Perceived Susceptibility to Developing Cancer and Cancer Screening Behaviour: A Longitudinal Analysis of Alberta's Tomorrow Project

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the publ

ABSTRACT

Background: Screening for cancer is a secondary prevention strategy that relies on early detection of disease. Screening is given to asymptomatic individuals who are at risk of developing cancer to identify and halt the pathological development of disease, reduce treatment invasiveness and improve outcomes. Perceived susceptibility (PS) – whether an individual feels they are personally vulnerable to a health-related condition or disease – has been shown to be associated with cancer screening uptake and past screening behaviour.

Overall Objective: We propose to use data from Alberta's Tomorrow Project (ATP) to address the research questions outlined below.

Research Questions: Is PS to developing cancer associated with the incidence of mammography, prostate-specific antigen, sigmoidoscopy, and colonoscopy screening tests? Does an individual's perceived susceptibility affect screening behaviour differently between tests?

Methods: We included ATP participants between the ages of 35 to 70 years who reported being free of chronic conditions at their baseline survey and who had completed at least one follow-up survey. PS was measured using three variables: PS1-5 (measured on a 5-point scale from 1 [low risk] to 5 [high risk]): "Compared to other people your age, what do you think are your chances of being diagnosed with cancer in your lifetime", PS100gen asked: "On a scale of 0% to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?" and PS100my asked: "On a scale from 0% to 100%, on which 0 means you definitely will not be diagnosed with cancer and 100 means you definitely will be diagnosed with cancer, what would you estimate to be your chance of being diagnosed with cancer in your lifetime?". To examine the association between PS and incident screening over the course of

follow-up, we built a series of multivariable logistic regression models for each of the screening tests of interest, and adjusted for covariates such as age, education, family history, and marital status.

Results: PS of developing cancer was statistically significantly associated with prostate-specific antigen (PSA) and sigmoidoscopy/colonoscopy screening behaviour over baseline and two waves of follow-up, spanning a total of 14 years, for both personal risk variables (PS1-5 and PS100my). Specifically, the odds of receiving compared to not receiving a PSA test were 1.36 times greater for a one-unit increase in PS1-5 (CI=1.07 – 1.72), and the odds were 1.02 times higher for a one-unit increase in PS100my ranging from 0 to 100 (CI=1.01 – 1.03). Furthermore, the odds of receiving compared to not receiving a sigmoidoscopy/colonoscopy were 1.97 times greater for a one-unit increase in PS1-5 (CI=1.52 – 2.55), and the odds were 1.03 times greater for a one-unit increase in PS100my ranging from 0 to 100 (CI=1.0 – 1.04).

Conclusion: Understanding how certain factors, such as PS, are associated with screening behaviour has been an important focus for addressing the underutilization of screening for cancer in Canada. Personal PS of developing cancer is predictive of screening behaviour for PSA and sigmoidoscopy/colonoscopy screening tests over time. These findings provide a basis for public health programming and policies throughout Canada, aimed at promoting screening behaviour. Future studies should explore additional factors, as outlined by existing social-cognitive models, such as perceived barriers to screening, to broaden the understanding these factors have in influencing behaviour and behaviour change.

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CHAPTER 1

Introduction and Overview

1.0 Introduction

Screening is a secondary prevention strategy that is usually directed at asymptomatic individuals with a high risk of disease. Screening relies on early detection to identify and halt the pathological development of disease.[1,2,3] In Canada, the benefits of screening are regularly communicated to the public and screening services are free to access. However, screening continues to be an underutilized preventive health service.[4,5] An important focus of research, specifically within the realm of health psychology and to public health practitioners, has been to study the role individuals play in contributing to their own health and well-being by adopting certain health behaviours, such as screening.[6]

This thesis will explore whether perceived susceptibility (PS) – whether an individual feels they are personally vulnerable to a health-related condition or disease – a core component of the Health Belief Model (HBM), influences individual screening behaviours for a variety of cancers (breast, prostate, and colorectal cancer). Screening behaviour in this thesis is defined as whether or not individuals report undergoing any of the following tests: mammography, prostate-specific antigen (PSA), colonoscopy, and sigmoidoscopy.[6,7,8,9,10]

1.1 Research Questions

This study explored whether an individual's perceived susceptibility to developing cancer is associated with the incidence of mammography, prostate-specific antigen (PSA), and

sigmoidoscopy/colonoscopy screening tests; and whether an individual's perceived susceptibility affects screening behaviour differently between tests.

1.2 Hypotheses

We hypothesize that persons between the ages of 35-70 years with greater levels of PS for developing cancer will be more likely to undergo screening tests over time. Furthermore, we hypothesize that the incidence of screening will differ among tests.

To our knowledge, only one existing cross-sectional study[11] examines PS and screening incidence across multiple cancer types and screening tests. Furthermore, only four out of 23 previously conducted studies in this area of research were longitudinal in design, and all four only examined PS of breast cancer and incidence of mammography.[11,12,13,14,15-29] Most previously published studies were cross-sectional, which prevents assessments of temporality, inhibiting our understanding of the direction of association between PS and screening behaviour. Furthermore, existing studies incorporated highly-select samples, limiting representation and generalization of study results. For example, Hassan et *al*.[22] recruited individuals for their study primarily through posters and flyers distributed at a private tertiary hospital, which restricts enrollment to individuals who are at the hospital and see the prints. By using the ATP dataset, we can investigate the longitudinal association between PS and cancer screening for multiple diseases, and tests, while using a population-based sample.[30]

In summary, this thesis used Alberta's Tomorrow Project (ATP), a population-based cohort study, to answer our research questions. The data were explored descriptively using histograms for continuous variables and bar charts for categorical variables. Normally distributed continuous variables were summarized as means and standard deviations, non-normally-distributed continuous variables as medians and interquartile ranges, and categorical variables as frequencies

and percentages. To examine the association between PS and incident screening over the course of follow-up, we built a series of multivariable logistic regression models for each of the screening tests of interest, and adjusted for covariates such as age, education, family history, and marital status. Results revealed that personal PS of developing cancer was statistically significantly associated with mammography screening when analyzed cross-sectionally. While, personal PS was statistically significantly associated with prostate-specific antigen (PSA) and sigmoidoscopy/colonoscopy screening over baseline and two waves of follow-up, spanning a total of 14 years.

These findings provide a basis for public health programming and policies throughout Canada, aimed at promoting screening behaviour, by fostering a better understanding for the associated role of PS of developing cancer to cancer screening health behaviour. More specifically, by highlighting personal PS to developing cancer for intervention-based targeted messaging in marketing campaigns, we may heighten an individual's PS to developing cancer, enhancing their likelihood of being screened for cancer.

CHAPTER 2

Study Rationale

2.0 Study Rationale

Standard screening practices for cancer include mammography, PSA, sigmoidoscopy, and colonoscopy.[31] The preventive and systematic application of screening tests can reduce disease-associated morbidity and mortality.[32,33] For example, breast cancer deaths can be reduced by approximately one-third in individuals who participate in regular screenings.[34] Despite the existence of well-established screening guidelines and the widely communicated benefits of screening in Canada, screening is still underutilized.[4,5] This underutilization points to the perplexing and multi-faceted question that continues to puzzle researchers: why is screening underutilized?

One important area of study to help address this question is health psychology, which highlights the role of psychological and behavioural processes in health, illness, and healthcare.[6] By incorporating a health psychology lens and an established theoretical framework, we can explore the specific elements and processes of change in health behaviour, and begin to address the "why?".[10]

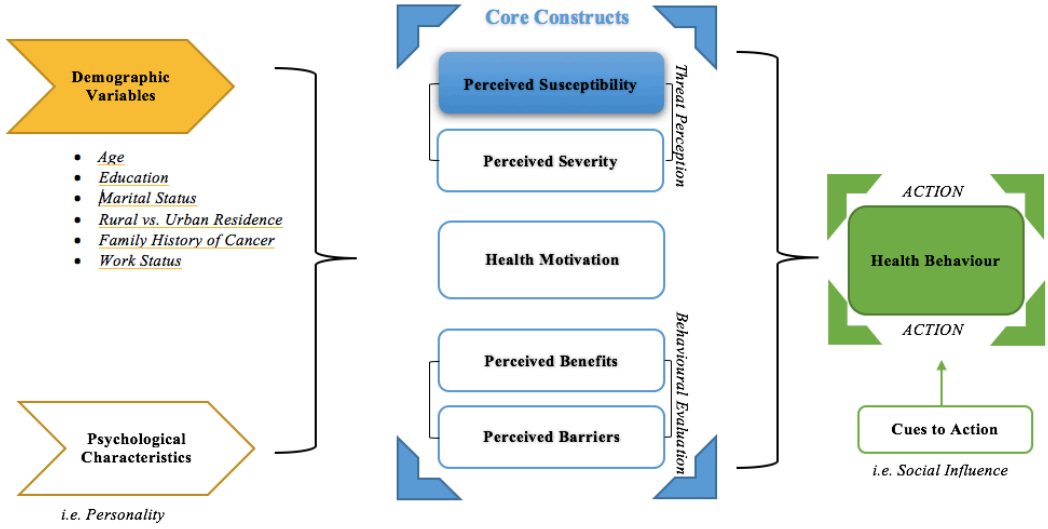
There are countless factors that may help explain individual differences in undertaking certain health behaviours, including socioeconomic status and demographic variables such as age and marital status.[6,7] Some of these factors (e.g., age, sex) are not amenable to change and do not explain why similar individuals differ in terms of their propensity to perform certain health behaviours.[6,7] This points to the role of cognitive factors, which may work with other variables to influence health behaviour. Specifically, the role of social cognition - how individuals make sense of social situations - in predicting health behaviour has been an important area of research for

numerous research disciplines.[6] A variety of social cognition models have been used to identify how cognitive factors, beliefs, and attitudes may play a more immediate and proximal role in influencing health behaviour.[6,7,12] The role of these identified proximal factors are important as they are amenable to change, and may provide a grounds for health behaviour interventions.

The Health Belief Model (HBM) is a cognitive model that is widely used today. This model comprises several core constructs, which are often examined additively to assess the likelihood of an individual performing a given behaviour (See Figure 1).[7,13] One of the five core constructs is PS, which has been identified as one of the model's most consistent predictors of behaviour.[6,7] This leads to the question being posed in this thesis: does PS have an independent influence on cancer screening behaviour? By controlling for a variety of known confounders and isolating PS, we can investigate the possible association that PS may have with specific cancer screening behaviours across multiple cancer screening tests, while contributing a piece to the complex puzzle surrounding "why?".

In order to assess this possible association between PS of developing cancer to cancer screening behaviour, we incorporated specific components of the HBM, which are shown in Figure 1 as the highlighted portions of the model.

Figure 1 The Health Belief Model (adapted from Conner and Norman, 2005[6])



There are additional cognitive models that also measure perceived susceptibility, such as the Protection Motivation Theory.[6] However, the data available for us to analyze in ATP, specifically the nature of the questions asked addressing PS, fit into the theoretical framework of the HBM.[6,7] For example, Protection Motivation Theory often describes PS as perceived vulnerability, and posits that it is modified by an individual's fear of acquiring a certain health threat (e.g., cancer).[6] However, as ATP doesn't measure fear of developing cancer, we wouldn't be able to adjust for this intervening factor and would not be able to properly assess the relationship between PS of developing cancer to cancer screening behaviour. Furthermore, PS questions in ATP used similar language and phrasing to PS questions in the HBM (based on the scale by Champion, 1984[35]), as they both assessed personal risk of acquiring a certain health threat (e.g., cancer) in the future.[6,36]

To address the primary research questions, this thesis will involve a secondary analysis of Alberta's Tomorrow Project (ATP) dataset, which is a longitudinal cohort of Albertan adults recruited between the ages of 35-69 years designed to investigate the etiology of cancer and

chronic disease. Bearing in mind the lack of longitudinal research specifically targeting the role of PS in influencing health behaviour (cancer screening), coupled with equivocal results from predominantly cross-sectional studies, this thesis can inform future research by examining the association between PS and screening in a longitudinal study design with a large sample size and a variety of questions that will allow for the collection of data on many potential confounders.[30] Specifically, exploring this research area using ATP data, we can examine the possible association between PS and incidence of cancer screening across multiple screening tests.[30] With this in mind, this research - the sole identified longitudinal study with a population-based sample to assess the possible association between PS across multiple screening tests - can assist in broadening the understanding surrounding the possible role that PS plays in influencing screening behaviour.

Data from five ATP questionnaires is used to address the research questions and hypotheses outlined in Section 1.1 and 1.2 above: the Health and Lifestyle Questionnaire (HLQ) (distributed to participants upon recruitment, which occurred in a rolling format between 2001-2009), Survey 2004, Survey 2008, Update Health and Lifestyle Questionnaire (UHLQ), and Core Questionnaire (Core).[30]

Results from this thesis can contribute to highlighting possible barriers and facilitators to cancer screening behaviour in Canada, while helping to inform public health initiatives by evaluating the role an individual's PS may play in influencing participation in cancer screening. Considering individuals within a given age bracket are more susceptible to certain types of cancer, according to research informed Canadian cancer screening guidelines[37], they are more likely to be targeted via screening interventions. With this in mind, knowledge of PS to developing cancer can be harnessed by policymakers and public health practitioners to encourage further targeted messaging of the benefits of screening for these high risk groups. For example, in Canada breast

cancer screening for mammography is most beneficial for women ages 50-69.[37] With this in mind, by encouraging further targeted messaging surrounding the benefits of screening for breast cancer or the individuals' personal risk of developing breast cancer, screening incidence may be improved in this group. Screening rates may also be improved for individuals in this high risk group by developing new means to target high risk individuals so perception of risk is in line with the reality of actual risk for developing breast cancer. Furthermore, this research can contribute to minimizing a knowledge gap by helping to address the unknowns regarding "why" people underutilize free, preventive, routine cancer screening tests when such tests have life-saving implications.

2.1 Covariates

A variety of factors may be associated with PS and cancer screening behaviour for mammography, PSA, and sigmoidoscopy/colonoscopy screening tests. With this in mind, a comprehensive list of covariates, including family history, education, income, age, marital status, employment status, and rural vs. urban residence, will be included in this study based on previously published literature and the relationship contained in the HBM.

Chapter 3

Literature Review

3.1 The Health Belief Model, Perceived Susceptibility and Cancer Screening

PS may be associated with cancer screening uptake and past screening behaviour.[14,38] PS, also referred to as perceived risk, is one of several theoretical components of the Health Belief Model (HBM), which was developed in the 1950s by Rosenstock, Hochbaum, and Kegels.[39] PS has been identified as a key social-cognitive factor that may contribute to cancer screening behaviour across multiple types of cancers and screening techniques, while being influenced by a variety of individual differences including demographic variables, social pressure, and personality.[6] Further evidence indicates that a higher PS of developing cancer is positively associated with the likelihood of participating or having participated in cancer screening practices for a variety of different cancers, including breast, prostate, and colorectal cancer.[4,12-24,38,39]

The HBM serves as an explanatory and interventionist framework to address health behaviour and is based on the notion that one's personal beliefs regarding a disease will be a key determinant of health behaviour.[7,8,9,12,14,38] For example, if a person believes they are likely to develop cancer, then they are more likely to get screened.[9,15,25] However, the screening behaviour is predicated on two assumptions: 1) the motivation to act is based on the individual's belief that screening for cancer will help reduce the chance of actually getting the disease; and 2) the benefits from screening, specifically in terms of risk reduction, outweigh the costs of actually getting screened for cancer.[8,9]

The purpose of the HBM is not to provide a comprehensive explanation for all health-related behaviours, but to identify key variables that may be identified as strong predictors of health behaviour.[8] Furthermore, the HBM advances the notion that individuals need to feel susceptible to

disease before actively seeking preventive actions such as cancer screening.[6,7,15,25] Specifically, the HBM highlights the association between an individual's subjective state and health behaviour through a social-psychological lens.[6,9] Health behaviour can be defined as an activity, such as cancer screening, which is undertaken by a person who perceives themselves as healthy to maintain health and to ultimately prevent disease or detect disease in an asymptomatic stage.[8,40]

Components of the HBM, especially PS, have been empirically useful in their ability to predict health behaviour, specifically through personal use of preventative health services, including cancer screening.[10,13,41]Additionally, the HBM is supported by a rich history of literature documenting the implementation of this model as a theoretical framework for predicting and changing behaviour.[10,25] The HBM is demonstrated to have a substantial effect on explaining PS of developing illness, compared to other models. HBM may better illustrate adherence and uptake of a health behaviour, while other models focus predominantly on the intention of adopting a health behaviour.[10,25] For example, Lostao et *al.*[16] explored whether women's health beliefs and attitudes in Navarre, Northern Spain contributed to their participation in mass screening mammography, when compared to non-participants who served as the control group. Study and control groups were matched for education and occupational levels.[16] Both study and control groups completed a questionnaire on attitudes toward health and illness.[16] The authors found that participants were more likely to undergo mass mammography screening if they rated themselves as more susceptible to breast cancer ($p<0.10$), a finding that is consistent with Rosenstock's updated 1974 HBM.[16]

3.2 Literature Search

A literature search was developed with the assistance of a health science librarian, incorporating systematic methods using Google Scholar and PubMed, which employed the following search terms to identify relevant published articles on PS and screening behaviour:

[cancer screening OR early detection of cancer AND motivation OR uptake OR attendance OR attend OR participation OR participate OR participating OR non-participating AND "perception of health" OR "health perception" OR "perceived health" OR "health belief" OR health knowledge, attitude, practice OR "self-rated health" OR "self-assessed" OR "health attitude" OR "perceived susceptibility"*].

