Socioeconomic Inequalities in Colorectal Cancer Screening Participation in Ontario, Canada

By

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Abstract

Objective: There is a growing acknowledgment that individuals with lower socioeconomic status face disproportionate challenges related to cancer screening. While the link between colorectal cancer (CRC) screening and socioeconomic status has been explored in non-Canadian context, it remains inadequately understood in Canada. This study aims to assess and elucidate socioeconomic inequality in CRC screening uptake in Ontario, Canada for the year 2017-2018.

Methods: The study utilizes data from 2017-2018 Canadian Community Health Survey (CCHS), conducted by Statistics Canada, to assess socioeconomic inequality in CRC uptake in Ontario, Canada. As a cross-sectional survey, the CCHS contains information on healthcare service utilization, and social determinants of health among Canadians. The Wagstaff index (WI) and the Erreygers Index (EI) were employed to quantify and decompose income-related inequality in CRC screening participation.

Results: Descriptive findings demonstrate that the overall CRC screening rate was 72.1%, with females exhibiting a higher rate of 74.4% compared to males at 69.6%. The positive values of the WI (0.184; 95% confidence interval [CI]: 0.161 to 0.207) and the EI (0.147; 95% CI: 0.129 to 0.167) indicated a pro-rich inequality in the CRC screening participation in Ontario. The decomposition analysis indicated that income (71.73%), education (8.20%), and language barriers with healthcare providers (4.39%) were the main factors explaining the observed income-related inequality in CRC screening participation in Ontario.

Conclusion: Addressing inequality in CRC screening remains a pressing health policy issue in Ontario. With income identified as the key driver behind the observed socioeconomic inequality, it is evident that targeted strategies and interventions are needed to enhance screening rates among low-income residents. The significant contributions of education and language barriers with healthcare providers indicated that initiatives should boost awareness of CRC screening benefits and implement language assistance to ensure equitable healthcare access and improve screening rates, aiming to diminish pro-rich inequality in CRC screening in Ontario, Canada.

Keywords: Colorectal cancer, Socioeconomic inequalities, Concentration index, Canada

List of Abbreviations Used

AB: Alberta
AC: Absolute Concentration Index
ACRCSP: Alberta Colorectal Cancer Screening Program
BC: British Columbia
CAG: Canadian Association of Gastroenterology
C: Concentration Index
CC: Concentration Curve
CCC: ColonCancerCheck
CCO: Cancer Care Ontario
CCHS: Canadian Community Health Survey
CCSP: Colorectal Cancer Screening Program
CHECS: Creating Health Equity in Cancer Screening
CI: Confidence Interval
CPAC: Canadian Partnership Against Cancer
CRC: Colorectal Cancer
EI: Erreygers Index
FIT: Fecal Immunochemical Testing
FOBT: Fecal Occult Blood Testing
FTg: Guaiac Fecal Testing
GGP: Global Gathering Place
HA: Health Ambassadors
MB: Manitoba
ME: Marginal Effects
NB: New Brunswick
NL: Newfoundland and Labrador
NS: Nova Scotia
NT: Northwest Territories
NU: Nunavut
OECD: Organization for Economic Co-operation and Development
OLS: Ordinary Least Squares
ON: Ontario
PCP: Primary Care Provider
PE: Prince Edward Island
PQDCCR: Programme québécois de dépistage du cancer colorectal
PUMF: Public Use Microdata Files
QC: Quebec
RC: Relative Concentration Index
SDH: Social Determinants of Health
SES: Socioeconomic Status

SK: Saskatchewan
UPP: Underserved Population Program
WGH: Whitehorse General Hospital
WI: Wagstaff index
YK: Yukon

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Chapter 1: Introduction

1.1 Background

Colorectal cancer (CRC) is a type of cancer that originates in the colon, the large intestine, or the rectum (Tamas et al., 2015). As one of the most prevalent cancers globally, CRC presents a considerable health challenge, contributing significantly to both mortality and morbidity (Tamas et al., 2015; Sharma, 2020). It accounts for approximately 10% of global cancer incidence and 9.4% of cancer-related deaths, ranking just below lung cancer, which accounts for 18% of cancer deaths. By 2040, it is expected to increase the number of new CRC cases to 3.2 million. Age is a well-documented risk factor for CRC, with most cases occurring in older adults. This is pertinent considering the global trend towards an aging population, which is likely to lead to an increase in CRC incidence. Furthermore, advancements in medical technology and screening programs have enhanced the detection of CRC, potentially leading to an apparent increase in reported cases (Keum et al., 2019, Murphy et al., 2019).

In Canada, CRC ranks as the third most common cancer diagnosis (Brenner et al., 2020). The rates of occurrence are marginally elevated in males compared to females, with approximately 1 in 14 Canadian men and 1 in 18 Canadian women being diagnosed with CRC during their lifetime (Canadian Cancer Statistics Advisory Committee, 2019). The overwhelming majority (93%) of cases in Canada are identified in individuals aged 50 or older, and the 5-year relative survival rate stands at 65% (Canadian Cancer Statistics Advisory Committee, 2019). CRC is the second most common cause of cancer-related mortality in Canada, accounting for 12% of all cancer-related deaths (Canadian Cancer Statistics Advisory Committee, 2019).

Approximately 70-80% of newly identified cases of CRC result from a combination of environmental and genetic factors, while 10-20% are linked to familial factors (Vassen, 2000). Approximately 5-10% of all CRC cases can be attributed to specific gene mutations (Gearhart et al., 2010). While some effective therapies for CRC are available, the growing number of cases and the rising incidence among younger generations continues to pose significant health concerns and financial burdens. Despite advancements in treatment, which offer substantial improvements in survival rates for many patients, the increasing prevalence of CRC, especially in younger populations, indicates the urgent need for enhanced prevention strategies and early detection (Keum et al., 2019; Campos, 2017; Lancet Oncology, 2017).The selection of treatment options and their effectiveness in managing CRC is determined by the stage at which the cancer is diagnosed (Ahmed et al., 2014).

There exists a correlation between socioeconomic status (SES) and the occurrence of cancer in several high-income countries (Sundquist et al., 2012, Dalton et al., 2010). Socioeconomic inequalities in the duration of survival in CRC have been also documented on a global scale, suggesting that there are inequalities in CRC survival rates that favor wealthier individuals over those from poorer socioeconomic backgrounds (Byers et al., 2008, Singh et al., 2011, McLaughlin et al., 2000). In fact, while the incidence rates among older adults have largely stabilized, the gap in CRC incidence based on SES has been expanding (Howren et al., 2021; Pan et al., 2022; Hajizadeh et al., 2022).

The reduction of socioeconomic inequality in healthcare utilization has emerged as an increasingly crucial area of emphasis within endeavors to control cancer, in conjunction with the overarching goal of enhancing overall survival rates. It is generally found that low SES corresponds to a later stage at cancer diagnosis and poorer standards of care, regardless of the setting (Aarts et al., 2010, Pulmer et al, 2005). Reduction in socioeconomic inequality in CRC screening is particularly important as early CRC screening is effective in reducing the rate of CRC mortality (Ferlizza et al., 2021).

Existing evidence has highlighted inequalities in cancer screening participation, which are evident based on factors such as educational attainment, access to a primary care physician (McGregor and Bryant, 2005), income, and area of residence (Kerner et al., 2015). However, there is limited evidence (Maddison et al., 2012) on socioeconomic inequalities in CRC screening participation in Canada. This study offers a comprehensive investigation of the relationship between SES and CRC screening participation in Ontario, allowing for the preliminary identification of specific Canadian population groups facing socioeconomic inequality in CRC screening uptake in Canada. Such insights can inform targeted interventions to benefit those at the greatest risk.

1.2 Objective

This study aims to fill this gap in the existing literature by measuring and explaining factors contributing to income-related inequalities in CRC screening uptake in Ontario for 2017-2018.

1.3 Organization of the Thesis

The subsequent chapters of this thesis are outlined as follows: Chapter 2 introduces the physiopathology of CRC, including definitions of different forms of CRC, development, diagnosis, prevention, and treatment. Chapter 3 delves into details of screening programs and guidelines in Canada. Chapter 4 reviews empirical works on socioeconomic inequalities in cancer screening in CRC. The gaps in current empirical works and the objectives of this research are also discussed in this Chapter. Chapter 5 reviews the study's statistical approach, including discussions related to the ethical considerations relevant to conducting this research. Chapter 6 reports the results and finally Chapter 7 discusses the findings and concludes the study.

Chapter 2: Physiopathology of Colorectal Cancer

This chapter reviews the physiopathology of CRC, exploring the intricate mechanisms leading to its development. From the initiation of abnormal cell growth to the formation of precancerous conditions and distinct cancer types, this chapter provides a comprehensive understanding of the biological underpinnings. Additionally, it emphasizes the critical role of screening in early detection.

2.1 Physiopathology of Colorectal Cancer

The colon and rectum are integral components of the large intestine and the digestive system. The colon absorbs water and nutrients while facilitating the passage of waste (stool) to the rectum (Schneeman, 2002). CRC encompasses both colon and rectal cancers because these organs are composed of similar tissues and there is no distinct boundary between them (Arvelo et al., 2015).

Occasionally, the cells in the colon or rectum undergo changes, deviating from their normal growth and behavior (Manne et al, 2011, Arvelo et al., 2015). These alterations can result in the formation of non-cancerous growths, including hyperplastic and inflammatory polyps (Yashiro, 2015). Changes in the cells of the colon and rectum may lead to precancerous conditions. These conditions imply that the abnormal cells have not yet developed into cancer, but there is a potential for them to become cancerous if left untreated (Conteduca et al., 2013). The most prevalent precancerous conditions in the colon and rectum are adenomas and hereditary colorectal syndromes. The predecessors of nearly all sporadic CRCs are colorectal adenomas. These symptom-free growths are frequently discovered by chance during colonoscopy conducted for reasons unrelated to symptoms or for CRC screening. Approximately one in four men and one in six women undergoing colonoscopic screening will have at least one adenoma. Colorectal adenomatous polyps can form in as many as 40% of individuals aged 60 or older (Levine et al., 2006).

CRC typically begins as a growth of abnormal cells in the lining of the colon or rectum, known as polyps (Sachdeo et al., 2020). Over time, some of these polyps can become cancerous, forming malignant tumors. A malignant tumor, which consists of cancerous cells, can infiltrate nearby tissue and cause damage. This tumor can also metastasize, spreading to other parts of the body (Williams et al., 2013). In some instances, changes in the cells of the colon or rectum can evolve into CRC (Conteduca et al., 2013).

2.2 Different Types of Colorectal Cancer

Table 2.1 details various types of CRC. As outlined in the table, CRC includes several distinct types, each with its unique characteristics and treatment approaches.

Table 2.1: Types of Colorectal Cancer

Type	Description	Treatment	Reference
Adenocarcinoma	The most common type of CRC, accounting for about 95% of cases. It arises from glandular cells that line the colon or rectum.	Mainly surgical removal, often followed by chemotherapy and/or radiation therapy.	(Alzahrani et al., 2021; White et al., 2020; M McQuade et al., 2017)
Mucinous Adenocarcinoma	A subtype characterized by excessive production of mucin. Associated with poorer prognosis and more aggressive behavior.	Treatment is similar to adenocarcinoma but tailored to the mucinous tumor's characteristics.	(Luo et al., 2019; Hogan et al., 2014)
Signet Ring Cell Carcinoma	A rare and aggressive variant. Cells have a distinctive appearance	More aggressive treatment including surgery, chemotherapy, and targeted therapies.	(Barresi et al., 2016)

	resembling signet rings.		
Squamous Cell Carcinoma	Less common in the colon and rectum. Originates from flat, scale-like cells.	Treatment may involve surgery, radiation therapy, and chemotherapy.	(Ozuner et al., 2015; Schizas et al., 2022)
Neuroendocrine (Carcinoid) Tumors	Arise from neuroendocrine cells, responsible for hormone production. Generally less aggressive.	Treatment includes surgery, targeted therapies, and somatostatin analogs.	(Strosberg, 2012; Plöckinger et al., 2004)
Gastrointestinal Stromal Tumors (GIST)	Typically found in the stomach or small intestine but can occur in the colon or rectum. Develops from cells in the digestive tract walls.	Surgery is common; targeted therapies like imatinib may be used.	(Miettinen et al., 2003; Heinrich et al., 2005)
Lymphomas	Rare in the colon or rectum, more common in the lymphatic system.	Treated with chemotherapy and sometimes radiation therapy, specific to lymphomas.	(Richards, 1986)

2.3 Risk Factors

Several risk factors are associated with the development of CRC, including age, family history of the disease, personal history of polyps or CRC, a diet high in red and processed meats, low intake of fruits and vegetables, smoking, excessive alcohol and tobacco consumption, a high body mass index, lack of physical activity, and certain genetic conditions such as Lynch syndrome and familial adenomatous polyposis (Wong et al., 2019, Al-Sukhni et al., 2008, Grevers et al., 2019, Zisman et al., 2006). Some diseases are an additional factor, such as inflammatory bowel disease, in increasing the risk of CRC (Nørgaard et al., 2011). Referencing the risk factors mentioned above, Smith et al. (2009) showed that individuals with lower income and education levels are more likely to smoke compared to those with higher income and education levels. People with lower SES may face more stressors and have fewer resources to cope with stress, leading to higher rates of smoking as a coping mechanism (Smith et al., 2009). Similarly, individuals with lower income and educational attainment are at a higher risk of obesity compared to those with greater socioeconomic advantages. However, the relationship between socioeconomic status and obesity varies by sex. According to a study from Canada, socioeconomic inequalities in obesity manifest differently for males and females; while obesity tends to be concentrated among high-income males, it is more prevalent among low-income females (Hajizadeh et al., 2014). Financial constraints often limit access to nutritious foods, leading people to opt for more affordable, calorie-dense options. Research indicates a strong link between SES and physical activity. Studies such as Huang et al. (2022) demonstrate that lower SES is associated with decreased physical activity, increased sedentary behavior, and poorer sleep patterns. Gidlow et al. (2006) find that lower SES is associated with fewer opportunities and resources for physical activity. Additionally, Beenackers et al. (2012) explores how SES impacts different types of physical activities like occupational, leisure-time, and transport-related activities, revealing varied influences on health depending on the type of activity. Moreover, those with lower levels of education may possess less understanding of proper nutrition and healthy lifestyle practices (Singh-Manoux et al., 2009).

2.4 Symptoms

CRC may not cause noticeable symptoms in its early stages. However, as it progresses, common symptoms may include changes in bowel habits (e.g., altered bowel patterns, like increased occurrences of diarrhea or constipation) (Sawicki et al., 2021), bleeding from the rectum or discovering blood in the stool), persistent abdominal discomfort, like cramps, gas, or pain, sensation of incomplete bowel excretion during defecation, experiencing weakness or unexplained fatigue, and unintentional weight loss (Majumdar et al., 1999).

