Manitoba Centre for Health Policy

Gastrointestinal Endoscopy (GIE) Utilization in Manitoba

Winter 2021

Lisa M. Lix, PhD
Harminder Singh, MD, MPH
Shelley Derksen, MSc
Monica Sirski, PhD
Scott McCulloch, MA

University of Manitoba | Rady Faculty of Health Sciences

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Manitoba Centre for Health Policy
University of Manitoba
Max Rady College of Medicine
Rady Faculty of Health Sciences

408-727 McDermot Avenue
Winnipeg, Manitoba, Canada
R3E 3P5

Tel: (204) 789-3819
Fax: (204) 789-3910
Email: reports@cpe.umanitoba.ca

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The Manitoba Centre for Health Policy (MCHP) is located within the Department of Community Health Sciences, Max Rady College of Medicine, Rady Faculty of Health Sciences, University of Manitoba. The mission of MCHP is to provide accurate and timely information to healthcare decision-makers, analysts and providers, so they can offer services that are effective and efficient in maintaining and improving the health of Manitobans. Our researchers rely upon the unique Manitoba Population Research Data Repository (Repository) to describe and explain patterns of care and profiles of illness and to explore other factors that influence health, including income, education, employment, and social status. This Repository is unique in terms of its comprehensiveness, degree of integration, and orientation around an anonymized population registry.

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We thank the Research Ethics Board on the Bannatyne Campus at the University of Manitoba for their review of this project. MCHP complies with all legislative acts and regulations governing the protection and use of sensitive information. We implement strict policies and procedures to protect the privacy and security of anonymized data used to produce this report and we keep the provincial Health Information Privacy Committee informed of all work undertaken for Manitoba Health and Seniors Care.

The Manitoba Centre for Health Policy

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Abbreviations

CCI	Charlson Comorbidity Index
CI	Confidence Interval
CRC	Colorectal Cancer
ED	Emergency Department
ERCP	Endoscopic Retrograde Cholangiopancreatography
FIT	Fecal Immunochemical Test
FOBT	Fecal Occult Blood Test
GEE	Generalized Estimating Equation
GI	Gastrointestinal
GIE	Gastrointestinal Endoscopy
FP	Family Physician
IBD	Inflammatory Bowel Disease
ICD	International Classification of Diseases
ICU	Intensive Care Unit
NHS	National Health Service
OR	Odds Ratio
PREM	Patient-Reported Experience Measure
PROM	Patient-Reported Outcome Measure
RHA	Regional Health Authority

Executive Summary

Please note that the results in this report were prepared prior to the start of the coronavirus (COVID-19) pandemic.

Gastrointestinal endoscopy (GIE) procedures, such as colonoscopy, are increasingly common procedures in Manitoba, paralleling trends seen in Canada and worldwide. In fiscal year 2016 (April 1, 2016 to March 31, 2017), there were more than 57,000 GIE procedures performed in Manitoba; 54% of these procedures were colonoscopies. GIE procedures are performed for a variety of reasons, including to screen individuals who are potentially at risk for gastrointestinal cancers such as colorectal cancer (CRC), and to diagnose and monitor individuals who have gastrointestinal conditions such as inflammatory bowel disease (IBD). Endoscopy is central to the effective detection and management of many digestive health issues.

This study about GIE procedures in Manitoba aims to provide insights about the patient, physician, and procedure characteristics associated with trends in utilization, wait times, and procedure outcomes. We used administrative health data from the Manitoba Population Research Data Repository to conduct this study. Other Canadian provinces, including Ontario and Alberta, have successfully used their administrative health data to describe GIE procedure volumes and to investigate factors associated with GIE use and outcomes. Prior Manitoba studies about GIE procedures primarily focused on colonoscopy for CRC screening and surveillance. This study provides a comprehensive investigation that encompasses lower GIE procedures including colonoscopy and sigmoidoscopy, upper GIE procedures including gastroscopy and esophagoscopy, and small bowel endoscopy procedures.

Purpose and Objectives

The purpose of this study was to describe the use and outcomes of GIE procedures in Manitoba. The objectives were to:

1. Examine trends in GIE procedure rates and factors associated with variation in trends;
2. Describe wait times for GIE procedures and the patient and procedure characteristics associated with wait times in two health regions;
3. Investigate outcomes for patients following a GIE procedure, including healthcare use, mortality, complications, and post-colonoscopy CRC diagnoses.

Trends in GIE Procedure Rates

To achieve the first study objective, we investigated GIE procedure rates for the adult (age 19+) population of Manitoba from fiscal years 1984/85 to 2016/17 (the last year of available data at the time of the study). We stratified the trends by age group, sex, health region of residence, and income quintile.

We found that 1.0% of the population had at least one GIE procedure in fiscal year 1984/85; the rate increased to 4.4% by fiscal year 2016/17, which translates to a relative increase of 365% between these two years. In fiscal year 1984/85, 0.4% of the population had at least one lower GIE procedure while this number increased to 3.4% in fiscal year 2016/17. For upper GIE procedures, the corresponding values were 0.6% and 1.8%. For small bowel endoscopy procedures, rates were very low throughout the study period; less than 0.1% of the population had at least one small bowel procedure in fiscal year 2016/17. When we looked at the percentage of the population that had at least one lower GIE procedure in a 10-year period, we found that this also increased, from 6.0% to 21.2% between the earliest and most recent 10-year periods of the study. The corresponding values for upper GIE procedures were 5.6% and 12.5%.

In general, the increase occurred in all age groups, though the magnitude of the increases in rates of GIE procedures over time were largest for the population age 50 and older. In fact, for lower GIE procedures, the greatest rate increase was amongst individuals between ages of 50 and 74. The rate increases were largely similar across income quintiles and between males and females. However, disparities by income groups were noticeable in the last year of the study, suggesting potentially higher use of GIE procedures for cancer screening and surveillance among the highest income group.

All health regions in Manitoba have hospitals in which GIE procedures are performed. Large regional variations in rates of GIE procedures and increases in trends persisted even after we controlled for differences in the age and sex structure of the population, and after accounting for the occurrence of cancers and other chronic conditions such as IBD. The average annual rate of increase in GIE procedures between 1984/85 and 2016/17 was 2.9% for residents of the Winnipeg Regional Health Authority (Winnipeg RHA); it was higher for Prairie Mountain Health (5.7%) and Southern Health-Santé Sud (5.2%).

We found large variations in other GIE procedure trend measures across the health regions. For example, for residents of the Winnipeg RHA, 1.1% of the population had a GIE procedure with an anesthesiologist present in fiscal year 1984/85; this number increased to 2.2% in fiscal year 2016/17. For residents of Prairie Mountain Health, the corresponding numbers were 2.3% and 25.0%, while for residents of Southern Health-Santé Sud, the corresponding numbers were 9.6% and 57.2%.

Wait Times for GIE Procedures

To achieve the second study objective, we obtained wait times data from the endoscopy central intake registries of the Winnipeg RHA and Southern Health-Santé Sud. Our study was the first in the province to link central intake registry data to administrative health data housed in the Manitoba Population Research Data Repository. As expected, wait times for urgent GIE procedures were shorter than for elective and semi-urgent GIE procedures. Moreover, wait times for urgent procedures were similar in the two regions (median = 12 days in the Winnipeg RHA and 14 days in Southern Health-Santé Sud). For the Winnipeg RHA, median wait times for all procedures dropped slightly during the study period, from 91 days in fiscal year 2015/16 to 84 days in fiscal year 2018/19. For Southern Health-Santé Sud, median wait times for all procedures remained relatively constant (49 days in fiscal year 2015/16 and 51 days in fiscal year 2018/19). When we examined patient characteristics associated with wait times for upper GIE procedures, we found that a new diagnosis of cancer (i.e., gastric, esophageal, gastroesophageal) was associated with a 40 days shorter median wait time in the Winnipeg RHA. A new colorectal cancer diagnosis had a similar association with wait times for lower GIE procedures.

Outcomes of GIE Procedures

To achieve the third study objective, we investigated potentially adverse outcomes following a GIE procedure. There are several measures of potentially adverse outcomes. We investigated a range of outcomes, including intensive care unit (ICU) admissions, hospitalization, emergency department (ED) visits, mortality, and potential complications after GIE procedures within seven and 30 days after the procedure date. We compared the rates of these outcomes amongst individuals who had a GIE procedure and matched controls who did not have a GIE procedure. As well, we investigated patient and provider characteristics associated with these outcomes.

Amongst individuals who had an upper GIE procedure, 2.8% had an ED visit, 2.8% were hospitalized, and 1.2% were admitted to an ICU within seven days of the procedure date. Amongst individuals who had a lower GIE procedure, 1.0% had an ED visit, 1.5% were hospitalized, and 0.3% were admitted to ICU within seven days of the procedure date. An important finding is that the risk of having one of these potentially adverse outcomes did not change substantially over time and was not associated with the region in which the provider practiced. Thus, the likelihood of having a potentially adverse outcome has not changed over time; the risk remains constant regardless of where a procedure is performed.

Complications associated with a GIE procedure were rare. Gastrointestinal perforations within 30 days after a GIE

procedure occurred in 0.1% of individuals having an upper GIE procedure and 0.2% of individuals having a lower GIE procedure. However, given the large and growing number of individuals who have a GIE procedure each year, even this small percentage can result in a large number of individuals requiring healthcare for a GIE procedure complication. GIE procedures performed for older individuals, people with pre-existing medical conditions, and by physicians performing lower volume of procedures had a greater risk of intestinal perforations.

Finally, we investigated post-colonoscopy CRC diagnosis rates, a key performance measure of colonoscopy quality. Most post-colonoscopy CRC are regarded as preventable. We found that the post-colonoscopy CRC rate in Manitoba over the study period was 10.5%, a number higher than that reported in recent times from other jurisdictions. Unfortunately, we also found that Manitoba's post-colonoscopy CRC rate is not decreasing, unlike in other jurisdictions. We found patients with a diagnosis of diverticulosis, previous colonoscopy, and previous CRC and IBD diagnoses were more likely to have post-colonoscopy CRC. Overall, people with CRC who had an earlier colonoscopy by a family physician were more likely to have post-colonoscopy CRC.

Recommendations

The recommendations that arise from this report pertain to: (a) data availability and reporting, (b) training and feedback for physicians, and (c) potential approaches to address increasing rates of GIE procedures. The frequency of GIE procedures and large variations in rates of GIE procedures across Manitoba health regions create the need for information and training to ensure consistent quality across all healthcare providers.

The recommendations pertaining to data availability and reporting are:

1. **Implement a province-wide standardized endoscopy reporting system.** The Canadian Association of Gastroenterology has already published a listing of key elements of a standardized reporting system. A standardized system can facilitate audits and benchmarking. Linkage of standardized reporting system data to administrative health data can result in information about the relationship between indications (i.e., reasons) for GIE procedures and outcomes, and detailed information about the findings of GIE procedures and subsequent patient follow-up.
2. **Implement a province-wide endoscopy wait list system and standardized wait time reports.** A wait list system will help to ensure that GIE procedure wait times can be collected and reported in a consistent way, irrespective of where the procedures are performed. This system could involve a single province-wide endoscopy wait list or standardized (i.e., using same definitions) but separate endoscopy wait lists in different health regions. This is essential to develop methods to ensure wait times for GIE procedures are similar across the province, so that equity of service delivery can be achieved.
3. **Adopt standardized indicators for key outcomes.** Several guidelines have previously recommended routine use of endoscopy performance process measures; these are being used in other jurisdictions for quality assurance and improvement. Examples include colonoscopy completion rates, complication rates, colorectal adenomatous polyp detection rates and documentation of use of procedures for accepted indications. More recently, an international panel developed standardized definitions of post-colonoscopy CRC, an important indicator of the quality of care. Following this lead, it is important that Manitoba adopts and routinely uses some or all of these measures to ensure delivery of high-quality endoscopy care.
4. **Collect and report on patient-reported outcome measures (PROMs) and/or patient-reported experience measures (PREMs) for GIE procedures.** A Provincial Patient-Reported Measurement Strategy Advisory Committee was established in December 2019 and has now developed Manitoba's Patient-Reported Measurement Strategy. High-quality patient-centred care is a priority for Manitoba's health system as it undergoes transformation. PROMs and PREMs are key metrics in a patient-centred care environment; they are used to assess the patient's perspective of their health and healthcare. PROMs and PREMs can provide invaluable insights about opportunities to improve the delivery of care.