The search yielded 519 articles for title and abstract screening. After screening by title and abstract, 122 potentially relevant articles were selected for full-text screening. A total of 23 relevant articles were identified at full text. Included articles were written in English, were quantitative in nature, included adults aged 18 years or over, and conducted primary or secondary analyses of human data. Furthermore, all 23 articles examined the relationship between individuals' perceived susceptibility of developing breast, prostate, or colorectal cancer and their participation in associated screening programs. PS was measured differently in many studies (Table 1 Section 3.7), and all confidence intervals (CI) reported were at a 95% confidence level.

3.3 Prostate Cancer

One out of 23 peer-reviewed studies examined the potential association between an individual's PS to developing prostate cancer and prostate cancer screening through PSA. This cross-sectional study by Sweetman et *al.*[42] was conducted in the United Kingdom and included participants (n=128) who were first-degree relatives (FDR) of prostate cancer patients diagnosed at age 65 years or less, within the last four years.[42] Participants were mailed an information package including a self-administered questionnaire to complete, which highlighted the possible psychosocial and behavioural factors associated with PSA screening, including HBM constructs such as PS of developing prostate cancer. Univariate analysis using a chi-square test to assess the

relationship between participants' PS of developing prostate cancer to PSA screening behaviour, revealed a statistically significant positive association (p=0.001).[42]

However, results from this study by Sweetman et *al*.[42] should be interpreted with caution because they assessed the association between PS and PSA screening behaviour through the use of a univariate chi-square test, and therefore did not adjust for additional variables that may be associated with PSA screening behaviour.[42] Also, the participants were FDRs of individuals diagnosed recently (in the last four years) with PSA, and they may therefore be more aware of their heightened risk level of developing PSA.[42] With this in mind, we cannot be sure whether family history of PSA, additional confounders, or the selective nature of the sample were influencing the association between PS and PSA screening behaviour.[42]

3.4 Colorectal Cancer

Seven out of 23 studies employed cross-sectional designs to assess whether PS to colorectal cancer may affect colonoscopy and sigmoidoscopy screening behaviour. All of these studies included participants between 34-70 years of age from Australia, China, Canada, United States, or England.[4,12-14,26,27,38] Six out of the seven studies found a statistically significant positive association between PS of developing colorectal cancer and incidence of colorectal cancer (CRC) screening.[4,12-14,27,38] In contrast, one study reported an inverse association between perceived susceptibility of developing colorectal cancer and CRC screening.[27]

Three of the seven cross-sectional studies measured screening behaviour of participants to understand and evaluate factors associated with CRC screening behaviour.[12,27,38] Hughes et *al*.[12] and Dear et *al*.[27] randomly selected participants via health-related databases, such as Regional West Health Services or University of Nebraska Medical Center[12], and primary care physician databases.[27] Dear et *al.*[27] also included an additional random sample from the Australian Electoral

Roll to enhance the reach of participant sampling. Palmer et *al.*[38] conducted Random Digit Dialing (RDD) of individuals in Maryland. Comparable to the age demographic used in Hughes et *al.*[12], Palmer et *al.*[38] also included study participants from 50-75 years of age.

Dear et *al.*[27], recruited participants aged 55-74 years and invited them to participate in a colonoscopy screening test and study questionnaire. Dear et *al.*[27] and Palmer et *al.*[38] compared those who participated in screening to those who did not participate to understand factors associated with screening, including PS to developing CRC. Comparatively, Hughes et *al.*[12] included individuals who responded to a mailed questionnaire (n=393) that asked about reasons for participating in past screening behaviour, while comparing individuals from rural and urban dwellings. Interestingly, Hughes et *al.*[12] and Palmer et *al.*[38] yielded a statistically significant positive association between PS to developing CRC and screening behaviour (adjusted Odds Ratio [aOR]=3.72, CI=1.27 – 10.88[12]; aOR=3.08, CI=1.46 – 6.37[38]), while Dear et *al.*[27] reported an inverse association between PS to developing CRC and screening behaviour, opposite of most findings (X^2=30.02, p<0.001).[12,27,38] However, uncontrolled confounding could be the cause of the inverse association in the Dear et *al*.[27] study because the authors only assessed the association through univariate analyses.[27]

Three studies, by Mack et *al.*[4], Madlensky et *al.*[26], and Garcia et *al.*[13], evaluated PS of developing CRC in persons with a first-degree relative (FDR) who had been previously diagnosed with CRC. Mack et *al.*[4] contacted a sample of CRC patients from a population-based registry (n=640) and asked these individuals to identify their asymptomatic FDRs to complete an additional study survey, where 15% (n=55) of FDRs had been previously diagnosed with cancer, and specifically 2.5% (n=9) of which had been previously diagnosed with CRC.[4] Three hundred and

seventy-six referred FDRs completed the study questionnaire to gauge potential predictors of screening behaviour.[4]

Madlensky et *al.*[26] assessed PS of developing CRC in FDRs of persons with CRC. FDRs who were over the age of 34 years and who did not have CRC completed a telephone interview and were included in the analysis.[26]

Garcia et *al.*[13] also recruited FDRs of CRC patients from a cohort of such patients listed on hospital or cancer registries (n=124), with additional participants recruited from a study assessing the accuracy of fecal immunochemical tests for CRC screening (n=210). A total of 334 FDRs were eligible to complete the study survey, which was administered in person prior to a gastroenterologist appointment.[13]

Mack et *al.*[4] and Garcia et *al.*[13] examined predictors of screening in all respondents, while Madlensky et *al.*[26] compared screeners to non-screeners. Screeners were participants who had received a past colonoscopy, sigmoidoscopy, or fecal occult blood test (FOBT), where reasons for the tests were based only on family history or routine, not PS of developing CRC. Comparatively, non-screeners were participants who had never underwent any of the above CRC screening tests.[26] Mack et *al.*[4] and Garcia et *al.*[13] found a statistically significant positive association for PS of developing CRC to having ever received a CRC screening test (aOR=1.18, CI=0.10 – 1.40[4]; unadjusted Odds Ratio [uOR]=2.77, CI=1.25 – 6.13[13]), while Madlensky et *al.*[26] did not find a statistically significant mean difference (p=0.42) between individuals' perceived susceptibility of developing CRC. Due to the lack of statistical significance, Madlensky et *al.*[26] did not include PS in the logistic regression model, and therefore did not assess the adjusted association between PS and CRC screening behaviour.

An additional cross-sectional study conducted by Leung et *al.*[14] explored self-reported factors associated with the prevalence of CRC screening in Chinese community-dwelling individuals aged 60 years or older who demonstrated no personal history of cancer (n=251). The PS of developing CRC was not statistically significantly associated with participation in CRC screening (aOR=1.05, CI=0.68 – 1.63).[14]

Despite the consistent results in support of a positive association between PS and CRC screening, the results must be interpreted with potential biases in mind. For example, Hughes et *al.*[12] included a sample of predominantly married women, and this group has been shown to have higher than average levels of screening.[15,16,19,24-26,43]

In addition, Hughes et *al.*[12] may be limited by selection bias as eligible participants must have attended one of two participating health clinics. These attendance requirements could lead to selection bias because they create a sample of individuals who are more likely to get screened. With selection bias in mind, Mack et *al.*[4] and Madlensky et *al.*[26] only enrolled persons whose FDRs had CRC. Given the restrictive samples enrolled in these studies, the results may not readily be applicable to the average population, e.g., people of any age, race, and SES who live in the community.

Furthermore, the approaches adopted by Dear et *al.*[27] and Leung et *al.*[14] demonstrated additional study limitations. Dear et *al.*[27] provided participants in the screened group with in-person assistance to complete the study questionnaires, while persons who did not get screened answered a condensed version of the questionnaires orally at home via telephone. Moreover, non-screened participants may have been less incentivized to join the study because they received their condensed questionnaires 12 months after being initially invited to join the study.[27] Furthermore, the different methods for administering the questionnaires could have created differential

misclassification, where more accurate responses were reported in the screened group compared to the unscreened group.

Leung et *al.*[14] defined CRC screening as having any type of past CRC screening test done within the last ten years. As use of screening could differ depending on screening type (e.g., colonoscopy, sigmoidoscopy), it would be useful to explore the relationship between PS of developing CRC to each type of screening test separately, potentially through a subgroup analysis.[14] With this in mind, non-stratified results may be overestimated as the relationship between exposure and outcome variables may differ depending on screening type. Furthermore, confounders including family history of CRC or any cancer, as well as the possession of health insurance were not reported, which could leave the results open to residual confounding.[14] Finally, the study design included a small sample, which could lead to a lack of precision and limited statistical power to detect true effects.

Furthermore, all seven studies are cross-sectional, thereby preventing the examination of temporality between PS and screening, a limitation impeding the ability to understand the extent to which PS is associated with screening behaviour, rather than vice versa. Given the cross-sectional nature of the data, we cannot estimate the incidence of screening by different levels of PS.

3.5 Breast Cancer

Fourteen out of 23 peer-reviewed studies assessed the association between perceived susceptibility, attitudes, and factors related to breast cancer and mammography screening behaviours.[15-25,28,29,43] Similar to the findings for prostate and colorectal cancer, most of the studies in breast cancer were cross-sectional. These cross-sectional studies compare to one another in a

variety of ways, specifically in regards to the study populations of interest, administered interventions, comparisons made, reported outcomes, and study timelines.

3.5.1 Cross-sectional studies that compared attenders vs. non-attenders of past mammography screening

Two cross-sectional studies conducted in Iran and Malaysia recruited women within the age range of persons who would be most likely to undergo mammography screening based on country-specific screening guidelines.[18,22] Participants in both studies (n=414[18], n=1,619[22]) completed in-person questionnaires to better understand predictors of mammography attendance, including cognitive motivators that were in-line with HBM.[18,22] Both studies excluded persons with a previous breast cancer diagnosis or any other medical condition, along with persons who had communication barriers that could impede their ability to complete the study questionnaires.[18,22] Both studies compared and contrasted reasons for receiving or not receiving a mammogram in the past using a cross-sectional study design, while assessing PS to developing breast cancer. Additionally, both studies reported a statistically significant positive association between PS of developing breast cancer and prior mammography participation.[18,22]

The two aforementioned studies differed in regards to their methods of recruitment. Allahverdipour et *al.*[18] recruited a specific population of Iranian women who attended five randomly selected urban health centres and two rural health centres on three weekdays over a two-month period. Hassan et *al.*[22] invited women to receive a mammogram at a private tertiary hospital in a suburban area of Malaysia, recruiting through the distribution of flyers and posters at the hospital, as well as through written articles in the media.

Two other studies, Abu-Helalah et *al.*[17] and Taylor et *al.*[24], classified participants based on frequency of mammography use, while further categorizing screening behaviour as non-users

(n=353;[24] n=444[17]), one time users (n=317;[24] n=19[17]), or repeat users (n=516;[24] n=44[17]). Specifically, Taylor et *al.*[24] surveyed a large sample (n=1357) of women aged 50-75 years in four Washington State counties via telephone during mid-1989 to assess factors associated with repeat mammography use. Abu-Helalah et *al*.[17] surveyed women (n=507) from 40-69 years of age who were randomly selected using a multistage cluster sampling technique throughout six randomly selected regions of Jordan. Both Abu-Helalah et *al*.[17] and Taylor et *al*.[24] had participants complete a questionnaire that incorporated the HBM as the conceptual framework for analysis and compared women with varying mammography experiences.[24] Taylor et *al*.[24], reported that a high personal belief of susceptibility to breast cancer (aOR=0.85, CI=0.45 – 1.62) and a minimum 10% lifetime risk of developing breast cancer (aOR=0.69, CI=0.49 – 0.97) were independently associated with repeat vs. onetime use of mammography screening. Furthermore, individuals who never had a mammogram in the last five years (7%) perceived themselves to be at a lower risk of developing breast cancer compared to onetime (8%) and repeat users (14%).[24]

Abu-Helalah et *al*.[17] reported that as PS decreased, so too did the frequency of screening attendance. Specifically, 44.8% (the highest percentage) of participants who agreed/strongly agreed with the statement "I think I have a low risk of breast cancer, and therefore, I do not need to undergo mammography screening" never underwent screening.[17] Comparatively, as screening frequency increased, agreement with the low risk statement decreased.[17] For example, people who had been screened via mammography agreed/strongly agreed less often to the low PS statement (20%) than those who had never been screened (44.8%), which further decreased (13.9%) in participants who regularly underwent screening ($p<0.0001$).[17]

An additional cross-sectional study conducted in Pennsylvania by Lerman et *al.*[15], administered a regional telephone survey to randomly selected women over the age of 50 years

(n=900). Participants were divided equally and allocated to either the case or control group. The case group consisted of women (n=450) randomly selected from the member list of the Health Maintenance Organization (HMO) of Pennsylvania and New Jersey, while the control group (n=450) included age-eligible women from the same region, but not from the HMO.[15] All participants received a brief 10-minute telephone questionnaire by trained interviewers to assess factors that may contribute to adherence to breast cancer screening.[15] Women who attended mammography screenings in the past were more likely to perceive themselves at a greater risk of developing breast cancer compared to women who did not attend mammography screening.[15] Furthermore, reported results revealed that PS was an independent predictor of repeat mammography use (aOR=1.8, CI=1.10 – 2.80).[15]

Lastly, a study by Holm et *al.*[43] also examined past mammography screening behaviour using a small convenience sample (n=97) of women aged 38-84 years. Holm et *al*.[43] compared PS to developing breast cancer to ever having received a mammogram, time since last mammogram, and frequency of mammograms. After calculating means, standard deviations, and correlations of PS to ever having received a mammogram, Holm et *al*.[43] did not report a statistically significant association using t-test analyses (p=1.00).

Despite the range of study populations and varying sample sizes, recruitment methods, study durations and sample characteristics, five out of six cross-sectional studies that explored the relationship between PS and past mammography screening behaviour found a statistically significant positive association between exposure and outcome.[15,17,18,22,24] All studies encompassed a variety of notable limitations, reducing confidence in the results, that should modulate the interpretation of results. Allahverdipour et *al.*[18] and Hassan et *al.*[22] may have employed recruitment methods that led to selection bias. Allahverdipour et *al.*[18] selected five out of 23 urban health

centres and two out of six rural health centres to recruit participants, limiting the study sample to women who attended these specific health centres. This sampling methodology was narrowed further by enrolling participants within a limited and select window of time throughout three days of the week over a two-month period.[18] This non-random, narrowed time frame for recruiting participants permitted only select individuals to be enrolled in the study, and included individuals who were seeking health care for any reason. This 'seeking' behaviour has been shown to be associated with screening behaviour.[18] With this in mind, recruitment bias is probable and may have generated a sample population that overrepresented women who were more likely to seek screening behaviour.