2.5 Diagnosis

CRC is typically diagnosed through a combination of methods, including colonoscopy (a procedure to visualize the colon and rectum), sigmoidoscopy, fecal occult blood tests (FOBT), and imaging techniques like Computed Tomography (CT) scans (Andersen et al., 2019). Biopsies of suspicious growths are often necessary for a definitive diagnosis (Wills et al., 2018). After diagnosis, doctors determine the stage of the cancer to understand the extent of its spread. Staging helps guide treatment decisions. CRC is typically categorized into stages 0 to IV, with higher stages indicating more advanced disease (Lugli et al., 2017).

2.6 Screening

The choice of screening method and frequency can depend on individual risk factors, age, and personal preferences. Since CRC is one of the most treatable cancers when detected at an early stage (Downing et al., 2010), regular screening can identify precancerous polyps or early-stage cancers before they have a chance to advance, allowing for prompt intervention and a higher likelihood of successful treatment. In other words, early detection and treatment can significantly increase the chances of survival (Gupta et al., 2022). CRC is often asymptomatic in its initial stages, making routine screenings crucial for detecting the disease before it progresses to more advanced and less treatable stages (Simon, 2016). This preventive aspect of screening can effectively reduce the overall incidence of CRC (Hajizadeh et al., 2022).

Common screening methods for CRC include colonoscopy, FOBT, and sigmoidoscopy (Singh et al., 2004). There exists an ongoing discussion pertaining to the comparative effectiveness of the two predominant CRC screening methods employed globally *viz.,* FOBT and colonoscopy programs. Despite the ongoing debate over the superiority of either approach, the ultimate effectiveness of a CRC screening program depends on both the program's quality and the patient's dedication to following all the prescribed steps (Lieberman et al., 2016).

The FOBT and colonoscopy programs employ distinct screening methodologies. While the FOBT programs are characterized by an initial, non-invasive, multi-step process, colonoscopy programs involve a single step but require a more invasive procedure. A positive FOBT result necessitates follow-up with a colonoscopy, while a negative FT result entails subsequent annual or biannual testing. Ensuring the completion of the recommended follow-up tests following a positive FT result is pivotal for the overall efficacy of any FOBT program (Lieberman et al., 2016).

Extensive research on CRC screening, originating from randomized controlled trials (RCTs) in the 1990s, reveals that CRC screening initiatives utilizing FOBT are linked to a 15% to 30% decrease in CRC mortality when compared to individuals who did not undergo screening (Mandel et al., 1993, Allison et al., 2001, Shaukat et al., 2013). The main way to decrease mortality is through the early detection and treatment of CRC when it is still curable. In addition to identifying CRC, screening also capable of identifying polyps that are not yet cancerous but can be removed, leading to a modest decrease in the occurrence of CRC (around 17 to 20%) (Allison et al., 2001, Shaukat et al., 2013).

Comparing mortality and other outcomes between individuals who were screened and those who were not, to assess the effectiveness of colorectal cancer screening, a meta-analysis by Hewitson and colleagues that included four randomized controlled trials (RCTs) with over 320,000 participants found that FOBT screening resulted in a 16% reduction in the relative risk of CRC mortality. When adjusting for individuals who attended at least one round of CRC screening, the risk reduction increased to 25% (Hewitson et al., 2008).

When CRC is detected at an advanced stage, treatment can be more aggressive and may require extensive surgeries, chemotherapy, and radiation therapy (Ahmed et al., 2014). Early detection through screening may lead to less invasive treatment options, reducing the physical and emotional burden on the patient (Itatani et al., 2018). CRC screening is particularly valuable for individuals with a family history of the disease or other risk factors. Identifying these high-risk individuals early can allow for more personalized monitoring and preventative measures (Canadian Cancer Statistics Advisory Committee, 2019).

The sensitivity FOBT tests can range from 25% to 80%, whereas the specificity is generally higher that 90%. This means they are better at correctly identifying those who do not have the disease than in identifying all actual cases of the disease (Allison et al., 1996). Colonoscopy is considered the gold standard for colorectal cancer screening with near 100% specificity. The sensitivity of colonoscopy is also very high, approaching 95% or more for cancer, although it can be lower for precancerous lesions depending on their size and location (Rex et al., 2017). Due to the variations mentioned in sensitivity, there are cases where FOBT can result in false positives, which can occur due to factors like diet or medications that affect the test results. False positives can lead to unnecessary follow-up tests, including colonoscopies (Levi et al., 2011). In contrast, false positives are rare since this method directly visualizes the colon and can distinguish between benign and malignant lesions with high accuracy (Rex et al., 2017). High false positive rates in non-invasive tests like FOBT can lead to increased use of colonoscopies, which are resource-intensive and carry their own risks, though minor, such as bleeding or perforation (Ness et al., 2000). False positives can cause significant anxiety for patients and may lead to unnecessary procedures that have their own risks and costs. Conversely, the high sensitivity and specificity of colonoscopy provides reassurance but at the cost of a more invasive initial screening method (Pignone et al., 2002). Despite concerns regarding false positives, screening programs are generally cost-effective when compared to treating advanced-stage CRC as detecting and treating the disease at an early stage can save both lives and healthcare resources. Widespread CRC screening programs can have a significant public health impact by reducing the overall burden of the disease and its associated healthcare costs (Redaelli et al., 2003).

Although the current literature has demonstrated positive outcomes associated with CRC screening, it is important to continually assess the relevance of their findings to specific populations and real-world settings beyond clinical trials. Various factors related to behavior, culture, program implementation, and healthcare systems can influence the effectiveness of screening programs (Power et al., 2009, Steele et al., 2010).

Chapter 3: Colorectal Cancer Screening Programs in Canada

This chapter provides a comprehensive overview of CRC screening in Canada, presenting key challenges and offering recommendations to enhance effectiveness and accessibility. It begins by outlining Canada's CRC screening guidelines and differentiating between various screening types and methods. The chapter also reviews historical improvements and evaluates the current state of screening across the provinces and territories, as well as future goals. Recruitment and retention strategies are then examined, with a focus on the use of reminder notifications and follow-ups in Canadian screening programs. Subsequent sections discuss strategies to improve screening access and efficacy in marginalized, rural, and immigrant communities. Finally, the chapter describes current screening methods employed in Canada, specifically the FOBT, and highlights specific screening guidelines for Ontario.

3.1 Current Colorectal Cancer Screening Guidelines

There are two different types of cancer screening in Canada: organized and opportunistic. These two screening types are differentiated between their structure and implementation (Bielawska et al., 2020). Organized cancer screening programs are systematic, population-based initiatives that are implemented at a regional or national level. They target specific populations based on age, sex, risk factors, or other criteria, inviting eligible individuals to undergo screening at regular intervals (Bielawska et al., 2020). Organized screening programs typically follow standardized guidelines and protocols for screening tests, follow-up procedures, and treatment pathways. They often involve centralized coordination, including the management of participant databases, appointment scheduling, and result notification systems. Examples of organized cancer screening programs in Canada include breast cancer screening with mammography, cervical cancer screening with Pap tests, and CRC screening with fecal tests or colonoscopies (Charters et al., 2013).

Opportunistic cancer screening occurs sporadically, or on an individual basis, often initiated by healthcare providers during routine medical visits or in response to patient symptoms and concerns (Chow et al., 2020). Opportunistic screening may not adhere to standardized guidelines or target specific populations in the same systematic manner as organized screening programs (Chow et al., 2020). It relies on healthcare providers to identify individuals who may benefit from screening based on their medical history, risk factors, or symptoms. While opportunistic screening can increase access to screening for some individuals, it may result in variations in screening practices and uneven coverage across different population groups (Rabeneck et al., 2006).

In Canada, organized screening programs for CRC target individuals who show no symptoms and are at an average risk of developing the disease (Canadian Task Force on Preventive Health Care, 2016). Presently, such programs are operational in one territory – Yukon (YK) – and nine provinces, namely Alberta (AB), British Columbia (BC), Manitoba (MB), New Brunswick (NB), Newfoundland and Labrador (NL), Nova Scotia (NS), Ontario (ON), Prince Edward Island (PE), and Saskatchewan (SK). Notably, the Northwest Territories (NT), Nunavut (NU), and Quebec (QC) lack organized screening programs. NU is in the process of establishing a comprehensive territorial program, with plans in motion to develop similar programs in the NT and QC (Canadian Partnership Against Cancer, 2018). In regions without organized programs, primary care providers may offer screening opportunistically (Canadian Partnership Against Cancer, 2018). With the recent developments of CRC screening programs, it can be stated that all

Canadian jurisdictions have either implemented organized CRC screening programs or are actively in the process of implementation (Canadian Partnership Against Cancer, 2018). Detailed information on CRC screening programs is presented in Table 3.1.

Structured CRC screening programs employ various methods for recruiting, reminding, and promoting eligible individuals to undergo screening according to established protocols (Canadian Task Force on Preventive Health Care, 2016). The approaches for recruitment differ throughout the country and can involve a referral from a physician, self-referral, or the issuance of an invitation letter through mail. Additionally, periodic reminder letters may be dispatched to eligible individuals to enhance screening participation rates.

Individuals receiving abnormal FOBT results are promptly informed and encouraged to undergo further assessment through a diagnostic colonoscopy (Canadian Partnership Against Cancer, 2018). Notifications regarding results are dispatched to participants, primary care providers, or both. Additionally, strategies have been deployed to address screening participation gaps among underserved populations, such as those residing in rural areas, new immigrants, and individuals with limited income. These initiatives are designed to bolster CRC screening involvement within these communities, striving for equity in healthcare utilization across Canada.

Table 3.1: Colorectal cancer screening programs in Canada

Province/Territory	Program start Date	Program status	Program name	Agency responsible for program administration
Alberta	2009	Full province wide program	Alberta Colorectal Cancer Screening Program (ACRCSP)	Alberta Health Services
British Columbia	2013	Partial program, the Northern Health Authority in BC does not participate in the program	Colon Screening Program	BC Cancer Agency
Manitoba	2007	Full province wide program	ColonCheck	CancerCare Manitoba
New Brunswick	2014	Full province wide program	New Brunswick Colon	New Brunswick Colon
Newfoundland and Labrador	2012	Full province wide program	Newfoundland and Labrador Colon Cancer Screening Program	Cancer Care Program, Eastern Health
Nova Scotia	2009	Full province wide program	Colon Cancer Prevention Program	Nova Scotia Health Authority, Nova Scotia Cancer Care Program
Northwest Territories*	No organized screening program available, but plans are underway.			
Nunavut*	2018	In process of implementation	Not applicable	Department of Health
Ontario	2008	Full province wide program	ColonCancerCheck (CCC)	Cancer Care Ontario (CCO)
Prince Edward Island	2011	Full province wide program	Colorectal Screening Program	Health PE
Quebec*	Not applicable	In planning stages	Programme québécois de dépistage du cancer colorectal (PQDCCR)	Ministère de la Santé et des Services sociaux
Saskatchewan	2009	Full province wide program	Screening Program for Colorectal Cancer	Saskatchewan Cancer Agency
Yukon	2017	Full province wide program	ColonCheck Yukon	Government of Yukon Health and Social Services

* Information in this jurisdiction refers to opportunistic CRC screening programs. Note: Adapted from "Canadian Partnership Against Cancer. (2018). Colorectal Cancer Screening in Canada: Environmental Scan. Toronto: Canadian Partnership Against Cancer."

In 2004, the Canadian Association of Gastroenterology (CAG) and the Canadian Digestive Health Foundation introduced the existing guidelines for CRC screening in Canada. These recommendations are founded on the needs of individuals with an average risk of developing CRC, a group that makes up the majority of the Canadian population (Leddin et al., 2004). The latest revision took place in 2016, when Canadian Task Force on Preventive Health Care issued their guidelines for CRC screening (Canadian Task Force on Preventive Health Care, 2016).

Colon cancer is rare in individuals under the age of 50. The likelihood of developing cancer within the next decade is 1 in 125 for those aged 50 to 59, and 1 in 50 for those aged 60 to 69, as opposed to 1 in 1000 for individuals aged 30 to 39 (Johns et al., 2001). Therefore, the consensus among most experts is to provide screening to individuals who are 50 years and older as well as to those who are at increased risk. While the relative advantages of screening seem comparable for both younger (50-59 years) and older (60-74 years) individuals, the older group experiences greater absolute benefits due to the higher occurrence of CRC (Canadian Task Force on Preventive Health Care, 2016).

In Canada, people aged 50 and above who do not have a family history of CRC are recommended to undergo screening using one of the following approaches:

1) FOBT every two years, which can utilize either guaiac-based or immunochemical-based FOBT.
2) Flexible sigmoidoscopy every 10 years (Canadian Task Force on Preventive Health Care, 2016).

Although the advice remains not to screen individuals aged 75 years and above for CRC, the updated guidelines now discourage the use of colonoscopy as a screening method for CRC, which is a change from previous recommendations (Canadian Task Force on Preventive Health Care, 2016). These guidelines are not relevant to individuals aged 50 years and above who are at higher risk of developing CRC. This includes individuals with a history of CRC or polyps, those with inflammatory bowel disease, those experiencing signs or symptoms of CRC, those with a family history of CRC in one or more first-degree relatives, and adults with inherited syndromes that increase their susceptibility to CRC, such as familial adenomatous polyposis or Lynch syndrome (Canadian Task Force on Preventive Health Care, 2016). All individuals aged 50 and older are considered as having an average risk. For individuals identified as having increased risk (such as having a family history of CRC and other situations aforementioned), the screening recommendations vary, but commonly include starting screening earlier, at age 40 (Canadian Partnership Against Cancer, 2018).

As outlined in Table. 3.2, each province and territory regularly assess symptom-free individuals with an average risk of CRC aged between 50 and 74 or 75 using a FOBT, such as the guaiac fecal test (FTg) or fecal immunochemical test (FIT), conducted every 12-30 months. While most areas opt for a two-year screening cycle, NT and AB vary between one to two years, while YK extends the interval to 30 months (Canadian Partnership Against Cancer, 2018).

Table 3.2: Provincial and territorial screening programs

Province/Territory	**Start age**	**Interval**	**Stop age**	**Primary screening test**
Alberta	50	1-2 years	75	FIT
British Columbia	50	2 years	75	FIT
Manitoba	50	2 years	75	FTg
New Brunswick	50	2 years	74	FIT
Newfoundland and Labrador	50	2 years	74	FIT
Northwest Territories	50	1-2 years	75	FIT
Nova Scotia	50	2 years	74	FIT
Nunavut	50	2 years	74	FIT
Ontario*	50	2 years	75	FIT
Prince Edward Island	50	2 years	75	FIT
Quebec	50	2 years	74	FIT

Saskatchewan	50	2 years	75	FIT
Yukon	50	2 years	75	FIT

* In Ontario, residents aged between 50 to 74 with no symptoms or family history of CRC may choose to get screened with flexible sigmoidoscopy instead of FOBT. It is recommended that eligible individuals who get screened with a flexible sigmoidoscopy repeat the test every 10 years. For FIT screening, the last kit is mailed shortly after the participant's 74th birthday. Participants can request a new kit (if lost or expired) up until their 76th birthday. Note: FIT=fecal immunochemical test; FTg=guaiac fecal test; Adapted from "Canadian Partnership Against Cancer. (2018). Colorectal Cancer Screening in Canada: Environmental Scan. Toronto: Canadian Partnership Against Cancer."

