-6 PCP visits, lowest quartile UPC, <5 years with PCP, male PCP]	0	57093	12.5	63.5	Reference
	1	181880	39.9	58.1	0.93 (0.92, 0.93)
	2	149387	32.8	52.5	0.84 (0.83, 0.85)
	3	56461	12.4	44.9	0.73 (0.72, 0.74)
	4	10859	2.4	36.6	0.61 (0.60, 0.63)
Retention cohort – first-time screeners [Factors considered: 3-6 PCP visits, lowest quartile UPC]	0	8910	57.6	47.1	Reference
	1	5632	36.4	44.1	0.93 (0.89, 0.96)
	2	927	6.0	38.4	0.80 (0.73, 0.87)

Adjusted relative rates were calculated using generalized estimating equations Poisson regression models adjusted for: Participation: age, rural residence, income quintile, number of ADGs; Retention: age, rural residence, income quintile, number of ADGs, index screen result and family history of breast cancer.

PCP = primary care physician; UPC = usual provider of care; CI = confidence interval; ADG = aggregate diagnosis groups

Chapter 7: Conclusion

In this chapter, a summary of key results from the four analytic chapters (Chapters 3-6) and unique contributions made within this research are provided. A discussion of strengths and limitations of this thesis, including a re-statement of some of the important points from prior chapters, as well as some comments across the thesis as a whole, is also provided. Finally, some examples of future research that could build on the work undertaken within this thesis are suggested and discussed.

7.1 Summary of Study Findings

7.1.1 Breast Cancer Screening among Immigrants and non-Immigrants

The study summarized in Chapter 3 explored breast cancer screening utilization among immigrant and non-immigrant women in BC. This study presented participation and retention rates by country of birth and assessed associations with several socio-demographic and health factors among common immigrant groups. Finally, an analysis was undertaken to identify factors associated with participation among recent immigrants (<10 years in Canada) from the most common source countries for recent immigrants.

Age-adjusted participation rates were lower for immigrant women born in several different countries compared to non-immigrants. Participation was 51.2% among non-immigrants, which was more than 5% higher than among women from any of the three most common immigrant groups of CMHT (45.9%), the Philippines (45.0%) or India (45.6%). Variability was apparent across groups of women aggregated by world region of birth (e.g. 45.1% for South Asia, 37.9% for Eastern Europe/Central Asia, 51.2% for Western Europe), but also among individual countries within a common world region. For example, South Asian women who immigrated from India had a much higher participation (45.6%) compared to women from Pakistan (36.1%). Among immigrants from East Asia/Pacific, participation similarly varied by birth country, with very low participation among women from Cambodia (37.3%), South Korea (40.1%) and Japan (41.1%), while women from Malaysia (53.2%), Indonesia (51.5%), and Brunei (59.6%) showed much higher rates. These findings demonstrating differences across populations of women by country of birth may better enable planning of interventions to improve screening among immigrant women compared to using data aggregated at the world region-level.

Associations between participation and several variables were assessed by country of birth for those with large populations of immigrants, as well as among non-immigrant women. For all groups, women with no PCP contacts screened significantly less (participation range 5.6% - 16.7%) than women with more PCP visits (e.g. participation range for women with 15+ visits during the look-back period 51.1% to 67.3%). Several other variables showed inconsistent associations with participation. Among non-immigrants, women aged 60-69 years screened more (55.1%) than women aged 50-59 years (48.5%), and this pattern was also observed for immigrants from South Korea. However, women from India, the Philippines and Vietnam generally reported lower participation among the older age group compared to the younger women. Recency of immigration to Canada was strongly associated with participation in several groups, with very low participation for the most recent immigrants, and rates among long-term immigrants (those residing in Canada twenty years or more) that were similar or higher than among non-immigrants. However, this pattern was not apparent among women from Iran, the United Kingdom or Vietnam. These findings may help in identifying subpopulations of immigrant women of particular importance when designing screening interventions.

Retention rates showed less variability than participation by country of birth, and less disparity between large immigrant and non-immigrant groups. For example, immigrants from CMHT showed similar retention overall, and among those women with prior screening history (73.9% and 75.8% respectively), to non-immigrants (74.4% and 76.2% respectively). Indian immigrants had overall lower retention (69.8%) compared to non-immigrants, however, retention among women with prior screening history (76.0%), was identical to that of non-immigrants. Among first-time screeners, women from Iran, India, the Philippines and the United Kingdom all had retention rates more than 5% higher (ranged from 48.9% to 61.2%) than rates among non-immigrants (43.3%). Among women with prior screening history, retention was lower among women from South Korea (68.0%) and the US (71.4%) compared to non-immigrants (76.2%); retention for the other seven immigrant groups examined were within 5% of non-immigrant rates.

The main message from the retention results in Chapter 3 is that while there are some disparities between immigrant and non-immigrant women, these disparities are generally not large among BC's most populous immigrant groups. When retention rates were stratified by recency of immigration, it was generally true that rates among the most recent immigrants were much lower than among long-term immigrants. First-time screeners are heavily represented among the most recent immigrants and this is reflected in the low retention in this group. Long-term immigrants (>20 years in Canada), however, had retention within 3% of the non-immigrant rate (74.4%) for most groups, with only women from the US (66.8%) and Other Immigrants (70.6%) showing modestly lower retention. There was a strong association between the number of PCP visits and screening retention in most groups. Women in several immigrant groups with no PCP visits had retention rates significantly lower than those with 15 or more visits, with differences as high as 30% across these two categories. Among women with some PCP contact, it was generally true that increased contact with a PCP was associated with higher retention. These findings may suggest a benefit of regular contact with a PCP on women's adherence to re-screening.

In the analysis that examined factors associated with participation among recent immigrants (<10 years in Canada), there were several interesting findings. In contrast to all other groups, recent immigrants from both Iran and the United Kingdom had higher participation than non-immigrants. Participation among older women (aged 60-69 years) from several countries, such as South Korea, India, CMHT, the Philippines and the former USSR, was very low (<36%), and generally less than among women aged 50-59 years from these countries. Despite very low overall participation among these groups of recent immigrants, women who had frequent contact with a PCP (10 or more visits) had rates approaching those of non-immigrants in many groups (e.g. CMHT 49.6%, the Philippines 47.4%, South Korea 46.1% vs non-immigrants 51.2%).

In the multivariable regression analyses performed on the recent immigrant cohorts, the number of PCP visits was the only variable consistently independently associated with participation in each group. The adjusted relative risks showed a consistent pattern of increasing participation with PCP visits in all groups. As in the descriptive analysis, age was not consistently associated with participation across groups, however, several of the groups reported significantly lower participation for older women. Lower education level was associated with lower participation among women from India, the US, the former USSR and Other Immigrants. These findings suggest that screening promotions and interventions contemplated for recent immigrants may need to be directed to specific subgroups of women within these populations, based on age or other factors.

7.1.2 Breast Cancer Risk and Stage at Diagnosis among Immigrants

The study in Chapter 4 described the population of women aged ≥ 40 years who were at-risk of developing breast cancer, according to country of birth. This work highlighted the diversity of the immigrant population in BC, providing demographic and socioeconomic information about each of these populations including group size, average age, duration of time in Canada, and income level. This study further provided estimates of breast cancer risk for immigrant women according to country and world region of birth, relative to the rate of non-immigrants.

The analysis of breast cancer risk revealed considerable variability in the standardized incidence ratios (SIRs) by both region and country of birth. When data were aggregated at a regional-level, several regions, such as East Asia/Pacific (SIR = 0.75), South Asia (0.52), and Caribbean/Latin America (0.80), demonstrated rates significantly lower than that of non-immigrants. Incidence rates among immigrants from the Middle East/North Africa, Eastern Europe/Central Asia and sub-Saharan African regions were not significantly different from the rate of non-immigrants. Women from Australia/NZ/USA and Western Europe both demonstrated higher rates than among non-immigrants.

Within some world regions, however, the SIRs varied considerably. Among immigrants from the East Asia/Pacific region, several groups, such as South Korean, Vietnamese and CMHT showed rates significantly lower than that of non-immigrants. However, women from several other countries (e.g. the Philippines, Japan, Indonesia) had rates comparable to the rate of non-immigrants. Among women from the Middle East and North Africa world region (SIR = 1.02), women from some countries had similar risk compared to non-immigrants (e.g. Iran), however, the small cohort from Egypt showed a much higher risk (SIR = 2.75, 95% CI: 1.51, 4.62).

Similarly, the rate for the Caribbean/Latin America region suggested a lower risk of breast cancer (SIR = 0.80, 95% CI: 0.65, 0.98), however, women within this group born in Brazil, showed a much higher SIR (2.47, 95% CI: 1.41, 4.00).

In Chapter 5, further investigations into the incidence patterns among immigrant and non-immigrants were undertaken. The study in this chapter examined incidence among the three largest immigrant populations when aggregated by country of birth (immigrants from CMHT, India and the Philippines) as well as a pooled Other Immigrants group (which included all immigrant women not represented in the three countries listed). This study examined both age-specific and stage-specific incidence rates across these groups, contrasting the rates with that of non-immigrant women. The analyses in this chapter also explored incidence rates for recent (<10 years in Canada) and longer-term (10+ years) immigrants through stratified analyses. Further, an analysis was undertaken to compare the frequency distribution of breast cancer stage at diagnosis across these populations.

The analysis of incidence by age suggested very different patterns of risk with age across immigrant groups. Among non-immigrant and Other Immigrant women, risk increased with age from a low among ages 40-49 years to a peak in ages 70-79 years. However, among immigrants from CMHT and India incidence increased from age group 40-49 to 50-59 years, but remained generally flat, or declined in older age groups. Immigrants from the Philippines showed a higher rate of breast cancer in ages 40-49 and 50-59 years compared to the others groups; although the risk in this population in ages 60-69 years appeared similar to non-immigrants, their risk at older age groups was dramatically lower, although these were estimated with low statistical precision.

As noted above, relative to non-immigrants, age-standardized incidence rates among immigrants from CMHT and India were significantly lower, whereas immigrants from the

Philippines and Other Immigrants showed comparable rates. When the immigrant cohorts were stratified by duration of time in Canada, more recent immigrants (<10 years since immigration) from CMHT, India and the Philippines showed lower age-standardized rates than more established (10+ years) immigrants from these regions. Stage-specific incidence rates by immigrant group revealed the rate of stage tumours was significantly lower among CMHT, Indian and Other Immigrant women. Rates of stage II-IV tumours were significantly lower for women from CMHT and India compared to non-immigrants and similar among the other populations. Results stratified by world region of birth suggested that overall and stage-specific rates for immigrants from East-Asia/Pacific and South Asian were significantly lower than among non-immigrants. Interestingly, the rate of stage I tumours among immigrants from Eastern Europe/Central Asia was significantly lower than among non-immigrants, however, the overall and stage II-IV rates were comparable to non-immigrant women.

Immigrants from India showed a significantly lower frequency of stage I disease (36.0%) compared to non-immigrants, or immigrants from the other three groups (range 42.7 – 48.6%). Using multivariable Poisson regression models, the relative risk of a later-stage (stage II-IV) tumour among Indian immigrants, compared to non-immigrants, was 1.18 (95% CI: 10.05, 1.33). Thus, after adjustment for income quintile, age and rural residence, this population showed a significantly higher frequency of later stage tumours. In contrast, immigrants from CMHT showed a significantly lower frequency of stage II-IV tumours (ARR = 0.88, 95% CI: 0.80, 0.96). When data were aggregated by world region of birth, immigrants from Eastern Europe/Central Asia also showed a significantly lower frequency of stage I disease compared to non-immigrants (37.1% vs 45.3%). South Asian women had a low proportion of stage I disease (35.0%) which mirrored the result for Indian immigrants described above.

These results demonstrate some interesting findings. Firstly, there are marked differences in breast cancer risk between non-immigrants and some groups of immigrant women, beyond what was observed in Chapter 4. Patterns by age vary across immigrant groups and stage-specific rates are dramatically different for some populations. Indian (South Asian) and Eastern European/Central Asian immigrant women showed a significantly lower proportion of stage I disease compared to non-immigrants and other immigrant groups. However, the stage-specific rates for later-stage cancers were also lower than, or comparable to, that of non-immigrants. Thus, these populations show both a higher frequency of later-stage disease and an overall lower risk of these tumours.

7.1.3 Associations between Breast Cancer Screening Utilization and Primary Care Physician Continuity and Characteristics

Chapter 6 describes a study that examined associations between primary care physician (PCP) characteristics, and measures of PCP and patient relationships, with breast screening utilization.

This study identified four PCP factors that were associated with significantly lower participation within the cohort as a whole: infrequent contact with a PCP; low continuity of care; shorter duration of affiliation with a PCP; and having a male PCP. Having 3-6 visits with a PCP over the study follow-up period was associated with 14% lower participation compared to women with the most frequent contact (16+ visits); among women with 7-9 visits, participation was approximately 6% lower than those with the most frequent PCP contact. The group of women with the lowest continuity of care (UPC < 0.54) participated 11% less than women with the highest continuity. Further, women with short (<5 years) duration of affiliation with their provider participated 12% less than those with affiliations of ten or more years. Patients of male

PCPs screened approximately 12% less than those with female providers. The prevalence of these factors in the cohort was high; 40% of the cohort had one of these factors associated with lower screening and a further 33% had two; a small proportion (2.4%) had all four factors and the absolute difference in participation rates between this group (36.6%) and those with none of these factors (63.5%) was 26.9%.

This study also assessed the extent to which associations between participation and PCP factors varied across a set of predetermined subgroups based on age, income quintile, and number of PCP visits (ten or more). Fewer PCP visits was consistently associated with lower participation across subgroups defined by age and income quintile. The relative difference in participation between women with 3-6 and 16 or more visits, however, was greater among women residing in low income areas (ARR = 0.82, 95% CI: 0.80, 0.84) compared to high income areas (ARR = 0.91, 95% CI: 0.90, 0.93). The effect of low continuity (compared to women in the highest quartile of continuity) was fairly consistent across subgroups (ARRs ranged from 0.88 to 0.94) with the weakest association observed among the subgroup of women with ten or more PCP visits. Short duration of affiliation (< 5 years) was associated with lower participation in each subgroup compared to women who had been with their PCP for more than ten years (ARRs ranged from 0.85 to 0.91). Lower participation for patients of male PCPs was observed in all subgroups with ARRs ranging from 0.85 to 0.90.

Some of the associations observed in the cohort as a whole were not apparent in all immigrant groups. Low continuity of care was not associated with worse participation among immigrants from CMHT, India and the Philippines. Among non-immigrants, immigrants from Eastern Europe and Other Immigrants, however, low continuity was associated with lower participation compared to women in the highest quartile of the UPC index. Among immigrants from CMHT, women in the highest quartile of the UPC index actually participated less than women in the third quartile (ARR = 1.08, 95% CI: 1.05, 1.12). In all immigrant subgroups, the ARR associated with 3-6 PCP visits (compared to 16+ visits) was much lower (ARRs ranged from 0.64 to 0.78) than estimated among non-immigrants (ARR = 0.89). Participation among women with 7-9 visits was also generally lower than among women with 16 or more visits for immigrant groups (ARRs ranged from 0.77 to 0.88), whereas among non-immigrants the difference between these two categories was less (ARR = 0.95). Short duration of affiliation with a provider and having a male PCP were generally consistently associated with lower screening across immigrant subgroups.