The recommendations pertaining to training and feedback for physicians are:

1. **Create processes for audit and feedback and root cause analysis.** This recommendation is particularly important when GIE procedures result in patient complications, such as bowel perforation and/or bleeding. As part of the audit and feedback process, we also emphasize the importance of evaluating individual cases of post-colonoscopy CRC, because many, if not all such cases, are likely to be preventable. In addition, the root causes for prolonged wait times for GIE procedure used to diagnosis serious medical conditions should be investigated.
2. **Follow up on regional variations in anesthesiology use.** Discussions with endoscopy providers can be used to explore the reasons for marked regional variation in anesthesiology use. Any efforts to

reduce anesthesiology use must be accompanied by assessment of the impact on patient outcomes and satisfaction with care. Establishing a provincial advisory committee to develop a list of provincial indications for anesthesia use has potential benefit for addressing wide variations in anesthesiology use.

The recommendation pertaining to increasing rates of GIE procedures is:

1. **Assess indications for procedures and explore alternative testing options.** Physician feedback and ongoing patient education is essential to optimize the use of GIE procedures. In addition, there are tests that can be used instead of GIE procedures, one of which is about to be implemented in the province. Finally, some tests may reduce the reliance of physicians on GIE procedures for some common indications (certain bowel symptoms and monitoring of IBD). There is opportunity for the province to pilot the introduction of these tests.

Conclusions

GIE procedures will continue to be amongst the most common procedures in Manitoba because of their role in diagnosis, surveillance, and screening. The recommendations we have made with respect to GIE procedure provision and monitoring can be viewed broadly as quality of care improvement initiatives. These recommendations largely focus on standardization of information and patient care, so that all residents of the province can have access to evidence-informed GIE procedure-related services. Standardizing and optimizing the provision of these very common procedures has the potential to decrease costs to the system, improve the benefits for patients, and decrease harms to patients.

Chapter 1: Introduction

Background

Gastrointestinal endoscopy (GIE) procedures are used to investigate the symptoms and signs of gastrointestinal (GI) diseases and responses to treatment. They are also used to aid in the prevention of certain cancers, such as colorectal cancer (CRC) and esophageal cancer. GIE procedures are used to examine both the lower and upper parts of the GI system. Colonoscopy and sigmoidoscopy are procedures for the lower part of the GI system, while gastroscopy and small bowel endoscopy are procedures for the upper part of the GI system. Small bowel endoscopy is a newer procedure; other procedures have been in use for much longer periods.

Previous Studies about GIE Procedure Use

GIE procedures have become increasingly common in Manitoba, as well as across Canada and worldwide, and this trend has been occurring for decades. For example, an Australian study found that rates of upper GIE procedures, including gastroscopy, esophagoscopy, and duodenoscopy increased by 128% over a ten-year period from 1988 to 1998 [1]. A recent systematic review examined population-wide use of lower GIE procedures (i.e., colonoscopy and sigmoidoscopy) amongst individuals 50+ years of age in the United States, Australia, Canada, England, Germany, Greece, Palestine, Saudi Arabia, and South Korea from 2000 onward [2]. This systematic review found increasing trends in the use of lower GIE procedures in countries where trend data were available. However, there were also wide variations in the use of these procedures across countries and within population sub-groups in individual countries. Factors associated with the increase include (a) population aging, with more health issues and healthcare use in older people, (b) increased preference amongst healthcare providers for GIE procedures over radiological procedures (e.g., barium tests), (c) increased emphasis in healthcare systems on screening, early disease detection and disease management, (d) technology developments that have improved the conduct and safety of GIE procedures, and (e) rising rates of GI conditions.

Indications for GIE Procedures

One of the most important indications (i.e., reasons) for colonoscopy, the most common GIE procedure, is screening and surveillance for CRC. Screening is the process of looking for a medical condition among people who are not known to have that condition (e.g., screening for colon cancer and polyps among those with a family history of colon cancer/polyps or

among older people), while surveillance refers to following individuals diagnosed with a certain condition. For example, surveillance might be conducted for individuals with a history of colorectal cancer. A colonoscopy may be performed as a first test for a patient or as a follow-up to other tests, such as a fecal occult blood test (FOBT). ColonCheck Manitoba, Manitoba's CRC screening program and the Canadian Task Force on Preventive Health Care recommends FOBT as the initial CRC screening test for people with no CRC risk factors, other than age above 50 years [3]. The Canadian Task Force on Preventive Health Care also recommends flexible sigmoidoscopy as an alternate first test for CRC screening. For those with high-risk family history or certain medical conditions such as high-risk polyps and IBD, colonoscopy is the universally recommended initial CRC screening test. CRC is a leading cause of cancer-related deaths in Canada; estimates for 2020 suggest that approximately 12 of every 100 cancer cases would be diagnosed as CRC [4]. There is good evidence to support CRC screening to aid in the reduction of CRC incidence and mortality through the identification and removal of pre-cancerous polyps and via detection of cancer at an early stage, when the cancer is likely to be more treatable. CRC screening was first advocated in guidelines beginning in 1997 and was gradually adopted by healthcare providers. A population-based CRC screening program was introduced in Manitoba in 2007. Colonoscopy is also used for patient surveillance after detection of colon polyps and cancers to identify additional polyps and cancers on subsequent colonoscopy.

GIE procedures are also used in the management of chronic health conditions such as chronic liver disease and inflammatory bowel disease (IBD); the latter disease includes Crohn's disease and ulcerative colitis. Patients who have symptoms such as iron deficiency anemia, rectal bleeding, chronic diarrhea, and chronic abdominal pain are typically referred for a GIE procedure to help determine the source of their symptoms. Prevalence of IBD is increasing worldwide; Canada has one of the highest rates of any country [5]. Manitoba is amongst the Canadian provinces with the highest rates of IBD [5].

Wait times for GIE Procedures

Wait times for GIE procedures can and do vary amongst providers when they maintain their own wait lists. Centralization of patient intake for GIE procedures is intended to support timely and efficient delivery of services. Timeliness of care is important for patient satisfaction with their care and therefore an important goal of healthcare improvement initiatives. In the Winnipeg Regional Health Authority (Winnipeg RHA), a centralized intake service for GIE procedures was implemented in 2015. Southern Health-Santé Sud initiated a similar but separate centralized intake service for GIE procedures in fiscal year 2014/15 [6]. Internal (i.e., unpublished) program data from the Winnipeg RHA suggests that wait times decreased after the introduction of this service. In Manitoba, wait times have been previously reported to increase for colonoscopies before cancer diagnosis for those diagnosed with colon cancer between 2004 and 2009 [7]. However, there are no comprehensive published reports about wait times for all GIE procedures in Manitoba.

In 2006, Canadian consensus guidelines on wait times for gastroenterology consultations and GIE procedures were published by the Canadian Association of Gastroenterology Wait Time Consensus Group [8]. In total, 24 consensus statements were developed about maximal medically appropriate wait times for consultations with specialists and for various procedures; these wait times are based on presenting signs and symptoms for patients referred for gastroenterology services. These consensus statements are based largely on expert opinion rather than evidence about the effect of wait times on patient outcomes. Nevertheless, the consensus statements have become standard goalposts across Canada. Benchmarks used for wait times for Manitoba's two centralized intake services are based on modifications of those advocated by the Canadian Association of Gastroenterology. Multiple factors may affect wait times, including the number of physicians who perform GIE procedures, availability of equipment and human resources, patient expectations, patient symptoms and signs, changes in technology and care pathways, and changes in patient load due to population growth and/or aging [9].

Adverse Outcomes of GIE Procedures

GIE procedures have many potential positive benefits for patient screening and monitoring, but they are not without risks [10]. Adverse outcomes, such as bleeding and perforation of the bowel following colonoscopy, are key outcomes to monitor. Other potentially adverse outcomes to monitor include increased healthcare use, including emergency department (ED) visits, hospitalization, and ICU admission. As Dubé and Rabeneck (2018) note, it can be difficult to "clearly define which AEs [adverse events] and harms should be measured, when to measure them, and how they should be measured" in quality monitoring initiatives (p. 526) [10] for GIE procedures. At the same time, information about potential GIE adverse outcomes, their frequency, and risk factors for their occurrence can help to minimize the likelihood of adverse outcomes occurring in the future.

Root cause analysis for adverse outcomes is increasingly recognized as an important process for improving the healthcare system. Root cause analysis initially became routine in other settings such as air travel industry. Root cause analysis is a method for examining the underlying causes of an adverse event [11]. Soncrant et al. (2020) stated that the focus of root cause analysis is "on the systemic and organizational factors that may have contributed to an adverse event, including environmental

factors, breakdowns in communication from one clinician to another, non-standardized processes for assessing or treating patients, training, and fatigue" (p.42) [11]. In particular, communication gaps and lack of standardized protocols are often recognized as contributors to adverse patient outcomes [12].

Another adverse outcome of interest, specifically with respect to colonoscopy, is a post-colonoscopy CRC diagnosis, also referred to as an interval CRC or early/missed CRC [13]. Given that one of the reasons for performing a colonoscopy is prevention and timely detection of CRC, the post-colonoscopy CRC rate is one of the most important markers of the quality of colonoscopies in a region and is recommended in international guidelines for monitoring on a regular basis [13]. Similar to other tests, colonoscopy is not a perfect test; some CRCs and their precursor, precancerous lesions, may not be detected during a colonoscopy. Importantly, a review of post-colonoscopy CRC in Gloucestershire, England between 2010 and 2017 concluded that 89% of post-colonoscopy CRCs could be classified as avoidable. Moreover, the study concluded that if half of these avoidable post-colonoscopy CRCs could be prevented, the proposed target of 2% for the three-year post-colonoscopy CRC rate, could be achieved [14]. Others have also reported that many post-colonoscopy CRCs are preventable [15]. In its recent consensus guidelines, the World Endoscopy Organization recommends all jurisdictions report unadjusted rates of post-colonoscopy CRC and a standardized methodology has been proposed to do this [13]. There has been increasing emphasis worldwide on colonoscopy quality over the last decade and hence it is important to examine post-colonoscopy CRC rates and factors associated with diagnoses of CRC after a colonoscopy.

GIE Procedures in Administrative Health Data

Population-based administrative health data are an important source of information about the use and outcomes of GIE procedures. These data have been used to describe procedure rates [16,17], characterize providers of GIE procedures [18], and measure outcomes following a GIE procedure [19–21].

Accuracy and completeness of administrative data to identify characteristics of GIE procedures have been examined in previous research. Studies suggest that administrative data have good sensitivity and specificity for ascertaining GIE procedures and key attributes of procedures, such as whether anesthesia is used [22,23]. For example, Li et al. (2012) conducted a study in Alberta to examine the accuracy and completeness of administrative health data, including hospital records (both inpatient and outpatient) and physician billing claims (outpatient), for identifying GIE procedures amongst patients with a CRC diagnosis [24]. The study cohort included patients ascertained from the Alberta Cancer Registry with a CRC diagnosis between 2000 and 2005; patient medical charts for the year prior to CRC diagnosis were reviewed to ascertain the procedure date. The researchers found that physician billing claims alone had very good agreement with chart review (81%) for identifying patients with a GIE procedure. Agreement increased to 90% when hospital inpatient and outpatient records were also used to identify patients with a GIE procedure.

A 2018 study from Ontario used a review of medical charts to evaluate the accuracy of five colonoscopy data elements (colonoscopy case, colonoscopy setting, colonoscopy completeness, anesthesiologist assistance, polypectomy) in administrative health data for inpatient and outpatient colonoscopies [22]. Sensitivity and specificity of colonoscopy case, non-hospital colonoscopy setting, and anesthesiologist assistance exceeded 95%. Sensitivity for colonoscopy completeness and polypectomy exceeded 95%, but specificity for both of these data elements was slightly less than 90%. The authors concluded that administrative health data are sufficiently accurate for identifying various elements of a colonoscopy procedure.

Wyse et al. (2011) examined the validity of physician billing claims data in Quebec for ascertaining colonoscopy with polypectomy in data from 2007 [25]. GIE procedure reports were used as the reference standard. The authors found that the sensitivity of physician billing claims was 85% and the specificity was 99%. While the authors concluded that physician billing claims are a valid source of information for case ascertainment, they note that under-ascertainment of polypectomy could affect the conclusions of quality improvement initiatives.

At the same time, administrative health data have some limitations for investigations of GIE procedures. Most notably, ascertaining the indication for a GIE procedure (e.g., screening, diagnosis, surveillance) using administrative health data is challenging because administrative data do not contain indication codes [26,27]. For example, a number of studies have attempted to distinguish screening colonoscopies, particularly for CRC, from non-screening colonoscopies in administrative data; some of these studies have attempted to use automated methods that rely on statistical models to construct empirical rules to ascertain colonoscopy indication. The general conclusion is that administrative data are not reliable for identifying the reasons for colonoscopy [28]. In addition, details of the findings of a GIE procedure (e.g., presence of a tumour) are often not available in administrative health data. It is possible to ascertain findings by linking to electronic medical records or conducting a manual chart review.