3.2 Recruitment and Retention Strategies

As reported in Table 3.3, CRC screening programs with organized structures employ various methods to encourage eligible individuals to participate according to guidelines. These methods encompass recruitment, reminders, and promotional activities. Recruitment tactics, which differ nationwide, may involve physician recommendations, self-referral options, or mailed invitations (Canadian Partnership Against Cancer, 2018). To enhance screening rates, some regions send reminder letters to eligible individuals.

In several jurisdictions, a physician's referral is necessary before individuals receive screening kits, while in others, kits are provided alongside invitation letters or upon the mailing of such letters (Canadian Partnership Against Cancer, 2018). Additionally, participants can directly obtain screening kits by contacting certain screening programs (Canadian Partnership Against Cancer, 2018).

Provinces and territories utilize diverse promotional strategies to advocate CRC screening. These methods include program-related communications, public awareness campaigns (e.g., during Colorectal Cancer Awareness Month), social media engagement, healthcare provider education initiatives, among others (Canadian Partnership Against Cancer, 2018).

Table 3.3: Colorectal cancer screening promotional and recruitment strategies in Canada

Province/Territory	Promotional strategies	Recruitment methods
Alberta	• Social media campaign (Facebook, Instagram, Twitter) • Booths at conferences	• Physician referral
British Columbia	• Recall letters are sent to primary care providers and patients • Annual quality reports are sent to providers	• Physician referral
Manitoba	• Mailed letters • Public advertising and public events • Social media campaign and web • Education and events for healthcare providers • Combined screening promotion (GetChecked Manitoba)	• Physician referral • Self-referral by phone, email, online or in person • Mailed invitation letter • Referral through other screening program (walk-ins from breast screening appointments)
New Brunswick	• Promotional and educational campaigns for healthcare providers, professionals and public	• Mailed invitation letter
Newfoundland and Labrador	• Education and posters for healthcare providers • Social media campaign (Facebook, Twitter) • Presentations at health symposiums and community events	• Physician referral • Self-referral by phone, email or in person (rare) • Referral through other screening program
Northwest Territories	Not applicable	Not applicable
Nova Scotia	• Mailed invitation letter and kit automatically sent 2 weeks later	• Mailed invitation letter and kit
Nunavut	• Public awareness campaign	• Physician referral • Self-referral in person • Referral through other screening programs
Ontario	• Mailed invitation, recall and reminder letters • Physician-linked correspondence program	• Physician referral • Self-referral by phone, and through pharmacy • Self-referral through mobile screening in certain areas

	• Online screening activity report (SAR) which allows physicians in patient enrollment model practices to see the complete screening status of each of their enrolled age-eligible patients, including those who are overdue or due for screening, and those who require follow-up. • Public awareness campaigns (social media)	• Mailed invitation letter
Prince Edward Island	• Awareness campaign for Colorectal Cancer Awareness Month (March) with public advertising (web, print ads, TV, radio)	• Physician referral • Self-referral by phone, email, online or in-person • Mailed invitation letter
Quebec	Not applicable	Not applicable
Saskatchewan	• Program website • Promotional and educational resources for healthcare providers and public • Radio and print advertisement	• Physician referral • Self-referral by phone • Mailed invitation letter
Yukon	• Awareness campaign for Colorectal Cancer Awareness Month (March) (web, social media, posters, radio, community outreach) • Recall letters are sent to primary care providers and patients	• Physician referral • Self-referral in person • FIT kits are distributed at public events

Notes: FIT=fecal immunochemical test; Adapted from "Canadian Partnership Against Cancer. (2018). Colorectal Cancer Screening in Canada: Environmental Scan. Toronto: Canadian Partnership Against Cancer."

Of the six regions that dispatch mailed invitation letters for screening, the four provinces –SK, MB, ON, and NB – also send follow-up reminders if screening has not commenced, with further details provided in Table 3.4 (Canadian Partnership Against Cancer, 2018).

Table 3.4: Colorectal cancer screening reminder notification in Canada

Province	Reminder timeframe
Saskatchewan	Reminder letter sent 9 weeks after initial invitation
Manitoba	Reminder letter sent 56 days after initial invitation
Ontario	Reminder letter sent 4 months after initial invitation
New Brunswick	Reminder letter sent 12 weeks after initial invitation

Note: Adapted from "Canadian Partnership Against Cancer. (2018). Colorectal Cancer Screening in Canada: Environmental Scan. Toronto: Canadian Partnership Against Cancer."

Many provincial and territorial CRC screening programs send a recall letter two years after a client receives a normal result, as shown in Table 3.5(Canadian Partnership Against Cancer, 2018).

Table 3.5: Colorectal cancer screening recall after a normal result

Province/Territory	Recall after normal result
Alberta	Not in place currently
British Columbia	Recall letter to primary care provider and participant
Manitoba	Recall letter to participants
New Brunswick	Recall letter to participants
Newfoundland and Labrador	Screening kits to participants
Northwest Territories	Not applicable
Nova Scotia	FIT kit to participants after next even birthday
Nunavut	Phone call to primary care provider
Ontario	Recall letter to participants
Prince Edward Island	Recall letter to participants
Quebec	Not applicable
Saskatchewan	Recall letter with FIT kit to participant
Yukon	Recall letter to primary care provider and participant

Notes: FIT=fecal immunochemical test; Adapted from "Canadian Partnership Against Cancer. (2018). Colorectal Cancer Screening in Canada: Environmental Scan. Toronto: Canadian Partnership Against Cancer."

Currently, there is no evidence-based method for screening high-risk patients in Canada, and the guidelines rely on consensus agreements. According to Cancer Care Ontario's CCC program, individuals deemed high-risk due to family history should undergo colonoscopy screening starting at age 40 or 50, or 10 years before the age at which their affected family member was diagnosed with CRC, whichever comes first. The exact timing depends on the specific CRC profile within their family history (Cancer Care Ontario, 2019). These guidelines were derived from the 2018 Clinical Practice Guidelines for Colorectal Cancer Screening by the CAG (Leddin et al., 2018). FT testing lacks sufficient sensitivity for individuals at elevated risk, and any CRC screening program should consider the resources required for endoscopic screening of high-risk patients (Leddin et al., 2004). Individuals displaying symptoms should not be categorized as 'screening' candidates, they need to undergo a proper diagnostic evaluation based on their specific symptoms. As for asymptomatic individuals aged below 50 years with an average risk, their chances of developing colon cancer are considerably lower, and therefore, screening for this group is not currently advised in Canada.

3.3 Fecal Occult Blood Testing

The primary screening test used for CRC in Canada is the FIT or FTg. The FIT involves collecting stool samples on three different days, then sent for laboratory testing. Many screening programs classify an unusual outcome as the presence of one or more positive windows on a FTg card. If the test result is considered abnormal and blood in the stool is detected, it is advisable to proceed with a diagnostic colonoscopy. While it is important to note that most individuals with blood in their stool do not necessarily have CRC, a colonoscopy is essential for all abnormal test results to definitively confirm or rule out the presence of cancer. In cases where no blood is detected in the stool, the test result is deemed normal, and patients are recommended to undergo FT-based rescreening every two years in Canada (Quality Determinants for Colorectal Cancer Screening in Canada, 2009, Cancer Care Ontario, 2019). Alternatively, screening can be conducted at intervals ranging from 1 to 3 years, as recommended by the US Preventative Services Task Force. If a quantitative FIT is employed, which identifies human hemoglobin in stool, a positive test is determined by a result exceeding a predefined threshold or cutoff level (Quality Determinants for Colorectal Cancer Screening in Canada, 2009).

Existing recommendations lean towards the Hemoccult SENSA FTg test or a FIT test as the preferred options (Liberman et al., 2016). Hemoccult SENSA has taken the place of Hemoccult II due to its enhanced ability to detect CRC and its rapid, convenient, and qualitative method for detecting fecal occult blood. Based on findings from three diagnostic accuracy studies, Hemoccult SENSA (using three samples) demonstrated a sensitivity ranging from 61.5% to 79.4% (Lin et al., 2016). The specificity was as low as 86.7 (Lin et al., 2016). The Cochrane Colorectal Cancer Group's update on CRC screening using Hemoccult testing indicated an overall reduction in CRC mortality by 16% through the use of FOBT (Hewitson et al., 2008). When compared to FTg, FIT demonstrates higher sensitivity while maintaining a similar level of specificity. Neither test appears to have significant direct adverse effects, except for potential harms related to follow-up investigations and therapy (Canadian Task Force on Preventive Health Care, 2016).

The effectiveness of both FIT and FTg relies on patients' adherence to various stages of the stool-based CRC screening program, including: 1) successfully completing the initial stool tests, 2) undergoing diagnostic colonoscopy if the initial test yields a positive result, and 3) participating in repeat stool testing every two years if the initial test result is negative (Lieberman et al., 2016). Research has revealed that patient adherence to the first round of testing ranges from 60% to 80%. Additionally, patients are notably more likely to complete a stool blood testing program when compared to a screening program that solely relies on periodic colonoscopy (Van Rossum et al., 2008, Moss et al., 2012).

3.3.1 Follow-Up After Abnormal Fecal Test

Following-up regarding an abnormal (positive) fecal test result in CRC screening programs is a subsequent outreach to the individual, shown below in Table 3.6 (Canadian Partnership Against Cancer, 2018). Result letters are typically sent by most provinces and territories to both the primary care providers (PCP) and participants, although in some instances, they may be directed solely to the participant. Additional communication methods include the use of laboratory reports and phone calls (Canadian Partnership Against Cancer, 2018).

The procedures for conveying abnormal results to both the individual and the primary care provider vary across the country (Canadian Partnership Against Cancer, 2018). In certain jurisdictions, there are coordinated systems in place where program administrators, nurse navigators, or patient coordinators reach out to participants and primary care providers to facilitate the scheduling of colonoscopies. On the other hand, some regions opt for direct communication with participants and primary care providers through centralized databases or referral processes, allowing them to efficiently arrange follow-up colonoscopies (Canadian Partnership Against Cancer, 2018).

Table 3.6: Follow-up after abnormal fecal tests by provincial and territorial screening Programs in Canada

Province/ Territory	**Notification methods**	**Notified person**	**Description**
Alberta	Letter	Participant	The provincial program sends a letter to the patients, advising them to consult their primary care physician. The physician may then refer the patient to the zone-based screening program or directly to an endoscopist. The physician has access to FIT results through the Netcare system, which is a laboratory reporting system.
British Columbia	Letter and phone call	PCP and participant	The primary care provider receives the abnormal laboratory result report, prompting the issuance of a letter to the patient indicating the need for follow-up. Subsequently, the patient is referred to their health authority. The health authority then contacts the patient to conduct a pre-colonoscopy assessment and schedule the colonoscopy appointment. Alternatively, they may inform the primary care provider if the patient opts not to proceed with the procedure.
Manitoba	Letter and phone call	PCP and participant	ColonCheck's navigator communicates with both the primary care provider and the client through direct or mail correspondence regarding the abnormal result and the referral process for follow-up. A colonoscopy brochure is included in the mail sent to the client. The process for referring patients for follow-up colonoscopy depends on agreements with each of the 5 Regional Health Authorities and on permissions granted by primary care providers. ColonCheck has obtained permission from most primary care providers to directly refer clients. For all patients receiving healthcare services in Winnipeg, ColonCheck's nurse practitioner completes a pre-colonoscopy assessment. The procedure is then scheduled at one of two facilities.
New Brunswick	Letter (PCP and participants) and phone call (participants)	PCP and participant	The laboratory sends a letter to primary care providers to notify them of abnormal results. A program nurse contacts the participant to discuss the results and follow-up procedures. If the participant cannot be reached by phone, a letter is sent to convey the same information.

Newfoundland and Labrador	Letter (PCP and participant) and phone call (participant)	PCP and participant	Upon receiving an abnormal test result, the screening program initiates contact with the patient through nurse coordinators. They inform the patient of the test result and conduct a telephone health assessment. Subsequently, the nurse refers the patient to the endoscopy unit nearest to their residence for a colonoscopy. Additionally, the nurse coordinators send a package of materials to the patient, which includes information on bowel preparation.
Northwest Territories	Laboratory	Not applicable	Not applicable
Nova Scotia	Letter (PCP and participant) and phone call (participant)	PCP and participant	The screening nurse contacts participants who have received abnormal results to conduct a pre-colonoscopy assessment. Once the assessment is completed, the individual is then scheduled for a colonoscopy with a physician authorized by the screening program.
Nunavut	Laboratory result	PCP	Healthcare professionals review abnormal results, and referrals for colonoscopy are recorded in electronic medical records. Except for Iqaluit, arrangements for transportation outside the community are necessary.
Ontario	Letter	PCP and participant	The CCC program implements two distinct processes for follow-up: • For attached patients (those with primary care providers): PCPs are responsible for informing their patients about the FOBT result and referring those with abnormal results for timely colonoscopy follow-up. As an additional safety measure, CCO also sends patients a mailed correspondence letter containing their test result. • For unattached patients (those without primary care providers or those who received their FOBT kit through a pharmacy or Telehealth Ontario): CCO dispatches abnormal result letters via courier to patients, instructing them to contact CCO's Contact Centre for assistance with abnormal follow-up. If the patient fails to respond within 5 business days, Contact Centre personnel make up to 3 phone calls to the patient. Once the patient confirms they lack a primary care provider, CCO obtains consent for provider attachment. Contact Centre staff then locate a physician and arrange an

			appointment for follow-up within 10 business days. If a physician cannot be found, the case is escalated, and CCO's provincial and regional leads assist with the attachment process.
Prince Edward Island	Letter (participant laboratory (PCP)	PCP and participant	The Colorectal Cancer Screening Program (CCSP) sends letters to clients informing them of abnormal results and instructing them to follow up with a primary care provider. The primary care provider assesses the results and determines the appropriate follow-up. A standardized colonoscopy referral form is provided for this purpose. The CCSP monitors follow-up activities and referrals (such as colonoscopies). If there is no activity or referral recorded in the client's chart, the primary care provider is contacted to ensure appropriate action is taken.
Quebec	Not applicable	Not applicable	Not applicable
Saskatchewan	Letter, phone call (participant only)	PCP and Participant	The PCP and participant are informed of abnormal results through direct correspondence. PCPs sign medical directives, granting client navigators the authority to refer clients for a colonoscopy. Client navigators then contact participants via phone to discuss the test results, refer them for a colonoscopy, and conduct a standardized assessment. However, not all units have agreed to client navigation services. Approximately 50% of participants undergo assessment and booking facilitated by client navigators.
Yukon	PCP	PCP	Healthcare providers receive FIT results directly from the Whitehorse General Hospital (WGH) laboratory via Plexia and Fax. ColonCheck obtains monthly FIT results from the WGH laboratory, where they are assessed, and positive results are flagged for follow-up. If the program does not receive a copy of the colonoscopy referral within 3 months of a positive result, a letter is sent to the primary care provider for further action.