For the screening retention endpoint, few of the PCP factors were associated with retention in the overall cohort. Duration of affiliation with a PCP, years since PCP graduation, and PCP sex were not associated with retention. Women in the lowest quartile of continuity were retained about 7% less than women in the highest quartile. The effect of few PCP visits (3-6 visits) was not strong in the retention analysis, with only a 4% relative reduction in retention compared to the group with 16 or more visits. The strongest associations with retention, rather than being the PCP factors examined, were properties of the index mammogram, namely, whether it represented the first or a subsequent screen, and the result (normal or abnormal).

Among subgroups defined by age, income level, PCP visits and index screen (first or subsequent), there were no strong associations observed between retention and PCP sex, years since graduation or duration of affiliation. The associations between retention and both number of PCP visits and continuity of care were also generally consistent across these subgroups and with findings in the cohort as a whole. The exception, however, was among first-time screeners where the ARRs associated with low continuity and few (3-6) PCP visits demonstrated much stronger associations than in the cohort as a whole, and other subgroups. Among first-time screeners, women with few visits were retained approximately 10% less than women with 16 or more visits. In this same population, women with the lowest continuity of care were retained 14% less than those with the highest. Thus, among first-time screeners, there were two PCP factors significantly associated with lower retention; these factors were present together among 6% of the total retention cohort, and women affected by both factors had a 30-month retention rate of only 38.4%. This finding is important as retention of first-time screeners in BC has been previously reported as poor [10] and this information may help to identify which women are at highest risk of program loss.

Among immigrant subgroups, duration of affiliation, PCP sex and PCP years since graduation were generally not significantly associated with retention. Low continuity of care was not associated with retention screening among immigrants from CMHT, India, and Eastern Europe, however, women from the Philippines and Other Immigrants showed slightly lower retention in this group compared to those with high continuity. The disparity in retention across women with few (3-6) and 16 or more PCP visits appeared to be larger in most immigrant groups compared to non-immigrants with significantly lower retention observed among immigrants from CMHT, the Philippines and Other Immigrants.

7.2 Study Strengths and Limitations

A discussion of study strengths and limitations was previously provided within each of the four analytic chapters. This section highlights some of more important strengths and limitations from those chapters and provides some summary thoughts on the thesis as a whole.

The studies undertaken within each of the analytic chapters utilized population-based administrative health and other data sets. There are numerous strengths to using these data for the work within this thesis. Firstly, there are a number of study variables measured with administrative data that would be subject to recall biases if data were ascertained by survey or other means directly from participants. Utilization and timing of recent mammograms, prior cancer history, number of PCPs seen, number of PCP visits, duration of affiliation with PCP, and time since immigration are examples. Imprecise measurement of these variables could lead to bias in study results and thus measuring these directly from health service data, should mitigate some of this potential bias.

The administrative data further contain the records of the entire population of screening-eligible women, enabling the examination of groups and subgroups that have been under-reported in prior research. For example, in the analysis of screening utilization by country of birth, screening rates were compiled on groups such as Filipino, South Korean, Iranian and Indian immigrants – all who have sizeable populations in BC, but have had limited specific focus in prior studies. The large data sets, permitted the examination of whether patterns within these, and other groups, varied by other key variables such as duration of time in Canada, PCP visits, income quintile and age. As noted, prior studies based on survey methods, have been limited in their ability to simultaneously study multiple variables among immigrant populations. However, in contemplating interventions to improve screening in specific populations, it is critical to be able to characterize the population of under-screened women within these subgroups. Finally, some of these groups may also participate less in survey-based approaches leading to under-representation in samples and potential selection bias.

In addition to the sample size of the various immigrant populations being large, relative to a prior national study examining breast cancer incidence among immigrants [54], the studies undertaken in chapters 4 and 5 include significantly more person-years of risk at ages where these women are likely to develop breast cancer. The prior national study included only ~73,000 immigrant cohort members (male and female) who were aged 45 years or more at the start of follow-up; approximately one third of their cohort was under 20 years of age at the start of follow-up. The provincial cohort from chapter 5, included more than 105,000 immigrant women aged 50 or over at the start of follow-up. Thus, the present study is able to summarize a greater number of breast cancer events owing to the age distribution of the cohort. The larger number of incident cancers permits the calculation of breast cancer rates by age, stage at diagnosis and immigrant population enabling a more comprehensive examination of incidence.

The use of government immigration data to identify both immigrant status and birth country is also a strength of the present methodology. Although several of the studies reviewed in Chapter 2, from Canada and elsewhere, have examined cancer incidence or screening in sub-populations that were meant to reflect "migrant" populations, a diversity of approaches have been used to identify these populations. The present approach improves on surname list methodology which may not be successful in identifying immigrant populations, but rather, identify individuals with a specific ethnicity. Surname methodology also assumes that surnames are reasonably unique to individuals from a given ethnic or world region group which may not be the case for many surnames. Individuals may also change surnames after marriage and may adopt a surname that does not reflect their ethnicity at all or identify them as a potential immigrant. Chart review of this information from clinical records also has weaknesses, as discussed in prior chapters; the records may not specifically identify women as immigrant or non-immigrant, or they may misclassify the ethnic population a woman belongs to based on the physician's assessment. The approach taken within this thesis enables the assessment of cancer risk and screening patterns specifically among immigrants and by specific country of birth, consistent with study objectives.

The data sources utilized are comprehensive and include information on demographics, residential location, public health insurance registration, all in-patient and day surgery hospitalizations, cancer diagnoses, breast cancer screening information, fee for service physician payment information, death registrations, immigrant records and physician characteristics. Through the use of data from a variety of sources, it was possible to include or exclude women based on study eligibility criteria, identify key follow-up events such as death, emigration or cancer diagnosis, and generate indicators and exposures of interest to associate with key study endpoints. These data could be linked at the patient level across files, as well as at the provider level for several variables. This enabled a diverse set of analyses across the four chapters.

There are also a number of limitations related to the data utilized within this study. Firstly, the year range of available immigration data included only immigrants who landed in Canada between 1985 and 2012. This meant that it was not always possible to differentiate long-term immigrants from Canadian-born individuals. This was true for both analyses examining screening and cancer incidence among immigrants. As discussed in the previous chapters, the implication is that reported screening rates among immigrants are likely lower than they would be, were long-term immigrants correctly identified. Screening rates generally increased with duration of time in Canada, and thus these long-term immigrants would be expected to have higher screening rates than more recent immigrants. For the analysis of cancer incidence among immigrants, this issue also likely results in an under-estimation of the cancer risk for immigrant populations who have immigrated from countries with lower risks than the BC population rates. This results from the fact that long-term immigrants from low-risk countries are likely to have higher rates than among recent immigrants, rates likely close to those of non-immigrants. As noted, prior research suggests that with increased time since immigration, immigrants from low-risk countries acculturate to the risk profiles of their adopted country.

There are other examples of truncation of data that result in further limitations to study findings. The first is that the medical histories of immigrants and inter-provincial migrants prior to arriving in BC are not known; this is because all health data accessed within this study are provincial. This may have resulted in inappropriate inclusions into the study cohorts for women who were ineligible based on, for example, a prior breast cancer diagnosis or mastectomy surgery. Further, the physician payment data available for this study included only encounters from the years 2001 to 2014. Thus, the duration of affiliation between patient and PCP could not be observed earlier than 2001. Consequently, this analysis did not examine durations with categories beyond >10 years among the participation cohort and >5 years for retention. This limits investigation into the relationship between screening and longer values of duration of affiliation. Cancer stage at diagnosis information was only available for cases diagnosed between 2010 and 2014, as the BC Cancer Registry did not collect population-based cancer stage data prior to these years.

The measures of rural status and income quintile were both based upon the residential postal code of the patients. Although the degree of completeness of this information in the study data was high, these variables are determined by geocoding the residential postal code rather than other means. It is possible the income quintile assigned does not reflect the income status of a specific individual in the cohort. However, there were no available measures of socio-economic status other than the area-based measure.

Despite using population-based data sets and having the capability of identifying immigrants over a near 30-year period, the number of incident breast cancers in many populations was very low. This limited the examination of age-specific, and stage-specific rates in a large number of immigrant populations as the number of incident cancers within many cells defined by combinations of birth country, age group, and stage at diagnosis was either equal to, or near, zero. The number of years of data to include in the cancer stage analysis could not be increased to overcome this limitation due to the years of available provincial cancer stage data described above. Thus, the study of cancer stage at diagnosis focused only on the largest immigrant populations in BC.

The positive associations between increased PCP contact or higher continuity and screening utilization are interpreted to result, at least in part, from PCP encouragement to screen, or perhaps, a decision to screen that might have been informed by a PCP consultation. A weakness of the present methodology is that it cannot measure the extent to which women and their PCPs discuss screening, or the extent to which patients are encouraged to screen by their PCP. The observational nature of the data renders making causal inferences from the findings challenging. Positive associations between PCP visits or continuity and screening may result from other behavioral characteristics of the women who see their physicians frequently, and also choose to screen. In order to understand if efforts to increase PCP contact or continuity would improve screening utilization, interventions would need to be contemplated and trialed to ascertain better measures of causal effects.

Finally, the methodology used within the present thesis cannot directly interrogate why some women do not screen for breast cancer. Immigrant and non-immigrant women may have different reasons as to why they do or do not screen, and likely face very different barriers to screening. The present study establishes patterns and associations that suggest factors that might relate to screening behaviors, however, to fully understand why women do not screen, further efforts are required. There is an extensive literature on barriers to screening faced by different populations of women, including many Canadian studies. There is also a rich literature on interventions to improve screening among under-screened populations. Thus, identifying potential barriers to screening in the BC population, or opportunities for interventions, may be facilitated by considering both this study's findings, and the rich literature in these areas.

7.3 Contributions and Implications

This study has made a number of new contributions, which are highlighted in this section. In addition, there is a discussion of some of the implications of the study's findings. Firstly, the work in Chapter 3 identified that within BC, a significant fraction of immigrant women in some groups, defined by birth country, are under-screened for breast cancer. Although prior studies have examined breast screening utilization among immigrant women in Canada [39-41], the present study extends the existing literature that largely presented data aggregated at the world region level. The findings from this chapter demonstrate that in BC, for example, women from South Korea, Vietnam, Japan and the Philippines – groups that all have sizeable populations in the province – do not screen as frequently as non-immigrants. There are other large populations of immigrants – such as women from Iran – for whom screening utilization data in Canada is sparse, and the present study suggests that these women screen similarly to non-immigrants. In addition, for some of these populations, it was possible to further assess screening utilization among specific population subgroups. These analyses for example, helped identify that the under-screened South Korean immigrant population contains a high percentage of women who do not see a PCP. Recent immigrants from Iran did not show the same pattern of low participation seen for other recent immigrant groups. Thus, the various findings from these analyses may support setting promotions priorities, or contemplating appropriate interventions, for specific groups of women.

This study contributes novel findings on associations of individual and physician characteristics and breast screening retention. None of the population-based, cohort studies reviewed in Chapter 2 included screening retention as an endpoint. The study described in Chapter 3 identified that some immigrant populations in BC are retained less than non-immigrants, however, some immigrant populations with very low participation have similar retention to non-immigrants. The findings further suggested that retention of first-time screeners is generally a significant issue in common immigrant groups, in addition to among non-immigrants. Among first-time screeners, only immigrant women from the United Kingdom showed a retention rate above 60%. Retention rates generally also improved with time since immigration, similar to participation. Thus, considering the findings as a whole, this may suggest that programs set priority to attracting new women to the program and supporting them after their first mammogram. The study described in Chapter 6 further identified that among first-time screeners, low continuity (UPC) and infrequent PCP contact were associated with significantly poorer retention, despite these factors showing little association in the cohort as a whole. These women are at particularly high-risk of program loss and thus this information may suggest a population of women that require special attention to minimize loss.

The data generated for the study in Chapter 3 have considerable value for knowledge translation efforts and screening promotions. Prior participation rate indicators generated by the BC Cancer Breast Screening Program include estimates of participation for three subpopulations, based on self-reported ethnicity (Chinese, South Asian and First Nations) [10]. The present study provides an evidence base to consult to plan promotions or interventions for specific populations of immigrants that are not participating in breast screening. Data from Chapter 3 have been featured in a breast screening promotional campaign within BC during Breast Cancer Awareness Month [142], including a television news feature specifically addressing the issue of under-screening among some immigrant populations [143]. Following the publication of Chapter 3 in the peer-review literature, study findings were also featured in a number of news stories including live radio and Chinese television and print media [144].

Chapter 4 provided estimates of breast cancer risk for many populations of immigrant women in BC. There was significant variation in the incidence ratios estimated by country of birth, even within common world regions. The estimates of relative breast cancer risk for these populations are unique in Canada, and provide data to inform risk across a diverse number of immigrant populations. The Canadian Preventive Taskforce Clinician Mammography Recommendation specifically notes that women of some ethnic groups may have higher or lower breast cancer risk, and this may be relevant to weighing mammography harms and benefits for patients [123]. They provide "East Asian" women as an example of a group with lower absolute risk. The findings from Chapter 4 provide a summary measure of relative risk for immigrant women from several East Asian countries, as well as the world region as a whole, and suggest that risk appears to vary considerably by birth country. Thus, these data may support risk assessment tools for subpopulations of women in Canada. They update previous estimates of among Canadian immigrant women, which for many groups, showed significantly lower standardized incidence ratios [54]. These findings also identified a number of immigrant populations with significantly higher breast cancer risk, compared to non-immigrants (e.g.

women from Egypt). If confirmed in other studies, these findings suggest a significant elevation of risk in these populations and may warrant further prevention or etiology research.

Chapter 5 demonstrated that some immigrant populations, such as Indian and Eastern European/Central Asian women, have a worse stage distribution at diagnosis, compared to non-immigrants. Although two prior studies from Ontario [57, 58] have noted worse stage at diagnosis among South Asian women, the present study demonstrates Eastern European/Central Asian women also show a similar pattern. This study also contributes data on the stage-specific risk of breast cancer by immigrant group. From these data, it is clear that the stage distributions in these groups do not arise strictly as a result of a higher risk of later stage cancers. Among Eastern-European/Central Asian women, the risk of later-stage tumours was identical to non-immigrants, however, the risk of stage I tumours in this population was lower. Among Indian (South Asian) immigrants, the rates of both stage I and II-IV tumours was significantly lower than among non-immigrants. Thus, the findings from this chapter suggest further investigation into the appropriate follow-up of breast abnormalities, timely diagnosis, and overall care access for these populations of women. This study's findings also suggest that further studies may need to consider how to address the large differences in overall cancer risk, or impact of potential over-diagnosis, in the assessment of contributors to late-stage presentation.

The studies across Chapters 3 to 6 provide a comprehensive examination of indicators of breast cancer control for several subpopulations of women. Immigrants from the Philippines are among the largest populations of immigrants in Canada [14], however, limited information on cancer screening or incidence is available for this population (Chapter 2). The studies contained here suggest this population of women has a similar breast cancer risk to non-immigrant women, however, they may exhibit a higher risk of cancer at younger ages. Further, despite similar overall breast cancer risk, overall screening participation among Filipino immigrants was slightly lower than among the general population, and considerably lower among women aged 60-69 years. This study also confirmed that this population had similar stage at diagnosis compared to non-immigrant women. The information in Chapter 6 provides an assessment of the impact of low PCP contact and continuity on screening utilization in this population. Women in this cohort who infrequently saw a PCP (3-6 visits), participated approximately 30% less, and were retained 11% less, than women with the most frequent contact. Thus, the studies contained in this thesis present a profile of information to support breast cancer control in this population, and provide similar information for other large immigrant populations in Canada.