Previous Manitoba Studies about GIE Procedures

In Manitoba, studies about GIE procedures using administrative data have primarily focused on their use amongst patients with CRC [7,29–43]. These studies highlight the strengths of administrative data to investigate GIE procedures in Manitoba. Several important issues were studied and recommendations made, leading to change in practices. These findings have been referenced in national and international guidelines and recommendations. The studies that have been conducted in Manitoba lend credibility to the current study and quality of data collection in the province and are useful when investigating issues not covered in this current report. For example, the use of lower GIE procedures before and after cancer diagnosis and outcomes following a GIE procedure have been investigated [29,30,39,41,43]. Factors found to predict CRC after a negative colonoscopy (i.e., post-colonoscopy CRC) in the study years included female sex, older age, and performance of the colonoscopy by a non-gastroenterologist [29]. Complication rates after lower GIE procedures were examined for Winnipeg hospitals between 2004 and 2006 using administrative data and concomitant medical records review for indications and findings. A key finding was that lower-volume endoscopists tended to have a higher rate of patients with complications due to lower GIE procedures. As a net result of dissemination of findings, the lowest volume endoscopy physicians in Winnipeg voluntarily stopped performing GIE procedures [41]. Endoscopy physicians now document completeness of colonoscopy procedures. High rates of CRC not detected by guaiac FOBT have promoted efforts to move to alternate FOBT for CRC screening in the province (i.e., fecal immunochemical test). Lack of increase in CRC after breast cancer among young women with breast cancer has led to of the cessation of use of early age screening for this group.

While these studies are informative, there is substantial opportunity for further studies about GIE procedures and their outcomes in Manitoba. These opportunities include investigating rates of utilization and variation in rates across sub-populations, which are important for understanding possible disparities in access to GIE procedures. Additional opportunities include compiling and reporting information on wait times for GIE procedures, an important element of patient satisfaction with care. Finally, outcomes following GIE procedures, which are potentially useful for the development of quality improvement initiatives, also warrant investigation.

Purpose and Objectives

The purpose of this study was to describe the use and outcomes of GIE procedures in Manitoba. The objectives were to:

1. Examine trends in GIE procedure rates and factors associated with variation in trends;
2. Describe wait times for GIE procedures and the patient and procedure characteristics associated with wait times in two health regions;

Investigate outcomes for patients following a GIE procedure, including healthcare use, mortality, complications, and post-colonoscopy CRC diagnoses.

Report Organization

This report is organized as follows. Chapter 2 contains an overview of the data and methods used to achieve each of the objectives. Chapter 2 also contains the results of a validation study for colonoscopy case ascertainment in administrative data. Chapter 3 reports on trends in GIE procedure rates and the patient and physician characteristics associated with these trends. Chapter 4 focuses on wait times for GIE procedures, using data from the Winnipeg RHA and Southern Health-Santé Sud Health Region. Chapter 5 describes multiple outcomes following a GIE procedure, including ED use, hospitalization, ICU admission, mortality, and gastrointestinal (i.e., intestinal perforations) and non-gastrointestinal complications, and examines risk factors for these outcomes. Chapter 6 focuses on post-colonoscopy CRC diagnoses. Key findings are summarized at the end of each chapter. Chapter 7 provides an overall summary of the research and recommendations arising from the research.

Chapter 2: Methods

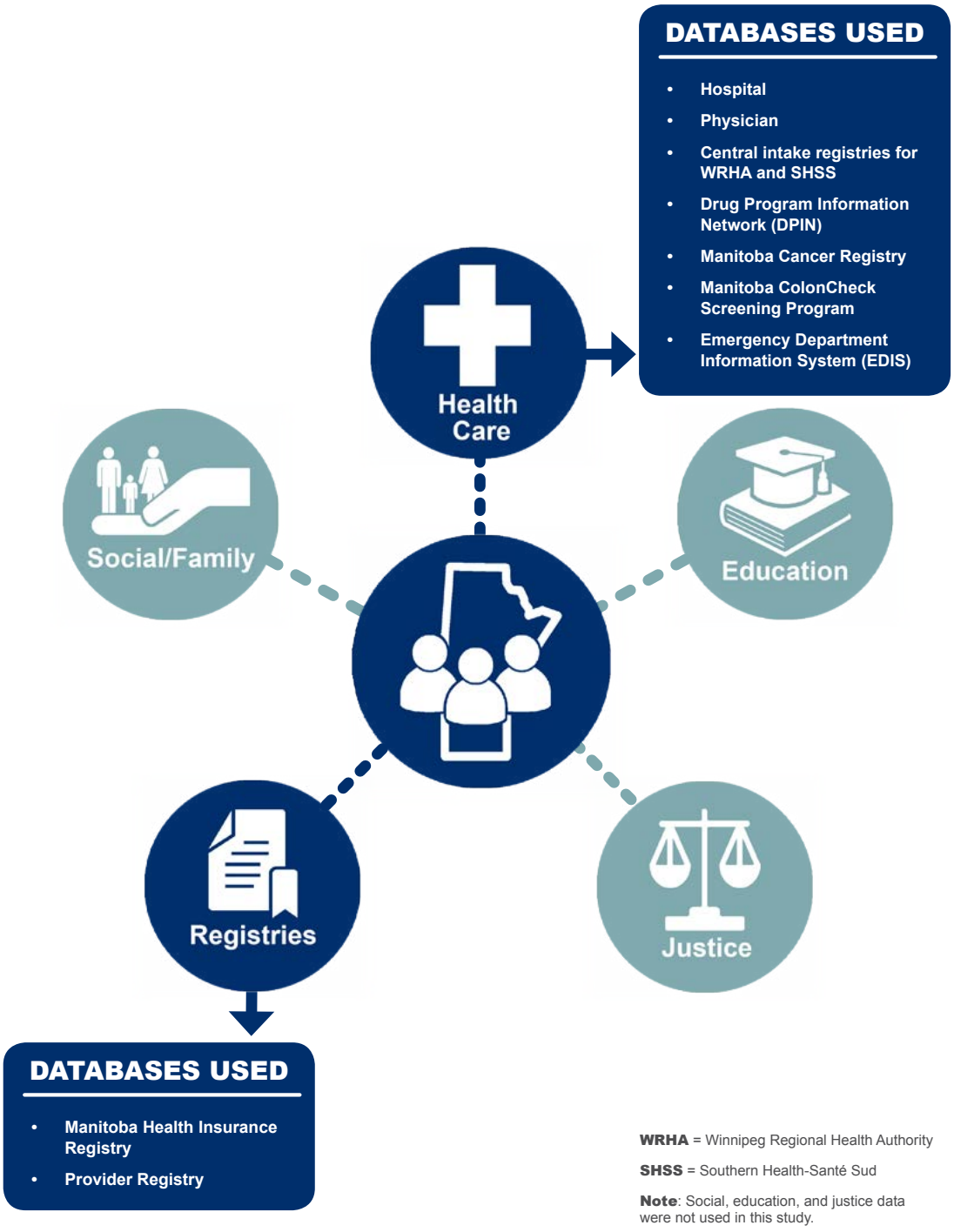
In this chapter, we begin by describing the administrative databases used to conduct the study. Then we describe the cohorts that were constructed for each of the objectives. The outcome measures and the variables used to describe the cohorts are also reported. We provide an overview of the statistical methods to conduct the analyses for this study. Finally, we describe a validation study to evaluate the accuracy of administrative health data for ascertaining colonoscopies. Definitions of most terms used in this report are available in MCHP's online Concept Dictionary: https://umanitoba.ca/manitoba-centre-for-health-policy/data-repository#concept-dictionary-and-glossary.

Data Sources

This study was conducted using multiple linked databases in the Manitoba Population Research Data Repository housed at the Manitoba Centre for Health Policy. These included the Manitoba Health Insurance Registry, Manitoba Cancer Registry, Manitoba ColonCheck Screening Program, central intake registries for the Winnipeg RHA and Southern Health-Santé Sud, physician billing claims, Emergency Department Information System (EDIS) from the Winnipeg RHA, Drug Program Information Network (DPIN), hospital discharge abstracts, and provider registry databases. Manitoba ColonCheck Screening Program data and central intake registries for the Winnipeg RHA and Southern Health-Santé Sud were added to the Repository for this study (see Figure 2.1). We also used Statistics Canada Census data for dissemination areas to define area-level income quintiles to characterize the study cohorts.

Additional information about Repository data that were used in this report is available on MCHP's website: http://mchp-appserv.cpe.umanitoba.ca/dataDescriptions.php.

Figure 2.1: Databases from the Manitoba Population Research Data Repository used in the Study



The Manitoba Health Insurance Registry contains information on all Manitobans registered for health insurance. The Registry includes healthcare coverage start and end dates, demographic characteristics, and postal code of residence. Coverage information was used to construct the study cohorts, and demographic characteristics were used to describe the cohorts. Postal codes were used to assign individuals to health regions and income quintiles. The study used data from fiscal years 1984/85 to 2016/17 (April 1 to March 31).

The Manitoba Cancer Registry was established in 1956; it captures all cases of cancer in the province identified at the time of biopsy, surgery, or hospital discharge; death certificates and autopsy records are also used to ascertain cancer cases. Given that cancer reporting is mandated by law in Manitoba, information on all potential new cases is reportable to the registrars of the Manitoba Cancer Registry. The Manitoba Cancer Registry consistently attains the highest rating for cancer registries assessed by the North American Association of Central Cancer Registries,

which administers a program that reviews member registries for their ability to prepare accurate and timely data [44]. The Manitoba Cancer Registry data were used to identify selected cancer cases (e.g., CRC) to define the study cohorts and outcome measures. Study data were from 1984, the first year of Cancer Registry data that are available in the Repository, to 2016.

The Winnipeg RHA Central Intake office for Endoscopy Procedures was established in 2015; this was the source of data from the Winnipeg RHA central intake registry (http://mchp-appserv.cpe.umanitoba.ca/supp/EndoUse_SupplementaryContent_TOC.htm). The Winnipeg RHA Central Intake office books appointments for gastroscopy, colonoscopy, flexible sigmoidoscopy, and endoscopic ultrasound. The office began providing services in November 2015; it became fully operational in January 2016. A phased-in approach was used across all six hospitals in the Winnipeg RHA to bring the Central Intake office to full operation. All referrals for outpatient endoscopy in hospitals are now booked using this system. The Central Intake office staff complete an intake sheet for each patient with a scheduled appointment; this sheet captures a variety of clinical information, including urgency of the indication, procedure booked, and date of booking. A parallel structure was established in Southern Health-Santé Sud; this led to the development of a central intake registry in that health region. The data from both intake registries was used to measure wait times; these data were from fiscal years 2014/15 to 2018/19.

Manitoba ColonCheck is the provincial population-based CRC screening program. Since August 2007, the program has been mailing Hemoccult II SENSA fecal occult blood tests (FOBTs) and instructions to average risk individuals who are 50 to 74 years of age. The program coordinates colonoscopies for those who have a positive result on the returned test. The program maintains a database of all colonoscopies. ColonCheck Screening Program data acquired for this study were from October 1, 2007 to March 31, 2017. These data were used to validate administrative health data for ascertaining colonoscopy procedures.

Physician billing claims capture all fee-for-service contacts with physicians and parallel billing claims for salaried physicians. Each claim includes a single diagnosis code based on the World Health Organization's International Classification of Diseases (ICD), version 9, clinical modification (i.e., ICD-9-CM). As well, each claim contains a tariff code linked to a fee paid by the province. A tariff code is a specific code used to identify each service provided by a physician or a nurse practitioner as defined in the Physician (Tariff) Manual. Study data were from fiscal years 1984/85 to 2016/17. Billing claims were used to ascertain GIE procedures, measure healthcare use outcomes for patients who had a GIE procedure, measure comorbidity, and characterize physicians who conduct GIE procedures.

The Winnipeg RHA EDIS database captures emergency department (ED) visits for all Winnipeg RHA acute care facilities. It contains patient demographics, date, time, mode and arrival status, chief complaint, and treatments provided. Study data were from fiscal years 2010/11 to 2016/17. EDIS data were used to capture ED visits following a GIE procedure.

Hospital discharge abstracts capture all inpatient stays in acute care facilities and are completed at the point of facility discharge. Prior to April 1, 2004, up to 16 diagnoses were recorded in these abstracts using ICD-9-CM. Since April 1, 2004, up to 25 diagnoses are captured using the Canadian version of the 10th revision of the ICD (i.e., ICD-10-CA). Study data were from fiscal years 1984/85 to 2016/17. Discharge abstracts were used to identify healthcare outcomes for patients who had a GIE procedure, and also to measure comorbidity.

The provider registry was used to identify characteristics of physicians who perform GIE procedures. These include location of practice and specialty. Study data were from fiscal years 1984/85 to 2016/17.

Statistics Canada Census files were used to define income quintiles based on average household income for dissemination areas (DAs). A DA is the smallest geographic unit for which Census data are made available for public use. The Census is conducted every five years. We used data from the 1991, 1996, 2001, 2006, 2011, and 2016 census years.