Notes: PCP = primary care providers; FIT=fecal immunochemical test; FOBT= fecal occult blood test; Adapted from “Canadian Partnership Against Cancer. (2018). Colorectal Cancer Screening in Canada: Environmental Scan. Toronto: Canadian Partnership Against Cancer.”

3.4 Colonoscopy

Colonoscopy services are available across Canada in various settings: hospitals in ten jurisdictions, private colonoscopy clinics in three jurisdictions, and public colonoscopy clinics in two jurisdictions (Canadian Partnership Against Cancer, 2018). The recommendation for follow-up after an individual receives an abnormal fecal test but a negative colonoscopy varies among Canadian jurisdictions. In some regions, individuals are recalled for FIT or FTg screening after two, five, or ten years. Table 3.7 provides further details (Canadian Partnership Against Cancer, 2018).

Table 3.7: Screening recall after an abnormal fecal test and a negative colonoscopy

Province/Territory	**Follow-up contact process for individuals with abnormal fecal tests and negative colonoscopy results**
Alberta	Recalled for FIT screening in 10 years
British Columbia	Recalled for FIT screening in 10 years
Manitoba	Recalled for FTg screening in 5 years
New Brunswick	Recalled for FIT screening in 10 years
Newfoundland and Labrador	Recalled for FIT screening in 5 years
Northwest Territories	N/A
Nova Scotia	Recalled for FIT screening in 2 years
Nunavut	Recalled for FIT screening in 10 years
Ontario	Recalled for FT screening in 10 years
Prince Edward Island	Recalled for FIT screening in 5 years
Quebec	Recalled for FIT screening in 10 years
Saskatchewan	Recalled for FIT screening in 5 years
Yukon	Recalled for FIT screening in 10 years

Notes: FIT=fecal immunochemical test; Adapted from “Canadian Partnership Against Cancer. (2018). Colorectal Cancer Screening in Canada: Environmental Scan. Toronto: Canadian Partnership Against Cancer.”

3.5 Strategies for Addressing Participation in Underserved Populations Implemented in Canadian Jurisdictions

Screening rates among low-income individuals, recent immigrants, and those residing in rural and remote areas are notably lower compared to the general Canadian population (Canadian Partnership Against Cancer, 2017). To address this inequality, five provinces and one territory have implemented targeted strategies aimed at improving participation among underserved populations (Canadian Partnership Against Cancer, 2018). These initiatives primarily focus on individuals in rural communities, recent immigrants, and low-income groups. Some of the identified strategies involve social media campaigns, presentations, and the dissemination of program materials to enhance awareness and educate communities about CRC screening (Canadian Partnership Against Cancer, 2017). In certain jurisdictions, test kits are distributed via mobile units or door-to-door visits to reach individuals in remote areas (Canadian Partnership Against Cancer, 2017). Additionally, there are strategies aimed at healthcare providers, who play a direct role in engaging underserved populations in screening initiatives (Canadian Partnership Against Cancer, 2017). This information is displayed below in Table 3.8.

Table 3.8: Approaches for enhancing colorectal cancer screening engagement in marginalized communities in Canada

Province/Territory	Target group	Interval
Alberta	• Individuals in rural communities	• Creating Health Equity in Cancer Screening (CHECS) initiative has been launched with the objective of evaluating the impact of SDH on cancer screening rates. The project aims to systematically identify areas with low or no screening rates and collaborate with stakeholders to develop strategies to increase breast, cervical, and CRC cancer screening. CHECS will facilitate policy development and support healthcare providers and community agencies in better serving under-screened populations. Initially, the project will commence in metro Calgary and expand to other regions of the province as deemed appropriate.
Manitoba	• New immigrants • Individuals in rural communities	• Collaborating with clinics catering to vulnerable or hard-to-reach groups by providing sample kits, conducting presentations for community groups, and participating in flu clinics. • Designing tailored activities for specific populations, such as modifying test instructions, conducting patient outreach, implementing door-to-door delivery of FOBT kits, and enlisting a university summer student to follow up with individuals who haven't completed their tests. • Actively offering interpreter services and translating most resources into 18 languages to ensure accessibility. • Partnering with CancerCare Manitoba's Underserved Populations Program (UPP), which supports individuals facing barriers to cancer screening and treatment due to geography, language, culture, or other factors. UPP builds relationships in underserved communities, educates and supports healthcare providers on health equity issues, and addresses systemic barriers. • Funding Community Liaisons to raise awareness of screening and prevention in rural and remote communities. ColonCheck collaborates with Community Liaisons in northern Manitoba to develop

		initiatives for distributing kits effectively and promoting awareness in hard-to-access areas.
New Brunswick	• New immigrants • Low-income individuals • Individuals in rural communities	• Underserved populations receive invitations by mail, and a toll-free number is provided for inquiries. Tele-Care attendants have access to a multilingual resource to assist individuals who do not speak English or French.
Ontario	• Low-income individuals • Individuals in rural communities	• In Ontario, two mobile coaches provide cancer screening services, with one operating in the Northwest region and the other in the Hamilton Niagara Haldimand Brant region. These coaches distribute FOBT kits to screen eligible Ontarians. • CCO has undertaken pilot projects aimed at enhancing CRC screening participation. Furthermore, the organization continues to support research initiatives targeting underserved populations, with a particular focus on First Nations communities.
Saskatchewan	• New immigrants • Low-income individuals • Individuals in rural communities	• The coordinators for breast, cervical, and CRC screening regularly engage in presentations at various events attended by underserved populations. Some examples include: o The Open Door Society (ODS): A non-profit organization in Regina and Saskatoon providing settlement and integration services to refugees and immigrants. Coordinators educate immigrants on screening, often with interpreters present for translation assistance. PowerPoint slides include visual aids to aid comprehension. o Global Gathering Place (GGP): A non-profit drop-in center in Saskatoon catering to immigrants and refugees. GGP supports newcomers in adapting to life in Canada through skill development, acceptance, and a welcoming environment. o Saskatchewan's North Mobile Health Unit: Travels to the northern part of the province, educating groups on the importance of cervical, CRC, and breast screening. Awareness campaigns primarily target First Nations, new immigrants, low-income individuals, and rural communities. • Saskatchewan International Physician Practice Assessment (SIPPA): A competency assessment

		program for internationally trained physicians practicing in Saskatchewan. Coordinators discuss screening programs with SIPPA participants, as these physicians may encounter underserved populations in their practice. • Healthcare Provider Conferences: Coordinators are invited to host booths or deliver education sessions at conferences attended by healthcare providers who work with underserved populations in their practices.
Yukon	• Low-income individuals • Individuals in rural communities	• Health centers in rural communities showcase ColonCheck posters and extend invitations to community members to undergo screening. • FIT kits are distributed to eligible populations through an outreach van in Whitehorse, with attendance at public events aimed at enhancing accessibility.

Notes: FIT=fecal immunochemical test; Adapted from "Canadian Partnership Against Cancer. (2018). Colorectal Cancer Screening in Canada: Environmental Scan. Toronto: Canadian Partnership Against Cancer."

3.6 Challenges in Colorectal Cancer Screening

As of 2016, each of Canada's 10 provinces had either implemented organized screening programs for CRC or was in the process of implementation (Findlay-Shirras, 2020). A recent work by Major et al. (2013) and collaborators from the Canadian Partnership Against Cancer (CPAC) shared the initial findings of FOBT screening, combining results from five provincial programs. The study reported an average Canadian participation rate of 16.1% (Major et al., 2013). Understanding this figure is challenging due to variations in the screened population across provinces. Participation rates showed significant inequalities both within and among the organized programs nationwide. Importantly, none of these programs achieved the participation goal set by CPAC in 2011, which was a minimum of 60% (Findlay-Shirras, 2020).

Canadian large-scale CRC screening initiatives encounter distinctive obstacles associated with geographically dispersed populations, restricted healthcare access for many residents in nonurban areas and limited endoscopic capacity within publicly funded healthcare systems. In comparison, participation rates in other population-based CRC screening programs globally typically fall within the range of 45% to 60% (Moss et al., 2012, UK Colorectal Cancer Screening Pilot Group, 2004, Denis et al., 2007, Steele et al., 2009). Although making direct comparisons between diverse populations and healthcare systems is challenging, the findings from CPAC and individual provinces strongly indicate the necessity for additional, more comprehensive evaluations.

3.7 Screening for Colorectal Cancer in Ontario

The FIT is a screening test for people at average risk of getting CRC. FIT is now used instead of the FTg, which used to be Ontario's CRC screening test. As of December 24, 2019, laboratories in Ontario will no longer test FTg kits for CCC program (Canadian Partnership Against Cancer, 2023). The FIT is a recommended screening tool for individuals at average risk, particularly those aged 50 to 74 with no first-degree relative diagnosed with CRC. This at-home screening test offers a safe and convenient method for detecting blood in the stool, with a recommended frequency of once every two years. Notably, abnormal FIT results prompt further investigation, potentially leading to a colonoscopy within 8 weeks (Canadian Partnership Against Cancer, 2013).

Flexible sigmoidoscopy, another screening option, is recommended for individuals at average risk aged 50 to 74 who have not undergone FIT in the past two years. This test, ordered by a family doctor or nurse practitioner, involves a visual examination of the rectum and sigmoid colon without the need for sedation (Canadian Task Force on Preventive Health Care, 2016). For those at increased risk, or with abnormal FIT results, a colonoscopy is strongly recommended. This comprehensive procedure allows doctors to examine the entire colon, facilitating both diagnosis and preventive intervention. It is imperative for individuals with abnormal FIT results to undergo a colonoscopy within eight weeks (Canadian Partnership Against Cancer, 2013). In Ontario, individuals are advised to undergo colonoscopy screening starting at age 50. If a first-degree relative is diagnosed before the age of 60, or if two or more first-degree relatives are diagnosed with colon cancer at any age, colonoscopy screenings should be conducted every 5 years. If first-degree relatives are diagnosed at age 60 or older, or if two or more second-degree relatives are diagnosed at any age, colonoscopy screenings should be conducted every 10 years (Canadian Partnership Against Cancer, 2018).

The guidelines also address tests not recommended for screening, highlighting the phase-out of FTg in favor of FIT. Other tests such as metabolomic tests, DNA tests, computed tomography colonography, double contrast barium enema, and capsule colonography are deemed unsuitable for routine screening due to insufficient evidence supporting their efficacy (Canadian Partnership Against Cancer, 2013). This program systematically invites eligible individuals to participate in screening, facilitates tracking of screening history, sends reminders for timely testing, and communicates results. Various letters, including invitations, reminders, and result notifications, contribute to efficient communication and engagement with the screening process (Canadian Task Force on Preventive Health Care, 2016).

Chapter 4: Literature Review

This chapter provides a review of the existing literature on socioeconomic inequalities in CRC screening participation in Canada. First, it reviews the research literature and empirical evidence pertaining to socioeconomic inequalities in CRC screening within developed nations, with a special emphasis on the Canadian context. Subsequently, it describes gaps in the current literature and objectives of the current study.

4.1. Socioeconomic Inequalities in Colorectal Cancer Screening

Despite the importance of screening for CRC for early detection and successful treatment, there are persistent inequalities in participation rates among various socioeconomic groups, even in countries with publicly funded healthcare systems, leading to unequal cancer outcomes. Mosquera et al. (2020) examined social inequalities in CRC screening participation in Canada, identifying that lower SES groups had notably lower participation rates. The study utilized a systematic literature review, revealing a need for targeted interventions to increase screening uptake among disadvantaged populations. The participation rates in screening programs ranged from 1.1% to 82.8% across different studies and countries, using a variety of methods such as FOBT, sigmoidoscopy, and colonoscopy (Mosquera et al., 2020). This finding is supported by Bygrave et al. (2020), who assessed the implementation of interventions designed to increase screening participation. Their analysis reveals that despite targeted efforts, participation rates in CRC screening programs among lower SES groups increased by only 5-10% in most studied regions. Their work shows the complexity of addressing SES inequalities in health interventions and calls for more nuanced strategies to mitigate these inequalities in high-income countries.

A study by Blair et al. (2019) found that lower area-level income was associated with reduced participation in CRC screening, pointing to the broader issue of access to healthcare services, as individuals in lower income areas may face barriers such as lack of awareness, availability, and accessibility of screening programs in Canada. Their analysis indicated that neighborhoods in the lowest income quintile had a screening participation rate approximately 20% lower than those in the highest income quintile. Deding et al. (2023) reported social inequalities in the participation rates for colon exams, with individuals from lower SES backgrounds shown to be less likely to engage in screening activities in Denmark. Their register-based cohort study revealed that the participation rate in colorectal screening among the lowest SES quartile was approximately 30% lower compared to the highest SES quartile. Kiran et al. (2017) provided an analysis of a population-based screening program in Ontario, highlighting the significant impact such initiatives can have on reducing socioeconomic inequalities in screening uptake. The study utilized retrospective data to assess the program's effectiveness, emphasizing the importance of accessible and widespread screening programs. Another study utilizing CCHS 2013-2014 data showed that half of Canadians, specifically 52%, report being up to date with CRC screening; however, screening rates were found to be higher among high-income Canadians. Specifically, the highest income quintile reported a 54% screening rate compared to 47.8% in the lowest income quintile. This gap indicates the influence of SES on health behavior, particularly in the uptake of preventive health measures like CRC screening (Simkin et al., 2019).

Kerner et al. (2015) provided a comprehensive analysis of the inequalities in cancer screening in Canada, particularly focusing on CRC. They found that the CRC screening participation rates for individuals in the lowest income quintile were significantly lower compared to those in the highest income quintile. Specifically, the participation rates in the lowest income quintile were about 18% in 2008 and 25% in 2012, whereas in the highest income quintile, they were 22% in 2008 and 32% in 2012. This suggests a persistent inequality in CRC screening rates related to income, with individuals in the lowest income bracket having notably lower screening rates. Their study highlighted that while overall cancer screening rates have improved, significant social inequalities persist.

Additionally, rural residents participated in screening 15% less frequently than urban residents. The research also indicated a gender inequality, with men being 10% less likely to participate in CRC screening compared to women. Despite the progress in screening technologies and public health initiatives, these findings underline the entrenched nature of socioeconomic inequalities affecting health access and emphasize the need for targeted interventions to improve screening uptake across all socioeconomic groups in Canada. The paper by Maddison et al. (2012) explores inequity in access to CRC treatment in Nova Scotia, Canada, by analyzing inequalities related to income, age, sex, and distance from cancer treatment centers. Utilizing population-based administrative data, the study differentiates between inequality and inequity, incorporates clinical practice guidelines, and employs inequity indices for robust analysis. It revealed significant inequities in access to chemotherapy and radiotherapy based on age, sex, and distance, but not income, emphasizing the need for precise evaluation of access to cancer care.