The analysis in Chapter 6 identified a number of PCP factors associated with lower screening participation among patients, including having a male physician. Patients of male PCPs have been shown to participate less in screening in prior studies (Chapter 2), however, the findings here further contribute that this factor has a similar impact on participation across an array of subgroups, including immigrant women. This study also suggests that among women who have previously screened, the sex of their PCP seems to be less a factor in their propensity to re-screen (retention). The lower participation among patients of male PCPs is clearly an important issue that requires further inquiry. PCPs do not complete the breast screening exam in BC, as women access mammograms through screening centres where they are aided by technicians. However, a male PCP may still be a barrier if patients are reluctant to discuss screening with their provider, or perhaps if some PCPs feel reluctant to discuss mammography with patients. Given the findings in Chapter 6, and the fact that the majority (60.1%) of screening-age women in BC have a male PCP as their most common provider, gaining a better understanding of this issue and considering PCP-directed education or promotion may be a warranted outcome.

This study also identified that infrequent PCP contact, short duration of affiliation with a PCP, and low continuity were associated with significantly lower participation. The groups of women affected by all of these factors (in addition to having male PCP), although not large relative to the total population, screened at a very low rate (ARR = 0.61, 95% CI: 0.60, 0.63) relative to those women with none of these factors. The individual factors, however, are highly prevalent among cohort members. For example, women with <5 years of affiliation with their PCP represented 42.2% of the overall eligible screening population; this number approached 50% for some of the immigrant populations. This study analyzed continuity in quartiles and found the women within the lowest quartile had lower participation. Thus, approximately one quarter of the population had the low value of continuity (<0.54) that this study identified as associated with lower participation. Research has suggested continuity with a PCP may be declining in BC [134] and thus low levels of continuity among screening eligible women may become more prevalent over time. If the observed associations truly reflect a primary care system that does not well support discussions of preventive health and screening, this could have implications for improving screening rates in BC given the high prevalence of these factors in the population.

7.4 Future Research

There are a number of areas of suggested future research relating to the themes and objectives examined within this thesis. Firstly, the examination of breast screening rates by country of birth performed in Chapter 3, largely compared participation or retention rates among immigrant and non-immigrant women in Canada. One could build on this work by adding a comparison to breast screening rates in the various birth countries represented in the cohort. Although many of the immigrant populations examined demonstrated rates similar, or even higher, than among non-immigrants, it is possible some of these women emigrate from regions with higher average screening rates than observed among members of the study cohort. Thus, one could examine screening rates among immigrants according to whether they emigrate from regions with high and low screening utilization and examine how immigrants compare in these groups to screening rates in their birth country. This may provide additional context for the observed rates among immigrant women, but also may provide a descriptive approach to measuring a potential barrier to screening initiation – i.e. potential lower familiarity with mammography and its role in early detection among some groups.

Eastern European women were found to have some of the lowest breast screening participation rates of all groups examined in Chapter 3; most of the individual birth country estimates were < 40%. However, due to smaller numbers of women within each specific country, this population was not examined in detail, beyond presenting age-standardized participation and retention rates by birth country. Women from this population also showed a slightly worse stage distribution among women diagnosed with breast cancer (Chapter 5). In Chapter 6, regression analysis suggested that within this population, low continuity of care and few PCP visits were both significantly associated with lower participation. Further work could include better characterizing the screening age population from this region, by country of birth, in terms of socio-demographic variables, primary care factors, other health service use, and geographic distribution of these women within the province. These analyses may help to identify important variation in these factors by immigrant sub-populations within this larger group which may better support screening promotions or interventions. For example, primary care continuity and access may differ across sub-populations and may suggest specific populations that may or may not easily be reached through PCPs.

The findings in Chapter 5 that Indian and Eastern European immigrants have worse stage distributions, but lower rates of early stage tumours, compared to non-immigrants suggest several additional areas of future study. The first is attempting to quantify the extent to which overdiagnosis may contribute to these findings. As these groups were shown to screen less for breast cancer and also show lower rates of stage I tumours, it is possible some of the difference in stage distribution results from less overdiagnosis in these populations compared to non-immigrants. There are a number of studies that have tried to quantify overdiagnosis of breast cancer resulting from programmatic breast screening, however, estimates vary considerably across studies [114-116, 145]. Identifying appropriate estimates of overdiagnosis and an approach to incorporate such information to examine residual disparities in stage distribution, after adjustment for overdiagnosis, could be an interesting future project.

Further work could also investigate whether there are differences in the diagnostic pathway for women in the groups that have shown later stage presentation. The investigations within this thesis have identified low screening utilization in some groups (Chapter 3), and further identified a worse stage in some of these same groups (Chapter 5). Further investigations could include, for example, the frequency that follow-up investigations are completed following an abnormal mammogram, and whether there are differences in the time to complete these by group. Analyses could also be undertaken to specifically examine the frequencies of screen-detected and non screen-detected cancers by group and examine stage distributions according to screening history. In the findings from Chapter 3, it was identified that for the retention cohort, the proportion of mammograms that were first-screens was very high among Indian immigrants compared to non-immigrants. Thus, it could be that in such groups, a higher proportion of late-stage tumours would be found on first-screens compared to subsequent screens. A more thorough analysis may help to identify from which specific screening and diagnosis pathways the later stage tumours arose in each group.

The analyses undertaken in Chapter 4 suggested immigrants from the Philippines had overall breast cancer incidence rates similar to non-immigrants. However, in Chapter 5, the age-specific rates among this group were shown to be higher in age groups 40-49 and 50-59 years compared to non-immigrants. These rates were estimated with low statistical precision due to the limited number of women and events in this group. The age-specific rate among Filipino immigrants aged 40-49 years was between the estimates for age groups 40-49 and 50-59 years among non-immigrants, with the upper bound of the confidence limit approaching the estimate for non-immigrant women aged 50-59 years. Screening guidelines that recommend average risk women start screening at age 50 years, in part, have been informed by the age-specific risk of cancer in the population. If the risk among Filipino immigrant women age 40-49 years is consistent with the risk of non-immigrant women age 50-59 this may be relevant information for these women to consider when weighing the potential harms and benefits of screening at ages 40-49. Thus, using a large database, such as the national Canadian Cancer Registry, to derive more precise estimates of age-specific risk for this (and possibly other) large immigrant populations is a possible continuation of this work.

The analyses undertaken in Chapter 6 largely examined measures of PCP and patient continuity and visit intensity, and the association of these factors with screening utilization. Further work could characterize the practice styles of the PCPs that see screening eligible women, and assess the extent to which PCP practice style associates with screening. Recent research in BC examined practice patterns of fee-for-service physicians and used indicators reflecting high-responsibility practice styles to group physicians into low, middle and high responsibility styles [87]. A high-responsibility PCP meant that, according to the indicators used, they frequently demonstrated clinical activity that suggests they accept responsibility for ongoing and comprehensive care of the patients they see. Thus, an analysis could be undertaken to contrast screening utilization among patients that see high and low-responsibility PCPs, and examine the roles of other factors such as PCP sex, continuity and visit intensity with such patients.

7.5 Concluding Remarks

This research contributes a number of new findings to support breast cancer control in Canada. These include findings of diverse breast cancer screening and risk patterns across immigrant populations that have not been previously reported in Canada. The research also found that within BC's largely fee for service primary care physician population, there are PCP factors that are associated with significantly lower screening utilization among patients. These factors are not uncommon in the population, and among some immigrant populations, have even stronger associations with low breast screening utilization. Thus, there is considerable opportunity for efforts to reduce screening disparities through further research, promotions and interventions.

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Appendices

Appendix A

This appendix contains supplemental tables for each of the four analytic chapters (Chapter 3 – 6); there is a sub-section of tables for each of the four chapters.

A.1 Supplemental Tables to Chapter 3

Table A1.1: Age-standardized participation rates by country of birth for all countries with 100 or more eligible women in the participation cohort

World Region	Country	Number of Eligible Women	Participation Rate [95% CI]
Non-immigrant	Non-immigrant	451881	51.2 [51.0,51.3]
East Asia/Pacific	Regional Rate	51378	45.4 [44.9,45.8]
	CMHT	30185	45.9 [45.3,46.5]
	Philippines	10911	45.0 [43.9,46.0]
	South Korea	4028	40.1 [38.4,41.7]
	Vietnam	2089	44.9 [42.5,47.2]
	Fiji	1018	42.6 [39.5,45.6]
	Japan	770	41.1 [37.3,44.8]
	Malaysia	745	53.2 [49.6,56.8]
	Singapore	518	46.9 [42.3,51.5]
	Indonesia	292	51.5 [45.6,57.3]
	Thailand	277	42.6 [35.2,50.0]
	Cambodia	198	37.3 [30.3,44.3]
	Brunei	154	59.6 [51.5,67.7]
	Myanmar (Burma)	113	49.5 [40.3,58.6]
	Other Regional Country	80	45.6 [32.6,58.6]
South Asia	Regional Rate	11043	45.1 [44.1,46.0]
	India	9958	45.6 [44.6,46.7]
	Pakistan	584	36.1 [32.1,40.2]
	Sri Lanka	347	47.5 [41.9,53.0]
	Bangladesh	123	41.2 [32.4,50.0]
	Other Regional Country	31	36.9 [21.8,51.9]
Caribbean/Latin America	Regional Rate	2946	52.6 [50.6,54.5]
	El Salvador	567	53.9 [49.6,58.2]
	Mexico	478	48.2 [42.9,53.4]
	Colombia	278	56.6 [50.4,62.8]
	Peru	212	57.4 [50.4,64.4]
	Guatemala	177	43.5 [35.6,51.3]
	Brazil	173	59.0 [51.3,66.7]
	Nicaragua	161	54.7 [46.8,62.5]
	Chile	118	50.1 [40.5,59.7]
	Trinidad and Tobago	112	47.3 [38.0,56.6]

World Region	Country	Number of Eligible Women	Participation Rate [95% CI]
	Jamaica	105	46.7 [37.0,56.4]
	Argentina	100	51.2 [40.9,61.6]
	Other Regional Country	465	54.3 [49.4,59.2]
Middle East/North Africa	Regional Rate	4261	52.2 [50.7,53.8]
	Iran	3517	54.0 [52.3,55.7]
	Iraq	249	44.1 [37.7,50.5]
	Egypt	110	53.7 [45.6,61.9]
	Lebanon	101	42.6 [32.5,52.7]
	Other Regional Country	284	42.6 [36.3,48.9]
Eastern Europe/Central Asia	Regional Rate	6316	37.9 [36.6,39.2]
	Former USSR State	1774	35.0 [32.5,37.5]
	Poland	1442	37.8 [35.1,40.5]
	Former Yugoslavia	1185	39.4 [36.4,42.4]
	Romania	650	36.3 [32.2,40.4]
	Czech/Slovak Republics	425	38.3 [33.5,43.1]
	Afghanistan	367	49.0 [43.6,54.3]
	Hungary	210	35.7 [29.3,42.1]
	Bulgaria	138	35.0 [26.0,43.9]
	Other Regional Country	125	42.2 [32.1,52.2]
Australia/NZ/US	Regional Rate	2958	47.1 [45.2,48.9]
	United States of America	2572	46.2 [44.2,48.1]
	Australia	234	59.0 [51.6,66.3]
	New Zealand	147	49.2 [40.1,58.2]
	Other Regional Country	5	0.0 [0.0,0.0]
Sub-Saharan Africa	Regional Rate	2088	51.3 [49.0,53.6]
	South Africa	1012	55.5 [52.2,58.7]
	Kenya	248	56.2 [49.9,62.6]
	Zimbabwe	149	50.6 [39.8,61.3]
	Tanzania	124	57.8 [49.1,66.4]
	Ethiopia	118	34.7 [24.9,44.6]
	Other Regional Country	437	42.3 [37.1,47.4]
Western Europe	Regional Rate	4912	51.2 [49.7,52.7]
	United Kingdom	2692	55.3 [53.3,57.3]
	Germany	986	41.2 [37.9,44.6]
	Switzerland	248	42.2 [35.7,48.8]
	Netherlands	206	55.8 [48.6,63.0]
	Ireland	169	59.6 [51.6,67.6]
	France	130	47.4 [37.9,56.9]
	Other Regional Country	481	50.7 [46.0,55.4]

CI = Confidence interval; NZ = New Zealand; US = United States of America; USSR = Union of Soviet Socialist Republics; ; CMHT = China, Macau, Hong Kong, Taiwan

Table A1.2: Participation rates for participation cohort by study factors – grouped by world region of birth for immigrant women