Study Cohorts

Sources of data used to construct the study cohorts included: (a) tariff codes for GIE procedures from physician billing claims, (b) diagnoses for GIE procedure indications including gastrointestinal conditions and specific types of cancers from physician billing claims, hospitalization records, and the Manitoba Cancer Registry, (c) referrals for GIE procedures from physician billing claims, and (d) centralized intake registries. For Objective 3, we constructed matched cohorts to compare selected outcomes in individuals who did and did not have a GIE procedure.

Cohorts for Objective 1: Trends in GIE Procedure Rates

The primary study cohort for the first study objective included all individuals who had at least one tariff code (see Appendix Table 3.2 in the online supplement) for a GIE procedure. The tariff codes were identified from physician billing claims with dates of service between April 1, 1984 and March 31, 2017. The selected tariff codes include lower GIE, upper GIE, and small bowel endoscopy procedures. All study cohort members were required to have health insurance coverage on the date of the procedure; the procedure date was the study index date. There were no requirements for health insurance coverage before or after

the index date for the primary study cohort. We limited our attention to adults; therefore, all individuals who were less than 19 years of age on the index date were excluded from this primary study cohort.

We identified sub-groups of the primary study cohort comprised of individuals with a higher likelihood of having a GIE procedure (except for negative colonoscopy, which is associated with a lower likelihood). We used these sub-groups in a variety of analyses. We did this because the prevalence/incidence of gastrointestinal conditions has changed over time and is not consistent in all parts of the province. For example, the incidence of IBD tends to be higher in urban than in rural areas; more people are diagnosed with colorectal cancer in some parts of the province than in others. Sub-group analyses were therefore useful for providing context for rising procedure rates.

1. **Inflammatory Bowel Disease (IBD) Sub-Group:** Individuals who met the case definition for IBD prior to or on the index date were included in this sub-group. Individuals had to have at least one day of health insurance coverage prior to the index date in order to be included in the IBD sub-group. The IBD case definition, which has previously been validated in Manitoba, is [45]:
    a. For an individual with at least two years of health insurance coverage on or before the index date, that individual is considered to be an IBD case if he/she had five or more hospital discharge abstracts or physician billing claims with a relevant ICD diagnosis code (in any diagnosis position in hospital discharge abstracts);
    b. For an individual with less than two years of health insurance coverage on or before the index date, that individual is considered to be an IBD case if he/she had three or more hospital discharge abstracts or physician billing claims with a relevant ICD diagnosis code (in any diagnosis position in hospital discharge abstracts);
    c. The relevant ICD diagnosis codes were ICD-9-CM 555 and 556 and ICD-10-CA K50 and K51.
2. **Colorectal Cancer Sub-Group:** Individuals who had a CRC diagnosis prior to or on the date of the GIE procedure (see Appendix Table 3.3 in the online supplement), as ascertained from the Manitoba Cancer Registry, were included. Individuals had to have at least one day of health insurance coverage prior to the index date in order to be included in the sub-group.
3. **IBD and Colorectal Cancer Sub-Group:** Individuals in this sub-group met the criteria for either the IBD sub-group or the colorectal cancer sub-group.
4. **Upper Gastrointestinal Cancer Sub-Group:** Individuals who had a diagnosis of gastric, esophageal, or gastroesophageal cancer prior to or on the date of the procedure (see Appendix Table 3.3 in the online supplement), as ascertained from the Manitoba Cancer Registry, were included in this sub-group. Individuals had to have at least one day of coverage prior to the index date in order to be included in the sub-group.
5. **Negative Colonoscopy Sub-Group:** Individuals in this sub-group, who have a lower likelihood of a GIE procedure, had a tariff code of 3185 (negative colonoscopy) between April 1, 1985 and March 31, 2016 and
    a. Did not have a CRC or IBD diagnosis prior to the index date
    b. Did not have a diagnosis for colorectal cancer or IBD on the index date or in the 180 days following the index date
    c. Did not have a full or partial colectomy before or on the index date

    If an individual had multiple 3185 tariff codes, we selected only the first one as the index event for the negative colonoscopy.
6. **Polyp Sub-Group:** Individuals in this sub-group had a tariff code of 3187 or 3189 (colonoscopy with polypectomy) between April 1, 1985 and March 31, 2016 and
    a. Did not have a CRC or IBD diagnosis prior to the index date
    b. Did not have a full or partial colectomy prior to the index date, on the index date, or up to 180 days after the index date (see Appendix 3 in the online supplement)
    c. Did not have a tariff code for 3188 (multiple polyps) on the index date.

Cohorts for Objective 2: Wait Times for GIE Procedures

For the second objective, wait time data from the two health regions that contained records with dates between April 1, 2014 and March 31, 2019 were used. The primary study cohort included all individuals who had at least one record in the Winnipeg RHA central intake registry or the Southern Health-Santé Sud central intake registry between April 1, 2015 and March 31, 2019. We focused on this time period because there were few Registry data available in the prior fiscal year. Our analyses were stratified by fiscal year. All records for an upper GIE procedure or a lower GIE procedure were used to define the cohort. The study index date was the family physician referral date. We excluded all individuals who were less than 19 years old on the index date.

We defined another cohort to test the patient characteristics, procedure priority level, physician characteristics, and

health region characteristics associated with wait times. This cohort retained only the first record of each type (i.e., upper GIE procedure or lower GIE procedure) for each individual. It excluded all individuals who did not have a minimum of 365 days of health insurance coverage prior to the study index date; we required this coverage to determine patient characteristics such as comorbid health conditions. Individuals who had missing information about patient priority level (e.g., urgent, semi-urgent, elective) were also excluded. The cohort was based on data from April 1, 2014 to March 31, 2018; we did not use data up to March 31, 2019 because at the time that we acquired these data, there were few individuals with a procedure in the last fiscal year of available data and follow-up time was needed after March 31, 2018 to ascertain some diagnoses.

Cohorts for Objective 3: Post-GIE Procedure Outcomes

For this objective, we constructed a number of different cohorts. These included a GIE procedure cohort (i.e., upper GIE procedure and lower GIE procedures only; small bowel endoscopy procedures were excluded because of their low numbers), post-colonoscopy CRC cohort, and some matched cohorts of individuals who did not have a GIE procedure.

The GIE procedure cohorts included individuals with a tariff code for an upper or lower GIE procedure with an index date (i.e., procedure date) between April 1, 1985 and February 28, 2017. We retained only adults; individuals who were less than 19 years old on the index date were excluded. All individuals in the GIE procedure cohort were required to have continuous health insurance coverage on the index date and for 365 days prior to the index date. If an individual had more than one upper GIE procedure and/or more than one lower GIE procedure during the study period, only the first one of each type was retained. Individuals were excluded from the cohort if the procedure location or their region of residence was missing.

For the cohort members with a lower GIE procedure, we excluded all individuals with a diagnosis of IBD or CRC or partial or total colectomy prior to the procedure, or a diagnosis of IBD or CRC following the date of the procedure to the end of the follow-up period. We made these exclusions to avoid capturing individuals who were already receiving care for IBD or CRC and to ensure that only individuals with an intact colon were included.

Similarly, for the cohort members with an upper GIE procedure, we excluded individuals with a diagnosis for one or more of the following: gastric cancer, esophageal cancer, gastroesophageal cancer. The cancer diagnosis could occur either prior to the index date or following the index date to the end of the follow-up period. We made these exclusions to avoid capturing individuals who were already receiving care for an upper gastrointestinal cancer and to exclude admissions/healthcare use for relevant cancers when looking at healthcare use after a GIE procedure.

Individuals included in the matched cohorts had 365 days of coverage prior to and including the index date and did not have a GIE procedure prior to or after the index date. An individual in the matched cohort was given the same index date as their match who had a GIE procedure. We matched on a 1:1 basis using the following matching variables: age (within 5 years) sex, health region district of residence for non-Winnipeg residents and Winnipeg community centre area for Winnipeg residents. If it was not possible to identify a match using either health region district or community centre area, then we matched on RHA. Health region districts are small units within health regions; there are currently 70 districts in the rural health regions. Community centre areas divide the city of Winnipeg into small units; there are currently 12 such areas.

When we investigated post-colonoscopy CRC, the study cohort included all individuals who had a diagnosis of CRC between April 1, 1990 and December 31, 2016, as ascertained from the Manitoba Cancer Registry and a colonoscopy within 36 months prior to the CRC diagnosis. Individuals had to be at least 19 years of age at CRC diagnosis and have at least 36 months of healthcare coverage prior to the CRC diagnosis to be retained in the cohort. As well, for our analyses of predictors of post-colonoscopy CRC, individuals included in the study cohort had to have at least a year of healthcare coverage prior to the index colonoscopy.

Characterizing the Study Cohorts

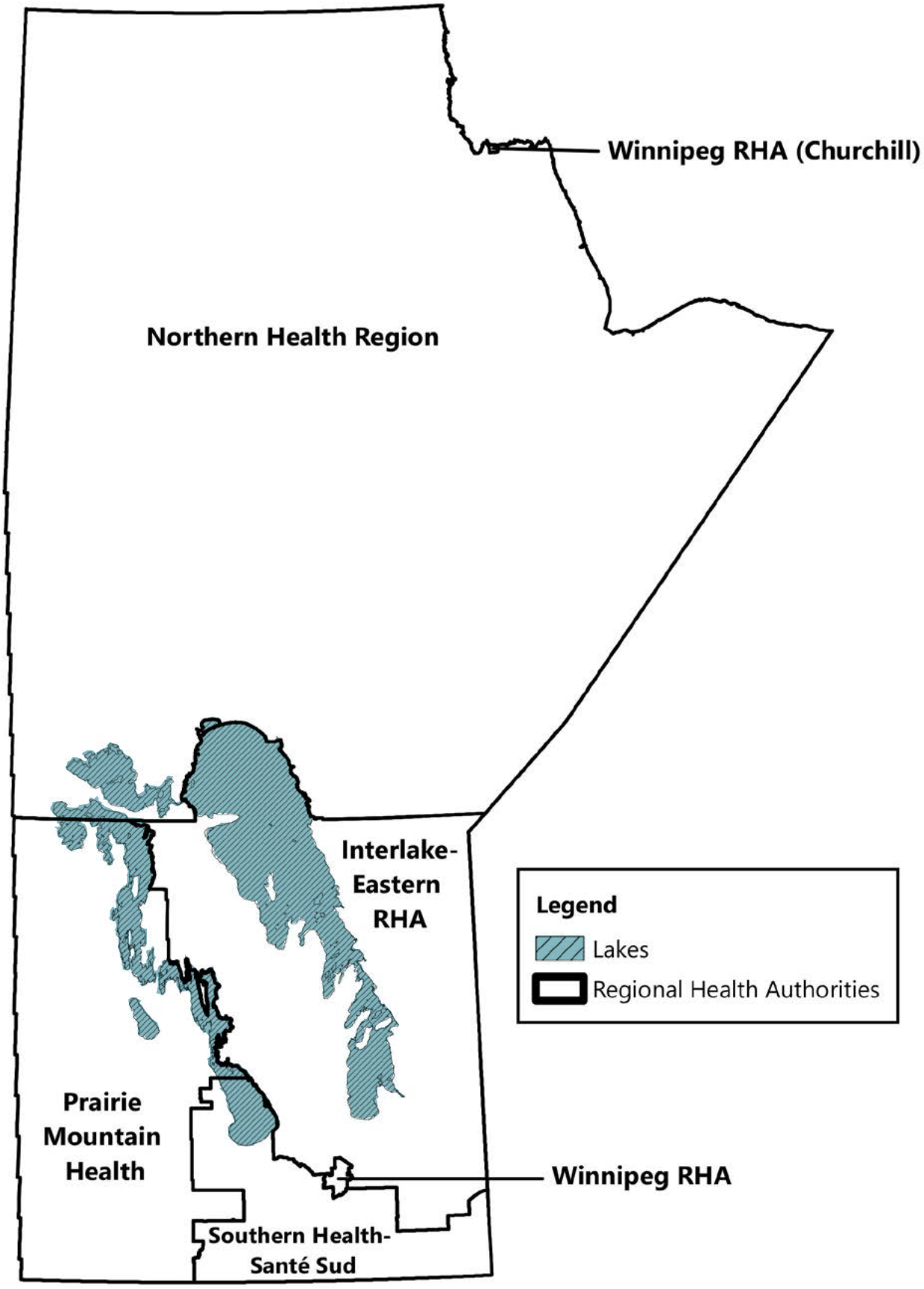
Socio-Demographic Characteristics

Each of the cohorts created for this study was initially described using socio-demographic variables from the Manitoba Health Insurance Registry. These socio-demographic variables included age group (19-34 years, 35-49 years, 50-74 years, 75 years and older), sex, income quintile of residence (Q1 is the lowest quintile and Q5 is the highest), and health region of residence. These characteristics were defined as of the study index date.