Hassan et *al.*'s[22] study may have been biased because of the limited recruitment methods used to enroll participants. The authors distributed posters and flyers at one private tertiary hospital in Malaysia, along with articles that were printed in local media.[22] This recruitment method is limiting in that participation is restricted to individuals who are at the hospital and see the prints, or individuals who have access to distributed media articles. Additionally, similar to the study by Allahverdipour et *al.*,[18] this recruitment method promotes the recruitment of women who are visiting the hospital, and are therefore already displaying health seeking behaviour.[18,22]

3.5.2 Cross-sectional studies that compared attenders vs. non-attenders of current mammography screening

Four additional cross-sectional studies conducted in Spain, Finland, Israel and the United States recruited women within the recommended screening age brackets to examine the role of perceived susceptibility of developing breast cancer to current, one-time mammography screening behaviour.[16,19,28,29] All three studies invited participants to attend mammography screening and compared PS of developing breast cancer in those who attended to those who did not attend.

Specifically, Lostao et *al.*[16] invited participants aged 45-60 years who were already enrolled in an early detection breast cancer program (n=708) to receive a mammogram and complete a self-administered questionnaire after the screening test. People who did not get screened completed the questionnaire from home. Lostao et *al.*[16] reported a statistically significant positive association between PS of developing breast cancer and participation in mammography screening tests ($p<0.05$).

Comparatively, Aro et *al.*[19] assessed psychosocial predictors of attendance for an organized breast cancer screening program in a large population of 50 year-old Finnish women (n=1,587) who were invited to attend their first mammogram screening.[19] Multivariable stepwise logistic regression did not reveal a statistically significant positive association between PS of developing breast cancer to mammography screening attendance (aOR=1.20, CI=0.99 – 1.47).[19]

Champion[28] also examined differences between compliant and noncompliant attenders of mammography screening (n=404), including PS to developing breast cancer and likelihood of pursuing mammography screening in women over 40, selected via random digit dialing.[28] Women who participated in the study completed a baseline questionnaire which assessed PS and past mammography usage.[28] About six weeks after the baseline questionnaire was completed, an in-home interview was conducted, which also incorporated an intervention-based teaching session designed to increase mammography usage.[28,44] Immediately following this interview, attitudes were assessed, which included PS and mammography screening behaviour.[28] Finally, one-year after the intervention, an additional interview was conducted to measure HBM beliefs, such as PS, as well as mammography screening behaviour.[28] Not surprisingly, as all women received the intervention, the majority of participants were compliant mammography users (n=286 compliant and n=118 non-compliant).[28] T-tests were conducted to compare PS of developing breast cancer

to mammography uptake in compliers and non-compliers and the result was not statistically significant (p=0.16).[28]

Azaiza and Cohen[29] conducted a cross-sectional study of Arab women (n=568) between 20-60 years of age. Women were placed in subgroups classified by religious denomination (Muslim, Christian, Druze) to identify differences in health beliefs depending on religious affiliation.[29] A telephone questionnaire was completed by all participants to evaluate the relationship between PS and mammography screening according to religious affiliation (Druze; n=104, Muslim; n=305, or Christian; n=159), which did not yield statistically significant mean differences across groups, calculated by univariate analysis of variance.[29] Simple logistic regression was conducted (combining all participants regardless of religious denomination), which also did not yield a statistically significant association (uOR=0.56, CI=0.29 – 1.06).[29]

Several study limitations were noted in all of the cross-sectional studies that compared PS of developing breast cancer to mammography use. Aro et *al.*[19], invited a select group of 50 year-old Finnish women who were due for their first mammogram. With a specific and limited population from which to sample based on the designated enrollment criteria, results can only be applied to this specific group, limiting the generalizability of study results.

Champion's[28] study may have been affected by selection factors because participants were already exposed to a prior screening intervention. Specifically, the previous intervention was geared at increasing screening uptake, and this predisposes participants to being screened, which could ultimately overestimate the association between PS of developing breast cancer and screening via mammography.[28] Furthermore, participants were predominantly middle class women, limiting applicability of results to other populations, including individuals of low SES.[28]

3.5.3 Longitudinal retrospective cohort study design

One out of 15 breast cancer studies was a longitudinal retrospective cohort study design and was conducted by Cockburn et *al.*[21]. Participants (n=180), women from 50-69 years of age, completed telephone interviews to assess factors that predicted attendance for mammography screening at a relocatable screening service in rural Victoria, Australia. Three months prior to the service becoming available in the area, a recruitment campaign took place via methods such as local media announcements and displays.[21] Two weeks prior to the screening service becoming available in the area, telephone interviews were conducted with study participants.[21] Upon attending the screening test, which was operating for a 10-week period, women were matched to their interview responses by telephone number and year of birth.[21] Each variable, including PS of developing breast cancer, was independently tested for an association with mammography attendance.[21] Results indicated that, when compared with persons who did not attend mammography screening, women who attended screening perceived themselves at some risk of developing breast cancer in the future (aOR=2.73, CI=1.07 – 6.99).[21]

Similar to the aforementioned cross-sectional studies, Cockburn et *al.*'s[21] study has potential issues with bias. Specifically, with telephone interviews assessing PS being conducted during the recruitment campaign, encouraging attendance and providing awareness for the relocatable mammography screening service, participants may have been made more cognizant of their risk of developing mammography prior to their telephone interview.[21] Additionally, participants may have been affected by a social desirability bias stemming from frequent exposure to recruitment material prior and/or during their telephone interview.[21] This bias could overestimate the study results by persuading the individual's responses to questions during their interview, to responses they think will be well received by others.[45] Moreover, as sampling was conducted through computer-driven, randomized telephone calls that were scheduled between 6

and 9 pm on weekdays and weekends, there was a limited window of opportunity for people to be enrolled in the study, which may have restricted the sample to individuals who answered their phones within these specified times.[21] Finally, the study incorporated a small sample size (n=180), which may have limited the study's power to detect differences between attenders and non-attenders.[21]

3.5.4 Longitudinal prospective cohort studies

Three out of 14 breast cancer studies were prospective in nature and incorporated a longitudinal study design.[20,23,25] Two of these three studies yielded statistically significant results when examining perceived susceptibility of developing breast cancer to mammography screening.[20,23] All three studies differed in regards to recruitment methods, follow-up periods, comparison groups, and participant age brackets. All three studies had a low response rate, and two studies reported excluding individuals with a history of breast cancer at baseline.

To expand, Chamot et *al.*[20] invited 4,000 women ages 50-69 years in Geneva, Switzerland who had not been screened within the past two years to join a prospective study that compared women who participated in either organized or opportunistic screening for breast cancer, to women who had not participated in any breast cancer screening. This study also examined the determinants of screening behaviour, which included risk perception for developing breast cancer compared to other women in the same age group at baseline and at follow-up.[20] The women were invited to participate in the study and subsequently 2,244 completed a baseline questionnaire. Within the eight-month span of following participants (beginning from their invitation to be screened), a follow-up questionnaire was sent to participants eligible for a mammogram within the study period (n=1,419) and 932 responded. Individuals were excluded from the study if they had high familial risk of breast cancer, a previous cancer diagnosis, or a recent mammogram.[20] Results reported that

having a higher risk perception was independently associated with mammography attendance (aOR=1.8, CI=0.89 – 3.60).[20]

Sutton et *al.*[23] conducted a prospective study with female participants from 50-64 years of age (n=1,301) who were due to be contacted for their first mammogram in inner city London, England. Women were randomly drawn from a pool of 24 general practitioners and 11 practices in four inner-city boroughs. Prior to receiving a mammography screening invitation, women were interviewed in their homes or sent a questionnaire via mail.[23] Additionally, a further control group was incorporated that comprised individuals who were not interviewed in their homes or sent a questionnaire via mail to assess the effect of being interviewed on attendance. Similar to other studies discussed above, participants were primarily white and married. Unadjusted univariate logistic regression reported PS as a significant predictor of mammography attendance (uOR=1.39, CI=1.16 – 1.66).[23]

Lastly, Manjer et *al.*[25] conducted a population-based prospective cohort study that recruited women living in Malmo, Sweden between 1991 and 1996 (n=17,035) and followed them over several time points, including a re-examination that took place 16 years after initial recruitment (n=3,045). Individuals who completed the re-examination up to September 2010, and who had also completed prior baseline questionnaires, were invited to participate in the present study (n=1,554) to investigate attitudes, social networks, and social relations in women who both attended and did not attend mammography screening.[25] Women were aged 61-84 years at re-examination.[25] Manjer et *al.*[25] assessed both exposure and outcome variables in the past and did not report a statistically significant relationship at follow-up for PS of developing breast cancer to mammography attendance.

Several limiting factors should be noted in the aforementioned studies. One common limitation among all three studies was the issue of bias due to exclusion criteria, loss to follow-up, and non-response.[20,23,25] Specifically, the remaining portion of the samples may not embody characteristics that accurately reflect the target population. For example, Sutton et *al.*[23] had a sample dominated by married women, which is a characteristic that has been shown to be positively associated with attendance for mammography.[15,16,19,24,25,43] Lastly, the study by Manjer et *al*.[25] was further limited at re-examination with an additional loss to non-response, but also a loss of participants from death, likely due to the 16-year follow-up since baseline. Ultimately, all three studies incorporated potential systematic errors into their study designs, thereby leading to the possibility of bias that could overestimate the association between PS and screening behaviour.[20,23,25]

3.6 Multiple types of cancer

One out of 23 studies assessed PS of developing breast cancer and colon cancer to screening behaviour via mammography and sigmoidoscopy/colonoscopy screening tests.[11] Helzlsouer et *al.*[11] conducted a cross-sectional study of employees from the Johns Hopkins Oncology Center to examine perceived susceptibility and compliance with screening behaviour. Participants (n=509) completed questionnaires about their perceived susceptibility of developing cancer, as well as their employment environment, job type, and exposure to carcinogens.[11] No association between PS and adherence to preventative health screening was observed for any of the screening tests.[11]

Helzlsouer et *al*'s.[11] sample of individuals was not representative of the general population. The authors included employees of an oncology center who could be presumably more aware and knowledgeable of sound health practices than the general population as a whole.[11] This creates a

possible overrepresentation of employees with good health practices, ultimately over representing people who get screened.[11] More specifically, regardless of their PS to developing cancer, employees of an oncology center would be more likely to have a heightened awareness surrounding the importance of screening behaviour, and be more apt to get screened for cancer.

3.7 Overall Summary

In summary, although the majority of existing literature suggests a link between perceived susceptibility of developing cancer and cancer screening, the existing body of evidence is limited by a predominance of cross-sectional studies, studies with limited generalizability, and studies (with one exception) that focus on a single cancer and a single screening approach. To better assess predictors of screening behaviour and to best identify behaviours related to preventive health practices, a comprehensive study design that examines several screening behaviours over time is important as we have no evidence to assume that behaviour is consistent across different screening tests or time points in the same population. Furthermore, a study with a large sample that is randomly recruited from the general population would be beneficial to evaluate the association between perceived susceptibility and cancer screening behaviours. Specifically, population-based studies like ATP incorporate a representative sample, increasing the probability of conducting unbiased analyses of the association between the exposure and outcome variable.[46] Furthermore, a population-based sample creates data that can be applied to the 'average' individual, which is necessary for informing the development of related policies, such as screening recommendations and guidelines. Existing studies appear to incorporate highly-select populations, limiting the ability to make inferences for the average person regarding PS of developing cancer to incidence of cancer screening. Therefore, existing studies impede the understanding of how the potential association between PS and cancer screening can inform public health policy.

The data compiled in Alberta's Tomorrow Project (ATP), which utilizes a longitudinal, population-based sample and assesses multiple types of cancer screening tests, will help to address the aforementioned knowledge gaps in the published literature.[30] Additionally, ATP includes a variety of demographic variables that have been shown to affect screening behaviour.[30] For example, out of 23 studies described above, 20 studies assessed the relationship between education and screening behaviour. Furthermore, 11 studies assessed the relationship between income and screening behaviour, 17 studies assessed age and screening behaviour, and 13 assessed family history of cancer to screening behaviour (refer to Table 2 in the Section 4.5 of the methodology for a complete list of covariates and the associated references). By collecting data on these covariates, along with data on other covariates that have been previously assessed in the published literature, such as urban vs. rural place of residence, work status, and marital status, we can better control for confounding factors and establish a stronger evidence base from which to evaluate the link between perceived susceptibility of developing cancer and incidence of screening behaviour.

Table 1 *Measurement of Perceived Susceptibility for Literature Review Studies*

Study Authors	Year	How PS Data were Collected	Measurement for PS
Abu-Helalah et *al.*[17]	2015	• Structured interview based on literature review • Delivered through face-to-face interviews	• Asked: "I think I have a low risk of breast cancer, and therefore do not need to undergo mammography screening" • 5-point Likert scale (strongly agree to strongly disagree)
Allahverdipour et *al.*[18]	2011	• Self-administered questionnaire • Champion's revised HBM scale	• 5-point Likert scale (strongly disagree to strongly agree)
Aro et *al.*[19]	1999	• Postal questionnaire	• Measured perceived breast cancer risk with 4-point Likert scale (low, moderate, high, don't know)
Azaiza and Cohen[29]	2006	• Telephone survey • HBM questions adapted from Champion's HBM	• Used two items eliciting self-PS from a) 1=very low chance, to 5=a very high chance and b) self-susceptibility in relation to the general population; 1= much lower than the general population, to 5, much higher than the general population

Study Authors	Year	How PS Data were Collected	Measurement for PS
Chamot et *al*.[20]	2007	• Postal questionnaire	• Question about perceived risk compared to women in the same age group (lower, similar, higher, no opinion)
Champion, V.[28]	1994	• Postal questionnaire	• 5-point Likert scale from 1 (strongly agree) to 5 (strongly disagree) • 5 items measuring self-perceived risk, such as " I am likely to get breast cancer in the future"
Cockburn et *al*.[21]	1997	• Telephone interview	• Perception of risk for breast cancer • Choice of either: none at all or at least slight
Dear et *al*.[27]	2008	• Self-administered questionnaire on study site (participants) • Telephone questionnaire (non-participants) • Agreed to participate, completed 15 page questionnaire, didn't agree to participate completed a 2-page questionnaire	• Questions asking; 1. "What is your risk of colon cancer over your whole life?", with choice from, 1 in 10, 1 in 25, 1 in 75, 1 in 100, 1 in 150, 1 in 250, 1 in 350, 1 in 500, and 1 in 1000 or less. 2. "What is your risk of colon cancer in the next 5 years" with the same choices as above, and 3. "If you get colon cancer, what if your chance of dying from it?", with the choices of 10%, 25%, 33%, 50%, 66%, 75%, and 100%.
Garcia et *al*.[13]	2011	• In-person interview	• Question asking participants about risk compared to general population (higher, same, lower)
Hassan et *al*.[22]	2015	• Self-administered questionnaire	• Cited perception that they are not at risk (yes/no)
Helzlsouer el *al*.[11]	1994	• Self-administered survey and brief written questionnaire and a computer-based questionnaire	• Participants were asked to estimate their absolute risk of developing cancer in the next 20 years or the next 40 years as a percentage from 0% to 100%.
Holm et *al*.[43]	1999	• Postal questionnaire	• Health Belief Model instrument developed by Champion[46] • HBM variables measured in a 31 question Likert scale with a choice of response from 1 (strongly disagree) to 5 (strongly agree)
Hughes et *al*.[12]	2015	• Postal questionnaire	• Developed own questionnaire (43 questions) based on HBM constructs • 5-point Likert scale from with choices from strongly disagree to strongly agree
Lerman et *al*.[15]	1990	• Telephone survey using a brief structured questionnaire	• Forced choice • 4-point scale, options; 1 in 5, 1 in 10, 1 in 25, or 1 in 50 chance of getting breast cancer
Leung et *al*.[14]	2016	• Questionnaire administered by trained student helpers	• Chinese version of the 35-item CRC Perceptions and Screening Instrument (CRCPS).[47,48] • 5-point Likert scale (strong disagree to strongly agree), higher scored indicated a greater PS.
Lostao et *al*.[16]	2001	• Self-administered, structured questionnaire	• Health Attitude Scale[49,50] • i.e., "my risk of getting breast cancer is