Variable	Subgroup	Population (N=537,783)	Non-immigrant (N=451,881)	East Asia/ Pacific (N=51,378)	South Asia (N=11,043)	Caribbean/ Latin America (N=2,946)	Middle East/ North Africa (N=4,261)	Eastern Europe/ Central Asia (N=6,316)	Australia/ NZ/ US (N=2,958)	Sub-Saharan Africa (N=2,088)	Western Europe (N=4,912)
All women	All women	50.3 [50.2, 50.4]	51.2 [51.0, 51.3]	45.3 [44.9, 45.7]	44.2 [43.3, 45.1]	51.7 [49.8, 53.5]	52.0 [50.5, 53.5]	37.8 [36.6, 39.0]	47.0 [45.2, 48.8]	50.9 [48.7, 53.1]	50.8 [49.4, 52.2]
Age	50-59	48.0 [47.8, 48.2]	48.5 [48.3, 48.7]	45.1 [44.6, 45.7]	47.6 [46.3, 49.0]	50.6 [48.5, 52.7]	51.9 [50.1, 53.7]	37.7 [36.4, 39.1]	46.7 [44.5, 48.9]	50.3 [47.8, 52.8]	50.1 [48.5, 51.7]
	60-69	53.9 [53.7, 54.2]	55.1 [54.9, 55.4]	45.7 [44.9, 46.6]	40.8 [39.5, 42.1]	54.7 [51.0, 58.3]	52.3 [49.5, 55.2]	38.1 [35.6, 40.6]	47.7 [44.4, 51.0]	52.7 [48.4, 57.1]	52.9 [50.0, 55.7]
Urban/Rural residence	Urban	51.2 [51.0, 51.3]	52.3 [52.2, 52.5]	45.4 [44.9, 45.8]	44.3 [43.4, 45.3]	51.7 [49.9, 53.6]	52.0 [50.5, 53.5]	38.1 [36.9, 39.3]	49.2 [47.1, 51.2]	50.9 [48.7, 53.1]	52.4 [50.8, 53.9]
	Rural	45.2 [44.8, 45.5]	45.3 [45.0, 45.7]	40.0 [35.6, 44.4]	36.4 [29.2, 44.1]	50.0 [39.6, 60.4]	53.8 [33.4, 73.4]	29.4 [23.1, 36.3]	39.4 [35.6, 43.2]	51.1 [40.3, 61.8]	44.4 [41.2, 47.6]
Income quintile	1 (lowest)	43.0 [42.7, 43.3]	42.9 [42.5, 43.2]	43.4 [42.6, 44.2]	42.9 [41.1, 44.7]	51.7 [48.1, 55.3]	45.9 [42.1, 49.6]	35.9 [33.6, 38.3]	43.8 [39.0, 48.7]	44.0 [38.9, 49.2]	46.5 [42.6, 50.5]
	2	48.3 [48.0, 48.6]	48.8 [48.5, 49.2]	47.1 [46.2, 48.0]	44.5 [42.9, 46.1]	50.2 [46.4, 54.1]	50.2 [46.8, 53.6]	35.4 [32.7, 38.1]	44.1 [39.6, 48.7]	46.9 [41.5, 52.2]	48.9 [45.2, 52.5]
	3	51.1 [50.8, 51.4]	51.9 [51.6, 52.2]	47.2 [46.3, 48.2]	45.2 [43.2, 47.3]	53.4 [49.4, 57.4]	55.9 [51.7, 59.9]	39.4 [36.6, 42.1]	44.4 [40.2, 48.8]	48.9 [43.8, 53.9]	49.8 [46.6, 53.0]
	4	52.7 [52.4, 53.0]	53.5 [53.2, 53.8]	45.5 [44.4, 46.6]	42.7 [39.8, 45.5]	51.5 [47.0, 56.0]	53.1 [49.7, 56.5]	40.5 [37.7, 43.5]	47.3 [43.2, 51.4]	53.9 [49.0, 58.7]	51.0 [48.0, 54.0]
	5 (highest)	55.7 [55.4, 56.0]	56.8 [56.5, 57.1]	43.4 [42.2, 44.6]	47.1 [43.7, 50.6]	52.3 [47.1, 57.4]	55.0 [52.1, 57.9]	39.3 [36.2, 42.6]	51.5 [48.2, 54.8]	57.7 [53.4, 61.9]	54.7 [52.0, 57.3]
# Major ADGs	0	48.3 [48.1, 48.4]	49.6 [49.4, 49.8]	41.3 [40.8, 41.8]	40.9 [39.7, 42.1]	48.1 [45.7, 50.6]	47.7 [45.7, 49.6]	35.1 [33.6, 36.6]	44.8 [42.5, 47.1]	48.2 [45.4, 51.0]	49.0 [47.2, 50.7]
	1	54.4 [54.1, 54.6]	54.6 [54.3, 54.9]	55.0 [54.0, 56.0]	47.8 [46.0, 49.6]	56.4 [52.8, 59.9]	57.4 [54.3, 60.3]	42.0 [39.6, 44.5]	52.0 [48.2, 55.8]	55.7 [51.4, 60.0]	55.0 [52.0, 57.9]
	2	53.6 [53.1, 54.0]	53.3 [52.9, 53.8]	57.6 [55.8, 59.4]	50.2 [47.2, 53.2]	60.7 [54.8, 66.3]	59.4 [54.3, 64.3]	46.2 [41.6, 50.9]	50.4 [43.9, 57.0]	52.7 [44.9, 60.4]	56.3 [50.3, 62.1]
	3+	47.8 [47.2, 48.5]	47.2 [46.5, 47.9]	56.3 [53.0, 59.5]	51.7 [46.6, 56.7]	50.5 [40.3, 60.7]	65.6 [56.7, 73.8]	44.8 [37.5, 52.3]	50.0 [39.0, 61.0]	49.1 [35.4, 62.9]	47.7 [37.9, 57.5]
	Unknown	50.7 [49.9, 51.4]	51.7 [50.9, 52.5]	44.6 [42.2, 47.1]	44.8 [39.5, 50.3]	50.5 [40.2, 60.8]	57.1 [48.0, 65.9]	32.8 [26.2, 39.9]	41.9 [32.3, 51.9]	62.7 [49.1, 75.0]	52.1 [43.6, 60.4]
# PCP visits	0	14.3 [13.9, 14.7]	16.4 [16.0, 16.9]	6.7 [6.1, 7.4]	8.2 [5.5, 11.6]	17.2 [11.1, 24.9]	7.5 [4.9, 11.0]	10.2 [7.5, 13.4]	13.7 [9.3, 19.1]	14.5 [8.5, 22.5]	15.7 [12.3, 19.7]
	1-4	43.1 [42.8, 43.4]	44.6 [44.3, 44.9]	33.5 [32.6, 34.4]	27.4 [24.6, 30.4]	39.4 [34.7, 44.1]	38.7 [34.5, 43.1]	28.5 [26.1, 31.0]	39.5 [35.9, 43.1]	41.7 [37.1, 46.3]	42.6 [39.9, 45.4]

Variable	Subgroup	Population (N=537,783)	Non-immigrant (N=451,881)	East Asia/ Pacific (N=51,378)	South Asia (N=11,043)	Caribbean/ Latin America (N=2,946)	Middle East/ North Africa (N=4,261)	Eastern Europe/ Central Asia (N=6,316)	Australia/ NZ/ US (N=2,958)	Sub-Saharan Africa (N=2,088)	Western Europe (N=4,912)
	5-9	54.2 [54.0, 54.5]	55.1 [54.9, 55.4]	49.7 [48.8, 50.5]	40.4 [38.4, 42.5]	49.3 [45.7, 53.0]	52.1 [48.8, 55.3]	38.1 [35.8, 40.4]	53.4 [50.1, 56.6]	53.0 [49.0, 56.9]	56.5 [53.9, 59.0]
	10-14	57.0 [56.7, 57.3]	57.5 [57.2, 57.8]	56.7 [55.7, 57.6]	45.5 [43.5, 47.5]	55.8 [51.9, 59.7]	58.7 [55.4, 61.9]	46.1 [43.3, 48.8]	55.6 [51.4, 59.7]	56.7 [51.9, 61.5]	60.5 [57.3, 63.7]
	15+	55.0 [54.8, 55.3]	54.4 [54.1, 54.7]	62.7 [61.7, 63.6]	50.7 [49.4, 52.1]	60.8 [57.6, 63.9]	61.5 [59.1, 63.9]	46.6 [44.0, 49.1]	50.2 [45.8, 54.6]	60.3 [55.8, 64.8]	58.9 [55.4, 62.3]
Prior screening	Yes	65.1 [65.0, 65.3]	65.7 [65.5, 65.8]	61.2 [60.7, 61.7]	63.7 [62.5, 64.8]	64.8 [62.7, 66.7]	64.5 [62.8, 66.2]	54.5 [52.9, 56.0]	63.9 [61.8, 66.0]	67.5 [65.0, 69.9]	67.3 [65.7, 68.8]
Years of residence in Canada †	< 5	37.0 [35.8, 38.2]	NA	34.1 [32.4, 35.9]	34.9 [32.6, 37.3]	48.2 [41.1, 55.4]	50.6 [45.6, 55.7]	27.1 [21.6, 33.3]	42.9 [37.3, 48.5]	38.4 [30.4, 46.8]	48.8 [43.4, 54.3]
	5 - 9	39.3 [38.5, 40.2]		36.7 [35.5, 37.9]	38.0 [36.2, 39.9]	48.6 [43.6, 53.7]	52.6 [49.0, 56.2]	37.6 [34.0, 41.4]	42.9 [39.0, 46.9]	42.2 [35.7, 49.0]	47.8 [43.7, 51.9]
	10 - 19	45.9 [45.4, 46.3]		45.2 [44.6, 45.7]	48.3 [46.9, 49.6]	50.4 [47.0, 53.8]	52.1 [49.9, 54.2]	38.1 [36.4, 39.8]	47.8 [44.3, 51.2]	51.5 [48.3, 54.7]	50.2 [47.8, 52.7]
	20+	50.6 [50.0, 51.2]		51.5 [50.7, 52.3]	51.4 [48.8, 54.0]	53.6 [51.1, 56.1]	51.9 [48.7, 55.1]	38.6 [36.6, 40.7]	49.6 [46.8, 52.5]	55.2 [51.6, 58.8]	52.2 [50.2, 54.3]

PCP = Primary care physician; ADG = aggregate diagnosis group; NA = Not applicable; NZ = New Zealand; US = United States of America

† Years of residence in Canada for the “Population” column refers to the pooled group of all immigrants

Table A1.3: Participation rates for participation cohort by study factors – including both BCBSP and MSP mammograms

Variable	Subgroup	Population (N=537,783)	Non-immigrant (N=451,881)	Chinese (N=30,185)	Philippines (N=10,911)	India (N=9,958)	South Korea (N=4,028)	Iran (N=3,517)	United Kingdom (N=2,692)	United States (N=2,572)	Vietnam (N=2,089)	Other Immigrants (N=19,950)
All Women	All Women	54.2 [54.1, 54.4]	55.3 [55.1, 55.4]	47.7 [47.1, 48.3]	48.8 [47.8, 49.7]	46.3 [45.3, 47.3]	42.2 [40.6, 43.7]	61.9 [60.2, 63.5]	59.1 [57.3, 61.0]	51.2 [49.2, 53.1]	49.9 [47.7, 52.0]	48.6 [47.9, 49.3]
Age	50-59	52.2 [52.0, 52.4]	52.9 [52.7, 53.1]	47.4 [46.8, 48.1]	49.8 [48.7, 50.9]	50.3 [48.9, 51.8]	40.9 [39.2, 42.7]	62.2 [60.3, 64.1]	58.8 [56.6, 61.0]	50.6 [48.2, 53.0]	52.1 [49.6, 54.6]	48.6 [47.8, 49.4]
	60-69	57.5 [57.2, 57.7]	58.8 [58.6, 59.0]	48.4 [47.4, 49.5]	45.0 [42.9, 47.0]	42.7 [41.4, 44.1]	46.2 [43.0, 49.4]	61.1 [58.0, 64.1]	60.1 [56.3, 63.8]	52.3 [48.9, 55.7]	42.9 [38.6, 47.4]	48.7 [47.3, 50.0]
Urban/Rural Residence	Urban	55.0 [54.8, 55.1]	56.3 [56.2, 56.5]	47.8 [47.2, 48.3]	48.9 [48.0, 49.9]	46.5 [45.5, 47.5]	42.1 [40.5, 43.6]	61.9 [60.2, 63.5]	60.0 [58.0, 62.0]	53.2 [51.0, 55.5]	49.8 [47.6, 52.0]	48.8 [48.1, 49.5]
	Rural	49.8 [49.4, 50.1]	49.9 [49.6, 50.3]	31.8 [22.3, 42.6]	41.5 [35.2, 48.1]	37.8 [30.4, 45.7]	48.6 [36.9, 60.6]	69.2 [38.6, 90.9]	53.8 [48.7, 59.0]	44.3 [40.3, 48.4]	80.0 [28.4, 99.5]	45.7 [42.7, 48.6]
Income Quintile	1 (lowest)	46.4 [46.0, 46.7]	46.5 [46.1, 46.8]	46.4 [45.3, 47.5]	45.8 [44.2, 47.5]	44.6 [42.7, 46.5]	37.9 [34.3, 41.5]	57.6 [53.0, 62.1]	52.2 [46.4, 57.9]	47.0 [41.9, 52.1]	45.0 [41.3, 48.7]	45.4 [44.0, 46.8]
	2	51.7 [51.4, 52.0]	52.4 [52.1, 52.7]	49.5 [48.3, 50.7]	48.9 [47.1, 50.7]	46.7 [45.0, 48.3]	45.0 [41.3, 48.7]	58.6 [54.9, 62.3]	51.3 [45.9, 56.6]	47.3 [42.4, 52.2]	53.8 [49.8, 57.7]	47.3 [45.8, 48.9]
	3	54.9 [54.6, 55.2]	55.8 [55.5, 56.1]	49.3 [48.1, 50.6]	51.2 [49.0, 53.3]	47.4 [45.2, 49.6]	45.9 [42.4, 49.4]	65.2 [60.8, 69.5]	59.1 [54.6, 63.4]	48.5 [43.8, 53.1]	49.5 [44.4, 54.6]	49.3 [47.7, 50.9]
	4	56.9 [56.6, 57.2]	57.9 [57.6, 58.2]	47.6 [46.2, 49.1]	52.1 [49.4, 54.9]	45.6 [42.6, 48.7]	43.3 [39.9, 46.6]	61.2 [57.5, 64.7]	59.6 [55.7, 63.4]	50.8 [46.4, 55.2]	52.7 [45.9, 59.4]	50.9 [49.2, 52.6]
	5 (highest)	60.5 [60.2, 60.8]	61.7 [61.4, 62.0]	45.4 [43.9, 46.9]	49.9 [46.4, 53.5]	49.0 [45.4, 52.7]	40.0 [36.7, 43.4]	66.2 [63.1, 69.1]	64.7 [61.5, 67.9]	57.1 [53.5, 60.6]	54.4 [44.8, 63.7]	52.1 [50.4, 53.8]
# Major ADGs	0	51.6 [51.4, 51.8]	53.1 [52.9, 53.3]	42.7 [42.0, 43.3]	45.8 [44.7, 47.0]	42.7 [41.4, 44.0]	36.6 [34.8, 38.4]	56.3 [54.1, 58.4]	57.5 [55.2, 59.9]	48.2 [45.7, 50.7]	46.2 [43.5, 48.9]	45.4 [44.5, 46.3]
	1	58.9 [58.6, 59.1]	59.2 [59.0, 59.5]	60.7 [59.4, 62.0]	54.7 [52.7, 56.7]	50.2 [48.3, 52.1]	56.1 [52.5, 59.6]	69.6 [66.5, 72.7]	62.3 [58.5, 66.0]	56.6 [52.5, 60.5]	60.5 [56.0, 64.9]	53.6 [52.1, 55.0]
	2	59.0 [58.5, 59.4]	58.9 [58.5, 59.4]	63.2 [60.7, 65.5]	57.4 [53.5, 61.2]	53.3 [50.1, 56.5]	61.1 [54.1, 67.7]	68.3 [62.8, 73.4]	60.0 [52.3, 67.3]	54.7 [47.8, 61.5]	53.2 [44.6, 61.6]	58.9 [56.3, 61.4]
	3+	54.0 [53.3, 54.7]	53.4 [52.7, 54.2]	67.6 [63.3, 71.8]	60.2 [53.4, 66.7]	54.2 [48.9, 59.4]	63.5 [49.0, 76.4]	81.7 [73.1, 88.4]	63.3 [49.9, 75.4]	58.3 [46.1, 69.8]	36.2 [22.7, 51.5]	50.9 [46.7, 55.0]
	Unknown	54.8 [54.0, 55.5]	55.9 [55.1, 56.7]	47.8 [44.6, 51.1]	46.8 [41.5, 52.2]	45.5 [39.8, 51.3]	42.8 [34.6, 51.2]	70.2 [60.9, 78.4]	62.4 [51.2, 72.6]	52.7 [42.1, 63.1]	48.0 [36.3, 59.8]	48.7 [44.6, 52.8]
# PCP Visits	0	15.5 [15.1, 15.9]	17.7 [17.2, 18.2]	5.9 [5.2, 6.6]	11.4 [8.9, 14.3]	9.7 [6.5, 13.8]	7.0 [5.1, 9.3]	11.7 [8.0, 16.3]	20.7 [14.9, 27.5]	17.0 [11.8, 23.4]	9.4 [4.9, 15.8]	13.4 [11.7, 15.3]
	1-4	46.0 [45.7, 46.3]	47.6 [47.3, 48.0]	35.0 [33.8, 36.2]	36.0 [33.9, 38.1]	28.6 [25.5, 31.7]	33.1 [30.1, 36.2]	44.1 [39.1, 49.1]	49.4 [45.4, 53.3]	41.8 [38.0, 45.7]	36.7 [31.4, 42.3]	38.5 [37.0, 40.0]
	5-9	58.2 [57.9, 58.4]	59.3 [59.0, 59.5]	53.5 [52.4, 54.6]	50.0 [48.3, 51.7]	42.3 [40.1, 44.6]	48.2 [45.2, 51.1]	61.0 [57.4, 64.4]	64.3 [61.0, 67.5]	57.1 [53.6, 60.5]	48.8 [44.4, 53.1]	50.1 [48.7, 51.4]