Income quintile is an area-level measure of socioeconomic status defined using Statistics Canada Census data for total household income from DAs [46]. Each quintile represents approximately 20% of the total Manitoba population; the methodology is often applied separately to urban and rural populations. We combined urban and rural quintiles due to the small number of individuals in some quintiles for some of our analyses.

Health region of residence was classified as Winnipeg RHA and non-Winnipeg. The latter included Northern Health Region, Interlake-Eastern RHA, Prairie Mountain Health, and Southern Health-Santé Sud. The town of Churchill was assigned to the Northern Health Region (Figure 2.2).

Figure 2.2: Map of Manitoba Health Regions



Other Characteristics

Other characteristics of the patient, as well as characteristics of the GIE procedure and the physician who performed the GIE procedure, were used to describe the study cohorts and/or served as covariates in statistical models. These characteristics included:

Patient Characteristics

- **Charlson Comorbidity Index (CCI) score:** The CCI score [47] was based on administrative health data for the 365-day period prior to the study index date. The score was defined using diagnosis codes from hospital discharge abstracts (in any diagnostic position) and physician billing claims. A score of zero indicates no comorbid conditions; higher scores indicate greater comorbidity. Index scores tend to have a highly skewed distribution, therefore we categorized them as 0, 1, 2, and 3 or more.
- **Lower GIE procedure diagnosis group:** Individuals were assigned to each of the following mutually exclusive diagnosis groups in a hierarchical order. These groupings were used in the analyses of wait times for a lower GIE procedure (i.e., Objective 2):
    - **Incident CRC:** first diagnosis code for CRC in the Manitoba Cancer Registry on or up to 90 days after the index date
    - **Incident IBD:** did not meet the case definition for IBD prior to index date and had at least one IBD diagnosis code on or up to 90 days after the index date in hospital records or physician billing claims
    - **Prevalent CRC:** diagnosis code for CRC in the Manitoba Cancer Registry prior to index date
    - **Prevalent IBD:** met the case definition for IBD prior to index date
    - **Other:** any individual who did not meet the criteria for any one of these diagnosis groups
- **Upper GIE procedure diagnosis group:** The following diagnosis groups were constructed. These groupings were used in the analysis of wait times for an upper GIE procedure for individuals with various diagnoses (i.e., Objective 2):
    - **Incident gastric, esophageal, or gastroesophageal cancer:** first diagnosis code for gastric cancer, esophageal cancer, or gastroesophageal cancer in the Manitoba Cancer Registry on or up to 90 days after the index date
    - **Prevalent gastric, esophageal, or gastroesophageal cancer:** diagnosis code for gastric cancer, esophageal cancer, or gastroesophageal cancer in the Manitoba Cancer Registry prior to the index date
    - **Other:** any individual who did not meet the criteria for either of these diagnosis groups
- **Diverticulosis diagnosis:** Hospital discharge abstracts with a relevant ICD-10-CA diagnosis code (see Appendix Table 3.1 in the online supplement) in any diagnostic position were used to identify individuals with a diagnosis for this condition.
- **IBD diagnosis:** The IBD case definition, which has previously been validated in Manitoba [45], is as follows:
    - For an individual with at least two years of health insurance coverage on or before the index date, that individual is considered to be an IBD case if he/she had five or more hospital discharge abstracts or physician billing claims with a relevant ICD diagnosis code (in any diagnosis position in hospital discharge abstracts);
    - For an individual with less than two years of health insurance coverage on or before the index date, that individual is considered to be an IBD case if he/she had three or more hospital discharge abstracts or physician billing claims with a relevant ICD diagnosis code (in any diagnosis position in hospital discharge abstracts);
    - The relevant ICD diagnosis codes are available in Appendix Table 3.1 in the online supplement.
- **Presence of an anesthesiologist:** Anesthesia services are billed in 15-minute units of procedure time. Hence, the presence of an anesthesiologist during the GIE procedure was identified using the following method:
    - Two of the same tariff codes for a GIE procedure occurred on the same day. For example, if the tariff code of 3185 (see Appendix Table 3.2 in the online supplement) appeared on two separate billing claims for a patient on the same day, that patient was identified as a potential anesthesia case, and
    - The UNITS field on the billing claims contained a non-missing value.
- **Colectomy:** The presence of a colectomy was identified in hospital records with ICD-9 procedure codes (see Appendix Table 3.1 in the online supplement).

GIE Procedure Characteristics

- **Procedure urgency:** GIE procedure urgency level was captured from intake registry data for the Winnipeg RHA and Southern Health-Santé Sud

Health Region; it was classified as urgent, semi-urgent, and elective. Registries in both health regions contain urgency information, although the definitions of urgency are not consistent between the two health regions. Specifically, the indicators for a GIE procedure, which are used to assess urgency, are not listed in the intake registry for Southern Health-Santé Sud Health Region and are listed for only some of the records in the Winnipeg RHA central intake registry.

- **Procedure decade:** The fiscal year of a procedure was classified into decades: 1985/86 – 1989/90, 1990/91 – 1999/00, 2000/01 – 2009/10, 2010/11 – February 28, 2017. This covariate was used in our analyses for Objective 3 (i.e., outcomes following a GIE procedure). Other time-related covariates were defined for other objectives.
- **Time since previous GIE procedure:** The number of years since an individual had a prior GIE procedure (upper GIE procedure, lower GIE procedure) was used in the analysis of wait times. It was classified as less than 1 year, 1 year to less than 5 years, 5 to 10 years, and greater than 10 years.

Physician Characteristics

- **Physician practice location:** Location of practice was based on the billing address for the physician. It was classified as Winnipeg RHA or non-Winnipeg health region.
- **Physician specialty:** Speciality was based on information contained in the provider registry. The categories were: family physician (FP), internal medicine specialist, gastroenterologist, surgeon, and other. Internal medicine specialists included internal medicine non-gastroenterologists as well as gastroenterologists who bill as internal medicine physicians. Gastroenterologists included all physicians who billed as gastroenterologist at any time during the study period.
- **Physician volume of GIE procedures:** Physician volume of GIE procedures was measured for the 365-day period prior to the index date of a GIE procedure. Volume was categorized into tertiles (i.e., low, medium, high). These tertiles were defined separately for upper GIE procedures and lower GIE procedures.

Outcome Measures

For Objective 1, trends in the following outcome measures were investigated:

- **One or more GIE procedures:** Percent of the population having one or more GIE procedures (i.e., one or more lower GIE procedure, upper GIE procedure, or small bowel endoscopy procedure) in a fiscal year.
- **One or more lower GIE procedures:** Percent of the population have one or more lower GIE procedures in a fiscal year.
- **One or more upper GIE procedures:** Percent of the population have one or more upper GIE procedures in a fiscal year.
- **One or more small bowel endoscopy procedures:** Percent of the population having one or more small bowel endoscopy procedures in a fiscal year.
- **Both an upper and lower GIE procedure on the same day:** Percent of the population having an upper GIE procedure and a lower GIE procedure on the same day.
- **One or more GIE procedures in 10 years:** Percent of the population having at least one GIE procedure in a 10-year period (i.e., one or more lower GIE procedure, upper GIE procedure, or small bowel endoscopy within 10 fiscal years)
- **One or more lower GIE procedures in 10 years:** Percent of the population having at least one lower GIE procedure in a 10-year period.
- **One or more upper GIE procedures in 10 years:** Percent of the population having at least one upper GIE procedure in a 10-year period.
- **One or more small bowel endoscopy procedures in 10 years:** Percent of the population having at least one small bowel endoscopy procedure in a 10-year period.

GIE procedure with an anesthesiologist present: Percent of population having a GIE procedure in a fiscal year with an anesthesiologist present for the GIE procedure.

For the 10-year procedure rates, age was defined at the midpoint of the period. Health region of residence and income quintile were defined at the end of the 10-year period. We did not require that an individual be alive for the entire 10-year period in order to be included in the analysis.

For Objective 2, the primary outcome was the median wait time for a GIE procedure. Secondary outcomes were the 25th and 75th percentile wait time values. The wait time was calculated as the number of days from the procedure referral date to the scheduled case date; wherever possible, we used the scheduled case date as recorded in the intake registry. However, if this was not available, we used the date of the procedure from the physician billing claims.

For Objective 3, the outcomes we investigated were measures of healthcare use, all-cause mortality, complications following a GIE procedure, and post-colonoscopy CRC. The measures of healthcare use were:

- **Emergency department (ED) visit:** An ED visit within 30 days after the index date. ED visits were identified for residents of the Winnipeg RHA only, using EDIS data.

- **Hospitalization:** An inpatient hospital admission within 30 days after the index date, as identified from hospital discharge abstracts.
- **Intensive care unit (ICU) admission:** An ICU admission within 30 days after the index date, as identified from hospital discharge abstracts.

All-cause mortality was defined using Manitoba Health Insurance Registry data (i.e., health insurance coverage cancellation due to death). It includes deaths for any reason within 30 days following the index date.

Complications within 30 days following a GIE procedure were defined using hospital discharge abstracts. Complications identified as pre-existing conditions on hospital admission were excluded. All complications were identified from the most responsible diagnosis field in the hospital discharge abstract. We initially identified five categories of complications: gastrointestinal, cardiac, cerebrovascular, infection, and pulmonary. Subsequently, these were classified as gastrointestinal complications and non-gastrointestinal complications (cardiac, cerebrovascular, infection, pulmonary). The former category included perforations, while the latter included cardiac, cerebrovascular, infection, and pulmonary complications. We excluded gastrointestinal bleeding (which is the most commonly reported complication) from this study, because there was no way of differentiating whether the bleeding occurred before (i.e., was the indication) or after a GIE procedure (i.e., was the outcome). We were not able to capture physician visits for complications across the province, and hence are reporting only on complications associated with hospitalization. Perforation codes were limited to those codes which are listed for use for perforations associated with procedures.

To investigate post-colonoscopy CRC diagnoses, individuals with colonoscopy within 6 months before CRC diagnosis were categorized as detected CRC; those with colonoscopy within 6-36 months before CRC diagnoses as post-colonoscopy CRC. Individuals could be part of either or both groups.

Statistical Analyses

Objective 1: Trends in GIE Procedure Rates

Crude rates of GIE procedures (upper GI procedures, lower GI procedures, and small bowel endoscopy procedures) were calculated. All rates were stratified by age group, sex, health region of residence, and income quintile. The Manitoba population with at least one day of health insurance coverage was the denominator. Crude rates were defined per 100 population.

Negative binomial regression models were used to estimate the average annual rate of increase in GIE procedures for each health region, after adjusting for age and sex. Generalized linear models with generalized estimating equations (GEEs) were used to account for the dependency amongst rate estimates over time (because a person could have GIE procedures in more than one year of the study period). We used the ratio of model deviance to degrees of freedom to assess whether a Poisson distribution or negative binomial distribution provided a better fit for the data. The natural logarithm of the population was used as the model offset. A compound symmetric correlation structure was adopted. To estimate the average annual rate of change, fiscal year was included in the model as a continuous variable. To test for differences between health regions in the adjusted average annual rate of change, the negative binomial regression model included the main effects of year, age group, sex, and health region, as well as the two-way interaction of health region and year. A large sample $\chi 2$ statistic was used to test for statistically significant differences in the rates for the Winnipeg RHA (reference group) and all other health regions. We produced 95% confidence intervals (95% CIs) for the average annual rates.

As a component of our analyses for Objective 1, we tested the patient and physician characteristics associated with the presence of an anesthesiologist for a GIE procedure. This analysis was limited to procedures conducted from fiscal year 2005/06 onward, because prior to this there was a low rate of anesthesiologist presence for a GIE procedure. Separate analyses were conducted for procedures performed in the Winnipeg RHA (i.e., urban) and those performed outside of the Winnipeg RHA (i.e., rural) because of large differences in rates of presence of an anesthesiologist for a GIE procedure in the Winnipeg RHA and outside of the Winnipeg RHA. We used logistic regression models with GEEs to account for the dependence amongst the procedures over time (because a person could have a GIE procedure in more than one year of the study period). A compound symmetric correlation structure was adopted. The model covariates included sex, age group, type of GIE procedure (lower, upper), CCI score, income quintile, procedure period (2005/06-2009/10, 2010/11-2016/17), physician specialty, volume of GIE procedures for the physician performing the GIE procedure, and health region in which the procedure was performed for the non-Winnipeg health regions analyses. We report odds ratios (ORs) and 95% CIs.