Study Authors	Year	How PS Data were Collected	Measurement for PS
			great" or "there is a great possibility that I will develop breast cancer" • 5-point Likert scale from strongly disagree to strongly agree
Mack et *al*.[4]	2009	• Postal questionnaire	• Self-developed questionnaire based on modification of a prior Alberta general population • 5-point Likert scale from strongly agree to strongly disagree • PS assessed through questions; 1. "The chance I may develop CRC is high" and 2. "Compared to others my age, I am at a lower risk of CRC
Madlensky et *al*.[26]	2003	• Telephone interview	• Scales assessing PS were scored using a 7-point Likert scale, and added together, and were developed by researchers at the Indiana University School of Nursing.
Manjer et *al*.[25]	2015	• Self-administered questionnaire	• "Self-rated risk for getting breast cancer" (low/medium/high)
Palmer et *al*.[38]	2011	• Telephone interview	• 80 item survey overall • PS consisted of three items modified from Lipkus[51] • Participants were asked about their lifetime risk, comparison of personal risk with peers, and level of concern participant's had for developing CRC • Measured on a 4-point Likert scale
Sutton et *al*.[23]	1994	• In-home interview or postal questionnaire	• 5-point scale completed in presence of interviewer (multi-item)
Sweetman et *al*.[42]	2006	• Self-administered questionnaire	• Asked: “What do you think your risk is compared with the average man your age?” • 5-point Likert scale (very much lower than average to very much higher than average)

*Abbreviation: PS = Perceived Susceptibility and HBM = Health Belief Model

CHAPTER 4

Methods

4.1 Alberta's Tomorrow Project Data Set

ATP is a population-based longitudinal cohort study that was launched in October 2000 as a research initiative by the Alberta Cancer Board, Division of Population Health and Information, to study the etiology of cancer and other chronic diseases.[30] Eligible participants recruited for the study included males and females aged 35-69 years who intended to live in Alberta for at least one year, who had no personal history of cancer other than non-melanoma skin cancer at baseline, and who were able to complete self-reported written questionnaires in English.[30,53,54]

Participant enrollment occurred from 2000 to 2008 and incorporated a two-stage sampling design.[53,54] As approximately 97% of Albertans within the targeted sampling frame had a landline, random digit dialing (RDD) was conducted by an experienced social research group at the University of Alberta.[53] Stage one identified eligible individuals from 17 regional health authorities in Alberta in the year 2000, and was followed in stage two by selecting one eligible adult in each household.[53]

Following recruitment, eligible adults were mailed a consent form and the Health and Lifestyle Questionnaire (HLQ) (n=31,212), the first administered survey containing questions addressing cancer screening tests, personal and family health history, reproductive health, smoking, sun exposure, spirituality, social support and stress, body measurements and demographic characteristics.[30,53] Participants were also invited to provide their health insurance numbers to allow for linkage to health administrative databases.[53]

Follow-up surveys about health and lifestyle characteristics were administered in 2004 and 2008.[30,53] Survey 2004 (n=9,693) was administered to individuals recruited from 2000-2003, while

Survey 2008 (n=20,801) was administered to participants who joined ATP between 2000-2007.[30] Thus, participants who were recruited between 2000-2003 received follow-up Survey 2004 and Survey 2008, while participants recruited later only received Survey 2008. All participants, regardless of recruitment date, completed the baseline HLQ.[30]

In 2008, ATP became one of five regional cohorts to join the Canadian Partnership for Tomorrow Project (CPTP).[30,53] ATP participants who joined the CTPT completed the Update: Health and Lifestyle Questionnaire (UHLQ) or Core Questionnaire, which are also included in the analyses for this study.[30,53]

In ATP, PS questions were only asked in Survey 2004. To establish a baseline for the analyses in this thesis, we merged participants' responses to the HLQ and Survey 2004 and formed a combined baseline straddling both time points. Variables drawn from HLQ included sample characteristics such as age, sex, marital status, education, etc. Responses to the screening questions at HLQ and Survey 2004 were merged to form baseline questions pertaining to whether participants were 'ever screened' for each of the cancers of interest in this thesis.

Figure 2 *Summary Timeline of ATP Survey Distribution*

<table>
<tr><td>Year</td><td>2001-2003</td><td>2004-2007</td><td>2008-2009</td><td>2009-2010</td><td>2009-2015</td></tr>
<tr><td>Thesis Timeline</td><td colspan="2">Baseline</td><td>Time 1</td><td></td><td>Time 2</td></tr>
<tr><td>Number of Participants (n) in Thesis</td><td colspan="5">Total Sample n=2,910</td></tr>
<tr><td></td><td colspan="2">Mammography: n=1,452
PSA: n=1,412
Sigmoidoscopy/Colonoscopy: n=2,905</td><td>Mammography: n= 1,379
PSA: n=1,341
Sigmoidoscopy/Colonoscopy : n=2,756</td><td></td><td>Mammography: n=1,021
PSA: n=880
Sigmoidoscopy/Colonoscopy: n=1,976</td></tr>
<tr><td>Survey</td><td colspan="2">Recruitment (via Random Digit Dialing)
↓
Research participant consents to participate in ATP
↓
Participant completes the Health and Lifestyle Questionnaire
→ Participant completes Survey 2004 (Baseline)</td><td>→ Participant completes Survey 2008 (Follow-up 1)</td><td>→ Participant decides to join CPTP</td><td>Participants complete Update Health and Lifestyle Questionnaire (UHLQ)(Follow-up 2)
OR
Participant completes Core Questionnaire (Follow-up 2)</td></tr>
<tr><td>Total Sample in ATP</td><td>n=11,973</td><td>n=3,731</td><td>n=9,974</td><td></td><td>Core: n=3,587 and UHLQ: n=3,789</td></tr>
<tr><td>ATP Number of Participants (n)</td><td colspan="2">Mammography: n=1,803
PSA: n=1,831
Sigmoidoscopy/Colonoscopy: n=3,656</td><td>Mammography: n= 5,624
PSA: n=4,216
Sigmoidoscopy/Colonoscopy : n=9,927</td><td></td><td>Mammography: Core n=2,129 UHLQ n=2,116
PSA: Core n=1,315 UHLQ n=1,560
Sigmoidoscopy/Colonoscopy: Core n=3,575 UHLQ n=3,774</td></tr>
</table>

4.2 Eligibility Criteria

For the purpose of this study, ATP male or female participants of any age between 35-70 years who reported being free of cancer at baseline and who had at least one follow-up interview after Survey 2004 were included in our analyses.

To determine if participants were free of cancer at baseline, we examined a subset of questions from the HLQ and Survey 2004. Specifically, from the HLQ, if participants were free of cancer at baseline they responded 'no' to the question asking participants if a doctor ever told them they had cancer other than non-melanoma skin cancer.

Similarly, a question in Survey 2004, asked participants to identify since joining the study if a doctor has ever told them they have cancer other than non-melanoma skin cancer (yes/no). If participants responded 'yes' to either question from HLQ or Survey 2004, they were not free of cancer at baseline, and therefore, were not eligible for this study.

Lastly, participants who were eligible for this study must have completed Survey 2004, the baseline survey for this study, as this survey contained the questions measuring PS.

4.3 Exposure Variable

To measure the exposure variable (PS) from ATP data, Survey 2004 was used.

Three questions from Survey 2004 measured an individual's perceived susceptibility to developing cancer. The first question asked participants: "Compared to other people your age, what do you think are your chances of being diagnosed with cancer during your lifetime? (Do not include skin cancer, other than melanoma)". As responses went on a 5-point Likert scale ranging from 1 ("I am at a much less risk than others") to 5 ("I am at a much higher risk than others"), this thesis will refer to this question as PS1-5. Furthermore, PS1-5 was treated as an ordinal, continuous variable in our analysis, to reflect the increasing levels and magnitude of personal PS. The second and third

PS questions asked participants to use a percentage value between 0% to 100% when they responded to the following questions: question two, "On a scale of 0% to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?"; and question three, "On a scale from 0% to 100%, on which 0 means you definitely will not be diagnosed with cancer and 100 means you definitely will be diagnosed with cancer, what would you estimate to be your chance of being diagnosed with cancer in your lifetime". Both questions two and three are continuous and measure PS on a scale from 0% to 100%, but differ in terms of how they direct the PS question. Specifically, question two asks participants about the general population risk of developing cancer, and will be referred to as PS100gen in this thesis, while question three asks participants about their personal PS to developing cancer, and therefore will be referred to as PS100my in this thesis. For the purpose of analyses, both PS100gen and PS100my will be interpreted on a scale from 0 to 100. See Table 1 in Section 3.7 above to find a complete list showing how all 23 studies collected data and measured PS.

4.4 Outcome Variable

We used self-report questions from HLQ and Survey 2004 to assess screening behaviour for mammography, PSA, and sigmoidoscopy/colonoscopy tests at baseline.

Questions in the HLQ concerning colorectal screening using sigmoidoscopy/colonoscopy screening tests were adapted from the 2000/01 Canadian Community Health Survey (CCHS)[55] and the California Health Interview Survey 2001 and were used to assess CRC screening incidence.[53] In the HLQ, participants were asked, "Have you ever had a sigmoidoscopy or colonoscopy exam?", followed by a brief description of the procedure.[54] Participants could then choose 1 of 3 answers: a) yes, followed by what year the last sigmoidoscopy occurred; b) No; c) Don't know.[30,54]

Questions in the HLQ regarding PSA, and mammography screening tests originated from the CCHS and followed the same aforementioned question format.[53,54,57] This information from the HLQ was used to supplement Survey 2004 as baseline data for this particular study, as HLQ addressed screening behaviour prior to commencing participation in ATP. As previously discussed, Survey 2004 captured data surrounding the exposure variable of interest (PS), but provided screening behaviour information "since joining the study". For example, Survey 2004 asked "Since you joined the study, have you had a colonoscopy", where participants could respond: a) yes, and the specific year they received the colonoscopy; b) No; or c) Don't know. Additional questionnaires that were used as "follow-up" surveys for this study included Survey 2008, which was administered between 2008 to 2009 and CORE from the CPTP, which was distributed from 2011-2015 (see Figure 2). Both questionnaires addressed cancer screening for mammography, PSA, and colonoscopy/sigmoidoscopy in a similar format to HLQ and Survey 2004.[30]

4.5 Covariates

There are a variety of factors that may be associated with PS and cancer screening behaviour for mammography, PSA, and sigmoidoscopy/colonoscopy screening tests. These potential confounders include sociodemographic characteristics such as education, age, and work status.[11-15,25-29] In addition, family history of cancer, and place of residence (rural vs. urban), have also been previously identified by at least one study as being associated with past screening behaviour. The effect of these covariates may be consistent or differ across types of screening. For example, age and family history have been assessed across all screening tests, while rural vs. urban residence has been assessed with mammography and sigmoidoscopy/colonoscopy screening, but not for PSA screening. Table 2 provides an overview of the seven potential confounders that will

be included in the data analysis, as well as the corresponding studies from the literature review that reported these covariates as confounders. In addition to being assessed in previously published literature, these variables should be considered in our study because of their underlining theoretical influence on PS and/or screening behaviour. Specifically, the HBM model (depicted in Figure 1 Section 2.0) posits that demographic variables, such as age and marital status, are related in some way to both PS and screening behaviour. For example, an individual who is married may be more likely to perform a health behaviour, such as cancer screening, because they feel a sense of responsibility for others and ultimately an obligation to exhibit healthy behaviours.[58] Comparatively, an individual with a family history of cancer may have had more exposure to the disease itself and may be more aware of their own heightened risk, influencing their PS of developing cancer.[59] In order to control for these possible associations, demographic variables were treated as confounders in our analyses.

Table 2 *Summary of Covariates in the 23 Studies Included in the Literature Review*

Authors	Screening type	Covariates Assessed with Screening						
		Family History	Education	Income	Age	Marital Status	Employment Status	Rural vs. Urban residence
Abu-Helalah, et al.[17]	Mammogram	x	x	x		x	x	x
Sweetman et al.[42]	PSA	x	x		x	x	x	
Allahverdipour et al.[18]	Mammogram	x	x		x	x	x	x
Aro et al.[19]	Mammogram		x	x		x	x	x
Azaiza and Cohen[40]	Mammogram	x	x		x	x	x	x
Chamot et al.[20]	Mammogram		x	x	x	x		
Champion, V.[28]	Mammogram							
Cockburn et al.[21]	Mammogram		x		x		x	
Dear et al.[27]	Colonoscopy	x						
Garcia et al.[13]	Colonoscopy	x	x		x	x	x	x
Hassan et al.[22]	Mammogram	x	x	x	x			
Helzlsouer el al.[11]	ALL TESTS							
Holm et al.[43]	Mammogram		x	x	x	x		

Hughes et al.[12]	Colonoscopy	x	x		x	x		x
Lerman et al.[15]	Mammogram	x	x		x	x	x	
Leung et al.[14]	Colonoscopy		x	x	x	x		
Lostao et al.[16]	Mammogram		x	x	x	x		
Mack et al.[4]	Colonoscopy		x	x	x	x	x	
Madlensky et al.[26]	Colonoscopy	x	x	x	x	x		
Manjer et al.[25]	Mammogram	x	x		x	x		
Palmer et al.[38]	Colonoscopy	x	x	x	x	x		
Sutton et al.[23]	Mammogram		x			x		
Taylor et al.[24]	Mammogram	x	x	x	x	x		
Total:		**13**	**20**	**11**	**17**	**18**	**9**	**6**

4.6 Analysis

The data were explored descriptively using histograms for continuous variables and bar charts for categorical variables. Normally-distributed continuous variables were summarized as means and standard deviations, non-normally-distributed continuous variables as medians and interquartile ranges, and categorical variables as frequencies. To learn more about possible relationships between variables of interest in our dataset, we utilized bivariate analysis, correlation coefficients, and scatterplots.

4.6.1 Modelling Approach

Since ATP data contain three different measures for our exposure, i.e., PS (PS1-5, PS100gen, PS100my), and we make no a priori assumptions about the optimal measure, we first checked whether or not we could combine PS measures via principle components analysis (PCA). Specifically, PCA is a widely used statistical technique for (possibly) correlated variables into a set of linearly independent principal components. These principal components orthogonally explain the proportion of variation observed in the original set of correlated variables.[60] Our goal with PCA was to observe if one principal component could explain the majority of the variation observed in the original set of correlated PS measures – PS1-5, PS100gen, PS100my.

Unfortunately, the largest proportion of variance explained by one principal component was only 67%. Therefore, PCA surrogate for PS measures was not feasible in our analyses.[61-63]

After excluding PCA as a viable option for a PS surrogate with each screening test, we built several models – three models for each of the PS exposure measures, and one model that included all three PS exposures (jointly) in the model. This yielded four models for each of the three screening outcomes, generating a total of twelve models. To assess model fit for each screening outcome, we used three model fit measures – area under the receiver operating curve (AUC), Akaike Information Criteria (AIC), and Schwarz Criteria (SC). These fit measures helped assess whether examining exposure variables separately or jointly would be better suited for our research objectives; these results are presented in *Appendix B*. For each type of screening test, including possible confounders in the model, we observed little distinction between the three model fit measures, as well as parameter estimates when exposure variables were modelled separately compared to jointly. However, when independently modelling with each of the exposures, the regression coefficient estimates for the PS variables were statistically significant, but when modelled jointly, only PS1-5 remained statistically significant. Considering the similarity between the model fit measures diagnostics and a decline in statistical significance for the exposure variables when modelled jointly, modelling the exposures separately was preferred.