Variable	Subgroup	Population (N=537,783)	Non-immigrant (N=451,881)	Chinese (N=30,185)	Philippines (N=10,911)	India (N=9,958)	South Korea (N=4,028)	Iran (N=3,517)	United Kingdom (N=2,692)	United States (N=2,572)	Vietnam (N=2,089)	Other Immigrants (N=19,950)
	10-14	61.4 [61.1, 61.7]	62.0 [61.7, 62.3]	63.1 [61.9, 64.4]	55.4 [53.4, 57.3]	46.9 [44.8, 49.0]	55.5 [51.8, 59.1]	69.0 [65.6, 72.3]	68.7 [64.5, 72.7]	61.3 [56.8, 65.6]	52.5 [47.9, 57.1]	56.6 [55.0, 58.1]
	15+	60.2 [59.9, 60.4]	59.8 [59.5, 60.1]	70.6 [69.4, 71.7]	59.9 [57.9, 61.9]	53.0 [51.6, 54.5]	63.7 [59.8, 67.4]	73.3 [70.9, 75.7]	66.1 [61.8, 70.3]	56.2 [51.5, 60.8]	63.3 [59.4, 67.0]	58.8 [57.4, 60.2]
Prior Screening	Yes	68.3 [68.1, 68.4]	68.9 [68.7, 69.0]	62.9 [62.3, 63.6]	66.1 [65.0, 67.1]	65.9 [64.7, 67.1]	56.8 [54.9, 58.6]	71.7 [70.0, 73.4]	73.0 [71.0, 75.0]	66.8 [64.6, 69.0]	63.7 [61.2, 66.2]	65.0 [64.2, 65.8]
Years Since Landing	< 5	40.2 [39.0, 41.5]	NA	35.4 [32.9, 37.9]	40.5 [37.4, 43.8]	36.4 [34.0, 38.9]	28.7 [23.1, 34.8]	63.4 [57.6, 68.9]	58.3 [51.4, 64.9]	48.3 [42.4, 54.2]	51.9 [37.8, 65.7]	41.6 [38.6, 44.6]
	5 - 9	42.6 [41.7, 43.5]		37.9 [36.3, 39.5]	46.8 [44.2, 49.5]	40.4 [38.5, 42.4]	32.9 [29.6, 36.4]	62.4 [58.5, 66.1]	58.0 [52.9, 63.0]	47.2 [43.0, 51.5]	37.2 [29.1, 45.9]	44.1 [42.1, 46.2]
	10 - 19	48.7 [48.2, 49.2]		47.2 [46.5, 47.9]	48.6 [47.2, 50.0]	50.5 [49.0, 51.9]	44.2 [42.2, 46.2]	61.8 [59.5, 64.0]	57.3 [53.8, 60.8]	53.4 [49.7, 57.1]	49.9 [45.7, 54.1]	48.1 [47.0, 49.1]
	20+	53.9 [53.3, 54.5]		56.5 [55.3, 57.6]	52.0 [50.3, 53.6]	55.2 [52.4, 58.0]	50.5 [46.7, 54.4]	61.2 [57.6, 64.6]	60.8 [58.0, 63.4]	52.6 [49.5, 55.7]	51.1 [48.4, 53.8]	51.5 [50.4, 52.6]

PCP = Primary care physician; ADG = aggregate diagnosis group; NA = Not applicable; BCBSP = BC Cancer Breast Screening Program; MSP = Medical Services Plan

Table A1.4: Age-standardized retention rates by country of birth for all countries with 100 or more eligible women in the retention cohort

				Retention Rate [95% CI]	
World Region	**Country**	**Number of Eligible Women**	**% First Screen**	**All Women**	**Prior Screening**
Non-immigrant	Non-immigrant	245123	5.6	74.4 [74.2,74.5]	76.2 [76.0,76.4]
East Asia/Pacific	Regional Rate	21369	8.1	73.3 [72.7,74.0]	75.4 [74.8,76.1]
	CMHT	12863	6.3	74.3 [73.5,75.1]	76.1 [75.3,76.9]
	Philippines	4324	11.4	71.4 [69.8,73.1]	73.7 [72.0,75.4]
	South Korea	1553	11.3	66.3 [63.8,68.8]	68.8 [66.2,71.4]
	Vietnam	849	9.5	74.4 [71.1,77.7]	77.4 [74.0,80.7]
	Fiji	439	13.9	67.3 [62.9,71.7]	72.0 [67.5,76.6]
	Malaysia	379	6.3	77.9 [73.6,82.1]	80.5 [76.3,84.7]
	Japan	272	11.0	73.8 [67.7,79.9]	76.5 [70.2,82.9]
	Singapore	224	5.4	77.2 [71.3,83.1]	79.7 [74.4,85.1]
	Indonesia	142	6.3	77.4 [70.9,83.8]	79.1 [72.6,85.6]
	Other Regional Country	324	10.8	76.9 [71.9,82.0]	79.8 [74.8,84.8]
South Asia	Regional Rate	4470	22.3	69.5 [68.1,70.8]	75.5 [74.0,76.9]
	India	4054	22.7	69.9 [68.4,71.3]	76.1 [74.6,77.6]
	Pakistan	209	19.1	67.9 [61.3,74.4]	74.7 [68.5,80.8]
	Sri Lanka	152	18.4	62.3 [54.0,70.6]	65.5 [56.5,74.5]
	Other Regional Country	55	16.4	67.2 [53.5,80.8]	73.4 [58.7,88.2]
Caribbean/Latin America	Regional Rate	1385	9.5	70.8 [68.2,73.4]	73.4 [70.8,76.1]
	El Salvador	300	7.0	73.1 [67.7,78.5]	74.4 [68.9,79.9]
	Mexico	193	10.4	67.6 [60.0,75.2]	70.3 [62.4,78.2]
	Colombia	121	11.6	71.5 [62.1,81.0]	69.8 [59.6,79.9]
	Peru	109	9.2	75.5 [67.7,83.4]	80.6 [73.5,87.7]
	Other Regional Country	662	10.1	69.3 [65.6,73.0]	72.3 [68.4,76.1]
Middle East/North Africa	Regional Rate	1985	11.7	70.3 [68.1,72.4]	72.5 [70.3,74.8]
	Iran	1716	11.4	70.3 [67.9,72.6]	72.6 [70.2,75.0]
	Other Regional Country	269	13.4	70.0 [64.3,75.7]	71.9 [65.9,77.9]
Eastern Europe/Central Asia	Regional Rate	2230	11.9	68.6 [66.5,70.8]	72.2 [70.0,74.4]
	Former USSR State	539	16.0	67.7 [63.1,72.2]	73.1 [68.5,77.7]
	Poland	534	10.9	68.9 [64.7,73.1]	72.0 [67.7,76.3]
	Former Yugoslavia	440	9.8	70.8 [65.8,75.7]	73.8 [68.9,78.8]
	Romania	222	9.9	61.6 [54.8,68.4]	65.1 [58.3,71.8]
	Czech/Slovak Republics	174	5.7	72.3 [65.6,78.9]	75.1 [68.4,81.7]
	Afghanistan	161	18.0	67.7 [60.1,75.4]	71.1 [62.7,79.5]
	Other Regional Country	160	10.6	74.6 [67.7,81.6]	75.2 [68.0,82.4]
Australia/NZ/USA	Regional Rate	1305	9.5	68.8 [66.2,71.4]	71.6 [68.9,74.3]
	United States of America	1141	9.8	68.9 [66.1,71.6]	71.8 [69.0,74.6]
	Other Regional Country	164	7.3	68.2 [59.6,76.7]	69.3 [60.5,78.1]
Sub-Saharan Africa	Regional Rate	968	9.6	75.2 [72.3,78.1]	77.0 [74.0,79.9]
	South Africa	501	7.2	76.1 [72.0,80.2]	77.1 [72.9,81.3]
	Kenya	135	8.1	77.8 [70.9,84.8]	79.9 [72.8,87.0]
	Other Regional Country	332	13.9	73.1 [67.9,78.3]	75.6 [70.3,80.9]
Western Europe	Regional Rate	2217	8.4	76.5 [74.6,78.3]	77.9 [76.0,79.8]

				Retention Rate [95% CI]	
World Region	**Country**	**Number of Eligible Women**	**% First Screen**	**All Women**	**Prior Screening**
	United Kingdom	1318	7.8	78.0 [75.7,80.4]	79.3 [76.9,81.7]
	Germany	359	12.3	73.0 [68.1,77.8]	74.9 [69.9,79.9]
	Other Regional Country	540	7.2	74.5 [70.5,78.4]	75.9 [71.9,79.9]
CI = Confidence interval; NZ = New Zealand; USA = United States of America; USSR = Union of Soviet Socialist Republics; CMHT = China, Macau, Hong Kong, Taiwan					

A.2 Supplemental Tables to Chapter 4

Table **Error! Use the Home tab to apply 0 to the text that you want to appear here.**1: Details of data sources accessed for the study in Chapter 4

Database	**Description**	**Years of data utilized**
Consolidation file [94]	The central demographic file containing residential and health coverage information for all individuals registered with the provincial government health plan or who receive health services in BC	2005-2014
BC Vital Statistics Agency database [97]	Captures all deaths registered in BC.	2015-2014
BC Cancer Registry (BCCR) [92]	A population-based registry of all cases of cancer diagnosed in BC residents since 1970. Data from BCCR can be linked to other data sources from 1985 on as this was the first year that the provincial personal health number was consistently captured across health databases in BC.	1985-2014
BC Cancer Breast Screening Program (BCBSP) database [91]	Contains information on BCBSP clients including demographics, self-reported breast cancer risk factors, screening mammogram information and results. The BCBSP database has captured information on clients since the program's inception in 1988.	1988-2014
Discharge Abstract Database [95]	Includes data on hospital discharges, transfers and deaths of in-patients as well as day surgery admissions to BC acute care facilities. This data set includes patient and facility information as well as clinical details (including in-hospital interventions) associated with the patient's hospital stay.	1985-2014
Immigration, Refugee and Citizenship Canada database [96]	Includes immigration details on individuals who immigrated to Canada between 1985 and 2012. Information includes details on countries of birth, last residence and citizenship, immigrant class, year of arrival and landing as well as socioeconomic information such as education-level, occupation skills and Canadian language proficiency.	1985-2012

BC = British Columbia

Table A2.2: Age-specific breast cancer incidence rates and population distribution for the BC non-immigrant population, 2005-2014

Age Group	Incidence Rate (per 100,000)	Age Distribution of Population
40-44	101.263	0.1267
45-49	155.694	0.1423
50-54	187.692	0.1475
55-59	227.193	0.1384
60-64	309.431	0.1181
65-69	365.560	0.0913
70-74	395.541	0.0704
75-79	396.756	0.0586
80-84	337.926	0.0485
85+	316.907	0.0582

A.3 Supplemental Tables to Chapter 5

Table A3.1: Details of data sources accessed for the study in Chapter 5

Database	**Description**	**Years of data utilized**
Consolidation file [94]	The central demographic file containing residential and health coverage information for all individuals registered with the provincial government health plan or who receive health services in BC	2008-2014
BC Vital Statistics Agency database [97]	Captures all deaths registered in BC.	2010-2014
BC Cancer Registry (BCCR) [92]	A population-based registry of all cases of cancer diagnosed in BC residents since 1970. Data from BCCR can be linked to other data sources from 1985 on as this was the first year that the provincial personal health number was consistently captured across health databases in BC.	1985-2014
BC Cancer Breast Screening Program (BCBSP*) database* [91]	Contains information on BCBSP clients including demographics, self-reported breast cancer risk factors, screening mammogram information and results. The BCBSP database has captured information on clients since the program's inception in 1988.	1988-2014
Discharge Abstract Database [95]	Includes data on hospital discharges, transfers and deaths of in-patients as well as day surgery admissions to BC acute care facilities. This data set includes patient and facility information as well as clinical details (including in-hospital interventions) associated with the patient's hospital stay.	1985-2014
Immigration, Refugee and Citizenship Canada database [96]	Includes immigration details on individuals who immigrated to Canada between 1985 and 2012. Information includes details on countries of birth, last residence and citizenship, immigrant class, year of arrival and landing as well as socioeconomic information such as education-level, occupation skills and Canadian language proficiency.	1985-2012

BC = British Columbia

Table A3.2: Overall and stage-specific age-standardized breast cancer incidence rates, 2010-2014, by region and country of birth

Group		**ASIR (95% CI)**			
		Overall	**Stage I**	**Stage II-IV**	**Stage Unknown**
Non-immigrant		242.9 (238.6, 247.2)	111.0 (108.1, 113.9)	125.5 (122.4, 128.6)	6.4 (5.8, 7.1)
Immigrant – by country of birth	CMHT	158.4 (144.7, 172.1)	77.9 (68.3, 87.6)	71.5 (62.4, 80.7)	9.0 (5.7, 12.3)
	India	143.2 (121.0, 165.5)	48.5 (36.2, 60.8)	91.9 (73.7, 110.1)	2.9 (0.0, 6.3)
	Philippines	227.5 (196.5, 258.5)	104.0 (82.6, 125.4)	118.9 (96.9, 140.9)	4.6 (0.3, 8.9)
	Other Immigrant	214.6 (198.1, 231.0)	93.9 (82.9, 104.8)	115.7 (103.7, 127.7)	5.0 (2.2, 7.7)
Immigrant - by world region of birth	East Asia/Pacific	170.3 (159.0, 181.5)	80.0 (72.3, 87.7)	83.0 (75.2, 90.8)	7.3 (4.9, 9.7)
	South Asia	143.0 (122.3, 163.8)	48.0 (36.4, 59.5)	92.5 (75.6, 109.4)	2.6 (0.0, 5.6)
	Caribbean/Latin America	193.8 (137.2, 250.5)	85.6 (45.9, 125.3)	108.2 (67.8, 148.7)	0.0 (0.0, 0.0)
	Middle East/North Africa	241.8 (191.3, 292.4)	118.8 (84.4, 153.2)	119.1 (82.4, 155.7)	3.9 (0.0, 9.4)
	Eastern Europe/Central Asia	212.7 (173.8, 251.6)	80.5 (56.4, 104.5)	125.6 (96.1, 155.1)	6.6 (0.0, 14.8)
	Australia/NZ/USA	296.0 (219.6, 372.5)	154.1 (98.7, 209.5)	139.0 (86.6, 191.4)	2.9 (0.0, 8.5)
	Sub-Saharan Africa	234.4 (164.9, 303.9)	112.3 (63.6, 160.9)	113.7 (66.9, 160.5)	8.4 (0.0, 25.0)
	Western Europe	284.3 (234.5, 334.1)	127.5 (93.3, 161.7)	145.1 (110.9, 179.3)	11.7 (0.0, 23.5)
CMHT = China, Macau, Hong Kong, Taiwan; NZ = New Zealand; USA = United States of America; ASIR = age-standardized incidence rates; CI = confidence interval					

Table A3.3: Standardized rate ratios of age-standardized breast cancer incidence rates, 2010-2014, by region and country of birth