The existing body of international research consistently demonstrates that individuals of lower SES are significantly less likely to participate in CRC screening programs (Ioannou et al., 2003; Doubeni et al., 2009). This phenomenon is not confined to a single country; rather, it spans across a broad number of countries such as the USA, Canada, and Sweden, where a higher incidence of CRC has been observed among individuals in lower SES groups (Clegg et al., 2009; Brooke et al., 2016; Gorey et al., 1998; Jandova et al., 2016; Doubeni et al., 2012). Furthermore, sociodemographic variables such as minority group status, recent immigrant status, and lower levels of educational attainment and lower income significantly reduce the likelihood of undergoing screening in North America (Decker et al., 2014). A 2019 report by the Organization for Economic Co-operation and Development (OECD) highlighted pronounced social inequalities in cancer screening programs. It was noted that such screenings, CRC included, are predominantly accessed by individuals from higher SES groups, with limited exceptions.

Another study analyzed inequalities in the Colorectal Cancer Screening Programme in Spain using information available in the Population Information System of the Region of Valencia (Vanaclocha-Espí et al., 2022). The study also revealed significant socioeconomic inequalities in CRC participation rates for screenings, with individuals in the lowest SES quartile being notably less likely to participate in screening than those in the highest SES quartile.

Beyond socioeconomic factors, cultural and ethnic inequalities play a crucial role in CRC screening rates. Javanparast et al. (2010) highlights the challenges in CRC screening participation among various ethnic populations in Australia, attributing inequalities to socio-cultural factors, knowledge gaps, and perceptions about the necessity of screening. Barriers such as fears of procedural discomfort, anxiety over results, and general mistrust in healthcare systems further exacerbate these inequalities (Shahidi et al., 2016).

Notably, Indigenous communities in Canada experience a disproportionately greater burden of CRC, with incidence and mortality rates surpassing those of other demographic groups (Perdue et al., 2014). Nonetheless, screening rates for these communities lag significantly behind other populations (Canadian Partnership Against Cancer, 2014).

4.2 Gaps in Research and Contribution of This Study

Despite the established evidence of socioeconomic inequalities in cancer screening rates in high-income countries, research measuring and explaining these inequalities in CRC screening is limited, especially within the Canadian context. Based on literature, low SES individuals are less likely to undergo CRC screening. However, none of the studies used a summary measure such as the Concentration index to quantify the extent of this inequality. Additionally, these studies did not investigate factors contributing to this income-related inequality in CRC screening. By identifying the specific factors driving socioeconomic inequality, targeted interventions can be developed to address and mitigate these inequalities effectively. Thus, this study aimed to augment evidence on socioeconomic inequalities in cancer screening participation by quantifying and identifying factors contributing to income-related inequalities in CRC participation in Ontario, Canada.

Chapter 5: Methodology

This chapter provides detailed information about data sources, variables used, and a statistical approach pertaining to the main objective of the study. It additionally discusses issues related to ethical consideration in conducting this study.

5.1 Data

This study utilized information from the Public Use Microdata Files (PUMF) from the Canadian Community Health Survey (CCHS), a repeated cross-sectional survey conducted by Statistics Canada in 2017-2018 (Statistics Canada, 2001). The CCHS, initially conducted biennially, transitioned to annual data collection in 2006. While the CCHS persists, a significant overhaul in 2015 altered sampling methods and income data collection procedures, cautioning against comparisons between pre-2015 and post-2015 surveys concerning income variables.

Certain criteria exclude specific groups from the CCHS survey population, such as individuals under 12, those on Indigenous reserves, full-time military personnel, residents in institutions, foster children aged 12 to 17, and individuals in Inuit and Cree regions of Quebec. Despite these exclusions, the CCHS is representative of 98% of Canadians aged 12 and above (Statistics Canada, 2001). The participant selection in the CCHS involves three strategies: area framing based on health region for most households, list framing of telephone numbers for a smaller subset, and random digit dialing for the fewest households. Sample numbers for each province are determined by population, employing multi-stage stratification to ensure adequate sampling across health regions (Statistics Canada, 2001).

The CCHS collects information on CRC screening across various provinces in different cycles. The 2017-2018 cycle of the CCHS is the most recent dataset that includes this information from

Ontario, as well as from Canada's territories. Given that Ontario is Canada's most populous province, accounting for 38% of the national population, it was chosen for our analysis. Although the dataset also gathers information from the territories, they were excluded from our study due to their relatively low population density and unique cultural characteristics, which distinguish them from the broader Canadian context (Allin, 2008; Statistics Canada, 2001).

The CCHS surveyed a total of 17,791 individuals in Ontario. We restricted our analysis to focus on respondents aged 50 years to74 years old, in line with CRC screening guidelines that recommend this demographic should undergo regular screening in Ontario. Since the current guideline recommends all people at this age group are at average risk, CRC screening can be considered a healthcare need for these individuals in Ontario. We did not include individuals at a high level of risk, such as those with family history, where the guidelines differ (Canadian Partnership Against Cancer, 2018). This focus resulted in a sample size of 13,656 participants. After removing individuals with missing data for our outcome or explanatory variables, our final sample consisted of 11,259 respondents.

5.2 Variables

Outcome variable: The variable of interest was the use of CRC screening tests. The CCHS collects information on CRC screening practices through self-reported survey questions. Individuals participating in the survey are asked about various aspects of their health, including preventive health measures such as CRC screening. The survey includes questions related to whether respondents have undergone CRC screening tests (the FOBT, colonoscopy, or sigmoidoscopy) within a specified time frame. Participants are asked about their screening history, frequency of screening, and other relevant details. Based on the available information by the CCHS, the use of CRC screening was classified as a binary outcome. It was assigned a value of one if the respondent has undergone a FOBT within the past two years, or a colonoscopy or sigmoidoscopy within the past ten years; it was assigned a value of zero if none of these screenings have been reported.

SES variable: Household income, which is reported into five income categories (less than \$20,000, \$20,000−39,999, \$40,000−59,999, \$60,000−79,999, \$80,000 and above) was used as the main SES variables. Given that household income was reported as categorical variable in the PUMF data, we assigned the middle value of the respective income categories to all households within those brackets. Following guidelines by Parker and Fenwick (Parker & Fenwick, 1983), which originate from Pareto's law of income distribution, we computed the midpoint for the higher income bracket. Subsequently, we derived equivalized household income by dividing household income by the square root of household size.

Other covariates: As per previous studies on the determinant of CRC screening participation (McGregor and Bryant, 2005; Kerner et al., 2015), other explanatory variables included were sex (male, female), age (50–54, 55-59, 60-64, 65-69, and 70-74 years old), marital status (married, common-law, widowed, divorced, separated, single), educational attainment (less than secondary school graduation, secondary school graduation, and post-secondary certificate diploma or university degree), immigration status (landed immigrant/non-permanent resident, and Canadian born), language of communication with the regular healthcare provider (communication in either of the official languages [English or French], and another language), racial background (white or non-white), access to a usual place for immediate or minor health problems (yes or no), and employment status (employed, retired, and other). Table 5.1 reports the definition of variables used in the study.

Table 5. 1. Definition of variables used in the study

Variables	Descriptions
Outcome variable	
CRC screening	1 = if the respondent has done fecal testing over the past two years or colonoscopy, sigmoidoscopy over the past 10 years; 0 = otherwise.
Explanatory variables	
Sociodemographic Variables	
Age	
50-54	1 = if the respondent is between 50-54 years old; 0 otherwise.
55-59	1 = if the respondent is between 55-59 years old; 0 otherwise.
60-64	1 = if the respondent is between 60-64 years old; 0 otherwise.
65-69	1 = if the respondent is between 65-69 years old; 0 otherwise.
70-74 (*Ref.*)	1 = if the respondent is between 70-74 years old; 0 otherwise.
Sex	
Male	1 = if the respondent is male; 0 if female (*Ref.*).
Race	
White (*Ref.*)	1 = if the respondent is white; 0 otherwise.
Non-white	1 = if the respondent is non-white; 0 otherwise.
Immigration status	
Immigrant	1 = if the respondent is a Landed immigrant or non-permanent resident; otherwise, 0 if Canadian born (*Ref.*).
Marital status	
Married (*Ref.*)	1 = if the respondent is married, 0 otherwise.
Common-law	1 = if the respondent is common-law, 0 otherwise.
Widow, divorced, separated	1 = if the respondent is widowed, divorced, separated, 0 otherwise.
Single	1 = if the respondent is single, 0 otherwise.
Socioeconomic Variables	
Equivalized household income (log)	Household income divided by the square root of the household size (log transformed)
Education level	
Less than secondary school graduation	1 = if the respondent has not completed secondary education; 0 Otherwise.
Secondary school graduation	1 = if the respondent has completed secondary education; 0 Otherwise.
Post-secondary certificate diploma (*Ref.*)	1 = if the respondent has completed post-secondary education; 0 Otherwise.
Employment	
Employed (*Ref.*)	1 = if the respondent is employed; 0 otherwise.
Retired	1 = if the respondent is retired; 0 otherwise.

		Other (e.g., student and unemployed)	1 = if the respondent is student, looking for a job, or not working due to an illness; 0 otherwise.
	Healthcare variables		
	Language of communication with the healthcare provider		
		Official language (*Ref.*)	1 = if the respondent speaks in English or French or both; 0 otherwise.
		Another language	1 = if the respondent speaks in another language; 0 otherwise.
	Knowledge of access to immediate care for minor problem		
		Usual place of care	1 = if the respondent knows a place for immediate care for a minor problem; 0 otherwise (*Ref.*).

Note: *Ref.* indicates reference category in the decomposition analysis; Equivalized household income logged to correct for skewness.

5.3 Statistical Approach

To date, various measures have been proposed to assess inequalities in health. Among these, the index of dissimilarity, the range, the relative index of inequality, the Gini coefficient, and the Concentration index (C) are noteworthy (Nikolaou et al., 2008). As discussed in the literature (Wagstaff et al., 1991) socioeconomic inequality measures in health must meet three fundamental criteria: 1) they should reflect health inequalities arising from socioeconomic factors; 2) they should be representative of the entire population; and 3) they should be sensitive to changes in population distribution across socioeconomic groups. Although the Gini coefficient and the C index are the most employed indices in health inequality research (Nikolaou et al., 2008), as noted by Wagstaff et al. (1991), The C and relative (slope) index of inequality satisfy the three criteria for the appropriate measure of socioeconomic inequalities in health. Thus, this study utilizes the C to examine socioeconomic inequalities in CRC screening participation. Our empirical approach entails two steps: computation of the C and subsequent decomposition of the C to identify factors contributing to income-related inequalities in CRC screening participation.

5.3.1 The Concentration Index

It is widely agreed upon that both relative measures (which stay constant with multiplicative changes) and absolute measures (which stay constant with additive changes) of health inequalities are useful for evaluating social inequalities in health (Asada, 2010; King et al., 2010). Therefore, we employ relative and absolute measures of the C to evaluate income inequalities in CRC screening participation in Ontario, Canada.

The relative (standard) Concentration index (RC) calculation is based on the Concentration curve (CC), which plots the cumulative percentage of a health outcome (here, CRC screening), on its vertical axis versus the cumulative share of the population, ranked based on increasing order of SES (e.g., income), on its horizontal axis (see Figure 5.1). If the entire population has a similar utilization of CRC screening, the curve is a 45-degree (perfect equality) line. If the CC lies above (below) the 45-degree line, the value of the RC is negative (positive) if CRC screening is more concentrated among the low (high) SES groups. Twice the area between the CC and 45-degree line is defined as the RC. The value of the RC varies between -1 to +1, with zero representing "perfect equality" (World Bank, 2017).

The RC for CRC screening can be estimated using the "convenient regression" method as follows (Kakwani et al., 1997):

$$2\sigma_r^2\left(\frac{y_i}{\mu}\right) = \alpha + \beta r_i + \varepsilon_i, \qquad (1)$$

where y_i denotes as individual i's CRC screening use, μ is the mean CRC screening use for the full sample, α is the intercept, and r_i is the individual i's fractional rank in the SES distribution and is calculated as $r_i = i/N$ ($i = 1$ for the lowest SES individual and N for the highest SES individual). The σ_r^2 demonstrates the variance of fractional rank. The ordinary least squares (OLS) estimate of β and its standard error represent the value and standard error for the RC.

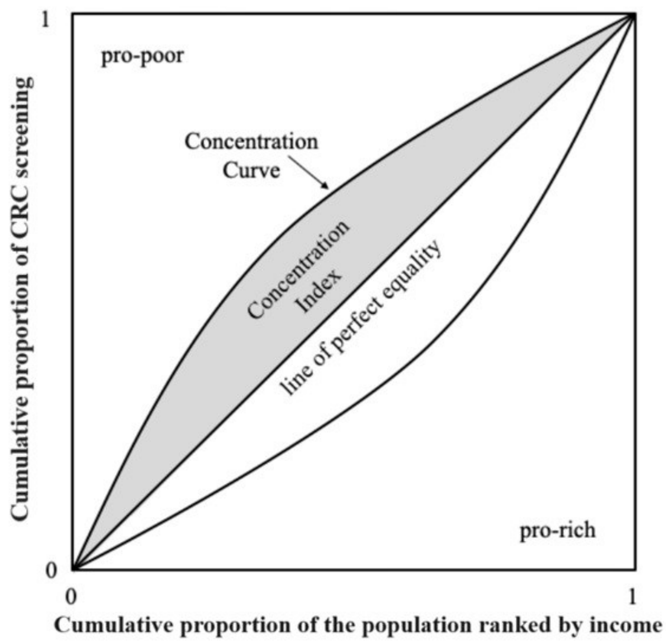

Figure 5.1: A graphical illustration of the Concentration curve for the income-related inequality in CRC screening participation

The value of the RC for a binary outcome creates minimum and maximum values bounded by the positive and negative mean, rather than the (-1, +1) range. To overcome this issue, as suggested by Wagstaff, the RC can normalized by multiplying it by 1/(1- μ). The Wagstaff index (WI) as a measure of relative inequality for binary outcomes can be calculated as follows:

$$\mathrm{WI} = \frac{RC}{1-\mu} \quad (2)$$

The CC can be generalized to capture the absolute variances in CRC screening rates across different SES groups. The generalized CC, obtained by multiplying the original CC by the mean (μ), illustrates the cumulative distribution of the population, arranged by ascending SES, relative to the cumulative CRC screening rates. The absolute Concentration index (AC) is twice the area between this generalized CC and the line representing perfect equality. It is computed by multiplying the RC by μ (Wagstaff et al., 1991). However, the AC value can change with scale transformations of health outcome variables. Thus, Erreygers proposed a modification called the Erreygers Index (EI) to address this issue (Erreygers, 2009). When the outcome variable is binary, the EI can be calculated as follows:

$$EI = 4\mu \times RC. \tag{3}$$

The EI spans from -1 to +1, where zero signifies perfect equality (O'Donnell et al., 2016). The WI and the EI were used to quantify income-related inequality of CRC screening utilization. The WI and EI were also measured for Ontario as a whole and by males and females, separately. The p-value ≤ 0.05 was considered statistically significant in the study.