Objective 2: Wait Times for GIE Procedures

For Objective 2, we produced descriptive analyses of the 25th, 50th (median), and 75th percentiles, stratified by year of GIE procedure referral, region of residence at referral (for the Winnipeg RHA central intake registry data only; the numbers for out-of-regional referrals were too small to be analyzed for Southern Health-Santé Sud), income quintile, and procedure urgency level. Multivariable quantile

regression was used to model the association between each of the 25th percentile, 50th percentile (median), and 75th percentile values and selected covariates. Specifically, we fit two models to the data. Both models were stratified by health region (Winnipeg RHA, Southern Health-Santé Sud) and type of procedure (upper GIE procedure, lower GIE procedure). The first model included procedure urgency level, in addition to the covariates of age group, sex, CCI score, region of residence (for the Winnipeg RHA model only), and years since previous GIE procedure (which was ascertained from administrative data); this model was used to test for differences in the quantiles of wait times by procedure urgency level, after controlling for patient and procedure characteristics. The second model included diagnosis group, in addition to the covariates of age group, sex, CCI score, region of residence (for the Winnipeg RHA model only), years since previous GIE procedure; this model was used to test for differences in the quantiles of wait times across cancer and chronic disease diagnosis groups after controlling for patient and procedure characteristics

Objective 3: Post-GIE Procedure Outcomes

For Objective 3, Cox proportional hazards models were used to test the association between patient, GIE procedure, and physician characteristics and the risk of a healthcare use outcome (i.e., ED visit, ICU admission, hospitalization) or death, following a GIE procedure. We report hazard ratios and 95% CIs for the healthcare use outcome and all-cause mortality models.

For the analysis of complications, we applied multivariable logistic regression models to the data. We conducted two sets of analyses. In the first set, we focused only on the cases (i.e., individuals having a GIE procedure); we tested the patient, GIE procedure, and physician characteristics associated with having a complication. Our model covariates include age group, sex, income quintile, CCI score, IBD diagnosis, cancer diagnosis, physician specialty, physician volume of GIE procedures, procedure decade, and same-day procedure/evaluation by a physician. We report ORs and 95% CIs. In the second set of analyses we included both cases (i.e., individuals having a GIE procedure) and matched controls (no GIE procedure); we tested whether the odds of a healthcare use outcome was significantly different for cases and matched controls; model covariates included group membership (i.e., GIE procedure, no GIE procedure), income quintile, CCI score, IBD diagnosis, cancer diagnosis, physician specialty, physician volume of GIE procedures, and procedure decade.

For the analysis of post-colonoscopy CRC diagnoses, we estimated crude rates (%) of overall by cancer site, decade of the CRC diagnosis, and selected other patient and physician characteristics. We fit logistic regression models to the data to test for a difference in the odds of post-colonoscopy CRC diagnosis across decades after adjusting for patient, physician, and procedure characteristics. The patient characteristics included age group, sex, CCI score, income quintile, prior colectomy, prior colonoscopy, prior CRC diagnosis, prior IBD diagnosis, and prior diverticulosis diagnosis. The physician and procedure characteristics included physician specialty, physician volume of colonoscopies, and location of GIE procedure (rural, urban hospital, urban outpatient setting). We did this analysis for all study years then repeated this analysis limiting it to the most recent decade (i.e., 2010/11 to December 31, 2016). The end date was based on the data for cancer diagnosis available at the time of the analysis. For all models we used GEEs to account for the clustering of patients within physicians. The results are reported using ORs and 95% CIs. All analyses were performed using SAS version 9.4.

Validating the Accuracy of Administrative Health Data for Colonoscopy

Background

We conducted a validation study to assess whether Manitoba's administrative health data were accurate for ascertaining GIE procedures. We focused on colonoscopy because we were able to identify a population-based "gold standard" data source to validate the occurrence of colonoscopy procedures.

Methods

Our validation study included individuals with at least one colonoscopy captured in Manitoba ColonCheck Screening Program data between October 1, 2007 and March 31, 2017. Screening Program data were used as our validation data source. The goal of the Screening Program is to detect CRC early by screening people who do not have any signs or symptoms of CRC. The Manitoba ColonCheck Screening Program colonoscopy database includes all colonoscopies performed following a positive result for FOBTs distributed by the Screening Program. Accordingly, this is a referral population.

Analyses were stratified by year, facility of the GIE procedure, and patient's region of residence. We report the frequency and percentage of colonoscopies in the Screening Program data that were identified in physician billing claims data (i.e., sensitivity). We also report the accuracy of the procedure date.

Results

A total of 5,606 colonoscopies were identified in the study period from the Screening Program data. Of this number, 5,472 were identified in physician billing claims, resulting in a sensitivity of 97.6%. There was little variation by

procedure year or quarter; sensitivity was 100% in the last quarter of 2007 and 100.0% in 2008. Sensitivity was 98.3% in 2016 and 94.9% in the first quarter of 2017. Sensitivities across the 23 facilities represented in the data ranged from 100% to 94.6%. There was little variation in sensitivity by the patient's location of residence; it ranged from 98.4% for the Interlake-Eastern RHA to 94.7% for the Northern Health Region. For the Winnipeg RHA, sensitivity was 97.6%. When we compared the procedure date in Screening Program data and physician billing claims, we found that 96.3% of procedures recorded in physician billing claims had the same date as in the Screening Program date. Another 0.6% of colonoscopies captured in physician billing claims had a procedure date within one day of the date recorded in the Screening Program data.

Summary

These findings aid in demonstrating that physician billing claims are a valid source of information about the occurrence and timing of colonoscopy procedures. However, there are some limitations associated with this analysis. The validation could not be performed for other types of GIE procedures. We could not calculate other measures of accuracy, including specificity, positive predictive value, and negative predictive value, because the Screening Program data only contain colonoscopy cases. The number of cases not identified in physician billing claims was too small to conduct sub-analyses of their attributes.

At the same time, the results concur with those produced in previous studies [22,24,25]. Thus, administrative health data are an accurate source of information to ascertain GIE procedures. Moreover, because administrative health data capture information for all residents of Manitoba, they are valuable for examining the use of GIE procedures in the entire population.

Chapter 3:
Trends and Variations in Gastrointestinal Endoscopy (GIE) Procedure Rates

Overview and Background

An understanding of GIE procedure rates over time and in different regions of the province or in different population groups can aid in the identification of potential inequities and inefficiencies and can be useful to plan for the future. Variations by age group, sex, region, and income group may help to identify under-served groups.

Hilsden (2004) used administrative health data to examine provincial trends and regional variations in flexible sigmoidoscopy, colonoscopy, and gastroscopy in Alberta from 1994 to 2002 [48]. Age- and sex-adjusted rates of colonoscopy more than doubled over that time period, from 5.03 per 1,000 population to 10.82 per 1,000 population. In contrast, flexible sigmoidoscopy rates remained relatively stable, and even decreased slightly (4.68 per 1,000 population in 1994; 3.68 per 1,000 population in 2002). Overall, rates of colonoscopy rose 147%, rates of flexible sigmoidoscopy rose 6%, and rates of gastroscopy rose 39% in the study period. In terms of regional variations, Hilsden found that for colonoscopy, there were three times as many procedures in the region with the highest rate as compared to the region with the lowest rate [48]. Increases were found in all age groups, not just those age groups recommended for screening. Hilsden did not find that rural regions were disadvantaged in access to GIE procedures. The author suggests that increased rates of GIE procedures cannot be attributed solely to increased screening but may also reflect a broader range of indications for the procedures over time.

Vinden, Schultz, and Rabeneck (2004) examined trends in lower GIE procedures in Ontario using administrative health data from 1992 to 2001 [16]. Over that period, the rate of colonoscopies increased threefold; in 1992 approximately 0.8% of the Ontario adult population (20+ years of age) had a colonoscopy, compared to approximately 1.8% of the Ontario adult population in 2001. Substantial regional variations were noted, with lower rates not necessarily found in rural regions of the province.

A previous Manitoba study evaluated trends in lower GIE procedures between 1984 and 2003. Use of lower GIE procedures increased over this period. A much greater increase in use of colonoscopies with polypectomy occurred between 2000 and 2003 than in the previous years. Use of flexible sigmoidoscopies decreased between 1999 and 2003. However, regional variations were not assessed, and no other GIE procedures were investigated [43].

In this study, we focused on trends in rates of GIE procedures (upper GIE, lower GIE, small bowel endoscopy procedures) between April 1, 1984 and

March 31, 2017. We used fiscal year 1984/85 as the first year of the study period because this enabled comparisons with a previous study about trends in lower GIE procedure rates in Manitoba [43]. Given that small bowel endoscopy procedures were not identified in physician billing claims until 2001, the trends in the rates of lower bowel endoscopy procedures are reported from April 1, 2001 to March 31, 2017.

We conducted descriptive analyses of the data as well as inferential analyses; all descriptive analyses were conducted by fiscal year (i.e., fiscal year 1984/85 was the first year of the study observation period; fiscal year 2016/17 was the last year of the study observation period). Crude rates are stratified by age group, sex, income quintile, and region of residence. Subsequently, age- and sex-adjusted rates were produced for each health region, and we tested for differences in the adjusted average annual rate of increase across health regions using negative binomial regression. Further details of the methods are provided in Chapter 2.

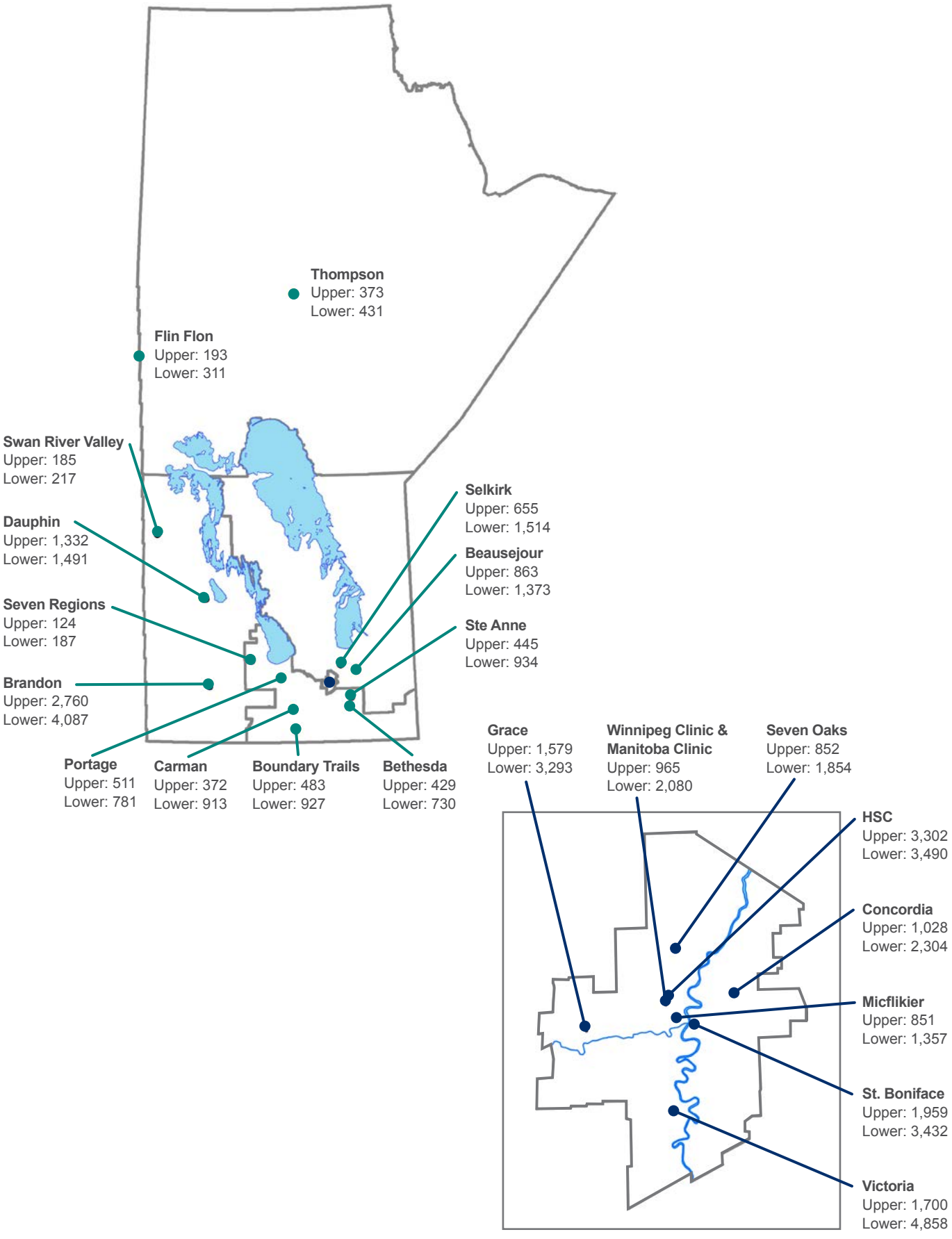
GIE Procedures by Site

Table 3.1 identifies the facilities and clinics that performed upper and lower GIE procedures in the last year of the study observation period (i.e., fiscal year 2016/17). Figure 3.1 also displays summary information graphically.