To examine the association between PS and incident screening at follow-up, we built a series of logistic regression models for each of the screening tests of interest (i.e., sigmoidoscopy or colonoscopy [modelled as a single outcome: 'yes' = participant was screened with either sigmoidoscopy or colonoscopy; 'no' = participant was not screened with both sigmoidoscopy and colonoscopy], PSA [men only], and mammography [women only]). All PS models controlled for the covariates mentioned in Table 2 of Section 4.5.

To investigate the association between PS and incident screening (dichotomous variable 1 = yes, 0 = no), we employed generalized linear mixed models to account for both interspecific and intraspecific variation and the fact participants could have either one or two separate follow-ups over the course of the study. Specifically, the probability of screening for the *i*-th participant at any particular follow-up time *t* (denoted as $\pi_i^{(t)}$) depended on PS (at baseline; denoted as PS_i) and the covariates (denoted as column vector $\boldsymbol{x}'_{i(t)}$). For any *i*-th participant:

$$logit\left(\pi_i^{(t)}\right) = \alpha_0 + \alpha_1 PS_i + \boldsymbol{x}'_{i(t)}\boldsymbol{\beta}$$

where

$\pi_i^{(t)} = \Pr(Y_i^{(t)} = 1)$ for $i = 1, \ldots, n$.

A generalized linear mixed modelling approach (using the GLIMMIX procedure in SAS) was chosen due to the nature of the data and the outlined research objectives. As the outcome of interest (screening behaviour) is composed of multiple measurements for each individual in the study, and we are interested in understanding both interspecific and intraspecific variation between and within subjects; hence, a random intercept was included in the model along with the linear predictor PS at baseline.[64] By including the random subject intercept in the model, we account for subject-specific screening behaviour over time.[64] Furthermore, since our data contains missing values, a GLIMMIX model was deemed appropriate as under the missing at random (MAR)[65] assumption GLIMMIX yields maximum likelihood estimates.[66]

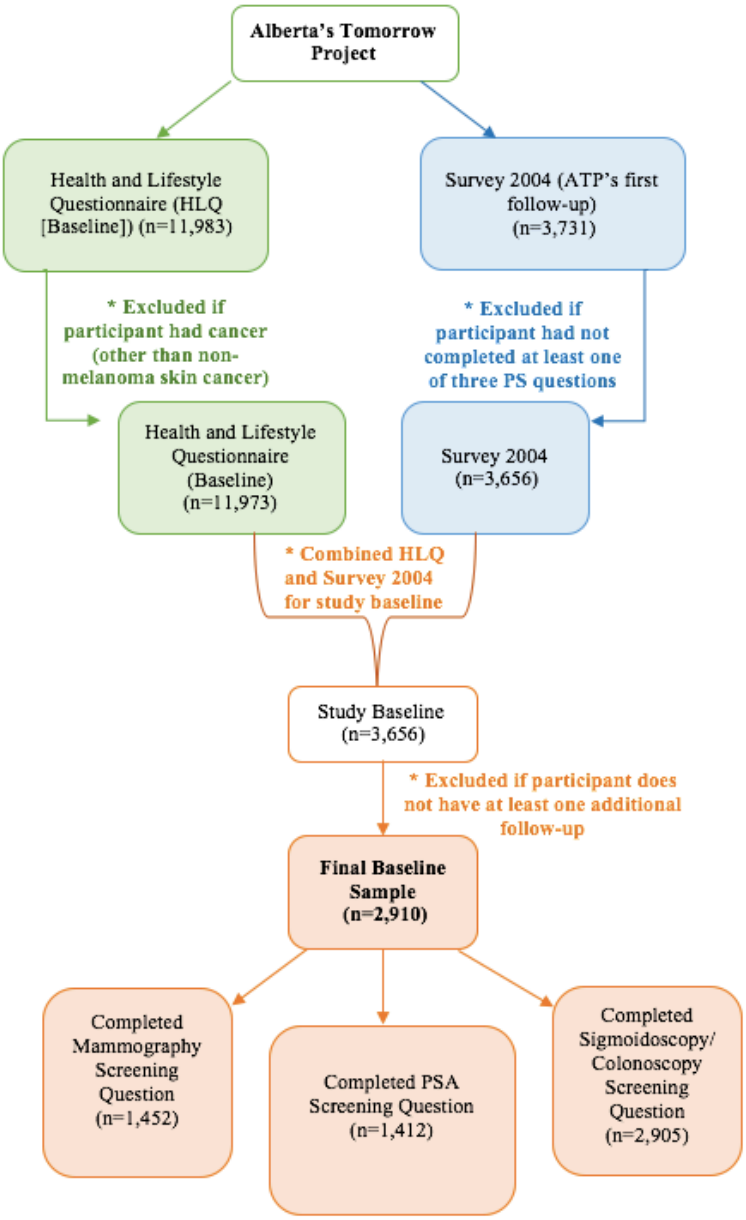
Chapter 5

Results

5.1 Baseline Descriptive Statistics

ATP enrolled a total of 11,983 participants to complete the baseline (HLQ) survey. We excluded participants (n=10) who did not report being free of cancer at baseline (other than non-melanoma skin cancer). HLQ was combined with Survey 2004 to create our baseline sample. We had excluded participants (n=75) in Survey 2004 who had not completed at least one of the three PS questions. Once combined (n=3,656), we excluded participants (n=746) who did not have at least one additional follow-up (Survey 2008 or Core/UHLQ). With this in mind, 2,910 participants [49.97% males and 50.03% females] between the ages of 35 and 70 comprised the final study sample (see Figure 3). Of these individuals, a total of 1,452 (99.73%) females completed the mammography screening question, while 1,412 (97.11%) males completed the PSA screening question, and 2,905 (99.83%) males and females completed the sigmoidoscopy/colonoscopy screening question. Descriptive statistics can be found in the following three tables (Tables 3, 4, and 5).

Figure 3 Derivation of Baseline Study Sample



As described above (Section 4.5), potential covariates were chosen based on previously published literature[11-29,42] and theoretical importance according to the research objectives of interest. However, due to absence of data in ATP, we were unable to explore the predictive ability of having a regular physician. Furthermore, we had to remove the impact of having pre-existing

conditions on screening behaviour from our regression models, as complete separation occurred, where individuals who were not screened generally had no pre-existing conditions. Finally, although a priori we were uncertain about the importance of including income in the model due to the socialized nature of Alberta's health system, we conducted preliminary analyses and found that income was not significantly associated with any type of screening behaviour. Therefore, we excluded income from the final models.

Table 3 depicts mammography screening behaviour in women with a median age of 45 years at baseline. When assessing PS1-5, we saw that the median PS level was mid-range (3.00 [1.00]) across both groups (screened and not screened via mammography). Furthermore, when examining PS100gen, median PS percentage was higher in those who were screened (40.00 [25.00]) compared to those who were not screened (35.00 [25.00]). Comparatively, although behaviour trends from the medians for the PS100my remained similar across groups (30.00), the IQR differed between those who were screened [35.00] and those who were not screened [40.00] for breast cancer. Opposite from our hypothesis, the IQR for PS100my was higher between the 1st and 3rd quartile for women who were not screened, compared to women who were screened for breast cancer.

Table 3 *Descriptive Statistics for Mammography Screening Behaviour at Baseline [females only]*

Mammography Screening						
Characteristics	**Total (n=1452)**	**Yes (n=1020)**	**No (n=432)**	**Chi-square**	**Mann-Whitney U Test**	**P-value**
PS1-5 (median [IQR])						
continuous	3.00 [1.00]	3.00 [1.00]	3.00 [1.00]		-1.0380	0.2993
PS100gen (median [IQR])						
	40.00 [25.00]	40.00 [25.00]	35.00 [25.00]	.	-1.6240	0.1044
PS100my (median [IQR])						
	30.00 [35.00]	30.00 [35.00]	30.00 [40.00]	.	-1.3159	0.1882
Marital Status (n [%])						
Never Married	119 (8.20)	82 (5.65)	37 (2.55)	1.5458	.	0.4617

Married	1137 (78.31)	793 (54.61)	344 (23.69)			
Previously, but no longer married	196 (13.50)	145 (9.99)	51 (11.81)			
Work Status (n [%])						
Not working	203 (14.16)	147 (10.25)	56 (3.91)	36.1950	.	<0.0001
Retired	127 (8.86)	118 (8.23)	9 (0.63)			
Working part-time	372 (25.94)	248 (17.29)	124 (8.65)			
Working full-time	732 (51.05)	296 (34.59)	236 (16.46)			
Education (n [%])						
High school or less	431 (29.70)	312 (21.50)	119 (8.20)	4.3215	.	0.1152
Post-secondary school, but not university	675 (46.52)	456 (31.43)	219 (15.09)			
University or more	345 (23.78)	251 (17.30)	94 (6.48)			
Family History of Cancer (n [%])						
Yes	686 (47.25)	516 (35.54)	170 (11.71)	15.3727	.	<0.0001
No	766 (52.75)	504 (34.71)	262 (18.04)			
Area of Residence (n [%])						
Rural	423 (29.19)	271 (18.70)	152 (10.49)	10.9505	.	0.0009
Urban	1026 (70.81)	747 (51.55)	279 (19.25)			
Age (median [IQR])						
	45.00 [11.00]	47.00 [11.00]	40.00 [7.00]		-16.6564	<0.0001

Perceived susceptibility question 1 (PS1-5): "Compared to other people you age, what do you think are your chances of being diagnosed with cancer during your lifetime?",
Perceived susceptibility question 2 (PS100gen): "On a scale of 0 %to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?",
Perceived susceptibility question 3 (PS100my): "On a scale of 0% to 100%, what would you estimate to be your chance of being diagnosed with cancer in your lifetime?",
Interquartile Range (IQR)

As shown in Table 4, trends for the PS100my variable and PSA screening behaviour (ever been screened) were more in line with our hypothesis. Specifically, men who had been screened for prostate cancer had a higher median PS (30.00 [40.00]) compared to men who had not been screened via PSA (25.00 [40.00]), however this was not statistically significant (p=0.2055). For PS assessed using the PS1-5 and PS100gen exposure variables, medians and IQRs did not differ between those who were screened compared to those who were not screened.

Table 4 *Descriptive Statistics for PSA Screening Behaviour at Baseline [males only]*

Prostate Specific Antigen (PSA) Screening						
Characteristics	**Total (n=1412)**	**Yes (n=469)**	**No (n=943)**	**Chi-square**	**Mann-Whitney U Test**	**P-value**
PS1-5 (median [IQR])						

continuous	3.00 (1.00)	3.00 (1.00)	3.00 (1.00)	.	-0.6160	0.5379
PS100gen (median [IQR])						
	30.00 (30.00)	30.00 (30.00)	30.00 (30.00)	.	1.7121	0.0869
PS100my (median [IQR])						
	27.00 (40.00)	30.00 (40.00)	25.00 (40.00)	.	1.2661	0.2055
Marital Status n (%)						
Never Married	141 (9.99)	25 (1.77)	116 (8.22)	16.9366	.	0.0002
Married	1166 (82.58)	407 (28.82)	759 (53.75)			
Previously, but no longer married	105 (7.44)	37 (2.62)	68 (4.82)			
Work Status n (%)						
Not working	20 (1.43)	4 (0.29)	16 (1.14)	95.4767	.	<0.0001
Retired	123 (8.80)	83 (5.94)	40 (2.86)			
Working part-time	78 (5.58)	43 (3.08)	35 (2.50)			
Working full-time	1177 (84.19)	335 (23.96)	842 (60.23)			
Education n (%)						
High school or less	370 (26.20)	121 (8.57)	249 (17.63)	12.6635	.	0.0018
Post-secondary school, but not university	676 (47.88)	200 (14.16)	476 (33.71)			
University or more	366 (25.92)	148 (10.48)	218 (15.44			
Family History of Cancer n (%)						
Yes	645 (45.68)	256 (18.13)	389 (27.55)	22.4395	.	<0.0001
No	767 (54.32)	213 (15.08)	554 (39.24)			
Area of Residence n (%)						
Rural	371 (26.31)	117 (8.30)	254 (18.01)	0.6220	.	0.4303
Urban	1039 (73.69)	351 (24.89)	688 (48.79)			
Age (median [IQR])						
	46.00 (14.00)	52.00 (11.00)	43.00 (10.00)	.	16.3091	<0.0001

Perceived susceptibility question 1 (PS1-5): "Compared to other people you age, what do you think are your chances of being diagnosed with cancer during your lifetime?",
Perceived susceptibility question 2 (PS100gen): "On a scale of 0 %to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?",
Perceived susceptibility question 3 (PS100my): "On a scale of 0% to 100%, what would you estimate to be your chance of being diagnosed with cancer in your lifetime?",
Interquartile Range (IQR)

In Table 5, which assessed sigmoidoscopy/colonoscopy screening behaviour for both males and females, results statistically significantly differed for those who were screened compared to those who were not screened via sigmoidoscopy/colonoscopy for both PS100gen ($p=0.0119$) and PS100my ($p<0.0001$) variables. Specifically, for PS100 gen, individuals who were screened via sigmoidoscopy/colonoscopy had higher median PS percentage (35.00 [25.00]) compared to those who were not screened (30.00 [30.00]). While for PS100my, individuals who were screened via sigmoidoscopy/colonoscopy had higher median PS percentage (35.00 [30.00]) compared to those who were not screened (25.00 [40.00]).

Table 5 *Descriptive Statistics for Sigmoidoscopy/Colonoscopy Screening Behaviour at Baseline [males and females]*

Sigmoidoscopy or Colonoscopy Screening						
Characteristics	**Total (n=2905)**	**Yes (n=497)**	**No (n=2408)**	**Chi-square**	**Mann-Whitney U Test**	**P-value**
PS1-5 (median [IQR])						
continuous	3.00 (1.00)	3.00 (1.00)	3.00 (1.00)	.	4.1261	<0.0001
PS100gen (median [IQR])						
	33.00 (28.00)	35.00 (25.00)	30.00 (30.00)	.	2.5145	0.0119
PS100my (median [IQR])						
	30.00 (40.00)	35.00 (30.00)	25.00 (40.00)	.	4.6164	<0.0001
Marital Status (n [%])						
Never Married	264 (9.09)	47 (1.62)	217 (7.47)	0.1366	.	0.9340
Married	2337 (80.45)	397 (13.67)	1940 (66.78)			
Previously, but no longer married	304 (10.46)	53 (1.82)	251 (8.64)			
Work Status (n [%])						
Not working	225 (7.83)	33 (1.15)	192 (6.68)	18.39	.	0.0004
Retired	251 (8.74)	66 (2.30)	185 (6.44)			
Working part-time	453 (15.77)	83 (2.89)	370 (12.88)			
Working full-time	1944 (67.66)	309 (10.76)	1635 (56.91)			
Education (n [%])						
High school or less	807 (27.79)	150 (5.17)	657 (22.62)	4.4344	.	0.1089
Post-secondary school, but not university	1375 (47.35)	214 (7.37)	1161 (39.98)			
University or more	722 (24.86)	133 (4.58)	589 (20.28)			
Family History of Cancer (n [%])						
Yes	1347 (46.37)	217 (7.47)	1341 (46.16)	23.96	.	<0.0001
No	1558 (53.63)	280 (9.64)	1067 (36.73)			
Area of Residence (n [%])						
Rural	808 (27.86)	140 (4.83)	668 (23.03)	0.0281	.	0.8668
Urban	2092 (72.14)	357 (12.31)	1735 (59.83)			
Age (median [IQR])						
	45.00 (12.00)	49.00 (13.00)	45.00 (11.00)	.	8.5744	<0.0001

Perceived susceptibility question 1 (PS1-5): "Compared to other people you age, what do you think are your chances of being diagnosed with cancer during your lifetime?",
Perceived susceptibility question 2 (PS100gen): "On a scale of 0 %to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?",
Perceived susceptibility question 3 (PS100my): "On a scale of 0% to 100%, what would you estimate to be your chance of being diagnosed with cancer in your lifetime?",
Interquartile Range (IQR)

5.2 Cross-sectional Results for PS variables and Screening Type

5.2.1 Mammography Screening

When further investigating PS variables separately for mammography screening tests using multivariable logistic regression models, we observed from the PS1-5 exposure variable (ordinal variable), that for a one-unit increase in PS of developing cancer, the odds of a female being screened for breast cancer (via mammography) also increased. For example, shown in *Appendix B* for PS1-5, the odds of baseline mammography were 1.24 times greater for a one-unit increase in PS1-5, while holding all other variables fixed (CI=1.08 – 1.42). Comparatively, for both PS100gen (CI=1.00 – 1.02) and PS100my (CI=1.00 – 1.02), the odds of baseline mammography were 1.01 times greater for a one-unit increase in the respective PS measures, when holding all other variables fixed. However, considering both 95% confidence intervals are near 1.00, results should be interpreted with caution.