5.3.2 Decomposition of the Concentration Index

The estimated value of the RC can be decomposed to identify the contribution of explanatory variables to the observed income-realted inequality in health outcomes (Wagstaf, 2003). Wagstaff et al., (2003) indicated that if we have a regression model relating a health outcome variable of y to a set of k explanatory variables, x, such as:

$$y = \alpha + \sum_k \beta_k \, x_k + \varepsilon, \tag{4}$$

the RC for y can be decomposed as (Wagstaff et al., 2003):

$$RC = \sum_k \left(\frac{\beta_k \bar{x}_k}{\mu} \right) RC_k + AC_\varepsilon / \mu. \tag{5}$$

In this equation, $\bar{x}_k$ indicates the mean of the explanatory variable, x , RC_k is the RC for each explanatory variable, and AC_ε shows the AC for ε. In equation 5, the first component

$\sum_k \left(\frac{\beta_k \bar{x}_k}{\mu}\right) RC_k$ indicates the contribution of explanatory variable x to the overall income inequality in the outcome variable. The positive contribution of an explanatory variable explains that the income-related distribution of this variable and its relationship with the utilization of screening tests increase the concentration of the outcome variable in people with higher income. The second component, $\frac{AC_\varepsilon}{\mu}$ indicates the proportion of income inequality in CRC screening utilization which is not explained by the systematic variation of the included explanatory variables across income groups. Applying Wagstaff's correction (Wagstaff, 2005) can yield:

$$\mathrm{WI} = \frac{RC}{1-\mu} = \frac{\sum_k \left(\frac{\beta_k \bar{x}_k}{\mu}\right) RC_k}{1-\mu} + \frac{AC_\varepsilon/\mu}{1-\mu} \qquad (6)$$

The decomposition of the EI can be written as:

$$EI = 4\sum_k (\beta_k \overline{x_k}) RC_k + 4AC_\varepsilon \qquad (7)$$

Using equations 6 and 7, we can estimate the "contribution" of each explanatory factor to the WI and the EI of CRC screening as: $\frac{\sum_k \left(\frac{\beta_k \bar{x}_k}{\mu}\right) RC_k}{1-\mu}$ and $4\beta_k \bar{x}_k RC_k$, respectively. This "contribution" illustrates how much the variation of an explanatory factor across different SES groups and the correlation between determinants and CRC screening can be explained by the observed relationship between SES and CRC screening in Canada. A negative (positive) contribution of an explanatory factor to the WI/EI indicates that the SES distribution of the factor and its association with CRC screening contribute to a concentration of CRC screening among low (high) SES groups. Since CRC screening is binary, we employed marginal effects (ME) derived from the logit model and used as β_k in the decomposition analysis.

We applied the sample weights provided in the CCHS to all analyses to yield estimates representative of the Ontario population. Since existing studies suggest different patterns in CRC screening participation by sex in Canada, our analysis was conducted for the total population as well as for males and females separately (Singh et al., 2015; Lofters et al., 2016). All analyses were performed in Stata 18 (StataCorp. 2022. *Stata Statistical Software: Release 18.* College Station, TX: StataCorp LLC.).

5.4 Ethics

The CCHS data used in this study is publicly available and therefore requires no ethics approval. Prior to releasing the PUMF of the CCHS, Statistics Canada processed the data to ensure the protection of individual identities.

Chapter 6: Results

This chapter presents the findings of the study. The first section details the characteristics of the sample. Descriptive statistics are presented in the subsequent section. The third section reviews the results of WI and EI. Finally, the findings from the decomposition analyses are reported.

6.1 Sample Characteristics

Table 6.1 reports descriptive statistics for variables used in the analysis. Values are reported as the proportion, except for equivalized household income, for which the mean value is reported. The overall CRC screening rate was 72.10%, with females exhibiting a higher rate of 74.40% compared to males at 69.60%. The average equivalized household income for 2017-2018 was $59,839 (SD= $26,326) for all respondents. Individuals aged 50-54 and 55-59 constituted 22.40% and 22.80% of the sample respectively, followed by a gradual decline in representation among older age cohorts. While most of the participants identified as white, non-white individuals comprised 22.40% of the sample. Immigrants constituted 37.11% of the sample. Married individuals accounted for 68.30% of the overall sample. 66.10% of the sample held a post-secondary certificate or diploma. Individuals communicating in languages other than the official language comprised 7.10% of the overall sample. 94.30% indicated knowing a usual place of care.

Table 6.1: Summary statistics of variables used in the study

Variables	Proportion/Mean		
	Total	**Males**	**Females**
Outcome variable			
CRC screening	0.721	0.696	0.744
Explanatory variables			
Sociodemographic variables			
Age			
50-54	0.224	0.225	0.222
55-59	0.228	0.236	0.221
60-64	0.211	0.213	0.210
65-69	0.190	0.181	0.199
70-74 (*Ref.*)	0.144	0.143	0.145
Sex			
Male	0.487	-	-
Female	0.513	-	-
Race			
White (*Ref.*)	0.775	0.756	0.794
Non-white	0.224	0.243	0.205
Immigration status			
Immigrant	0.371	0.376	0.366
Non-immigrant	0.629	0.624	0.634
Marital status			
Married (*Ref.*)	0.683	0.749	0.620
Common-law	0.058	0.06	0.056
Widow, divorced, separated	0.170	0.108	0.229
Single	0.087	0.08	0.093
Socioeconomic variables			
Equivalized household income (log)	10.859	10.874	10.844
Education level			
Less than secondary school graduation	0.098	0.102	0.095
Secondary school graduation	0.239	0.214	0.262
Post-secondary certificate diploma (*Ref.*)	0.661	0.683	0.641
Employment			
Employed (*Ref.*)	0.562	0.600	0.527
Retired	0.384	0.344	0.423
Other	0.052	0.055	0.049
Healthcare variables			
Language of communication			
Official language (*Ref.*)	0.928	0.908	0.948
Another language	0.710	0.091	0.051
Usual place of care	0.943	0.923	0.959

Note: *Ref.* indicates reference category in the decomposition analysis.

6.2 CRC Screening Participation among Ontario residents

Table 6.2 presents the distribution of CRC screening participation within different demographic and socioeconomic subgroups alongside associated chi-square p-values reflecting the statistical significance of observed differences.

Exploring sociodemographic variables reveals notable differences in CRC screening uptake across various age groups. Individuals aged 50-54 had the lowest CRC screening proportion at 56.80%, compared to other age groups. Significant differences in CRC screening participation were observed among the various age categories, with a notable monotonic increase in screening proportions among males as age increased. This increase does not follow a specific pattern in females. Female participants demonstrated a marginally higher proportion of CRC screening at 74.40% compared to male participants at 69.60%.

Differences in CRC screening participation were observed across racial and immigration status categories, with white individuals (75.20%) and those born in Canada (75.60%) demonstrating higher screening proportion. Married individuals (72.90%), those with higher educational attainment with a post-secondary certificate or diploma (73.60%) and retired respondents (69.30%) exhibited a higher proportion of screening. Individuals who communicate in languages other than the official language (52.50%) as well as those without a regular place of care (56.80%) had lower screening proportions. CRC screening proportion among male and female residents of Ontario, when analyzed by respondent characteristics, show a consistent pattern with the overall sample. In each category, males demonstrated a lower screening proportion compared to their female counterparts.

Table 6.2: Proportion of CRC screening among Ontario residents by the characteristics of respondents

Variables	Total		Male		Female	
	Proportion	**p-value**	**Proportion**	**p-value**	**Proportion**	**p-value**
Sociodemographic variables						
Age						
50-54	0.568	<0.001	0.530	< 0.001	0.604	< 0.001
55-59	0.731		0.704		0.758	
60-64	0.778		0.776		0.780	
65-69	0.773		0.745		0.797	
70-74 (*Ref.*)	0.790		0.764		0.814	
Sex						
Male	0.696	< 0.001	-		-	
Female	0.744		-		-	
Race						
White (*Ref.*)	0.752	< 0.001	0.734	< 0.001	0.768	< 0.001
Non-white	0.614		0.580		0.652	
Immigration status						
Immigrant	0.661	< 0.001	0.631	< 0.001	0.690	< 0.001
Canadian born (*Ref.*)	0.756		0.736		0.776	
Marital status						
Married (*Ref.*)	0.729	< 0.001	0.707	< 0.001	0.753	< 0.001
Common-law	0.722		0.667		0.779	
Widow, divorced, separated	0.720		0.677		0.740	
Single	0.661		0.643		0.675	
Socioeconomic variables						
Education level						
Less than secondary school graduation	0.649	< 0.001	0.605	< 0.001	0.695	< 0.001
Secondary school graduation	0.708		0.679		0.730	
Post-secondary certificate diploma (*Ref.*)	0.736		0.715		0.758	
Employment						
Employed (*Ref.*)	0.693	< 0.001	0.684	< 0.001	0.702	< 0.001
Retired	0.779		0.744		0.805	
Other	0.600		0.536		0.669	
Healthcare variables						

Language of communication with the healthcare provider						
Official language (*Ref.*)	0.736	< 0.001	0.715	< 0.001	0.755	< 0.001
Another language	0.525		0.508		0.555	
Usual place of care						
Know	0.730	< 0.001	0.706	< 0.001	0.752	< 0.001
Not know (*Ref.*)	0.568		0.573		0.560	

Note: *Ref.* indicates reference category in the decomposition analysis. p-values are based on Chi-squared test.

6.3 Socioeconomic Inequalities in CRC Screening Participation

Figures 6.1 presents the CCs for CRC screening participation in the total population of Ontario, with separate curves for males and females. The CCs are depicted below the line representing perfect equality, which suggests that CRC screening is disproportionately higher among individuals with higher income Ontario residents.

Table 6.3 reported the WI and the EI for CRC screening uptake among residents of Ontario, Canada. The WI values revealed a noteworthy degree of income-related inequality in CRC screening participation. The estimated value for the WI was 0.184 (95% confidence interval [CI]: 0.161 to 0.207) for the total population, indicating a concentration of CRC screening among rich individuals. This trend is further pronounced when disaggregated by sex, with males exhibiting a higher WI value of 0.236 (95% CI: 0.204 to 0.270) compared to females at 0.135 (95% CI: 0.103 to 0.168). The difference between the WI values for males and females, calculated at 0.101, emphasizes a significant difference income-related inequality in CRC screening uptake among those with higher SES, with males experiencing a greater socioeconomic inequality in CRC screening.

Similarly, the EI highlights the presence of income-related inequality in CRC screening participation. With a value of 0.147 (95% CI: 0.129 to 0.167) for the total population, the index indicates a disproportionate concentration of CRC screening among individuals with higher SES. When analyzed by sex, males displayed a higher EI value of 0.200 (95% CI: 0.172 to 0.228) compared to females at 0.103 (95% CI: 0.078 to 0.128), suggesting a pronounced sex difference in CRC screening uptake among higher socioeconomic groups. The difference between the EI values for males and females, calculated as 0.097, emphasized the variation in income-related inequality in CRC screening participation by sex.

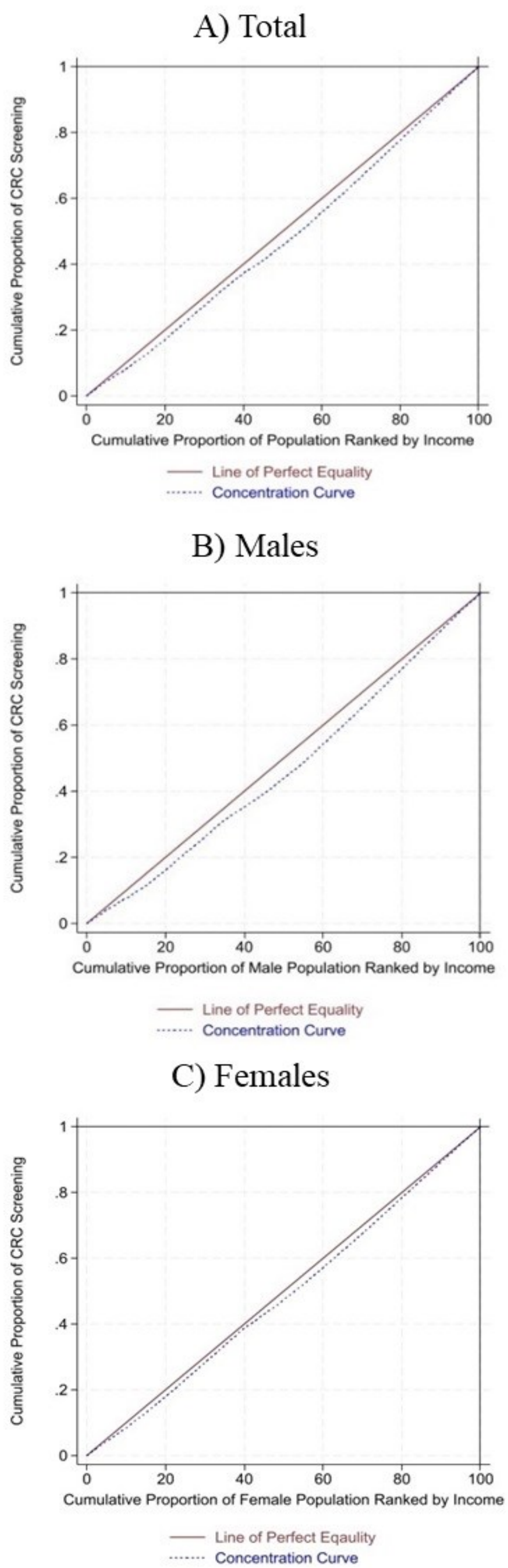

Figure 6.1: Concentration Curves for CRC Screening in Ontario, Canada

Table 6.3: Concentration Index for CRC screening in Ontario, Canada

Index	Total (95% confidence interval)	Males (95% confidence interval)	Females (95% confidence interval)	Difference between Males and Female (p-value)
The Wagstaff Index (WI)	0.184 (0.161 to 0.207)	0.236 (0.204 to 0.270)	0.135 (0.103 to 0.168)	0.101 (< 0.001)
The Erreygers Index (EI)	0.147 (0.129 to 0.167)	0.200 (0.172 to 0.228)	0.103 (0.078 to 0.128)	0.097 (< 0.001)

6.4 Decomposition of Socioeconomic Inequalities in CRC Screening Participation

Tables 6.4–6.6 present the results of the decomposition analysis of income-related inequality in in CRC screening uptake in the total population of Ontario, with separate results for males and females. These tables report marginal effects (ME) obtained from logit model, the elasticities, the RC_k of the explanatory variables, and the contribution of explanatory variables to the WI/EI.

As shown by the marginal effects detailed in Table 6.4, certain demographic and socioeconomic factors are statistically significantly associated with CRC screening uptake. Individuals aged 50-54 show a markedly lower participation rate (ME: -0.212, $p< 0.001$) in CRC screening compared to those in the 70-74 age group. Sex differences are also pronounced, with males demonstrating a lower likelihood of undergoing screening (ME: -0.039, $p< 0.05$) compared to females. As illustrated by the positive ME of equivalized household income (ME: 0.085, $p< 0.001$), income demonstrated a positive association with CRC screening uptake. Individuals having less than a secondary school education showing significantly lower participation rates (ME: -0.085, $p< 0.001$). Education attainment shows greater impact on CRC screening participation in males. For instance, the likelihood of males who have not completed secondary school education compared to those with a post-secondary certificate or diploma to participate less in screening (ME: -0.108, p< 0.01) was greater than that among females (ME: -0.069, p< 0.05). Communication barriers (ME: -0.114, p< 0.01), and knowing a usual place of care (ME: 0.139, p< 0.001) are significant factors in the use of CRC screening. Those who communicate in languages other than Canada's official languages and those without a regular place of care are less likely to participate in screening.