Table 3.1: Number of Upper and Lower GIE Procedures by Health Region, 2016/17

Endoscopy Unit	Upper GIE Procedures N (%)	Lower GIE Procedures N (%)	Total Upper and Lower GIE Procedures N (%)
Southern Health-Santé Sud			
Bethesda Hospital	429 (18.1)	730 (30.9)	1,159 (17.0)
Boundary Trails Health Centre	483 (20.4)	927 (39.2)	1,410 (20.6)
Carman Memorial Hospital	372 (15.7)	913 (38.6)	1,285 (18.8)
Seven Regions Health Centre	124 (5.2)	187 (7.9)	311 (4.5)
Portage District General Hospital	511 (21.6)	781 (33.0)	1,292 (18.9)
Ste. Anne Hospital	445 (18.8)	934 (39.5)	1,379 (20.2)
Health Region Total	**2,364**	**4,472**	**6,836**
Winnipeg RHA			
Grace General Hospital	1,579 (12.9)	3,293 (14.5)	4,872 (13.9)
St. Boniface General Hospital	1,989 (16.2)	3,432 (15.1)	5,421 (15.5)
Victoria General Hospital	1,700 (13.9)	4,858 (21.4)	6,558 (18.8)
Health Sciences Centre	3,302 (26.9)	3,490 (15.4)	6,792 (19.4)
Concordia Hospital	1,028 (8.4)	2,304 (10.2)	3,332 (9.5)
Seven Oaks General Hospital	852 (6.9)	1,854 (8.2)	2,706 (7.7)
Micflikier Endoscopy Facility	851 (6.9)	1,357 (6.0)	2,208 (6.3)
Winnipeg Clinic and Manitoba Clinic	965 (7.9)	2,080 (9.2)	3,045 (8.7)
Health Region Total	**12,266**	**22,668**	**34,934**
Prairie Mountain Health			
Brandon Regional Health Centre	2,760 (64.5)	4,087 (95.6)	6,847 (68.0)
Dauphin Regional Health Centre	1,332 (31.1)	1,491 (34.9)	2,823 (28.0)
Swan River Valley Hospital	185 (4.3)	217 (5.1)	402 (4.0)
Health Region Total	**4,277**	**5,795**	**10,072**
Interlake-Eastern RHA			
Beausejour District Hospital	863 (56.9)	1,373 (47.6)	2,236 (50.8)
Selkirk & District General Hospital	655 (43.1)	1,514 (52.4)	2,169 (49.2)
Health Region Total	**1,518**	**2,887**	**4,405**
Northern Health Region			
Flin Flon General Hospital Inc.	193 (34.1)	311 (41.9)	504 (38.5)
Thompson General Hospital	373 (65.9)	431 (58.1)	804 (61.5)
Health Region Total	**566**	**742**	**1,308**
Provincial Total	**20,991**	**36,564**	**57,555**

Figure 3.1: Number of Upper and Lower GIE Procedures by Endoscopy Unit, 2016/17



Within the Winnipeg RHA, the three most common locations were St. Boniface General Hospital, Victoria General Hospital, and Health Sciences Centre. Outside of the Winnipeg RHA, Brandon Regional Health Centre was the location that performed the greatest number of GIE procedures, followed by Dauphin Regional Health Centre.

Characteristics of the Primary Study Cohort

The socio-demographic characteristics of the primary study cohort in the first year of the observation period (i.e., fiscal year 1984/85) and the last year of the observation period (i.e., fiscal year 2016/17) are provided in Table 3.2. Note that the cohorts defined for successive years of the study observation period are not mutually exclusive; in other words, if an individual had a procedure in fiscal year 1984/85, that individual would be included in the cohort for 1984/85. If the same individual had a procedure in 2016/17, that individual would also be included in the cohort for 2016/17.

The results of this descriptive analysis reveal some changes in the characteristics of individuals who receive a GIE procedure over time. In 1984/85, 13.7% of the cohort was between 19 and 34 years old; this number dropped to 7.0% by 2016/17. Slightly more than half of all individuals who had a GIE procedure in 1984/85 were between 50 and 74 years old; this number grew to 62.1% by 2016/17. The percentage of male and female GIE procedure recipients remained largely the same over time. With respect to health region of residence, in 1984/85, almost two-thirds of all GIE procedures were performed for residents of the Winnipeg RHA. By 2016/17, this number had dropped to slightly more than 50%, despite the fact that approximately two-thirds of the Manitoba population lives in Winnipeg. The largest growth was for the Interlake-Eastern RHA, which represented 6.3% of all individuals having a GIE procedure in 1984/85 and 12.3% of all individuals having a GIE procedure in 2016/17. There was some change in the income quintile of individuals having a GIE procedure over time. In fiscal year 1984/85, 21.7% of individuals who had a GIE procedure were in the lowest income quintile; this number dropped slightly to 17.4% in 2016/17. In contrast, 16.0% of individuals who had a GIE procedure in 1984/85 were in the highest income quintile; this number increased to 20.5% in 2016/17. In general, individuals in the highest income quintile have fewer medical issues than individuals in the lowest income quintile. These emerging disparities are worrisome.

Table 3.2: Characteristics of the Cohort with a Gastrointestinal Endoscopy Procedure in the First and Last Fiscal Years of the Study Observation Period

Cohort Characteristics	1984/85 N = 7,523		2016/17 N = 57,851		Percent Change
	Count	Percent	Count	Percent	
Age Group (Years)					
19-34	1,029	13.7	4,047	7.0	-6.7
35-49	1,389	18.5	9,262	16.0	-2.5
50-74	3,947	52.5	35,940	62.1	9.7
75 and older	1,158	15.4	8,602	14.9	-0.5
Sex					
Male	3,599	47.8	27,172	47.0	-0.9
Female	3,924	52.2	30,679	53.0	0.9
Region of Residence					
Southern Health-Santé Sud	756	10.0	8,015	13.9	3.8
Winnipeg RHA	4,777	63.5	29,561	51.1	-12.4
Prairie Mountain Health	1,207	16.0	10,530	18.2	2.2
Interlake-Eastern RHA	473	6.3	7,103	12.3	6.0
Northern Health Region	310	4.1	2,642	4.6	0.4
Income Quintile					
Unknown	122	1.6	241	0.4	-1.2
Q1 (Lowest)	1,632	21.7	10,042	17.4	-4.3
Q2	1,600	21.3	11,272	19.5	-1.8
Q3	1,545	20.5	12,001	20.7	0.2
Q4	1,424	18.9	12,462	21.5	2.6
Q5 (Highest)	1,200	16.0	11,833	20.5	4.5

Characteristics of the Cohort Sub-Groups

Cohort sub-groups were defined for Objective 1; these cohorts are comprised of individuals who are most likely to have at least one GIE procedure (with the exception of those having a negative colonoscopy result) in the Manitoba population. These sub-groups were used to conduct supplementary analyses of trends in GIE procedures, which are reported in the Data Extras in the online supplement.

Table 3.3 describes the socio-demographic characteristics of the IBD sub-group in the first and last years of the study observation period. The IBD sub-group increased in size over the study period from 185 cases in 1984/85 to 1,848 cases in 2016/17. In the analyses provided in the online supplement, we excluded all individuals in the IBD sub-group in each year of the observation period when describing the rate of lower GIE procedures. We did this because individuals with an IBD diagnosis have an increased likelihood of a GIE procedure for diagnosis and treatment of IBD (i.e., for assessing patient response to IBD treatment).

Table 3.3: Characteristics of the IBD Sub-Group in the First and Last Fiscal Years of the Study Observation Period

Cohort Characteristics	1984/85 N = 185		2016/17 N = 1,848		Percent Change
	Count	Percent	Count	Percent	
Age Group (Years)					
19-34	90	48.7	307	16.6	-32.0
35-49	49	26.5	479	25.9	-0.6
50-74	s	s	932	50.4	s
75 and older	s	s	130	7.0	s
Sex					
Male	89	48.1	882	47.7	-0.4
Female	96	51.9	966	52.3	0.4
Region of Residence					
Southern Health-Santé Sud	17	9.2	220	11.9	2.7
Winnipeg RHA	119	64.3	1,063	57.5	-6.8
Prairie Mountain Health	28	15.1	302	16.3	1.2
Interlake-Eastern RHA	14	7.6	197	10.7	3.1
Northern Health Region	7	3.8	66	3.6	-0.2
Income Quintile					
Q1 (Lowest)	34	18.4	251	13.6	-4.8
Q2	39	21.1	342	18.5	-2.6
Q3	26	14.1	413	22.4	8.3
Q4	44	23.8	397	21.5	-2.3
Q5 (Highest)	42	22.7	445	24.1	1.4

s Indicates data suppressed due to small numbers.

Table 3.4 describes the socio-demographic characteristics of the colorectal cancer sub-group in the first and last years of the study observation period. This sub-group also increased in size over the study period from 86 cases in 1984/85 to 1,891 cases in 2016/17. In the analyses provided in the online supplement, we excluded all individuals in the colorectal caner sub-group in each year of the observation period when describing rates of upper and lower GIE procedures. Individuals at risk of a colorectal cancer diagnosis have an increased likelihood of a GIE procedure for diagnosis.

Table 3.4: Characteristics of the Colorectal Cancer Sub-Group in the First and Last Years of the Study Observation Period

Cohort Characteristics	1984/85 N = 83		2016/17 N = 1,891		Percent Change
	Count	Percent	Count	Percent	
Age Group (Years)					
19-34	s	s	10	0.5	s
35-49	s	s	114	6.0	s
50-74	55	66.3	1,161	61.4	-4.9
75 and older	21	25.3	606	32.1	6.8
Sex					
Male	43	51.8	1,118	59.1	7.3
Female	40	48.2	773	40.9	-7.3
Region of Residence					
Southern Health-Santé Sud	s	s	266	14.1	s
Winnipeg RHA	49	59.0	976	51.6	-7.4
Prairie Mountain Health	24	28.9	357	18.9	-10.0
Interlake-Eastern RHA	s	s	229	12.1	s
Northern Health Region	-	-	63	3.3	s
Income Quintile					
Q1 (Lowest)	20	24.1	330	17.5	-6.7
Q2	26	31.3	384	20.3	-11.0
Q3	17	20.5	405	21.4	0.9
Q4	8	9.6	418	22.1	12.5
Q5 (Highest)	12	14.5	345	18.2	3.8

s Indicates data suppressed due to small numbers.

Table 3.5 describes the socio-demographic characteristics of the upper gastrointestinal cancer sub-group in the first and last years of the study observation period. This sub-group also increased in size over the study period from 69 cases in 1984/85 to 298 cases in 2016/17. In the analyses provided in the online supplement, we excluded individuals in this upper gastrointestinal cancer sub-group in each year of the observation period when describing rates of upper GIE procedures. Individuals at risk for a diagnosis of this cancer have an increased likelihood of an upper GIE procedure for diagnosis.

Table 3.5: Characteristics of the Upper Gastrointestinal Cancer Sub-Group in the First and Last Fiscal Years of the Study Observation Period

Cohort Characteristics	1984/85 N = 69		2016/17 N = 298		Percent Change
	Count	Percent	Count	Percent	
Age Group (Years)					
19-34	s	s	-	-	s
35-49	s	s	8	2.7	s
50-74	42	60.9	194	65.1	4.2
75 and older	22	31.9	96	32.2	0.3
Sex					
Male	45	65.2	211	70.8	5.6
Female	24	34.8	87	29.2	-5.6
Region of Residence					
Southern Health-Santé Sud	s	s	24	8.1	s
Winnipeg RHA	35	50.7	166	55.7	5.0
Prairie Mountain Health	24	34.8	70	23.5	-11.3
Interlake-Eastern RHA	s	s	24	8.1	s
Northern Health Region	s	s	14	4.7	s
Income Quintile					
Q1 (Lowest)	12	17.4	37	12.4	-5.0
Q2	20	29.0	62	20.8	-8.2
Q3	18	26.1	79	26.5	0.4
Q4	s	s	59	19.8	s
Q5 (Highest)	s	s	61	20.5	s

s Indicates data suppressed due to small numbers.

Table 3.6 describes the socio-demographic characteristics of both the IBD and colorectal cancer sub-groups in the first and last years of the study observation period. In the analyses provided in the online supplement, we excluded individuals with either of these conditions in each year of the observation period when describing rates of lower GIE procedures.

Table 3.7 describes the socio-demographic characteristics of the negative colonoscopy sub-group in the first and last years of the study observation period. Similarly, Table 3.7 describes the socio-demographic characteristics of colonoscopy with polypectomy sub-group in the first and last years of the study observation period. There was approximately a 7% difference between the highest and lowest income quintiles in the last year of the study period in both of these subgroups. This suggests a higher percentage of colonoscopies in the highest income group may occur for screening purposes. This is consistent with previously reported differences in CRC screening rates by income level and is worrisome because it suggests worsening disparities in use of GIE procedures for cancer screening and surveillance [29].