5.2.2 Sigmoidoscopy/Colonoscopy Screening

Sigmoidoscopy/colonoscopy screening behaviour, trends were similar to mammography. For PS1-5, the odds of being of screened versus not screened increased by 1.29 times for a one-unit change in PS (CI=1.16 – 1.44).

For both PS100gen and PS100my, a one-unit increase in these PS score increased the odds of being screened via sigmoidoscopy/colonoscopy by 1.01 (CI=1.00 – 1.02). However, similar to mammography screening the 95% confidence interval was near 1.00, so results should be interpreted with caution.

5.2.3 PSA

After examining PSA, trends were similar to mammography and sigmoidoscopy/colonoscopy. Specifically, as PS increased, the odds of being screened (via PSA) also increased. However, this increase in the odds of being screened (via PSA) was only statistically significant for the PS100my variable. Furthermore, the ROC was above 70% across all exposure variables, which indicated suitable model fit.

5.3 Screening Behaviour Over Time

Due to data access restrictions, there were uncertainties of when data collection was completed at Time 2 (ranging from 2008 – 2015). Specifically, we were unable to obtain the date of survey completion for participants who completed either the Core or the UHLQ survey, which were administered between 2008 – 2015. As a result, we could not establish exact distance between time variables and could therefore not treat time as a continuous variable. With this in mind, time was treated as a categorical variable with levels baseline (referent category), Time 1 (T1: first follow-up at 1 year from baseline), and Time 2 (T2: second follow-up between 2-8 years from baseline).

5.3.1 Mammography Screening Behaviour Over Time

Table 6 depicts screening behaviour frequencies for mammography screening in women over time. Interestingly, at each time point, the majority of women reported being screened versus not screened via mammography. Specifically, at baseline, 70% of women were screened compared to 30% who were not screened, followed by Time 1 where 87% of women were screened and 13% of women were not screened, and at Time 2 where 98% of women were screened compared to 2% who were not screened.

The 2% of individuals who were not screened at Time 2 created issues of small cell counts when conducting regression analysis. Specifically, after conducting bivariate analyses for mammography, creating frequency tables stratifying screening by each time point (*Appendix C*), we observed low cell counts for women who were not screened via mammography at Time 2 (screened at 2-8 years, from 2008 – 2015) (n=19). With this in mind, issues of complete separation were apparent, preventing the longitudinal analysis for mammography. For example, when the ORs were calculated (shown in *Appendix D*), it was observed that small cell counts resulted in unreliable OR estimates that were exceptionally high.

Table 6 *Screening Behaviour Frequencies for Mammography Over Time (Baseline, Time 1, Time 2)*

Screening Frequency via Mammography [women only]			
	Surveys from ATP		
	Baseline	**Survey 2008 (T1)**	**UHLQ/Core (T2)**
Screening Behaviour	**(n=1452)**	**(n=1379)**	**(n=1021)**
Outcome (Screened yes or no (n (%))			
Yes	1020 (70.25%)	1195 (86.66%)	1002 (98.14)
No	432 (29.75%)	184 (13.34%)	19 (1.86%)

List of Abbreviations: *ATP (Alberta's Tomorrow Project), Baseline (Health and Lifestyle Questionnaire with Survey 2004), UHLQ (Updated health and Lifestyle Questionnaire), T1, T2 (Follow up Time 1 and Time 2)*

5.3.2 PSA Screening Behaviour Over Time

Table 7 depicts screening behaviour frequencies for prostate-specific antigen (PSA) screening tests over time. Based on this output, we can see that at baseline, almost twice as many participants were not screened via sigmoidoscopy/colonoscopy (67%) compared to those who were screened (33%). This trend changed over Time 1, as screening became split almost evenly between those who were screened (51%) compared to those who were not screened (49%) via

sigmoidoscopy/colonoscopy. Trends in Time 2, displayed increasing frequencies in those who were screened (72%) compared to those who were not screened (28%) for sigmoidoscopy/colonoscopy. Therefore, similar to mammography screening behaviour, over time PSA screening behaviour increased.

Table 7 *Screening Behaviour Frequencies for PSA Over Time (Baseline, Time 1, Time 2)*

Screening Frequency via PSA [men only]			
	Surveys from ATP		
	Baseline	Survey 2008 (T1)	UHLQ/Core (T2)
Screening Behaviour	(n=1412)	(n=1341)	(n=880)
Outcome (Screened yes or no (n (%))			
Yes	469 (33.22%)	680 (50.71%)	635 (72.16%)
No	943 (66.78%)	661 (49.29%)	245 (27.84%)

List of Abbreviations: *ATP (Alberta's Tomorrow Project), Baseline (Health and Lifestyle Questionnaire with Survey 2004), UHLQ (Updated health and Lifestyle Questionnaire), T1, T2 (Follow up Time 1 and Time 2)*

5.3.3 Sigmoidoscopy/Colonoscopy Screening Behaviour Over Time

Table 8 depicts screening behaviour frequencies for sigmoidoscopy/colonoscopy screening in men and women over time. Similar to PSA, we observed that the majority of individuals were not screened (83%) compared to screened (17%) at baseline. This trend is consistent across both Time 1 and Time 2 where 25% and 36% of individuals were screened compared to 75% and 64% of individuals who were not screened via sigmoidoscopy/colonoscopy, respectively. Therefore, similar to mammography and PSA screening behaviour, sigmoidoscopy/colonoscopy screening behaviour increased over time.

Table 8 *Screening Behaviour Frequencies for Sigmoidoscopy/Colonoscopy Over Time (Baseline, Time 1, Time 2)*

Screening Frequency via Sigmoidoscopy or Colonoscopy [men and women]				
		Surveys from ATP		
		Baseline	Survey 2008 (T1)	UHLQ /Core (T2)
Screening Behaviour		(n=2905)	(n=2756)	(n=1976)
Outcome (Screened yes or no (n(%))				
	Yes	497 (17.11%)	696 (25.25%)	704 (35.63%)
	No	2408 (82.89%)	2060 (74.75%)	1272 (64.37%)

List of Abbreviations: *ATP (Alberta's Tomorrow Project), Baseline (Health and Lifestyle Questionnaire with Survey 2004), UHLQ (Updated health and Lifestyle Questionnaire), T1, T2 (Follow up Time 1 and Time 2)*

5.4 Cross-sectional Analysis for Mammography Screening [females only]

5.4.1 – PS1-5

Multivariable logistic regression cross-sectional results depicted in Table 9 for PS1-5 suggested that mammography screening at baseline was statistically significantly associated with a female's PS. Specifically, the adjusted odds of a female getting screened for breast cancer were 1.24 times greater for a one-unit increase in PS1-5 (CI=1.08 – 1.42).

5.4.2 – PS100gen

When examining cross-sectional results between PS100gen and mammography screening in Table 9, PS of developing cancer was statistically significantly associated with being screened for breast cancer (aOR=1.01, CI=1.00 – 1.02). However, this result should be interpreted with caution as the odds ratio estimate for PS100gen was near 1.00, and the 95% confidence interval contained 1.00.

5.4.2 – PS100my

Furthermore, the multivariable regression results for PS100my variable in Table 9 yielded very similar results to the aforementioned model including PS100gen. Specifically, an individual's PS of developing cancer was statistically significantly associated with baseline mammography screening (aOR=1.01, CI=1.00 – 1.01). Furthermore, the odds ratio estimate was very close to 1.00, and the 95% confidence interval contained 1.00. With this in mind, the results should be interpreted with caution.

Table 9 *Multivariable Logistic Regression Models (PS) for Predicting Mammography Screening Behaviour at Baseline*

Mammography Screening Behaviour by Perceived Susceptibility									
	***PS1-5*[a,b,c]**			***PS100gen*[d,e,f]**			***PS100my*[g,h,i]**		
Characteristics	Adjusted Odds Ratio Estimate	95% Confidence Interval		Adjusted Odds Ratio Estimate	95% Confidence Interval		Adjusted Odds Ratio Estimate	95% Confidence Interval	
Perceived Susceptibility									
(continuous)	**1.24**	**1.08**	**1.42**	**1.01**	**1.00**	**1.02**	**1.01**	**1.00**	**1.01**
Marital Status									
Never Married	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Married	0.77	0.49	1.22	0.79	0.50	1.25	0.76	0.48	1.21
Previously, but no longer married	0.71	0.40	1.25	0.71	0.40	1.25	0.69	0.39	1.22
Work Status									
Not working	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Retired	0.50	0.21	1.18	0.50	0.21	1.18	0.50	0.21	1.18
Working part-time	0.94	0.61	1.45	0.91	0.59	1.41	0.92	0.60	1.42
Working full-time	0.97	0.64	1.45	0.97	0.64	1.46	0.95	0.63	1.44
Education									
High school or less	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Post-secondary school, but not university	1.08	0.80	1.47	1.08	0.79	1.47	1.08	0.80	1.48
University or more	1.37	0.95	1.97	1.41	0.98	2.04	1.40	0.97	2.03
Family History of Cancer									
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.12	0.85	1.46	1.24	0.95	1.61	1.17	0.90	1.54
Area of Residence									
Rural	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Urban	**1.82**	**1.37**	**2.42**	**1.81**	**1.36**	**2.41**	**1.75**	**1.32**	**2.34**
Age									
	1.20	**1.17**	**1.23**	**1.19**	**1.16**	**1.22**	**1.19**	**1.16**	**1.22**

[a] *c-statistic=0.791, Bolded values are significant at a 5% level of significance*
[b] *yes (n=1007), no (n=424), 21 missing values*
[c] *Perceived susceptibility question 1 (PS1-5): "Compared to other people you age, what do you think are your chances of being diagnosed with cancer during your lifetime?"*
[d] *c-statistic=0.789*
[e] *yes (n=984), no (n=421), 47 missing values*
[f] *Perceived susceptibility question 2 (PS100gen): "On a scale of 0 %to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?"*
[g] *c-statistic=0.789*
[h] *yes (n=994), no (n=420), 38 missing values*
[i] *Perceived susceptibility question 3 (PS100my): "On a scale of 0% to 100%, what would you estimate to be your chance of being diagnosed with cancer in your lifetime?"*
Reference group (ref)

5.5 Longitudinal Logistic Regression Models

To assess how an individual's PS of developing cancer influenced screening behaviour over time for PSA and sigmoidoscopy/colonoscopy, several longitudinal logistic regression models were implemented. Longitudinal models allowed us to preserve temporality, as well as to better understand whether screening behaviours were consistent across screening types.

5.5.1 Analyses for Prostate-Specific Antigen (PSA) Screening Behaviour

Results from Table 10, Model 1 examined the association between an individual's PS of developing cancer (represented via PS1-5) to prostate-specific antigen (PSA) screening behaviour. Results from Model 1 indicated that the odds of being screened via PSA were 1.36 times greater for a one-unit increase in PS1-5 (CI=1.07 – 1.72).

In Table 10, Model 2 examined the association between PS of developing cancer (represented via PS100gen) to prostate-specific antigen (PSA) screening behaviour. Results from Model 2 indicated that the odds of being screened via PSA were not statistically significantly associated with PS of developing cancer (based on the PS100gen variable).

Results from Model 3 are depicted in Table 10 below. Model 3 examined the association between PS of developing cancer (represented via PS100my) to prostate-specific antigen (PSA)

screening behaviour. The odds of being screened via PSA were 1.02 times greater for a one-unit increase in PS100my (CI=1.01 – 1.03).

Table 10 *Longitudinal Multivariable Logistic Regression Models for Predicting PSA Screening Behaviour Over Time (Models 1-3)*

Mixed-Effects Regression Models- Prostate Specific Antigen (PSA) Screening									
	Model 1 (PS1-5)[a]			***Model 2 (PS100gen)[b]***			***Model 3 (PS100my)[c]***		
Characteristics	Adjusted Odds Ratio Estimate	95% Confidence Interval		Adjusted Odds Ratio Estimate	95% Confidence Interval		Adjusted Odds Ratio Estimate	95% Confidence Interval	
Perceived Susceptibility									
(continuous)	**1.36**	**1.07**	**1.72**	1.00	0.99	1.01	**1.02**	**1.01**	**1.03**
Time									
Baseline (time 0)	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Time 1 (follow-up 1)	**7.11**	**5.22**	**9.69**	**7.20**	**5.27**	**9.83**	**7.00**	**5.14**	**9.54**
Time ≥ 2 (follow-up 2)	**62.13**	**38.85**	**99.38**	**60.82**	**38.08**	**97.15**	**59.61**	**37.42**	**94.96**
Marital Status									
Never Married	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Married	**2.36**	**1.11**	**5.00**	**2.56**	**1.20**	**5.46**	**2.89**	**1.36**	**6.16**
Previously, but no longer married	0.81	0.27	2.41	0.90	0.30	2.71	1.01	0.34	2.99
Work Status									
Not working	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Retired	6.40	0.74	55.50	5.61	0.65	48.35	0.72	0.09	5.70
Working part-time	7.64	0.85	68.86	5.95	0.67	52.87	0.98	0.12	8.00
Working full-time	6.30	0.87	45.36	5.11	0.72	36.26	0.82	0.13	5.32
Education									
High school or less	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Post-secondary school, but not university	1.70	0.98	2.93	1.69	0.98	2.92	1.72	1.00	2.97
University or more	**3.53**	**1.88**	**6.62**	**3.25**	**1.73**	**6.11**	**3.53**	**1.88**	**6.60**
Family History of Cancer									
No	Ref	Ref	Ref	**Ref**	**Ref**	**Ref**	Ref	Ref	Ref
Yes	1.46	0.92	2.30	**1.63**	**1.04**	**2.55**	1.47	0.93	2.31
Area of Residence									
Rural	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Urban	1.20	0.72	1.98	1.33	0.80	2.20	1.31	0.79	2.17
Age									
	1.27	**1.22**	**1.32**	**1.26**	**1.21**	**1.31**	**1.27**	**1.22**	**1.32**

[a] *Perceived susceptibility question 1 (PS1-5): "Compared to other people you age, what do you think are your chances of being diagnosed with cancer during your lifetime?",*
[b] *Perceived susceptibility question 2 (PS100gen): "On a scale of 0 %to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?",*
[c] *Perceived susceptibility question 3 (PS100my): "On a scale of 0% to 100%, what would you estimate to be your chance of*

being diagnosed with cancer in your lifetime?"
Bolded values are significant at a 5% level of significance
Reference group (ref)

5.5.2 Analyses for Sigmoidoscopy/Colonoscopy Screening Behaviour

In Table 11, Model 4 examined the association between an individual's personal PS of developing cancer (represented via PS1-5) to sigmoidoscopy/colonoscopy screening behaviour. Results from Model 4 indicated that the odds of sigmoidoscopy/colonoscopy screening were 1.97 times greater for a one-unit increase in PS (CI=1.52 – 2.55).