The RC_k provide insight into how certain determinants were distributed across different income groups. The negative RC_k values for variables such as non-white, immigrants, widow, divorced, separated, lower educational attainment, or speak a language other than the official languages with the healthcare provider are mainly concentrated among low-income residents. Conversely, being male and having a common-law partner, as well as knowing a usual place of care, were characteristics more frequently associated with high-income residents.

Based on the contribution results, income, independent of other factors, stands out as the most significant contributor accounting for 71.73% of the overall income-related inequality in CRC screening participation. Apart from income, education also plays a crucial role, accounting for 8.20% of the concentration of CRC screening among high income residents in Ontario, Canada. Language of communication contributes significantly (4.39%) to the lower utilization of CRC screening among the poor, leading to a higher concentration of screening uptake among high-income residents in Ontario, Canada. Education and proficiency in the official language exacerbate pro-rich inequality in CRC screening participation, as these factors, more prevalent among high-income individuals (see negative RC_k values for lower educational levels and non-official languages), are associated with increased screening rates (see negative ME for these variables). The decomposition analysis suggested the residual explains 8.21% of total income-related inequality in CRC screening uptake. This suggests that there are additional factors influencing the socioeconomic distribution of CRC screening uptake that our model does not account for or control.

Table 6.4: Decomposition of income-related inequality in CRC screening among total population in Ontario, Canada

Variables		**Marginal effects**	**Mean**	**Elasticities**†	***RC_K***	**Contribution to the *WI***		**Contribution to the *EI***		***% sum* for the WI/EI**‡
						Absolute	***Sum***	***Absolute***	***Sum***	
Sociodemographic variables										
Age										
	50-54	-0.2123***	0.2240	-0.0659	-0.0099	0.0023		0.0018		
	55-59	-0.0745*	0.2288	-0.0236	0.0446	-0.0037		-0.0030		
	60-64	-0.0225	0.2118	-0.0066	0.0388	-0.0009		-0.0007		
	65-69	-0.0302	0.1908	-0.0079	-0.0053	0.0001	-0.0022	0.0001	-0.0017	-1.20
	70-74 (*Ref.*)									
Sex										
	Male	-0.0397*	0.4870	-0.0267	0.0104	-0.001		-0.0008		-0.55
	Female (*Ref.*)									
Race										
	White (*Ref.*)									
	Non-white	-0.0458	0.2242	-0.0142	-0.1454	0.0074		0.0059		4.05
Immigration status										
	Immigrant	-0.0360	0.3716	-0.0185	-0.0797	0.0053		0.0042		2.88
	Canadian born (*Ref.*)									
Marital status										
	Married (*Ref.*)									
	Common-law	-0.0117	0.0584	-0.0009	0.0618	-0.0002		-0.0001		
	Widow, divorced, separated	-0.0085	0.1705	-0.0020	-0.193	0.0014		0.0011		
	Single	-0.0235	0.0873	-0.0028	-0.2079	0.0021	0.0033	0.0017	0.0026	1.87
Socioeconomic variables										

Equivalized household income (log)	0.0851***	10.8594	1.2807	0.0287	0.1319		0.1061		71.73
Education level									
Less than secondary school graduation	-0.0856***	0.0988	-0.0117	-0.2901	0.0122		0.0098		
Secondary school graduation	-0.0362*	0.2392	-0.0120	-0.0664	0.0028	0.0150	0.0023	0.0121	8.20
Post-secondary certificate diploma (*Ref.*)									
Employment									
Employed (*Ref.*)									
Retired	0.0187	0.3849	0.0099	-0.0570	-0.0020		-0.0016		
Other	-0.0224	0.0520	-0.0016	-0.4542	0.0026	0.0005	0.0021	0.0004	1.44
Healthcare variables									
Language of communication									
Official language (*Ref.*)									
Another language	-0.1142**	0.0710	-0.0112	-0.2002	0.0080		0.0064		4.39
Usual place of care									
Know	0.1301***	0.9433	0.1701	0.0005	0.0003		0.0002		0.17
Sum						0.1688		0.1357	91.79
Residual						0.0151		0.0121	8.21
The WI/EI						0.1840		0.1479	100

Notes: Marginal effect calculated at mean values of explanatory variables; *Ref.* indicates reference category in the regression analysis.
*, **, *** denotes for the p-values; $P \leq 0.05$, $P \leq 0.01$, and $P \leq 0.001$, respectively.
† "Elasticity" is not a fully correct term for the income variable because it is measured in log rather than level.
‡ Percentage contributions were calculated by dividing the corresponding "summed" contribution by the absolute values of WI/EI. Percentage summed contributions for educational attainment factor in 2017-2018, for example, indicates that addressing education inequalities among total population in Ontario could potentially reduce 8.20% of the observed income-related inequality in CRC screening participation.

Tables 6.5 and 6.6 present the results of decomposing income-related inequality in CRC screening for males and females in Ontario, respectively, providing insights into sex-specific dynamics. Similar to the findings from the overall sample, the language of communication similarly contributed to the income-related inequality in CRC screening for both sexes, accounting for a 4.72% contribution in males and a 4.01% contribution in females.

Significant differences are apparent in the effects of income and education on the income-related inequality in CRC screening participation. The role of income on income-related inequality of CRC screening uptake is less pronounced among males. Despite these differences, income is the predominant factor driving the observed income-related inequality in CRC screening in both sexes, contributing 61.71% to the inequality in males and 87.81% in females.

Similarly, the contribution of educational attainment to income-related inequality in CRC screening also differs by sex. The impact of education on income-related inequality in CRC screening shows sex-specific variations, contributing 5.74% for males and 12.14% for females to the overall pro-rich distribution in CRC screening in Ontario. Furthermore, immigration status presents distinct sex-based differences in CRC screening rates. In males, immigrant status accounts for a 2.09% contribution to the pro-rich inequality in CRC screening, while for females, it has a marginally higher impact, contributing 3.44%. The results also show varying contributions of residuals between males and females. The contribution of residuals is 12.96% for males, whereas for females, it accounts for 1.41% of the observed income-related inequality in CRC screening in Ontario.

Table 6.5: Decomposition of income-related inequality in CRC screening among males in Ontario, Canada

Variables	**Marginal effects**	**Mean**	**Elasticities**†	***RC_K***	**Contribution to the *WI***		**Contribution to the *EI***		***% sum* for the WI/EI**‡
					Absolute	***Sum***	***Absolute***	***Sum***	
Sociodemographic variables									
Age									
50-54	-0.2311***	0.2252	-0.0747	-0.0423	0.0104		0.0088		
55-59	-0.0778	0.2365	-0.0264	0.0174	-0.0015		-0.0012		
60-64	0.0010	0.2133	0.0003	0.0508	5.2705		4.4605		
65-69	-0.0275	0.1817	-0.0071	0.0235	-0.0005	0.0084	-0.0004	0.0071	3.55
70-74 (*Ref.*)									
Race									
White (*Ref.*)									
Non-white	-0.0717	0.2435	-0.0270	-0.1488	0.0123		0.0103		5.20
Immigration status									
Immigrant	-0.0282	0.3769	-0.0152	-0.0982	0.0049		0.0041		2.09
Canadian born (*Ref.*)									
Marital status									
Married (*Ref.*)									
Common-law	-0.0387	0.0607	-0.0033	0.0104	-0.0001		-9.9005		
Widow, divorced, separated	-0.0165	0.1089	-0.0025	-0.1124	0.0009		0.0008		
Single	-0.0075	0.0806	-0.0008	-0.2400	0.0006	0.0015	0.0005	0.0012	0.64
Socioeconomic variables									
Equivalized household income (log)	0.1023***	10.8749	1.5970	0.0277	0.1461		0.1234		61.71
Education level									

Less than secondary school graduation	-0.1089**	0.1025	-0.0160	-0.2245	0.0118		0.0100		
Secondary school graduation	-0.0331	0.2143	-0.0101	-0.0516	0.0017	0.013599	0.0014	0.0114	5.74
Post-secondary certificate diploma (*Ref.*)									
Employment									
Employed (*Ref.*)									
Retired	-0.0123	0.3443	-0.0060	-0.0499	0.0009		0.0008		
Other	-0.0536	0.0552	-0.0042	-0.4800	0.0067	0.0077	0.0056	0.0065	3.26
Healthcare variables									
Language of communication									
Official language (*Ref.*)									
Another language	-0.1112*	0.0917	-0.0146	-0.2314	0.0111		0.0094		4.72
Usual place of care									
Know	0.1208	0.9261	0.1605	0.0005	0.0002		0.0002		0.12
Sum						0.2060		0.1741	87.04
Residual						0.0306		0.0259	12.96
The WI/EI						0.2367		0.2001	100

Notes: Marginal effect calculated at mean values of explanatory variables; *Ref.* indicates reference category in the regression analysis.
*, **, *** denotes for the p-values; P ≤ 0.05, P ≤ 0.01, and P ≤ 0.001, respectively.
† "Elasticity" is not a fully correct term for the income variable because it is measured in log rather than level.
‡ Percentage contributions were calculated by dividing the corresponding "summed" contribution by the absolute values of WI /EI. Percentage summed contributions for educational attainment factor in 2017-2018, for example, indicates that addressing education inequalities among males in Ontario could potentially reduce 5.74% of the observed income-related inequality in CRC screening participation.

Table 6.6: Decomposition of income-related inequality in CRC screening among females in Ontario, Canada

Variables		**Marginal effects**	**Mean**	**Elasticities**†	RC_K	**Contribution to the *WI***		**Contribution to the *EI***		***% sum* for the WI/EI** ‡
						Absolute	***Sum***	***Absolute***	***Sum***	
Sociodemographic variables										
Age										
	50-54	-0.1914***	0.2229	-0.0573	0.0190	-0.0042		-0.0032		
	55-59	-0.0724	0.2215	-0.0215	0.0681	-0.0057		-0.0043		
	60-64	-0.0446	0.2104	-0.0126	0.0288	-0.0014		-0.0010		
	65-69	-0.0332	0.1993	-0.0088	-0.0256	0.0008	-0.0105	0.0006	-0.0080	-7.78
	70-74 (*Ref.*)									
Race										
	White (*Ref.*)									
	Non-white	-0.0253	0.2059	-0.0070	-0.1446	0.0039		0.0030		2.93
Immigration status										
	Immigrant	-0.0385	0.3666	-0.0189	-0.0627	0.0046		0.003		3.44
	Canadian born (*Ref.*)									
Marital status										
	Married (*Ref.*)									
	Common-law	0.0196	0.0563	0.0014	0.1112	0.0006		0.0004		
	Widow, divorced, separated	-0.0072	0.2290	-0.0022	-0.2197	0.0018		0.0014		
	Single	-0.0318	0.0936	-0.004	-0.1804	0.0028	0.0053	0.0021	0.0040	3.96
Socioeconomic variables										
Equivalized household income (log)		0.0706***	10.8446	1.0278	0.0295	0.1191		0.0905		87.81
Education level										

Less than secondary school graduation	-0.0695*	0.0952	-0.0088	-0.3561	0.0124		0.0094		
Secondary school graduation	-0.0391	0.2629	-0.0137	-0.0753	0.0040	0.0164	0.0030	0.0125	12.14
Post-secondary certificate diploma (*Ref.*)									
Employment									
Employed (*Ref.*)									
Retired	0.0463	0.4234	0.0263	-0.0594	-0.0061		-0.0046		
Other	0.0143	0.0490	0.0009	-0.4316	-0.0015	-0.0077	-0.0012	-0.0058	-5.69
Healthcare variables									
Language of communication									
Official language (*Ref.*)									
Another language	-0.1238*	0.0513	-0.0085	-0.1626	0.0054		0.0041		4.01
Usual place of care									
Know	0.1433***	0.9596	0.1846	0.0011	0.0008		0.0006		0.69
Sum						0.1376		0.1046	101.41%
Residual						-0.0019		-0.0014	-1.41%
The WI/EI						0.1356		0.1031	100

Notes: Marginal effect calculated at mean values of explanatory variables; *Ref.* indicates reference category in the regression analysis.
*, **, *** denotes for the p-values; P ≤ 0.05, P ≤ 0.01, and P ≤ 0.001, respectively.
[†] "Elasticity" is not a fully correct term for the income variable because it is measured in log rather than level.
[‡] Percentage contributions were calculated by dividing the corresponding "summed" contribution by the absolute values of WI/EI. Percentage summed contributions for educational attainment factor in 2017-2018, for example, indicates that addressing education inequalities among females in Ontario could potentially reduce 12.14% of the observed income-related inequality in CRC screening participation.

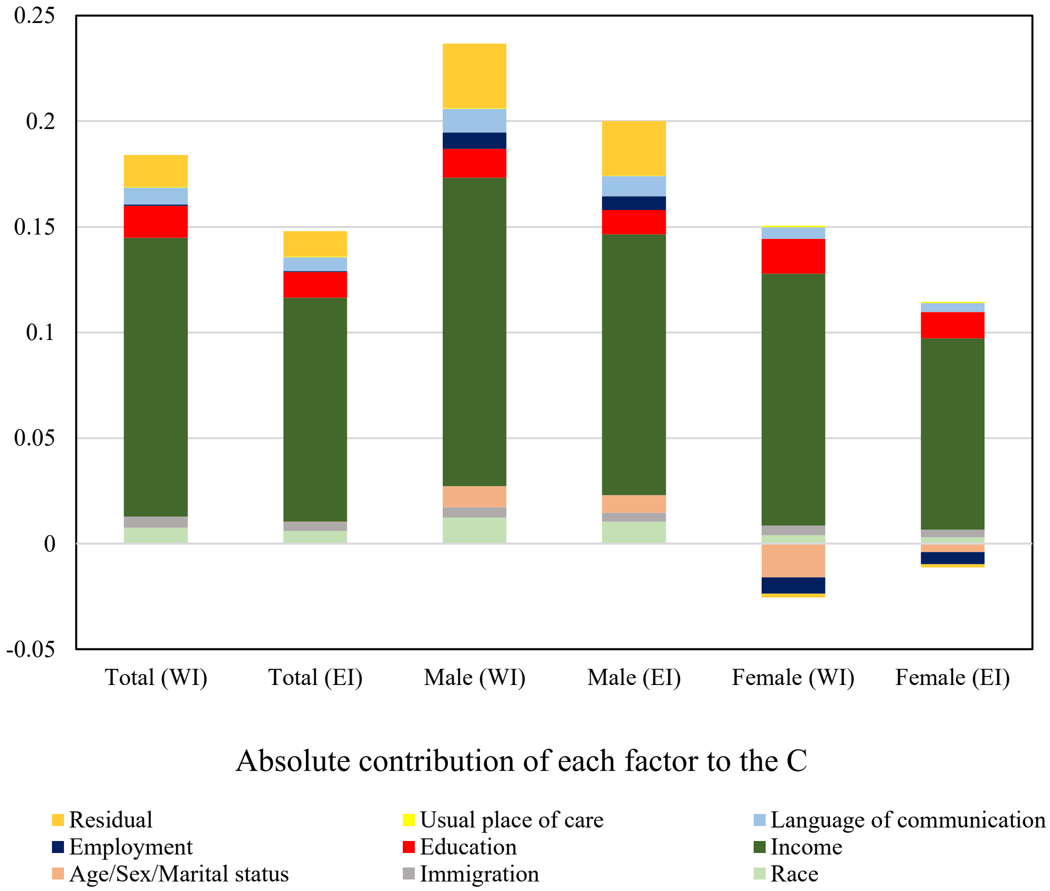

Figure 6.2: Contribution of each factor to income-related inequality in CRC screening in Ontario, Canada

Figure 6.2 illustrates the absolute contribution of each factor to the observed income-related inequalities in CRC screening participation. As shown in the figure, income, education, and language of communication are the three main factors contributing to pro-rich inequality in CRC screening in Ontario, Canada.