Group		**SRR (95% CI)**			
		Overall	**Stage I**	**Stage II-IV**	**Stage Unknown**
Immigrant – by country of birth	CMHT	0.65 (0.60, 0.71)	0.70 (0.62, 0.80)	0.57 (0.50, 0.65)	1.39 (0.95, 2.04)
	India	0.59 (0.50, 0.69)	0.44 (0.34, 0.56)	0.73 (0.60, 0.89)	0.45 (0.14, 1.48)
	Philippines	0.94 (0.82, 1.07)	0.94 (0.76, 1.15)	0.95 (0.79, 1.14)	0.71 (0.28, 1.84)
	Other Immigrant	0.88 (0.82, 0.96)	0.85 (0.75, 0.95)	0.92 (0.83, 1.03)	0.77 (0.44, 1.35)
Immigrant - by world region of birth	East Asia/Pacific	0.70 (0.65, 0.75)	0.72 (0.65, 0.80)	0.66 (0.60, 0.73)	1.13 (0.80, 1.60)
	South Asia	0.59 (0.51, 0.68)	0.43 (0.34, 0.55)	0.74 (0.61, 0.89)	0.40 (0.12, 1.29)
	Caribbean/Latin America	0.80 (0.60, 1.07)	0.77 (0.48, 1.23)	0.86 (0.59, 1.25)	NA
	Middle East/North Africa	1.00 (0.81, 1.23)	1.07 (0.80, 1.43)	0.95 (0.70, 1.29)	0.61 (0.15, 2.46)
	Eastern Europe/Central Asia	0.88 (0.73, 1.05)	0.73 (0.54, 0.98)	1.00 (0.79, 1.27)	1.03 (0.30, 3.56)
	Australia/NZ/USA	1.22 (0.94, 1.58)	1.39 (0.97, 1.99)	1.11 (0.76, 1.62)	0.45 (0.06, 3.19)
	Sub-Saharan Africa	0.96 (0.72, 1.30)	1.01 (0.66, 1.56)	0.91 (0.60, 1.37)	1.31 (0.18, 9.34)
	Western Europe	1.17 (0.98, 1.40)	1.15 (0.88, 1.50)	1.16 (0.91, 1.47)	1.82 (0.66, 5.01)

CMHT = China, Macau, Hong Kong, Taiwan; NZ = New Zealand; USA = United States of America; SRR = Standardized rate ratio; CI = confidence interval

Table A3.4: Histo-pathological features and stage at diagnosis of incident breast cancer cases, 2010-2014, by age and country of birth

Age at Diagnosis	Variable	Statistic	Non-immigrant (N=12,352)	CMHT (N=566)	India (N=175)	Philippines (N=269)	Other Immigrant (N=791)
40-49	# Incident Cancers	N	1,544	182	37	94	278
	HER2	Negative	1,244 (80.6%)	138 (75.8%)	33 (89.2%)	64 (68.1%)	214 (77.0%)
		Positive	284 (18.4%)	41 (22.5%)	<5 (<13.5%)	25 (26.6%)	59 (21.2%)
		Unknown	16 (1.0%)	<5 (<2.7%)	<5 (<13.5%)	5 (5.3%)	5 (1.8%)
	Hormone Receptor	Negative	247 (16.0%)	33 (18.1%)	<5 (<13.5%)	15 (16.0%)	50 (18.0%)
		Positive	1,290 (83.5%)	148 (81.3%)	33 (89.2%)	77 (81.9%)	227 (81.7%)
		Unknown	7 (0.5%)	<5 (<2.7%)	0 (0.0%)	<5 (<5.3%)	<5 (<1.8%)
	Stage	I	616 (39.9%)	80 (44.0%)	13 (35.1%)	35 (37.2%)	110 (39.6%)
		II-IV	916 (59.3%)	98 (53.8%)	24 (64.9%)	56 (59.6%)	164 (59.0%)
		Unknown	12 (0.8%)	<5 (<2.7%)	0 (0.0%)	<5 (<5.3%)	<5 (<1.8%)
50+	# Incident Cancers	N	10,808	384	138	175	513
	HER2	Negative	9,076 (84.0%)	296 (77.1%)	117 (84.8%)	127 (72.6%)	421 (82.1%)
		Positive	1,366 (12.6%)	64 (16.7%)	18 (13.0%)	43 (24.6%)	79 (15.4%)
		Unknown	366 (3.4%)	24 (6.3%)	<5 (<3.6%)	5 (2.9%)	13 (2.5%)
	Hormone Receptor	Negative	1,364 (12.6%)	53 (13.8%)	19 (13.8%)	28 (16.0%)	67 (13.1%)
		Positive	9,193 (85.1%)	313 (81.5%)	117 (84.8%)	147 (84.0%)	439 (85.6%)
		Unknown	251 (2.3%)	18 (4.7%)	<5 (<3.6%)	0 (0.0%)	7 (1.4%)
	Stage	I	4,979 (46.1%)	195 (50.8%)	50 (36.2%)	82 (46.9%)	228 (44.4%)
		II-IV	5,438 (50.3%)	163 (42.4%)	85 (61.6%)	90 (51.4%)	274 (53.4%)
		Unknown	391 (3.6%)	26 (6.8%)	<5 (<3.6%)	<5 (<2.9%)	11 (2.1%)

HER2 = human epidermal growth factor receptor 2; CMHT = China, Macau, Hong Kong, Taiwan; N = sample size

A.4 Supplemental Tables to Chapter 6

Table A4.1: Details of data sources accessed

Database	Description	Years of data utilized by present study
Consolidation file [94]	The central demographic file containing residential and health coverage information for all individuals registered with MSP or who receive health services in BC	2001-2014
BC Vital Statistics Agency database [97]	Captures all deaths registered in BC.	2010-2014
BC Cancer Registry (BCCR) [92]	A population-based registry of all cases of cancer diagnosed in BC residents since 1970. Data from BCCR can be linked to other data sources from 1985 on, as this was the first year that the provincial personal health number was consistently captured across health databases in BC.	1985-2014
BC Cancer Breast Screening Program (BCBSP) database [91]	Includes information on BCBSP clients including demographics, self-reported breast cancer risk factors, screening mammogram information and results. The BCBSP database has captured information on clients since the program's inception in 1988.	1988-2014
Medical Services Plan (MSP) physician payment file [93]	Includes all services provided by fee-for-service practitioners to individuals and billed to BC's Medical Services Plan. MSP is BC's public universal health coverage plan. Data include service dates, fee codes, and diagnoses responsible for paid physician services.	2001-2014
Discharge Abstract Database [95]	Includes data on hospital discharges, transfers and deaths of in-patients, as well as day surgery admissions to BC acute care facilities. This data set includes patient and facility information, as well as clinical details (including in-hospital interventions) associated with the patient's hospital stay.	1985-2014
College of Physician and Surgeons of BC database [146]	Includes demographic information on physicians in BC such as year of medical school graduation and sex.	2010-2014
Immigration, Refugee and Citizenship Canada database [96]	Includes immigration details on individuals who immigrated to Canada between 1985 and 2012. Information includes details on countries of birth, last residence and citizenship, immigrant class, year of arrival and landing as well as socioeconomic information such as education-level, occupation skills and Canadian language proficiency.	1985-2012

BC = British Columbia

Table A4.2: Distribution of PCP factors for participation cohort by immigrant group

Variable	Subgroup	Non-immigrant (N=385,761)	CMHT (N=22,540)	India (N=9,346)	Philippines (N=9,444)	Eastern Europe (N=5,167)	Other Immigrants (N=23,422)
# PCP visits	3-6	109,190 (28.3%)	6,589 (29.2%)	1,068 (11.4%)	2,409 (25.5%)	1,412 (27.3%)	6,387 (27.3%)
	7-9	79,533 (20.6%)	4,751 (21.1%)	1,211 (13.0%)	2,077 (22.0%)	1,053 (20.4%)	4,672 (19.9%)
	10-15	106,072 (27.5%)	6,552 (29.1%)	2,701 (28.9%)	2,971 (31.5%)	1,436 (27.8%)	6,394 (27.3%)
	16+	90,966 (23.6%)	4,648 (20.6%)	4,366 (46.7%)	1,987 (21.0%)	1,266 (24.5%)	5,969 (25.5%)
# PCPs seen	1	77,676 (20.1%)	7,554 (33.5%)	2,354 (25.2%)	2,352 (24.9%)	1,123 (21.7%)	5,409 (23.1%)
	2	97,680 (25.3%)	6,842 (30.4%)	2,599 (27.8%)	2,489 (26.4%)	1,343 (26.0%)	6,084 (26.0%)
	3-5	161,202 (41.8%)	7,095 (31.5%)	3,658 (39.1%)	3,672 (38.9%)	2,097 (40.6%)	9,336 (39.9%)
	6-10	44,680 (11.6%)	996 (4.4%)	697 (7.5%)	859 (9.1%)	555 (10.7%)	2,389 (10.2%)
	>10	4,523 (1.2%)	53 (0.2%)	38 (0.4%)	72 (0.8%)	49 (0.9%)	204 (0.9%)
UPC index (quartiles)	<0.54 (QRT 1)	88,188 (22.9%)	3,601 (16.0%)	1,427 (15.3%)	2,066 (21.9%)	1,142 (22.1%)	5,279 (22.5%)
	0.54-0.78 (QRT 2)	120,500 (31.2%)	5,875 (26.1%)	2,416 (25.9%)	2,562 (27.1%)	1,598 (30.9%)	6,899 (29.5%)
	0.78-0.99 (QRT 3)	99,397 (25.8%)	5,510 (24.4%)	3,149 (33.7%)	2,464 (26.1%)	1,304 (25.2%)	5,835 (24.9%)
	1.00 (QRT 4)	77,676 (20.1%)	7,554 (33.5%)	2,354 (25.2%)	2,352 (24.9%)	1,123 (21.7%)	5,409 (23.1%)
Duration with PCP	<5 years	162,656 (42.2%)	6,952 (30.8%)	4,172 (44.6%)	3,452 (36.6%)	2,394 (46.3%)	11,122 (47.5%)
	5-9 years	83,042 (21.5%)	5,665 (25.1%)	2,834 (30.3%)	2,318 (24.5%)	1,257 (24.3%)	5,349 (22.8%)
	10+ years	140,063 (36.3%)	9,923 (44.0%)	2,340 (25.0%)	3,674 (38.9%)	1,516 (29.3%)	6,951 (29.7%)
PCP sex	Female	156,643 (40.6%)	8,533 (37.9%)	1,785 (19.1%)	3,988 (42.2%)	2,104 (40.7%)	8,660 (37.0%)
	Male	229,118 (59.4%)	14,007 (62.1%)	7,561 (80.9%)	5,456 (57.8%)	3,063 (59.3%)	14,762 (63.0%)
PCP years since graduation (quartiles)	QRT 1 (<19)	112,308 (29.1%)	4,661 (20.7%)	2,275 (24.3%)	2,032 (21.5%)	1,450 (28.1%)	6,921 (29.5%)
	QRT 2 (19-25)	83,591 (21.7%)	5,315 (23.6%)	2,136 (22.9%)	2,014 (21.3%)	1,130 (21.9%)	5,353 (22.9%)
	QRT 3 (26-35)	105,580 (27.4%)	5,701 (25.3%)	2,695 (28.8%)	2,451 (26.0%)	1,674 (32.4%)	6,176 (26.4%)
	QRT 4 (36+)	84,282 (21.8%)	6,863 (30.4%)	2,240 (24.0%)	2,947 (31.2%)	913 (17.7%)	4,972 (21.2%)

CMHT = China, Macau, Hong Kong, Taiwan; PCP = primary care physician; UPC = usual provider of care; QRT = quartile

Table A4.3: Breast screening participation rates by PCP factors and immigrant groups within the participation cohort

Variable	Subgroup	Non-immigrant (N=385,761)	CMHT (N=22,540)	India (N=9,346)	Philippines (N=9,444)	Eastern Europe (N=5,167)	Other Immigrants (N=23,422)
# PCP visits	3-6	52.0 [51.7, 52.3]	45.3 [44.1, 46.5]	33.5 [30.7, 36.4]	40.3 [38.4, 42.3]	35.1 [32.6, 37.7]	46.6 [45.4, 47.8]
	7-9	56.2 [55.9, 56.6]	55.7 [54.2, 57.1]	39.6 [36.8, 42.4]	48.1 [45.9, 50.3]	43.0 [40.0, 46.1]	52.8 [51.4, 54.2]
	10-15	57.7 [57.4, 58.0]	63.7 [62.5, 64.8]	46.5 [44.6, 48.4]	54.7 [52.9, 56.5]	45.8 [43.2, 48.4]	57.5 [56.3, 58.7]
	16+	55.0 [54.6, 55.3]	68.0 [66.6, 69.3]	52.0 [50.5, 53.5]	57.2 [55.0, 59.4]	47.8 [45.0, 50.6]	59.0 [57.7, 60.3]
# PCPs seen	1	57.7 [57.3, 58.0]	52.8 [51.6, 53.9]	41.5 [39.5, 43.5]	47.3 [45.2, 49.3]	42.5 [39.6, 45.4]	52.3 [51.0, 53.7]
	2	56.8 [56.5, 57.1]	58.8 [57.6, 60.0]	46.0 [44.1, 48.0]	51.1 [49.2, 53.1]	41.8 [39.2, 44.5]	54.4 [53.1, 55.6]
	3-5	54.6 [54.4, 54.9]	60.6 [59.5, 61.8]	48.8 [47.2, 50.4]	51.2 [49.5, 52.8]	43.5 [41.4, 45.7]	54.4 [53.4, 55.4]
	6-10	50.3 [49.9, 50.8]	61.4 [58.3, 64.5]	55.5 [51.7, 59.3]	49.9 [46.5, 53.3]	43.1 [38.9, 47.3]	55.2 [53.2, 57.2]
	>10	41.5 [40.0, 42.9]	64.2 [49.8, 76.9]	52.6 [35.8, 69.0]	52.8 [40.7, 64.7]	42.9 [28.8, 57.8]	53.9 [46.8, 60.9]
UPC index (quartiles)	<0.54 (QRT 1)	48.5 [48.2, 48.9]	54.7 [53.0, 56.3]	47.7 [45.1, 50.4]	46.0 [43.8, 48.2]	38.2 [35.4, 41.1]	50.0 [48.7, 51.4]
	0.54-0.78 (QRT 2)	55.8 [55.5, 56.1]	59.2 [57.9, 60.4]	47.8 [45.8, 49.8]	50.2 [48.2, 52.1]	44.9 [42.4, 47.3]	55.1 [53.9, 56.2]
	0.78-0.99 (QRT 3)	58.2 [57.9, 58.6]	64.0 [62.7, 65.3]	49.3 [47.5, 51.0]	56.2 [54.2, 58.1]	44.6 [41.9, 47.4]	57.8 [56.5, 59.1]
	1.00 (QRT 4)	57.7 [57.3, 58.0]	52.8 [51.6, 53.9]	41.5 [39.5, 43.5]	47.3 [45.2, 49.3]	42.5 [39.6, 45.4]	52.3 [51.0, 53.7]
Duration with PCP	<5 years	51.5 [51.3, 51.8]	50.4 [49.2, 51.6]	42.8 [41.3, 44.4]	45.2 [43.5, 46.9]	40.3 [38.3, 42.3]	50.5 [49.6, 51.5]
	5-9 years	55.7 [55.4, 56.0]	55.7 [54.4, 57.0]	48.1 [46.2, 49.9]	49.9 [47.8, 51.9]	43.5 [40.8, 46.3]	55.6 [54.3, 56.9]
	10+ years	59.0 [58.7, 59.3]	63.5 [62.5, 64.4]	51.9 [49.9, 54.0]	54.8 [53.2, 56.5]	46.2 [43.6, 48.7]	58.2 [57.1, 59.4]
PCP sex	Female	58.8 [58.6, 59.1]	62.5 [61.5, 63.5]	52.8 [50.5, 55.2]	53.6 [52.1, 55.2]	46.5 [44.4, 48.7]	58.1 [57.0, 59.1]
	Male	52.6 [52.4, 52.8]	54.4 [53.6, 55.3]	45.2 [44.1, 46.4]	47.5 [46.2, 48.8]	40.3 [38.5, 42.0]	51.6 [50.7, 52.4]
PCP years since graduation (quartiles)	QRT 1 (<19)	54.5 [54.2, 54.8]	57.5 [56.0, 58.9]	47.5 [45.4, 49.5]	50.3 [48.1, 52.5]	42.3 [39.7, 44.9]	53.0 [51.8, 54.1]
	QRT 2 (19-25)	55.2 [54.9, 55.6]	59.2 [57.9, 60.6]	47.5 [45.4, 49.7]	49.3 [47.1, 51.5]	45.3 [42.4, 48.3]	54.4 [53.1, 55.8]
	QRT 3 (26-35)	56.0 [55.7, 56.3]	58.1 [56.8, 59.4]	45.3 [43.4, 47.2]	50.4 [48.4, 52.4]	42.7 [40.3, 45.1]	55.6 [54.4, 56.9]
	QRT 4 (36+)	54.9 [54.5, 55.2]	55.6 [54.5, 56.8]	46.8 [44.7, 48.9]	50.2 [48.4, 52.0]	40.9 [37.6, 44.1]	52.8 [51.4, 54.2]