In Table 11, Model 5 examined the association between PS of developing cancer (represented via PS100gen) to sigmoidoscopy/colonoscopy screening behaviour. Results from Model 5 indicated that the odds of being screened via sigmoidoscopy/colonoscopy were not statistically significantly associated with PS of developing cancer (based on the PS100gen variable).

In Table 11, Model 6 examined the association between PS of developing cancer (represented via PS100my) to sigmoidoscopy/colonoscopy screening behaviour. Results from Model 6 indicated that the odds of being screened via sigmoidoscopy/colonoscopy were 1.03 times higher for a unit increase in PS on a scale of 0 to 100 (CI=1.02 – 1.04).

Table 11 *Longitudinal Multivariable Logistic Regression Models for Predicting Sigmoidoscopy/Colonoscopy Screening Behaviour Over Time (Models 4-6)*

Longitudinal Logistic Regression Models for Predicting Sigmoidoscopy/Colonoscopy Screening Behaviour Over Time									
		Model 4 (PS1-5)[a]			***Model 5 (PS100gen)[b]***			***Model 6 (PS100my)[c]***	
Characteristics	Adjusted Odds Ratio Estimate	95% Confidence Interval		Adjusted Odds Ratio Estimate	95% CI Confidence Interval		Adjusted Odds Ratio Estimate	95% Confidence Interval	
Perceived Susceptibility									
(continuous)	**1.97**	**1.52**	**2.55**	1.01	1.00	1.02	**1.03**	**1.02**	**1.04**

Time									
Baseline (time 0)	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Time 1 (follow-up 1)	**4.87**	**3.77**	**6.28**	**4.81**	**3.72**	**6.21**	**4.85**	**3.76**	**6.27**
Time ≥ 2 (follow-up 2)	**24.87**	**17.77**	**34.82**	**24.55**	**17.50**	**34.44**	**24.66**	**17.60**	**34.54**
Marital Status									
Never Married	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Married	1.20	0.50	2.87	1.16	0.48	2.78	1.29	0.54	3.08
Previously, but no longer married	0.97	0.32	2.95	0.90	0.29	2.76	0.93	0.31	2.83
Work Status									
Not working	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Retired	0.94	0.28	3.13	1.17	0.34	3.96	1.04	0.31	3.48
Working part-time	1.54	0.54	4.38	1.76	0.61	5.09	1.65	0.58	4.70
Working full-time	1.49	0.59	3.73	1.66	0.65	4.23	1.53	0.61	3.84
Education									
High school or less	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Post-secondary school, but not university	1.04	0.58	1.84	1.06	0.59	1.89	1.06	0.59	1.89
University or more	1.85	0.96	3.60	1.84	0.94	3.59	**1.97**	**1.02**	**3.83**
Family History of Cancer									
No	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
Yes	**3.09**	**1.87**	**5.12**	**4.03**	**2.45**	**6.64**	**3.27**	**1.98**	**5.41**
Area of Residence									
Rural	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Urban	1.14	0.66	1.95	1.04	0.60	1.79	1.20	0.70	2.06
Age									
	1.21	**1.17**	**1.26**	**1.20**	**1.15**	**1.24**	**1.21**	**1.16**	**1.26**

[a] *Perceived susceptibility question 1 (PS1-5): "Compared to other people you age, what do you think are your chances of being diagnosed with cancer during your lifetime?",*
[b] *Perceived susceptibility question 2 (PS100gen): "On a scale of 0 %to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?",*
[c] *Perceived susceptibility question 3 (PS100my): "On a scale of 0% to 100%, what would you estimate to be your chance of being diagnosed with cancer in your lifetime?"*
Bolded values are significant at a 5% level of significance
Reference group (ref)

CHAPTER 6

Discussion

6.1 PS and Screening Behaviour

When choosing which of the three exposure variables (PS1-5, PS100gen, PS100my) best modelled an individual's PS of developing cancer and screening behaviour across all screening tests, the similarities in fit diagnostics and model predictive abilities suggested any choice of exposure variable would be suitable for analysis.

However, considering the nature of PS100gen, which evaluated general PS of those in a similar age group, choosing variables PS1-5 or PS100my that assessed personal PS may be preferred.

6.1.1 Mammography Screening

Despite the inability to analyze the association between PS and mammography screening from a longitudinal perspective, our cross-sectional findings showed that a woman's personal PS is associated with mammography screening behaviour. This finding is consistent with the theoretical framework outlined by the Health Belief Model, which suggests that screening behaviour is linked to one's perception of the risk of developing cancer. This finding has also been reported by several additional studies from around the world, including Iran, Jordan and the United States, each of which assessed personal PS to mammography screening behaviour via questions that were adapted from the HBM.[17,18,24]

Despite our research findings, ATP contained a high proportion of women who were already being screened for breast cancer via mammography at baseline (70.25%). This high proportion is likely attributable to the success of current mammography screening policy and

programming efforts in Alberta. Therefore, compared to other cancers, further targeted messaging highlighting personal PS to breast cancer may produce fewer additional mammography screenings because most women who will get screened have already gotten screened.

However, the high proportion of mammography screens was not observed for PSA and sigmoidoscopy/colonoscopy. With this in mind, health promotion efforts focused on PS and screening can be directed at other cancers, or at mammography in jurisdictions where screening rates are lower than in Alberta. For example, data from the 2008 European Health Interview Survey (EHIS), which collected comprehensive health data from all countries in the European union (EU), revealed low mammography screening rates in Belgium (39%), Turkey (28%), and Romania (14%) for women between 50 and 69 years of age.[67] Furthermore, mammography screening guidelines for women in the EU are comparable to those of Canada, recommending mammography screening every 2-3 years for women between the ages or 50-69 years.[67]

6.1.2 PSA Screening

Our study findings revealed that personal PS was associated with PSA screening behaviour for men over time, consistent with the limited identified research available for this screening type.[42] Specifically, only one study, by Sweetman et *al*.[42] explored the relationship between PS and PSA screening behaviour. However, as discussed in Section 3.3 above, Sweetman et *al.*[42] enrolled a highly select sample and failed to account for potential confounders in their analysis. This thesis confirms the positive association between PS and PSA screening from Sweetman et *al*.[42], but at the population-level using analyses adjusted for potential confounders.

The lack of literature on PS and PSA screening behaviour underscores a need for further research in this area. With this in mind, our research findings revealed important insight into the role played by a male's personal PS of developing cancer and PSA screening behaviour. This

finding not only adds to the existing literature by assessing the association between PS and PSA screening behaviour longitudinally in an analysis that controls for confounding, with a population-based sample, but also provides insight that can be incorporated into PSA screening programs and policies required to tackle the low PSA screening rates (33%) depicted by our study findings at baseline. For example, current guidelines in Canada do not recommend men to be screened via PSA to detect prostate cancer due to potential risks associated with the test, such as false positives, creating an obvious barrier to PSA screening uptake.[68] However, similar guidelines in the United States (from 2012) are in the process of being updated to reflect new evidence-based recommendations.[69] These new recommendations suggest that doctors and patients should discuss the risks and benefits of the PSA test, while allowing the patient to make their own informed decision whether they would like to be screened or not via PSA.[69] With this in mind, it may be more beneficial for doctor/patient discussions to emphasize the role of personal PS of developing cancer to highlight the patient's PS. Nevertheless, a large barrier for PSA screening uptake in Canada is related to the current Canadian screening guidelines, which do not recommend screening via PSA.[68] With this in mind, promoting personal PS of developing cancer may not be as effective for PSA in Canada.

With that being said, there is a need to improve screening rates, which is further heightened by evidence supporting the importance of detecting prostate cancer early. Specifically, in Alberta there is a 100% three-year survival rate, provided diagnosis is made within the early stages of development (stages I to III).[70] This survival rate drops to 52% when diagnosis occurs in the later stages of development (stage IV).[70]

6.1.3 Sigmoidoscopy/Colonoscopy Screening

Consistent with both mammography and PSA screening types, our study results reported a positive association between an individual's personal PS of developing cancer and sigmoidoscopy/colonoscopy screening behaviour. This positive association between personal PS and sigmoidoscopy/colonoscopy screening behaviour was consistent with other literature, which included diverse study samples from the United States, Canada, and China.[4,12,14,38] Interestingly, the Canadian study from this literature was also conducted in Alberta, but included a sample of participants whose first-degree relatives were previously diagnosed with colorectal cancer.[4] Furthermore, all of the additional studies that found a positive association between PS and sigmoidoscopy/colonoscopy screening behaviour were limited to being cross-sectional in nature. Our study, however, contributes to this identified research gap by being the sole identified longitudinal study that included a population-based sample. Furthermore, results of this thesis revealed that cross-sectional findings of previously published literature, which identified a positive association between PS and screening behaviour, were consistent over time.

With this in mind, our research findings can provide insight into improving the low sigmoidoscopy/colonoscopy screening rates identified by our study findings (17% from 2001-2007), which were similar to Canadian sigmoidoscopy/colonoscopy screening trends.[71] Specifically, Canadian trends reported from the Canadian Community Health Survey (2003) (CCHS 2003), stated that only 20.6% of Canadian respondents adhered to sigmoidoscopy/colonoscopy guidelines.[71] Furthermore, later results from CCHS 2012 showed slightly better trends, yet still low, indicating that 37.2% of individuals across Canada had been screened using sigmoidoscopy/colonoscopy, and 36.7% in Alberta, specifically.[56] Although recommendations for colorectal cancer screening guidelines were outlined in 2001 by the Canadian Task Force on Preventive Health Care and in 2002 by the Public Health Agency of

Canada, this increase in screening behaviour in 2012 could be related to the sizeable influx of additional resources (e.g., increase funding and awareness) for screening programs across all provinces in Canada by 2010.[72]

What is problematic are the low rates of screening in this study population, especially considering the effectiveness of sigmoidoscopy/colonoscopy screening strategies in reducing incidence of colorectal cancer and mortality. A systematic review of randomized controlled trials, and of observational studies from Europe and the United States assessed the effectiveness of sigmoidoscopy/colonoscopy screening tests for the prevention of colorectal cancer incidence and deaths, and revealed a consistent reduction in colorectal cancer incidence and mortality rates, ranging from 40% to 60%, in those who were screened.[73]

6.1.4 Why PS is Related to Screening Behaviour

To improve our understanding of how PS influences screening behaviour across screening types, we can draw upon the perspective of social cognition. Cognitive theories discuss the need for both an individual's subjective value of an outcome and the expectation that a particular behaviour will achieve this valued outcome to be present, in order to exhibit a health behaviour.[74] More specifically, if the individual values the idea of not getting a specific illness, i.e., colon cancer, and expects that screening for colon cancer will allow them to avoid getting the disease, then they will undergo screening.[74] The notion of expecting a successful outcome as a prompt to action is linked to the personal PS construct identified by the HBM.[74] For example, if an individual's personal PS of developing cancer is high, then they would be more likely to observe the outcome (of getting cancer) as a subjective threat, and therefore be more likely to seek screening.[74]

Although this thesis showed the PS construct was an independent predictor of screening behaviour, PS is often examined in combination with other constructs, namely perceived severity.[6,74] Together, these two constructs represent an individual's perceived threat for developing a disease (e.g., cancer). Perceived threat influences health behaviour by affecting an individual's subjective value regarding the importance of not getting an illness (e.g., severity associated with the outcome of cancer), and by contributing to their expectation that screening can reduce the chances of getting the undesired outcome (e.g., cancer).[6,74] With that being said, future studies could measure both constructs (PS and perceived severity) in combination as perceived threat to see if together there is a stronger predictive capacity for screening behaviour, compared to PS on its own.

In summary, PS encourages screening behaviour based on social cognition concepts, such as self-regulation - that an individual will bring about outcomes in line with their self-perceptions (e.g., PS of developing cancer) and personal goals, by changing their behaviour (e.g., getting screened for cancer) or environment.[6] With this in mind, we can help shape health promotion policies and interventions by better understanding why PS influences screening behaviour. Specifically, policies and interventions could incorporate this enhanced understanding surrounding how PS relates to screening behaviour, and focus on heightening an individual's personal PS of developing cancer to help promote screening behaviour (see Section 6.2.3.2 for more details on policy implications).[6]

6.2 Demographic Characteristics and Screening Behaviour

Demographic characteristics are identified by the HBM as factors that affect PS of developing cancer and in turn, health behaviour.[6] With this in mind, we included additional variables such as time and demographic characteristics that were previously identified by

published literature to influence the association between PS and screening behaviour.[11-22, 24-27,29,38-41,43] However, the adjusted relationship between PS of developing cancer and screening behaviour were observed over and above the effect that these additional covariates may have had on screening behaviour. Refer to Table 12 for a summary explanation of the proposed link between demographic variables, PS, and screening behaviour.

6.2.1 Mammography

Personal PS was positively associated with being screened via mammography when analyzed cross-sectionally, while adjusting for possible confounders. Specifically, we incorporated six potential confounders that were outlined by previous literature as having an effect on mammography screening behaviour, including marital status, employment status, education, family history of cancer, area of residence (rural vs. urban), and age. [11-22,24-27,29,38-41,43] Not surprisingly, age and place of residence (rural vs. urban) were shown to have a statistically significant effect on mammography screening behaviour (as presented in section 5.4). This is not surprising as living in an urban area would facilitate access to healthcare centres that offer screening, and in turn, screening programming and interventions.[75] Similarly (reported in section 5.4), age was shown to have an important effect on screening behaviour. These results for age coincide with the influx of programming and policies targeted at high-risk groups for developing breast cancer, in this case middle-aged (50+).[37] Furthermore, age alone could be influencing screening behaviour regardless of programming or targeted information. Specifically, as individuals progress into older age, they may become more health conscious due to their general awareness between age and health, and therefore may be more likely to get screened for breast cancer.[76]

6.2.2 Prostate-specific antigen (PSA)

Personal PS was also associated with PSA screening when adjusting for possible confounders and time. With only one identified study assessing the unadjusted association between PS and PSA screening, we included six possible confounders found to impact mammography and sigmoidoscopy/colonoscopy screening behaviour.[15,16,19,25,38,43] Furthermore, our study included time as an additional variable in the model, which had only been incorporated by four studies assessing PS to mammography screening behaviour and therefore only examined a female study sample.[20,21,23,25] Moreover, time across all time points was found to have a large, statistically significant, positive association with screening behaviour, regardless of which PS variable (PS1-5, PS100gen, or PS100my) was included in the model. This highlights the value of assessing PS of developing cancer to PSA screening behaviour over time, as individuals who have been screened before are highly likely to be screened again in the future.[77] Likewise, being married, having at least a university education, and age were all found to possess a strong, independent, positive association with screening behaviour. This was not surprising as marriage has been found to be linked to social control, where married people feel a sense of responsibility for others and therefore a heightened need and obligation to engage in their own healthy behaviours.[58] While higher education[17,22,75,78] and older age[76] have been shown to be linked to having a great comprehension and heightened awareness of the importance of health promoting behaviours, such as cancer screening. Therefore, as one of the only identified longitudinal studies assessing PS to PSA screening, while adjusting for important confounders and screening behaviour over time, these results contribute to an important knowledge gap, while highlighting the positive association between PS and PSA screening.