Chapter 7: Discussion and Conclusions

This chapter discusses the key findings of the study, highlighting its strengths and limitations. Subsequently, it offers a conclusion derived from the findings.

7.1 Discussion

This study sought to investigate socioeconomic inequalities in CRC screening participation within Ontario, Canada. The findings revealed variations in CRC screening rates among different demographic and socioeconomic groups. A pronounced pro-rich inequality in CRC screening participation was observed in Ontario, with such inequality being more significant among males than their female counterparts. Factors such as income, education, and language of communication with healthcare provider were identified as key contributors to the observed inequalities in CRC screening participation among the study population.

The descriptive results suggest a sex gap in CRC screening participation, with females exhibiting a higher rate of screening compared to males. These findings are consistent with previous Canadian research (Singh et al., 2015), which reported that 55.2% of Canadians aged 50–74 years were up to date with CRC screening in 2012, with females showing slightly higher participation rates. This contrasts with the study conducted by Valery et al. (2020) in the USA, where no significant difference was found in the rate of initial colon cancer screening between females (83.0%) and males (80.9%) in either unadjusted or multivariable analysis adjusting for potential confounding variables. In contrast, another US-based study assessing 30,000 participants in California reported that females undergo less CRC screening compared to males (Yager et al., 2011). The sex gap in CRC screening highlights the need for sex-tailored approaches to ensure equitable access to CRC screening services.

The rates of CRC screening uptake were found to be different across various sociodemographic and socioeconomic groups. Age, race, immigration status, marital status, income, education level, and employment status all demonstrate significant associations with CRC screening participation. Older individuals, non-white race, immigrants, and those with lower income are consistently found to have lower screening rates. In alignment with our findings, an analysis of the CCHS data from 2005, 2007-2008, and 2011-2012 – corresponding to the periods before, during, and after the ColonCancerCheck program implementation in Ontario – indicates that both recent immigrants (those who arrived in Canada within the last 0-9 years) and long-term immigrants (those who have been in Canada for 10 years or more) were more likely to be nonadherent with CRC screening guidelines compared to the Canadian-born populace (Moustaqim-Barrette et al., 2019).

Previous international studies examining racial inequalities in CRC screening have yielded varied results depending on the demographic characteristics of the study populations. National survey data from the United States in the year 2000 showed that Hispanic individuals and those identifying as black had lower odds of being current with CRC screening compared to their non-Hispanic and white counterparts (James et al., 2006). Ananthakrishnan et al. (2007) observed that non-white Medicare patients were less likely to undergo screening for colonoscopy in the initial years following Medicare coverage. However, Doubeni et al. (2009) did not find significant differences between Hispanic or those identifying as black compared to white people in a Medicare cohort after adjusting for socioeconomic factors. A study conducted by El-Haddad et al. (2015) observed individuals living in the USA who were married and had an increase in undergoing CRC screening in comparison to individuals in other marital status groups.

The findings of this study also indicate that language barriers and lack of regular access to healthcare services as significant factors influencing CRC screening uptake. Individuals communicating in languages other than the two official languages and those without a usual place of care exhibit lower screening rates, highlighting the importance of addressing linguistic and structural barriers in healthcare delivery. Efforts to enhance language access and improve culturally competent care are essential for ensuring equitable access to CRC screening services for all residents.

When patients and healthcare providers do not share a common language, there is a higher risk of miscommunication. This can lead to misunderstandings about the importance of CRC screening, the procedures involved, and the potential risks and benefits. Patients may struggle to comprehend complex medical terminology and instructions provided in a language in which they are not fluent (Lee et al., 2023). Language plays a significant role in CRC screening (Menon et al., 2014; Thompson et al., 2014; Manne et al., 2021; Mukherjea et al., 2022; Palmer et al., 2015; Rastogi et al., 2019). Thompson et al. (2014) observed that a lack of concordance between patient and physician languages notably decreased the likelihood of undergoing CRC screening. Mukherjea et al. (2022) found that nonadherence to CRC screening, as per the guidelines of the United States Preventive Services Task Force (USPSTF), was lower among South Asians who primarily not spoke English at home. A systematic review by Lee et al. (2023) showed that South Asians population, comprising individuals from India, Pakistan, Bangladesh, Bhutan, and Nepal residing in countries such as Canada, Hong Kong, the United Kingdom, the United States, and Australia, generally have low rates of CRC screening. Key factors contributing to these low rates among South Asians include a limited understanding or awareness of CRC and its screening processes, a lack of physician recommendations, and a range of psychological and sociodemographic factors such as fear, anxiety, shame, and language barriers.

Healthcare institutions often provide CRC screening materials in various languages. This helps ensure that patients from diverse linguistic backgrounds have access to understandable information, which is crucial for informed decision-making about their health (Percac-Lima et al., 2009). Many healthcare settings offer interpreter services to facilitate communication during medical appointments and procedures. This includes in-person, over-the-phone, or video interpreting services. Ensuring that patients can communicate effectively with their healthcare providers in their preferred language is vital to avoid misunderstandings that could affect their care (Espinoza et al., 2021). Programs like the Culturally Tailored Navigator Intervention Program for CRC screening employ navigators who assist patients through the screening process. These navigators are often bilingual and culturally competent, helping to bridge the gap between different languages and cultural nuances. They support patients by providing education, scheduling screenings, and even accompanying them to appointments if necessary (Percac-Lima et al., 2009).

The study's results indicate a pro-rich inequality in CRC screening participation among Ontario residents, with a more pronounced inequality among males compared to females. An analysis of Canadian literature from 2011 reveals that income consistently emerges as the most significant factor influencing cancer screening (Maddison et al, 2011). More recent evidence also suggested that income inequalities persist in the utilization of FOBT in Canada (Decker et al., 2016), as well as in staying up to date with CRC screening (Singh et al., 2015).

In theory, organized screening programs are expected to offer fair access to screening services compared to opportunistic screening. A systematic review evaluating the effectiveness of interventions aimed at improving CRC screening provides some indication that organized screening can diminish socioeconomic inequalities in screening (Senore et al., 2015). As organized screening programs for CRC become more established in Canada, it is anticipated that these initiatives will effectively boost participation rates (Brenneret al., 2020). It is expected that the establishment of organized screening programs will significantly increase participation rates, particularly among low SES groups. Consequently, this should result in a decline in socioeconomic inequalities in CRC incidence rates. Notably, organized programmatic FOBT screening has already demonstrated its effectiveness in reducing income inequalities in screening within a Canadian jurisdiction (Decker et al., 2016). However, according to a national study utilizing data from the CCHS, individuals with higher income levels are more likely to stay up to date with CRC screening compared to those in lower income groups, even in provinces where population-based programmatic screening is in place (Singh et al., 2015). The differences noted in screening rates based on income were more pronounced in provinces with organized screening programs. An assessment of Ontario's organized CRC screening program revealed that income-related inequalities in CRC screening persisted even after its implementation (Honein-AbouHaidar et al., 2013).

Despite CRC screening being offered at no direct cost through Canada’s public healthcare system, the observed pro-rich inequality in our study indicates underlying financial and non-financial barriers that hinder equitable utilization of screening services. These barriers are evident both within and beyond the healthcare system, including broader expenses associated with accessing healthcare services. Within the healthcare system, anything not covered by

Canada's public healthcare could potentially pose a financial obstacle to utilization. For instance, medication expenses exacerbate inequality in healthcare use, as individuals with low incomes are less inclined to seek treatment if they cannot afford the associated medication costs (Gemmill et al., 2008). Moreover, there are logistical challenges associated with accessing healthcare, such as time away from employment, transportation issues, and childcare responsibilities (Levesque et al., 2013). Additionally, when addressing barriers to CRC screening, psychosocial and behavioral factors come into play. Individuals who harbor mistrust towards the healthcare system, have encountered negative experiences with healthcare in the past, or are unfamiliar with the structure and terminology of the Canadian healthcare system may refrain from seeking necessary care (Tang et al., 2015). The levels of pro-rich inequality in CRC screening participation in Canada likely stem from a combination of these factors, with distinct considerations for different individuals and populations. These findings indicate the need for tailored interventions that address the specific barriers faced by these vulnerable populations, including targeted outreach programs, culturally sensitive communication strategies, and improved access to screening services in underserved communities.

The results of the decomposition analysis of the WI/EI further elucidate some of the above-mentioned factors contributing to pro-rich inequalities in CRC screening participation in Ontario. Income, education, and language of communication appear to be key determinants of income-related inequality in CRC screening uptake. These findings suggest the necessity for holistic strategies to mitigate socioeconomic inequalities in CRC screening, including targeted outreach to lower-income and less-educated populations (Issaka and Dominitz, 2021, Facciorusso et al., 2021).

Given that income itself was identified as the main factor driving pro-rich inequality in CRC screening uptake, the implementation of financial support could be crucial in enhancing and reducing inequality in screening rates within the healthcare system. Several strategies can be implemented to encourage individuals to undergo screening. Cash incentives, such as monetary rewards upon completion of screening tests, directly motivate participation by addressing financial barriers outside the health care system. Culturally tailored educational programs could also potentially improve socioeconomic inequality in CRC screening participation. Several studies have investigated the impact of various interventions on increasing CRC screening, highlighting positive effects on screening behavior. Cullerton et al. (2016) emphasized that educational programs enhance attitudes, knowledge about CRC, and intent toward CRC screening. After the education session, participants' interest in undergoing FOBT screening doubled. (Cullerton et al., 2016). In a study by Manne et al. (2021), one-on-one sessions were highly regarded by participants, demonstrating an increase in knowledge and decreased barriers to screening, such as worries about the screening process. Physician-led presentations on CRC screening (Mukherjea et al., 2020) demonstrated a positive impact on previously unscreened individuals. The distribution of culturally sensitive brochures (Mukherjea et al., 2020) increased awareness of CRC screenings among family and friends. So et al. (2022) illustrated that a multifaceted intervention, including CRC screening presentations, distribution of booklet information translated into multiple languages, and targeting younger family members to encourage older family members to undergo CRC screening, led to higher FIT rates among participants in the intervention group compared to the control group. Community-based education events have also proven effective in increasing knowledge and improving attitudes toward CRC screening. A follow-up conducted 6-12 months after the intervention revealed the positive effect of the intervention, with a high uptake in CRC screening being the result (Wu et al., 2010). Lofters et al. (2017) demonstrated that Health Ambassadors, making phone calls to patients overdue for CRC screening at certain physician offices reached a larger population compared to Health Ambassadors providing education at physician's offices.

Although language of communication with healthcare providers is not as significant a contributor as income or education in the decomposition results, it still accounts for an estimated 5% of the pro-rich distribution observed in CRC screening. Removing language barrier for low-income Ontario residents not only directly enhances healthcare equity but also significantly contributes to reducing socioeconomic inequalities in CRC screening rates. This initiative tackles the root causes of healthcare inequality by ensuring that all individuals, irrespective of language proficiency, have equal access to life-saving screening. Such inclusive health policies empower underrepresented communities, leading to increased participation in CRC screening programs. Consequently, this diminishes the gap in screening rates between different socioeconomic groups, thereby contributing to the overall goal of reducing health inequalities.

It is important to acknowledge some limitations in this study that should be considered when evaluating the findings. First, our study relies on data from the most recent PUMF of CCHS for 2017-2018, potentially missing out on recent shifts in CRC screening behaviors. Considering the widespread impact of Covid-19 since early 2020, affecting various facets of our lives, including behaviors, policies, and routines, I suggest conducting research using post-pandemic era data to ensure relevance and accuracy. Second, the study focused on the likelihood of undergoing CRC screening rather than the frequency of its use. By converting utilization into a binary outcome, there is an implicit assumption that all individuals utilize screening healthcare services to the same extent. Consequently, this does not offer insight into which individuals constitute the bulk of healthcare use for CRC screening. Third, the choice of variables in this study was constrained by their availability in the CCHS, resulting in a non-comprehensive representation of all factors that may explain CRC screening behaviors. This was particularly evident among males, where the contributions of the residual component to income-related inequalities in CRC were significant. This implies that other factors not accounted for in our models, such as geographic accessibility and cultural beliefs and practices, influence income-related inequalities in CRC among females (Lian et al., Palmer et al., 2014; Brown et al., 2019). Lastly, focusing solely on Ontario may restrict the generalizability of results to other provinces, overlooking regional variations in screening behaviors and socioeconomic factors as the population of Ontario differs in SES and healthcare delivery when compared to other provinces in Canada.

7.2 Conclusion

Although CRC screening programs are free at the point of care in Ontario, this study indicated pro-rich inequality in CRC screening participation. Decomposition of socioeconomic inequalities reveals the multifaceted nature of factors contributing to CRC screening uptake. While income emerges as a major contributor to income-related inequality, factors such as education and language also play significant roles. These findings indicate the presence of barriers both within and beyond the healthcare system to CRC screening uptake in Ontario. There are some strategies to address the identified barriers and reduce pro-rich inequalities in CRC screening participation in Ontario. Implementing multilingual health promotion campaigns and ensuring that screening information, consent forms, and navigation services are available in multiple languages can help overcome language barriers. Tailored public health campaigns that target populations with lower levels of education or awareness about CRC screening can increase knowledge and uptake. These campaigns can be designed to highlight the benefits of early detection and address common misconceptions about CRC screening. Employing professional interpreters within healthcare settings can also improve communication and understanding of CRC screening importance among non-English or non-French speaking populations. Initiatives that address the broader determinants of healthcare use, such as income support programs or subsidized transportation for low-income individuals, can mitigate the indirect costs associated with accessing healthcare services, including time off work and travel expenses. Together, these strategies can significantly contribute to reducing pro-rich inequality in CRC screening participation, leading to earlier detection, treatment, and potentially better outcomes for individuals across all socioeconomic groups.

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