CMHT = China, Macau, Hong Kong, Taiwan; PCP = primary care physician; UPC = usual provider of care; QRT = quartile

Table A4.4: Select demographic and health characteristics of participation cohort by immigrant group

Variable	Subgroup	Non-immigrant (N=385,761)	CMHT (N=22,540)	India (N=9,346)	Philippines (N=9,444)	Eastern Europe (N=5,167)	Other Immigrants (N=23,422)
Age	50-59	225,136 (58.4%)	15,860 (70.4%)	4,414 (47.2%)	7,394 (78.3%)	3,870 (74.9%)	16,787 (71.7%)
	60-69	160,625 (41.6%)	6,680 (29.6%)	4,932 (52.8%)	2,050 (21.7%)	1,297 (25.1%)	6,635 (28.3%)
Urban/rural residence	Urban	323,839 (83.9%)	22,469 (99.7%)	9,191 (98.3%)	9,242 (97.9%)	5,021 (97.2%)	21,835 (93.2%)
	Rural	61,841 (16.0%)	67 (0.3%)	152 (1.6%)	202 (2.1%)	144 (2.8%)	1,584 (6.8%)
	Unknown	81 (0.0%)	<5 (<0.0%)	<5 (<0.0%)	<5 (<0.0%)	<5 (<0.0%)	<5 (<0.0%)
Income quintile	Q1 (lowest)	65,374 (16.9%)	6,238 (27.7%)	2,474 (26.5%)	3,060 (32.4%)	1,357 (26.3%)	4,672 (19.9%)
	Q2	70,866 (18.4%)	5,077 (22.5%)	3,288 (35.2%)	2,722 (28.8%)	1,042 (20.2%)	4,892 (20.9%)
	Q3	76,702 (19.9%)	4,507 (20.0%)	1,918 (20.5%)	1,839 (19.5%)	1,045 (20.2%)	4,401 (18.8%)
	Q4	83,228 (21.6%)	3,379 (15.0%)	983 (10.5%)	1,129 (12.0%)	923 (17.9%)	4,311 (18.4%)
	Q5 (highest)	86,274 (22.4%)	3,131 (13.9%)	676 (7.2%)	635 (6.7%)	752 (14.6%)	4,900 (20.9%)
	Unknown	3,317 (0.9%)	208 (0.9%)	7 (0.1%)	59 (0.6%)	48 (0.9%)	246 (1.1%)
Prior screening	Yes	303,653 (78.7%)	18,038 (80.0%)	5,722 (61.2%)	6,698 (70.9%)	3,643 (70.5%)	17,756 (75.8%)
# Major ADGs	0	212,738 (55.1%)	14,658 (65.0%)	5,124 (54.8%)	6,090 (64.5%)	2,991 (57.9%)	13,943 (59.5%)
	1	109,472 (28.4%)	5,472 (24.3%)	2,749 (29.4%)	2,320 (24.6%)	1,469 (28.4%)	6,301 (26.9%)
	2	39,707 (10.3%)	1,576 (7.0%)	977 (10.5%)	663 (7.0%)	448 (8.7%)	2,065 (8.8%)
	3+	17,671 (4.6%)	473 (2.1%)	358 (3.8%)	219 (2.3%)	183 (3.5%)	735 (3.1%)
	Unknown	6,173 (1.6%)	361 (1.6%)	138 (1.5%)	152 (1.6%)	76 (1.5%)	378 (1.6%)
Years since landing	< 5	NA	1,054 (4.7%)	1,433 (15.3%)	778 (8.2%)	176 (3.4%)	1,553 (6.6%)
	5 - 9		2,524 (11.2%)	2,352 (25.2%)	1,224 (13.0%)	514 (9.9%)	3,256 (13.9%)
	10 - 19		13,221 (58.7%)	4,386 (46.9%)	4,328 (45.8%)	2,622 (50.7%)	9,281 (39.6%)
	20+		5,741 (25.5%)	1,175 (12.6%)	3,114 (33.0%)	1,855 (35.9%)	9,332 (39.8%)

CMHT = China, Macau, Hong Kong, Taiwan; ADG = Aggregate diagnosis group; Q = quintile

Table A4.5: Breast screening participation rates by select demographic or health characteristics and immigrant group within the participation cohort

Variable	Subgroup	Non-immigrant (N=385,761)	CMHT (N=22,540)	India (N=9,346)	Philippines (N=9,444)	Eastern Europe (N=5,167)	Other Immigrants (N=23,422)
All women	All women	55.1 [55.0, 55.3]	57.5 [56.8, 58.1]	46.7 [45.7, 47.7]	50.1 [49.1, 51.1]	42.8 [41.5, 44.2]	54.0 [53.3, 54.6]
Age	50-59	52.5 [52.3, 52.7]	57.4 [56.7, 58.2]	50.6 [49.1, 52.1]	51.0 [49.9, 52.2]	42.9 [41.3, 44.4]	53.8 [53.1, 54.6]
	60-69	58.8 [58.5, 59.0]	57.6 [56.4, 58.8]	43.2 [41.8, 44.6]	46.7 [44.6, 48.9]	42.6 [39.9, 45.4]	54.4 [53.2, 55.6]
Urban/rural residence	Urban	56.3 [56.1, 56.4]	57.6 [56.9, 58.2]	46.8 [45.8, 47.9]	50.2 [49.2, 51.3]	42.9 [41.6, 44.3]	54.3 [53.6, 54.9]
	Rural	49.2 [48.8, 49.6]	35.8 [24.5, 48.5]	38.8 [31.0, 47.0]	43.1 [36.1, 50.2]	38.2 [30.2, 46.7]	50.1 [47.6, 52.6]
Income quintile	Q1 (lowest)	47.1 [46.7, 47.5]	55.5 [54.3, 56.8]	45.5 [43.5, 47.5]	47.5 [45.7, 49.2]	41.5 [38.9, 44.2]	49.7 [48.3, 51.2]
	Q2	52.8 [52.4, 53.2]	58.7 [57.3, 60.1]	46.9 [45.2, 48.7]	49.2 [47.3, 51.1]	40.0 [37.0, 43.1]	53.1 [51.7, 54.5]
	Q3	55.8 [55.4, 56.1]	59.3 [57.9, 60.8]	48.0 [45.7, 50.2]	53.0 [50.7, 55.3]	44.1 [41.1, 47.2]	54.4 [52.9, 55.9]
	Q4	57.3 [57.0, 57.7]	57.7 [56.0, 59.4]	44.8 [41.6, 47.9]	53.3 [50.4, 56.3]	45.7 [42.5, 49.0]	55.8 [54.3, 57.3]
	Q5 (highest)	60.7 [60.4, 61.1]	56.9 [55.1, 58.6]	49.3 [45.4, 53.1]	52.9 [48.9, 56.9]	44.0 [40.4, 47.6]	57.2 [55.8, 58.6]
Prior screening	None	9.0 [8.8, 9.2]	12.7 [11.8, 13.8]	17.4 [16.2, 18.7]	12.4 [11.2, 13.7]	8.9 [7.5, 10.5]	14.0 [13.1, 14.9]
	Yes	67.6 [67.5, 67.8]	68.7 [68.0, 69.3]	65.2 [64.0, 66.5]	65.5 [64.4, 66.7]	57.0 [55.4, 58.6]	66.7 [66.0, 67.4]
# Major ADGs	0	55.6 [55.4, 55.8]	56.1 [55.3, 56.9]	44.4 [43.0, 45.8]	48.7 [47.4, 49.9]	41.9 [40.1, 43.7]	53.0 [52.2, 53.8]
	1	55.8 [55.5, 56.1]	59.6 [58.3, 60.9]	48.4 [46.5, 50.3]	52.7 [50.6, 54.7]	43.3 [40.7, 45.9]	55.5 [54.3, 56.8]
	2	53.9 [53.4, 54.4]	61.5 [59.1, 64.0]	51.4 [48.2, 54.6]	52.6 [48.8, 56.5]	47.1 [42.4, 51.8]	56.3 [54.1, 58.4]
	3+	47.8 [47.1, 48.6]	64.3 [59.8, 68.6]	53.1 [47.8, 58.3]	54.3 [47.5, 61.1]	44.8 [37.5, 52.3]	50.7 [47.1, 54.4]
Years since landing	< 5	NA	42.4 [39.4, 45.5]	36.8 [34.3, 39.3]	41.8 [38.3, 45.3]	33.0 [26.1, 40.4]	48.2 [45.7, 50.7]
	5 - 9		47.2 [45.3, 49.2]	40.8 [38.8, 42.8]	45.9 [43.1, 48.8]	45.3 [41.0, 49.7]	49.3 [47.5, 51.0]
	10 - 19		58.3 [57.5, 59.2]	50.8 [49.3, 52.3]	50.0 [48.5, 51.5]	43.0 [41.1, 44.9]	54.8 [53.8, 55.8]
	20+		62.9 [61.6, 64.1]	55.3 [52.4, 58.2]	54.0 [52.2, 55.7]	42.7 [40.5, 45.0]	55.7 [54.7, 56.7]

CMHT = China, Macau, Hong Kong, Taiwan; ADG = Aggregate diagnosis group; Q = quintile

Table A4.6: Distribution of PCP factors for retention cohort by immigrant group

Variable	Subgroup	Non-immigrant (N=225,243)	CMHT (N=11,929)	India (N=3,964)	Philippines (N=4,015)	Eastern Europe (N=2,051)	Other Immigrants (N=11,551)
# PCP visits	3-6	57,968 (25.7%)	2,629 (22.0%)	294 (7.4%)	850 (21.2%)	436 (21.3%)	2,608 (22.6%)
	7-9	46,530 (20.7%)	2,277 (19.1%)	454 (11.5%)	819 (20.4%)	417 (20.3%)	2,142 (18.5%)
	10-15	65,241 (29.0%)	3,779 (31.7%)	1,154 (29.1%)	1,312 (32.7%)	604 (29.4%)	3,393 (29.4%)
	16+	55,504 (24.6%)	3,244 (27.2%)	2,062 (52.0%)	1,034 (25.8%)	594 (29.0%)	3,408 (29.5%)
# PCPs seen	1	46,982 (20.9%)	3,687 (30.9%)	882 (22.3%)	990 (24.7%)	446 (21.7%)	2,458 (21.3%)
	2	58,834 (26.1%)	3,801 (31.9%)	1,131 (28.5%)	1,031 (25.7%)	524 (25.5%)	3,036 (26.3%)
	3-5	93,254 (41.4%)	3,865 (32.4%)	1,553 (39.2%)	1,565 (39.0%)	791 (38.6%)	4,656 (40.3%)
	6-10	24,105 (10.7%)	546 (4.6%)	384 (9.7%)	399 (9.9%)	266 (13.0%)	1,279 (11.1%)
	>10	2,068 (0.9%)	30 (0.3%)	14 (0.4%)	30 (0.7%)	24 (1.2%)	122 (1.1%)
UPC index (quartiles)	<0.54 (QRT 1)	44,801 (19.9%)	1,707 (14.3%)	641 (16.2%)	763 (19.0%)	438 (21.4%)	2,490 (21.6%)
	0.54-0.78 (QRT 2)	70,406 (31.3%)	3,160 (26.5%)	1,001 (25.3%)	1,150 (28.6%)	594 (29.0%)	3,503 (30.3%)
	0.78-0.99 (QRT 3)	63,054 (28.0%)	3,375 (28.3%)	1,440 (36.3%)	1,112 (27.7%)	573 (27.9%)	3,100 (26.8%)
	1.00 (QRT 4)	46,982 (20.9%)	3,687 (30.9%)	882 (22.3%)	990 (24.7%)	446 (21.7%)	2,458 (21.3%)
Duration with PCP	<5 years	92,847 (41.2%)	3,201 (26.8%)	1,754 (44.2%)	1,441 (35.9%)	988 (48.2%)	5,227 (45.3%)
	5+ years	132,396 (58.8%)	8,728 (73.2%)	2,210 (55.8%)	2,574 (64.1%)	1,063 (51.8%)	6,324 (54.7%)
PCP sex	Female	91,781 (40.7%)	4,957 (41.6%)	848 (21.4%)	1,867 (46.5%)	885 (43.1%)	4,206 (36.4%)
	Male	133,462 (59.3%)	6,972 (58.4%)	3,116 (78.6%)	2,148 (53.5%)	1,166 (56.9%)	7,345 (63.6%)
PCP years since graduation (quartiles)	QRT 1 (<19)	54,701 (24.3%)	2,109 (17.7%)	832 (21.0%)	725 (18.1%)	487 (23.7%)	2,688 (23.3%)
	QRT 2 (19-25)	47,869 (21.3%)	3,105 (26.0%)	913 (23.0%)	798 (19.9%)	465 (22.7%)	2,689 (23.3%)
	QRT 3 (26-35)	64,018 (28.4%)	2,993 (25.1%)	1,201 (30.3%)	1,081 (26.9%)	686 (33.4%)	3,286 (28.4%)
	QRT 4 (36+)	58,655 (26.0%)	3,722 (31.2%)	1,018 (25.7%)	1,411 (35.1%)	413 (20.1%)	2,888 (25.0%)

CMHT = China, Macau, Hong Kong, Taiwan; PCP = primary care physician; UPC = usual provider of care; QRT = quartile

Table A4.7: Breast screening retention rates by PCP factors and immigrant group for the retention cohort