6.2.3 Sigmoidoscopy/Colonoscopy

Personal PS of developing cancer was also found to be associated with sigmoidoscopy/colonoscopy screening behaviour, while adjusting for possible confounders and the effect of time. None of the other identified studies included the effect of time on screening behaviour as they were all cross-sectional in nature.[4,12-14,26,27,38] This is an important feature of our study, as the proportion of people who reported having been screened at each time point was greater than the previous time point for colonoscopy and sigmoidoscopy screening tests, regardless of which PS variable was included in the model (PS1-5, PS100gen, and PS100my). Moreover, having a family history of cancer was positively associated with sigmoidoscopy/colonoscopy screening behaviour. This statistically significant positive association between family history of cancer and sigmoidoscopy/colonoscopy screening behaviour was consistent with previous research[13,26,27] and may also be related to the strong genetic linkage between family history to the development of colon cancer, especially in first-degree relatives of those with colon cancer.[59] With this in mind, those with a family history of colon cancer are deemed to be at a higher risk of developing colon cancer than the general population, and are therefore recommended to have more frequent screening tests that begin at a younger age.[59]

Table 12 *A Summary of Proposed Explanation for the Relationship between Covariates and PS*

Variable	Proposed Explanation for the Relationship to PS and Screening Behaviour
Age	• As a person ages they become more aware of their increased risk of developing illness.[76] • Programming efforts and guidelines are generally directed at middle-older aged people.[37]
Marital Status	• Social control: married people feel a sense of responsibility for others and therefore a heightened need and obligation to engage in their own healthy behaviours.[58]

Education	• A higher education is linked to a greater comprehension and heightened awareness of the importance of health promoting behaviours, such as cancer screening.[17,22,75,78]
Work Status	• Working leads to the development of social networks, and in turn, more social contacts shown to be an important source for providing information about health risks.[79,80,81] • Working more leads to a greater income, which enhances access and affordability of healthcare services, leading to greater exposure of health information, and in turn, health risks.[79]
Family History of Cancer	• People with a family history of cancer are deemed to be at a higher risk of developing cancer than the general population, and are therefore recommended to have more frequent screening tests that begin at a younger age. This may heighten their PS of developing cancer.[59]
Rural vs. Urban Location of Residence	• Living in an urban area would facilitate access to healthcare centres that offer screening, and in turn, screening programming and interventions.[75]

6.2.4 Other Factors That May Influence PS and Screening Behaviour

Although the demographic characteristics outlined above were important to include due to their possible confounding effects on PS and screening behaviour, longitudinal results still revealed a positive association between PS and screening behaviour for PSA and sigmoidoscopy/colonoscopy tests. These results, along with concepts presented in theoretical frameworks, such as the HBM, suggest that other elements are influencing PS of developing cancer. [6]

For example, important factors to consider in the understanding of PS and health behaviour (e.g., screening), also proposed by the HBM, is the role of psychological characteristics such as personality and social pressure.[6] For example, studies by Miller et al.[82-85] discussed that individuals differ in terms of their information processing styles, which influence how they process threatening information and thus, their PS.[82-86] More specifically, a term labelled high monitors, describes

individuals that have a heightened attention to health threats that are of personal relevance, compared to low monitors who differ in attentional style and do not feel as vulnerable to health threats.[84] Specifically, high monitors are likely to scan for and amplify threatening cues, and therefore may have a higher PS compared to who are not low-monitors.[82-86] With this in mind, assessing the association between PS and screening behaviour, while controlling for psychological characteristics, such as personality, could offer additional insight into the relationship between possible modifying factors, PS and screening behaviour.

6.3 Strengths, Limitations, and Implications

6.3.1 Strengths

The use of ATP enabled us to explore the association between PS of developing cancer and screening behaviour at the population-level over time, while limiting selection bias and preserving temporality, compared to existing studies. Therefore, the study design in this thesis is useful to establish more reliable inferences and clear recommendations for future health behaviour interventions.[87]

6.3.2 Limitations

As only one of ATP's questionnaires, Survey 2004, incorporates questions surrounding PS to developing cancer, we were limited to measuring PS at baseline, and therefore could not assess how PS changed over time. Also, as the questions assessed PS of developing cancer in general, we could not assess PS to developing specific types of cancer. In addition, as there were three questions to assess PS in Survey 2004, we were limited to measuring PS with these questions. Measuring PS with these three variables in ATP is limiting due to the lack of a firm means to

measure PS and the variety of different ways that exist to measure this construct (as presented in Table 1 Section 3.7). With this in mind, we could not be sure that we were validly measuring PS. However, despite the range of possibilities to measure this construct, our results were consistent with previously published analyses, so it was unlikely that the absence of a firm means to measure PS materially affected the results in our study. Furthermore, based on the receiver operating characteristic (ROC), the predictive abilities for the cross-sectional model assessing PS to sigmoidoscopy/colonoscopy screening behaviour were slightly below the 70% cut-off score for a model with a good fit. Moreover, due to data access restrictions, we were unable to receive information pertaining to the date of study completion, which prevented us from establishing the exact time for Time 2, which could be within a 7-year range, from 2008 – 2015. Lastly, we encountered issues pertaining to small cell counts for mammography when stratified by time, resulting in complete separation of the data, which prevented us from exploring mammography screening behaviour over time.

6.3.3 Implications for Future Research and Policy Development

6.2.3.1 Future Research

Based on the study findings, strengths, and limitations, a breadth of opportunities exist for future research and policy development. Future research opportunities could include developing a questionnaire with more questions assessing PS as well as a scale designed to measure PS. More PS questions and scale items adapted from Champion, 1984[35] could include, "my physical health makes it more likely that I will get *(type)* cancer" or "I worry a lot about getting *(type)* cancer".[6] Furthermore, the questionnaire could include a more comprehensive set of questions addressing additional cognitive factors outlined by the Health Belief Model (HBM), such as perceived severity and perceived barriers, and other social-cognitive models, such as the Protection

Motivation Theory.[6] Examples of additional questions outlined by the HBM adapted from Champion, 1984[35] for the perceived severity construct could include, "if I got (*type*) cancer my whole life would change", while a question assessing the perceived barriers construct could include "it is embarrassing for me to do (*screening test)*".[6] In addition, the questionnaire could incorporate dichotomous incident screening for each type of screening test. This will assist with understanding more of the causal mechanisms that may be operating to influence cancer screening behaviour.

6.2.3.2 Policy Implications

Current findings also offer important policy implications. Across Canada, there have been a wide variety of screening awareness campaigns to promote screening guidelines, especially for colon cancer. For example, in January 2007, Ontario launched a $193.5-million five-year ColonCancerCheck program designed to highlight the reductions in mortality from colon cancer due to regular screening.[88] This campaign consisted of television ads broadcasted in 22 languages, as well as the distribution of screening kits for individuals over the age of 50 by health care providers.[88] Further targeted messaging, similar to the campaign discussed above, or through more personal means such as during a scheduled doctor's appointment, should highlight individuals' personal risk of developing colon cancer, in addition to the reduction in mortality rates by colon cancer in individuals who get screened. Specifically, strategies highlighting an individual's personal risk of developing cancer based on factors that are relevant to the individual, such as family history or age, could be important when highlighting their PS level and in turn help to promote screening behaviour. With that in mind, creating targeted programs delivered through a more personalized method, such as from a family medical practice, may be a more suitable mode of delivery to effectively heighten an individual's PS of developing cancer.

Meanwhile, in Alberta, Alberta Health Services launched a social marketing campaign in 2009: "Colorectal Cancer (CRC) Screening For Life" with the hope of increasing adherence to screening guidelines through a variety of methods such as mail packages, promotional packages for primary care facilities, and ads in professional publications.[89] This concept of strategic social marketing has been useful in developing comprehensive campaigns for health promotion and disease and injury prevention in Canada.[90] Furthermore, the social marketing approach adopted by Alberta Health Services is also considered a thorough way of implementing cancer prevention and screening campaigns.[90] Interestingly, the first of eight outlined benchmark criteria for social marketing involves behaviour change – where the campaign focuses predominantly on changing the behaviour, not just raising awareness or changing attitudes.[90] With this in mind, by better understanding the associated role of perceived personal risk of developing cancer to cancer screening health behaviour, this research can offer insight for achieving this first benchmark of behaviour change, by enhancing focus on an individual's personal risk of developing cancer in marketing campaigns, and ultimately increase their PS to developing cancer.

6.4 Conclusion

The results reported herein were consistent with the theoretical framework outlined by the Health Belief Model. Specifically, screening behaviour for mammography (based on cross-sectional analyses), as well as PSA and sigmoidoscopy/colonoscopy (based on longitudinal analyses), were linked to one's perception of their risk of developing cancer.

This relationship between PS and screening behaviour is consistent with cognitive theories, including the concept that an individual will exhibit a given behaviour if their subjective value of an outcome is in combination with their expectation that the behaviour in question will achieve the outcome. Similar to this theory, the concept of self-regulation also provides reasoning for the

relationship between PS and screening behaviour. For example, self-regulation posits that an individual will bring about outcomes in line with their self-perceptions (e.g., PS of developing cancer) and personal goals, by changing their behaviour (e.g., getting screened for cancer) or environment.

Demographic variables, such as age, marital status, and education were deemed factors to potentially confound the relationship between PS and screening behaviour, outlined by the HBM and previously published literature. Given the explanatory value of the HBM, additional factors in the HBM such as personality or social pressure, may also be influencing PS and should be explored in future research.

Regardless, these study findings provide valuable insight into the role of PS and screening behaviour by providing a reliable study design that was population-based and measured over time. Not only do our reported findings add to existing literature, they also provide important policy implications, including the notion of highlighting personal PS to developing cancer for intervention-based targeted messaging, to improve screening rates in Canada.

Furthermore, this study offers valuable insight into the association between an individual's PS of developing cancer and cancer screening behaviour. The longitudinal study design, incorporating a population-based sample from Alberta, provides an important foundation to address the outlined research questions, and contributes to the current gaps in the literature surrounding this topic. Some of these gaps consist of evidence limited by a predominance of cross-sectional studies, studies with limited generalizability, and studies (with one exception) that focus on a single cancer and a single screening test.

In conclusion, when using data from Alberta's Tomorrow Project (ATP), personal PS of developing cancer (assessed via two PS variables) was found to be statistically significantly

associated with sigmoidoscopy/colonoscopy and prostate-specific antigen (PSA) screening tests when examined longitudinally. Furthermore, PS was statistically significantly associated with mammography screening behaviour when analyzed cross-sectionally.

Based on these findings, future studies should further explore the role of other cognitive factors, such as psychological characteristics and perceived barriers, as outlined by existing social-cognitive models, to broaden the understanding these factors have in influencing behaviour and behaviour change. This enhanced understanding can help inform policies and interventions throughout Canada that aim to promote screening behaviour.

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Appendices

Appendix A: *Principle Component Analysis (PCA) [correlation matrix and eigenvalues]*

Correlation Matrix			
	PS1-5	**PS100gen**	**PS100my**
PS1-5	1.00	0.26	0.70
PS100gen	0.26	1.00	0.51
PS100my	0.70	0.51	1.00

Eigenvalues of the Correlation Matrix				
	Eigenvalue	**Difference**	**Proportion**	**Cumulative**
1	2.00	1.25	0.67	0.67
2	0.76	0.52	0.25	0.92
3	0.24		0.08	1.00

Appendix B- *Assessing Model Fit*

Independent Block Model (Link=Logit)

			Without Confounders				With Confounders			
			$\hat{\beta}(se)$	AUC	AIC	SC	$\hat{\beta}(se)$	AUC	AIC	SC
Outcome	**Exposure**									
Mammography	*PS1-5*		0.0739 (0.0581)	0.5163	1770.185	1780.747	0.2112 (0.0692)*	0.7894	1440.372	1503.566
Screening Behaviour (n) yes = 1020 (70%) no = 432 (30%)	*PS100gen*		0.00529 (0.00311)	0.5269	1745.302	1755.827	0.00812 (0.00359)*	0.789	1426.95	1489.924
	PS100my		0.00328 (0.00253)	0.5218	1751.235	1761.773	0.00749 (0.00297)*	0.7892	1427.527	1490.578
	Joint (All PS)	PS1-5	0.0944 (0.0865)				0.2194 (0.1012)*			
		PS100gen	0.00502 (0.00361)	0.5264	1740.674	1761.711	0.00632 (0.00413)	0.7903	1417.779	1491.198
		PS100my	-0.00139 (0.00412)				-0.00143 (0.00472)			
Sigmoidoscopy and Colonoscopy	*PS1-5*		0.2182 (0.0506)	0.5555	2642.846	2654.792	0.2577 (0.0539)*	0.6451	2539.615	2617.099
Screening Behaviour (n) yes = 497 (17%) no = 2408 (83%)	*PS100gen*		0.00677 (0.00258)*	0.5357	2631.314	2643.235	0.00638 (0.00266)*	0.6371	2530.673	2602.041
	PS100my		0.0103 (0.00212)*	0.5654	2619.86	2631.79	0.0117 (0.00226)*	0.6479	2515.061	2586.484
	Joint (All PS)	PS1-5	0.1214 (0.0730)				0.1507 (0.0749)*			
		PS100gen	0.00148 (0.00309)	0.5676	2605.686	2629.509	0.000292 (0.00316)	0.6497	2501.071	2590.211
		PS100my	0.00594 (0.00347)				0.00724 (0.00356)*			
PSA	*PS1-5*		-0.0305 (0.0593)	0.5095	1796.507	1807.008	0.1355 (0.0696)	0.7747	1503.012	1565.882
Screening Behaviour (n) yes = 469 (33%) no = 943 (67%)	*PS100gen*		0.00508 (0.00302)	0.528	1775.28	1785.766	0.00532 (0.00347)	0.7771	1483.071	1545.846
	PS100my		0.00346 (0.00254)	0.5206	1782.274	1792.765	0.0105 (0.00299)*	0.7803	1480.49	1543.3
	Joint (All PS)	PS1-5	-0.1522 (0.0837)				-0.0650 (0.0944)			
		PS100gen	0.00303 (0.00370)	0.5400	1767.727	1788.676	-0.00227 (0.00422)	0.7821	1469.280	1542.437
		PS100my	0.00637 (0.00412)				0.0135 (0.00466)			

p<0.05*

AUC= area under the curve

AIC= akaike information criterion

SC=schwarz criterion

Perceived susceptibility question 1 (PS1-5): "Compared to other people you age, what do you think are your chances of being diagnosed with cancer during your lifetime?",

Perceived susceptibility question 2 (PS100gen): "On a scale of 0 %to 100%, what percentage of people your age in the general population do you think will be diagnosed with cancer in their lifetime?",

Perceived susceptibility question 3 (PS100my): "On a scale of 0% to 100%, what would you estimate to be your chance of being diagnosed with cancer in your lifetime?"

Appendix C- *Frequencies for Mammography Screening by Time*

Table of Time by Mammography				
Time	**Mammogram**	**Frequency**	**Percent**	**Standard Error Percent**
0	Yes	1020	26.50	0.71
	No (Ref)	432	11.22	0.51
	Total	1452	37.69	0.78
1	Yes	1195	31.02	0.75
	No (Ref)	184	4.78	0.34
	Total	1379	35.80	0.77
2	Yes	1002	26.01	0.71
	No (Ref)	19	0.49	0.11
	Total	1021	26.51	0.71

Appendix D – *Odds Ratios for Time Variables from Mammography Screening - SAS Output*

Mammography Screening Behaviour		
PS Variable	**Time**	**OR estimate**
PS1-5	0	0
	1	24.09
	2	3,111.31
PS100gen	0	0
	1	25.95
	2	3,383.62
PS100my	0	0
	1	25.77
	2	3,408.07

Appendix E - *Screening via Sigmoidoscopy/Colonoscopy and PSA by Age Category According to Screening Guidelines*

Table of Age by Screening Behaviour for Sigmoidoscopy/Colonoscopy			
Age	**Screened via sigmoidoscopy/colonoscopy**		
Frequency			
(Row Percent)	**Yes**	**No**	**Total**
35-49	247 (13.26)	1616 (86.74)	1863
50-59	145 (24.53)	446 (75.47)	591
60+	59 (26.58)	163 (73.42)	222
Total:	451	2225	2676
Frequency Missing = 2 29			

Table of Age by Screening Behaviour for PSA			
Age	**Screened via PSA**		
Frequency			
(Row Percent)	**Yes**	**No**	**Total**
35-49	170 (19.77)	690 (80.23)	860
50-59	182 (57.05)	137 (42.95)	319
60+	79 (62.70)	47 (37.30)	126
Total:	431	874	1305
Frequency Missing = 1 07			