Variable	Subgroup	Non-immigrant (N=225,243)	CMHT (N=11,929)	India (N=3,964)	Philippines (N=4,015)	Eastern Europe (N=2,051)	Other Immigrants (N=11,551)
# PCP visits	3-6	73.5 [73.1, 73.9]	68.5 [66.7, 70.2]	64.6 [58.9, 70.1]	67.2 [63.9, 70.3]	66.7 [62.1, 71.2]	68.5 [66.7, 70.3]
	7-9	75.9 [75.5, 76.3]	73.4 [71.5, 75.2]	70.7 [66.3, 74.9]	71.4 [68.2, 74.5]	67.6 [62.9, 72.1]	72.7 [70.7, 74.6]
	10-15	76.3 [76.0, 76.7]	77.8 [76.5, 79.1]	70.1 [67.4, 72.7]	74.9 [72.5, 77.2]	70.2 [66.4, 73.8]	73.1 [71.6, 74.6]
	16+	74.2 [73.8, 74.5]	80.5 [79.1, 81.8]	70.8 [68.8, 72.8]	75.3 [72.6, 77.9]	68.4 [64.4, 72.1]	74.7 [73.2, 76.1]
# PCPs seen	1	77.6 [77.2, 77.9]	74.3 [72.9, 75.7]	69.0 [65.9, 72.1]	73.5 [70.7, 76.3]	67.7 [63.2, 72.0]	73.4 [71.6, 75.1]
	2	76.1 [75.8, 76.5]	76.1 [74.7, 77.4]	69.7 [66.9, 72.3]	72.0 [69.1, 74.7]	67.7 [63.6, 71.7]	72.6 [71.0, 74.2]
	3-5	74.4 [74.1, 74.7]	76.5 [75.1, 77.8]	70.8 [68.5, 73.1]	72.8 [70.5, 75.0]	69.8 [66.5, 73.0]	72.3 [71.0, 73.6]
	6-10	70.4 [69.8, 71.0]	75.8 [72.0, 79.4]	71.1 [66.3, 75.6]	71.4 [66.7, 75.8]	66.2 [60.1, 71.8]	71.3 [68.7, 73.8]
	>10	64.4 [62.3, 66.5]	70.0 [50.6, 85.3]	71.4 [41.9, 91.6]	80.0 [61.4, 92.3]	75.0 [53.3, 90.2]	69.7 [60.7, 77.7]
UPC index (quartiles)	<0.54 (QRT 1)	70.7 [70.3, 71.1]	74.3 [72.2, 76.4]	70.4 [66.7, 73.9]	68.5 [65.1, 71.8]	66.9 [62.3, 71.3]	70.6 [68.8, 72.4]
	0.54-0.78 (QRT 2)	74.5 [74.2, 74.8]	75.0 [73.4, 76.5]	69.3 [66.4, 72.2]	73.8 [71.2, 76.3]	68.2 [64.3, 71.9]	71.9 [70.3, 73.3]
	0.78-0.99 (QRT 3)	76.6 [76.3, 77.0]	78.3 [76.9, 79.7]	71.3 [68.8, 73.6]	73.6 [70.9, 76.1]	70.3 [66.4, 74.0]	73.9 [72.3, 75.4]
	1.00 (QRT 4)	77.6 [77.2, 77.9]	74.3 [72.9, 75.7]	69.0 [65.9, 72.1]	73.5 [70.7, 76.3]	67.7 [63.2, 72.0]	73.4 [71.6, 75.1]
Duration with PCP	<5 years	73.1 [72.8, 73.4]	70.1 [68.5, 71.7]	66.2 [63.9, 68.4]	71.0 [68.6, 73.3]	65.3 [62.2, 68.3]	70.2 [68.9, 71.4]
	5+ years	76.3 [76.1, 76.6]	77.7 [76.8, 78.6]	73.3 [71.4, 75.1]	73.6 [71.9, 75.3]	71.3 [68.5, 74.0]	74.4 [73.3, 75.4]
PCP sex	Female	75.1 [74.8, 75.3]	75.5 [74.3, 76.7]	72.4 [69.3, 75.4]	72.3 [70.2, 74.3]	67.5 [64.3, 70.5]	72.4 [71.1, 73.8]
	Male	74.9 [74.7, 75.2]	75.7 [74.7, 76.7]	69.5 [67.9, 71.1]	73.0 [71.1, 74.9]	69.1 [66.4, 71.8]	72.5 [71.4, 73.5]
PCP years since graduation (quartiles)	QRT 1 (<19)	73.1 [72.8, 73.5]	72.5 [70.5, 74.4]	68.3 [65.0, 71.4]	70.8 [67.3, 74.0]	67.6 [63.2, 71.7]	70.7 [69.0, 72.4]
	QRT 2 (19-25)	74.8 [74.4, 75.2]	76.0 [74.5, 77.5]	71.3 [68.2, 74.2]	75.3 [72.2, 78.3]	65.4 [60.9, 69.7]	73.1 [71.4, 74.7]
	QRT 3 (26-35)	75.4 [75.0, 75.7]	75.4 [73.8, 76.9]	70.8 [68.1, 73.3]	70.1 [67.3, 72.8]	68.1 [64.4, 71.6]	72.0 [70.4, 73.5]
	QRT 4 (36+)	76.4 [76.1, 76.8]	77.3 [75.9, 78.7]	69.8 [66.9, 72.7]	74.1 [71.8, 76.4]	73.4 [68.8, 77.6]	74.1 [72.4, 75.7]

CMHT = China, Macau, Hong Kong, Taiwan; PCP = primary care physician; UPC = usual provider of care; QRT = quartile

Table A4.8: Select demographic and health characteristics of retention cohort by immigrant group

Variable	Subgroup	Non-immigrant (N=225,243)	CMHT (N=11,929)	India (N=3,964)	Philippines (N=4,015)	Eastern Europe (N=2,051)	Other Immigrants (N=11,551)
Age	50-59	132,216 (58.7%)	8,743 (73.3%)	2,128 (53.7%)	3,298 (82.1%)	1,619 (78.9%)	8,427 (73.0%)
	60-69	93,027 (41.3%)	3,186 (26.7%)	1,836 (46.3%)	717 (17.9%)	432 (21.1%)	3,124 (27.0%)
Urban/rural residence	Urban	192,641 (85.5%)	11,912 (99.9%)	3,910 (98.6%)	3,940 (98.1%)	2,001 (97.6%)	10,809 (93.6%)
	Rural	32,581 (14.5%)	17 (0.1%)	52 (1.3%)	75 (1.9%)	50 (2.4%)	742 (6.4%)
	Unknown	21 (0.0%)	0 (0.0%)	<5 (<0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Income quintile	1 (lowest)	32,888 (14.6%)	3,200 (26.8%)	1,127 (28.4%)	1,268 (31.6%)	514 (25.1%)	2,176 (18.8%)
	2	39,772 (17.7%)	2,752 (23.1%)	1,352 (34.1%)	1,095 (27.3%)	435 (21.2%)	2,377 (20.6%)
	3	45,023 (20.0%)	2,513 (21.1%)	800 (20.2%)	808 (20.1%)	431 (21.0%)	2,157 (18.7%)
	4	50,316 (22.3%)	1,796 (15.1%)	422 (10.6%)	506 (12.6%)	357 (17.4%)	2,201 (19.1%)
	5 (highest)	55,622 (24.7%)	1,597 (13.4%)	258 (6.5%)	315 (7.8%)	299 (14.6%)	2,547 (22.1%)
	Unknown	1,622 (0.7%)	71 (0.6%)	5 (0.1%)	23 (0.6%)	15 (0.7%)	93 (0.8%)
Prior screening	Yes	213,196 (94.7%)	11,213 (94.0%)	3,067 (77.4%)	3,568 (88.9%)	1,819 (88.7%)	10,421 (90.2%)
Family history	Yes	33,182 (14.7%)	1,012 (8.5%)	184 (4.6%)	370 (9.2%)	136 (6.6%)	1,155 (10.0%)
Index screen result	Normal	210,140 (93.3%)	11,319 (94.9%)	3,588 (90.5%)	3,657 (91.1%)	1,877 (91.5%)	10,734 (92.9%)
	Abnormal	15,103 (6.7%)	610 (5.1%)	376 (9.5%)	358 (8.9%)	174 (8.5%)	817 (7.1%)
# Major ADGs	0	128,604 (57.1%)	7,692 (64.5%)	2,133 (53.8%)	2,502 (62.3%)	1,156 (56.4%)	6,840 (59.2%)
	1	64,621 (28.7%)	2,964 (24.8%)	1,217 (30.7%)	1,055 (26.3%)	608 (29.6%)	3,237 (28.0%)
	2	21,806 (9.7%)	920 (7.7%)	436 (11.0%)	317 (7.9%)	201 (9.8%)	1,039 (9.0%)
	3+	8,308 (3.7%)	257 (2.2%)	146 (3.7%)	102 (2.5%)	73 (3.6%)	346 (3.0%)
	Unknown	1,904 (0.8%)	96 (0.8%)	32 (0.8%)	39 (1.0%)	13 (0.6%)	89 (0.8%)
Years since landing	< 5	NA	406 (3.4%)	562 (14.2%)	341 (8.5%)	85 (4.1%)	847 (7.3%)
	5 - 9		1,198 (10.0%)	1,024 (25.8%)	487 (12.1%)	261 (12.7%)	1,641 (14.2%)
	10 - 19		8,252 (69.2%)	1,987 (50.1%)	2,260 (56.3%)	1,124 (54.8%)	5,458 (47.3%)
	20+		2,073 (17.4%)	391 (9.9%)	927 (23.1%)	581 (28.3%)	3,605 (31.2%)

CMHT = China, Macau, Hong Kong, Taiwan; ADG = Aggregate diagnosis group; Q = quintile

Table A4.9: Breast screening retention rates by select demographic or health characteristics and immigrant group for the retention cohort

Variable	Subgroup	Non-immigrant (N=225,243)	CMHT (N=11,929)	India (N=3,964)	Philippines (N=4,015)	Eastern Europe (N=2,051)	Other Immigrants (N=11,551)
All women	All women	75.0 [74.8, 75.2]	75.6 [74.9, 76.4]	70.1 [68.7, 71.6]	72.7 [71.3, 74.1]	68.4 [66.3, 70.4]	72.5 [71.6, 73.3]
Age	50-59	72.3 [72.1, 72.5]	74.7 [73.8, 75.6]	70.5 [68.5, 72.4]	73.0 [71.4, 74.5]	67.5 [65.2, 69.8]	71.9 [71.0, 72.9]
	60-69	78.8 [78.6, 79.1]	78.1 [76.6, 79.5]	69.7 [67.6, 71.8]	71.4 [67.9, 74.7]	71.8 [67.3, 76.0]	73.9 [72.3, 75.4]
Urban/rural residence	Urban	75.9 [75.7, 76.1]	75.6 [74.8, 76.4]	70.3 [68.8, 71.7]	72.8 [71.4, 74.2]	68.4 [66.3, 70.4]	72.7 [71.9, 73.6]
	Rural	69.8 [69.3, 70.3]	82.4 [56.6, 96.2]	57.7 [43.2, 71.3]	66.7 [54.8, 77.1]	68.0 [53.3, 80.5]	68.7 [65.3, 72.1]
Income quintile	Q1 (lowest)	71.5 [71.0, 72.0]	74.6 [73.1, 76.1]	69.4 [66.6, 72.1]	71.5 [69.0, 74.0]	67.9 [63.7, 71.9]	71.3 [69.4, 73.2]
	Q2	74.3 [73.8, 74.7]	75.1 [73.5, 76.8]	70.6 [68.1, 73.1]	72.1 [69.3, 74.7]	66.9 [62.3, 71.3]	72.2 [70.4, 74.0]
	Q3	75.2 [74.8, 75.6]	76.8 [75.1, 78.4]	71.1 [67.8, 74.2]	74.8 [71.6, 77.7]	70.5 [66.0, 74.8]	72.1 [70.2, 74.0]
	Q4	75.7 [75.3, 76.1]	76.6 [74.5, 78.5]	70.1 [65.5, 74.5]	71.5 [67.4, 75.4]	67.2 [62.1, 72.1]	74.1 [72.2, 75.9]
	Q5 (highest)	76.9 [76.5, 77.2]	75.5 [73.3, 77.5]	67.8 [61.8, 73.5]	75.6 [70.4, 80.2]	69.6 [64.0, 74.7]	72.8 [71.0, 74.5]
Prior screening	None	44.4 [43.5, 45.2]	47.5 [43.8, 51.2]	49.4 [46.1, 52.7]	54.8 [50.1, 59.5]	41.8 [35.4, 48.4]	49.7 [46.8, 52.7]
	Yes	76.7 [76.5, 76.9]	77.4 [76.7, 78.2]	76.2 [74.7, 77.7]	74.9 [73.5, 76.3]	71.8 [69.7, 73.9]	74.9 [74.1, 75.8]
Family history	None	74.4 [74.2, 74.6]	75.2 [74.4, 76.0]	69.9 [68.4, 71.4]	72.4 [70.9, 73.8]	68.8 [66.6, 70.8]	71.9 [71.1, 72.8]
	Yes	78.4 [78.0, 78.8]	80.4 [77.9, 82.8]	75.0 [68.1, 81.1]	75.4 [70.7, 79.7]	63.2 [54.5, 71.3]	77.2 [74.7, 79.6]
Index screen result	Normal	75.5 [75.4, 75.7]	76.0 [75.2, 76.8]	70.6 [69.1, 72.1]	73.2 [71.7, 74.6]	69.3 [67.2, 71.4]	73.0 [72.1, 73.8]
	Abnormal	67.3 [66.5, 68.0]	69.2 [65.3, 72.8]	65.4 [60.4, 70.2]	67.6 [62.5, 72.4]	58.6 [50.9, 66.0]	65.9 [62.5, 69.1]
# Major ADGs	0	75.3 [75.0, 75.5]	74.9 [73.9, 75.8]	69.8 [67.8, 71.8]	72.1 [70.3, 73.9]	69.1 [66.4, 71.8]	73.1 [72.0, 74.1]
	1	75.2 [74.8, 75.5]	77.0 [75.4, 78.5]	70.2 [67.5, 72.7]	73.8 [71.1, 76.5]	67.1 [63.2, 70.8]	72.1 [70.5, 73.6]
	2	74.4 [73.8, 74.9]	77.4 [74.5, 80.1]	71.1 [66.6, 75.3]	74.8 [69.6, 79.5]	69.2 [62.3, 75.5]	72.6 [69.7, 75.3]
	3+	70.9 [70.0, 71.9]	78.6 [73.1, 83.5]	71.9 [63.9, 79.0]	69.6 [59.7, 78.3]	68.5 [56.6, 78.9]	66.2 [60.9, 71.2]
Years since landing	< 5	NA	61.6 [56.7, 66.3]	63.2 [59.0, 67.2]	69.2 [64.0, 74.1]	62.4 [51.2, 72.6]	68.2 [65.0, 71.4]
	5 - 9		67.4 [64.6, 70.0]	68.7 [65.7, 71.5]	71.0 [66.8, 75.0]	65.1 [59.0, 70.9]	68.6 [66.3, 70.9]
	10 - 19		76.6 [75.7, 77.5]	72.1 [70.0, 74.0]	73.5 [71.6, 75.3]	69.9 [67.2, 72.6]	73.7 [72.5, 74.9]
	20+		79.4 [77.5, 81.1]	74.2 [69.5, 78.4]	72.9 [69.9, 75.8]	67.8 [63.8, 71.6]	73.3 [71.8, 74.8]

CMHT = China, Macau, Hong Kong, Taiwan; ADG = Aggregate diagnosis group; Q = quintile