Table 3.6: Characteristics of the IBD and Colorectal Sub-Group in the First and Last Fiscal Years of the Study Observation Period

Cohort Characteristics	1984/85 N = 266		2016/17 N = 3,701		Percent Change
	Count	Percent	Count	Percent	
Age Group (Years)					
19-34	91	34.2	315	8.5	-25.7
35-49	53	19.9	589	15.9	-4.0
50-74	99	37.2	2,073	56.0	18.8
75 and older	23	8.7	724	19.6	10.9
Sex					
Male	132	49.6	1,977	53.4	3.8
Female	134	50.4	1,724	46.6	-3.8
Region of Residence					
Southern Health-Santé Sud	22	8.3	484	13.1	4.8
Winnipeg RHA	168	63.2	2,015	54.4	-8.7
Prairie Mountain Health	50	18.8	654	17.7	-1.1
Interlake-Eastern RHA	19	7.1	419	11.3	4.2
Northern Health Region	7	2.6	129	3.5	0.9
Income Quintile					
Q1 (Lowest)	52	19.6	578	15.6	-3.9
Q2	65	24.4	721	19.5	-5.0
Q3	43	16.2	809	21.9	5.7
Q4	52	19.6	812	21.9	2.4
Q5 (Highest)	54	20.3	781	21.1	0.8

Table 3.7: Characteristics of the Negative Colonoscopy Sub-Group in the First and Last Fiscal Years of the Study Observation Period

Cohort Characteristics	1985/86 N = 3,193		2015/16 N = 25,048		Percent Change
	Count	Percent	Count	Percent	
Age Group (Years)					
19-34	470	14.7	1,388	5.5	-9.2
35-49	578	18.1	3,287	13.1	-5.0
50-74	1,658	51.9	16,522	66.0	14.0
75 and older	487	15.3	3,851	15.4	0.1
Sex					
Male	1,461	45.8	12,229	48.8	3.1
Female	1,732	54.2	12,819	51.2	-3.1
Region of Residence					
Southern Health-Santé Sud	303	9.5	3,139	12.5	3.0
Winnipeg RHA	2,278	71.3	13,257	52.9	-18.4
Prairie Mountain Health	295	9.2	4,488	17.9	8.7
Interlake-Eastern RHA	208	6.5	3,260	13.0	6.5
Northern Health Region	109	3.4	904	3.6	0.2
Income Quintile					
Q1 (Lowest)	614	19.2	3,727	14.9	-4.4
Q2	662	20.7	4,887	19.5	-1.2
Q3	632	19.8	5,281	21.1	1.3
Q4	584	18.3	5,711	22.8	4.5
Q5 (Highest)	701	22.0	5,442	21.7	-0.2

Note: Negative colonoscopy sub-group was defined using an end date of March 31, 2016, to allow for follow-up time for subsequent colonoscopies.

Table 3.8: Characteristics of the Polyp Sub-Group in the First and Last Fiscal Years of the Study Observation Period

Cohort Characteristics	1985/86 N = 4,424		2015/16 N = 27,079		Percent Change
	Count	Percent	Count	Percent	
Age Group (Years)					
19-34	590	13.3	1,813	6.7	-6.6
35-49	841	19.0	4,348	16.1	-3.0
50-74	2,319	52.4	17,129	63.3	10.8
75 and older	674	15.2	3,789	14.0	-1.3
Sex					
Male	1,882	42.5	12,684	46.8	4.3
Female	2,542	57.5	14,395	53.2	-4.3
Region of Residence					
Southern Health-Santé Sud	388	8.8	3,865	14.3	5.5
Winnipeg RHA	3,078	69.6	14,664	54.2	-15.4
Prairie Mountain Health	479	10.8	4,409	16.3	5.5
Interlake-Easstern RHA	342	7.7	3,047	11.3	3.5
Northern Health Region	137	3.1	1,094	4.0	0.9
Income Quintile					
Q1 (Lowest)	856	19.4	4,187	15.5	-3.9
Q2	925	20.9	5,235	19.3	-1.6
Q3	889	20.1	5,593	20.7	0.6
Q4	801	18.1	5,980	22.1	4.0
Q5 (Highest)	953	21.5	6,084	22.5	0.9

Note: Polyp sub-group was defined using an end date of March 31, 2016, to allow for follow-up time for subsequent colonoscopies.

Table 3.9: Characteristics of Cohort by Presence of an Anesthesiologist for a Gastrointestinal Endoscopy (GIE) Procedure

Cohort Characteristics	2005/06				2016/17			
	No Anesthesiologist N = 35,598		Anesthesiologist Present N = 1,622		No Anesthesiologist N = 43,347		Anesthesiologist Present N = 7,964	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Age Group (Years)								
19-34	2,522	7.1	100	6.2	3,217	7.4	631	7.9
35-49	7,257	20.4	317	19.5	7,170	16.5	1,402	17.6
50-74	19,058	53.5	831	51.2	27,107	62.5	4,905	61.6
75 and older	6,761	19.0	374	23.1	5,853	13.5	1,026	12.9
Sex								
Male	16,169	45.4	724	44.6	20,351	47.0	3,750	47.1
Female	19,429	54.6	898	55.4	22,996	53.1	4,214	52.9
Region of Residence								
Southern Health-Santé Sud	3,932	11.1	325	20.0	3,052	7.0	4,275	53.7
Winnipeg RHA	21,169	59.5	87	5.4	25,855	59.7	556	7.0
Prairie Mountain Health	5,369	15.1	1,126	69.4	6,534	15.1	2,209	27.7
Interlake-Eastern RHA	3,966	11.1	70	4.3	6,128	14.1	329	4.1
Northern Health Region	1,162	3.3	14	0.9	1,778	4.1	595	7.5
Income Quintile								
Q1 (Lowest)	6,236	17.5	544	33.5	6,867	15.8	1,948	24.5
Q2	7,205	20.2	463	28.6	8,353	19.3	1,628	20.4
Q3	7,666	21.5	324	20.0	9,211	21.3	1,555	19.5
Q4	7,445	20.9	178	11.0	9,326	21.5	1,745	21.9
Q5 (Highest)	7,046	19.8	113	7.0	9,590	22.1	1,088	13.7

Note: This analysis was based only on the most recent decade of data

Table 3.9 describes the socio-demographic characteristics of the subgroup with an anesthesiologist present in the first and last years of the study observation period; note that we limited our attention to only the most recent decade when defining the study observation period. Interestingly, more than half of these procedures in the last year of the study were performed in Southern Health-Santé Sud. A higher percentage were in the lowest income quintile than in the highest income quintile.

Description of Trends in GIE Procedure Rates

Any GIE Procedure

The crude percent of the population having one or more GIE procedures in a year is reported by age group (Figure 3.2), sex (Figure 3.3), health region of residence (Figure 3.4) and income quintile (Figure 3.5). There were increasing trends observed over time for these socio-demographic variables.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 0.39% in 1984/85 and 1.32% in 2016/17, which represents a 238.5% increase.
  - For the 35-49 years age group, the rate was 0.87% in 1984/85 and 3.60% in 2016/17, which represents a 313.8% increase.
  - For the 50-74 years age group, the rate was 2.01% in 1984/85 and 9.65% in 2016/17, which represents a 380.0% increase.
  - For the oldest age group (75 years and older), the rate was 2.55% in 1984/95 and 9.69% in 2016/17, which represents a 280.0% increase.
- **By Sex:**
  - Rates were consistently higher for females than for males throughout the study observation period, although the magnitude of the difference was not large.
  - For males, the rate was 1.11% in 1984/85 and 5.41% in 2016/17, which represents a 387.4% increase.
  - For females, the rate was 1.15% in 1984/85 and 5.88% in 2016/17, which represents a 411.3% increase.
- **By Health Region of Residence:**
  - The amount of the variation amongst the regions grew slightly over time. The ratio of the largest to the smallest regional rate was 1.43 in 1984/85, and it was 1.67 in 2016/17. The regions with the highest and lowest rates changed over time, because there were marked differences in rates of increase across the regions.
  - For Southern Health-Santé Sud, the rate was 0.87% in 1984/85 and 5.73% in 2016/17, which represents a 558.6% increase.
  - For the Winnipeg RHA, the rate was 1.24% in 1984/85 and 4.87% in 2016/17, which represents a 292.7% increase.
  - For Prairie Mountain Health, the rate was 1.16% in 1984/85 and 8.11% in 2016/17, which represents a 599.1% increase.
  - For the Interlake-Eastern RHA, the rate was 0.88% in 1984/85 and 7.28% in 2016/17, which represents a 727.3% increase.
  - For Northern Health Region, the rate was 0.87% in 1984/85 and 5.27% in 2016/17, which represents a 505.7% increase.
  - After adjusting for age and sex in a negative binomial regression model (Table 3.9), the estimated average annual rate of increase was highest in Prairie Mountain Health and lowest in the Winnipeg RHA.
- **By Income Quintile:**
  - The results stratified by income quintile showed little variation at both the beginning and end of the study observation period.
  - For Q1 (lowest income quintile), the rate was 1.16% in 1984/85 and 5.13% in 2016/17, which represents a 342.2% increase.
  - For Q5 (highest income quintile), the rate was 1.00% in 1984/85 and 5.71% in 2016/17, which represents a 471.0% increase.

Figure 3.2: Rate of Gastrointestinal Endoscopy (GIE) Procedures by Age Group
Manitobans with 1 or more GIE procedures per year

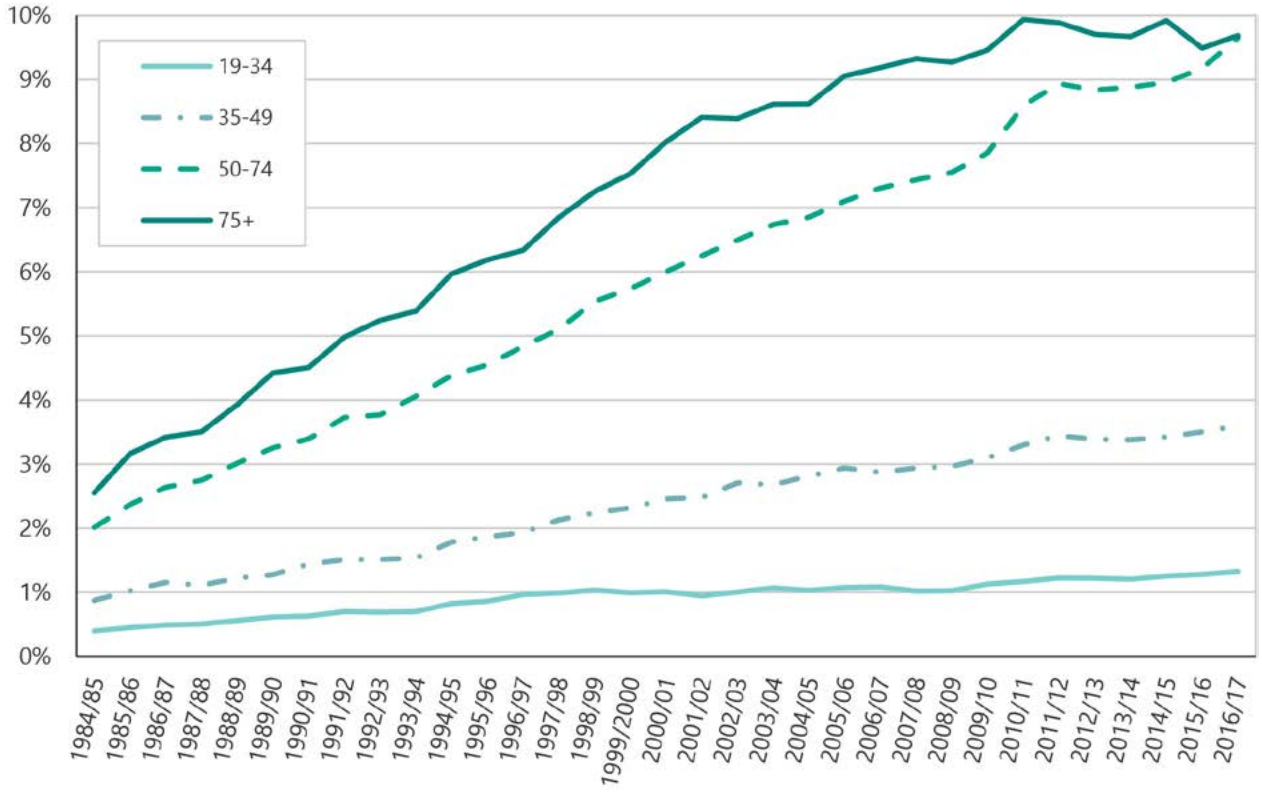


Figure 3.3: Rate of Gastrointestinal Endoscopy (GIE) Procedures by Sex
Manitobans with 1 or more GIE procedures per year

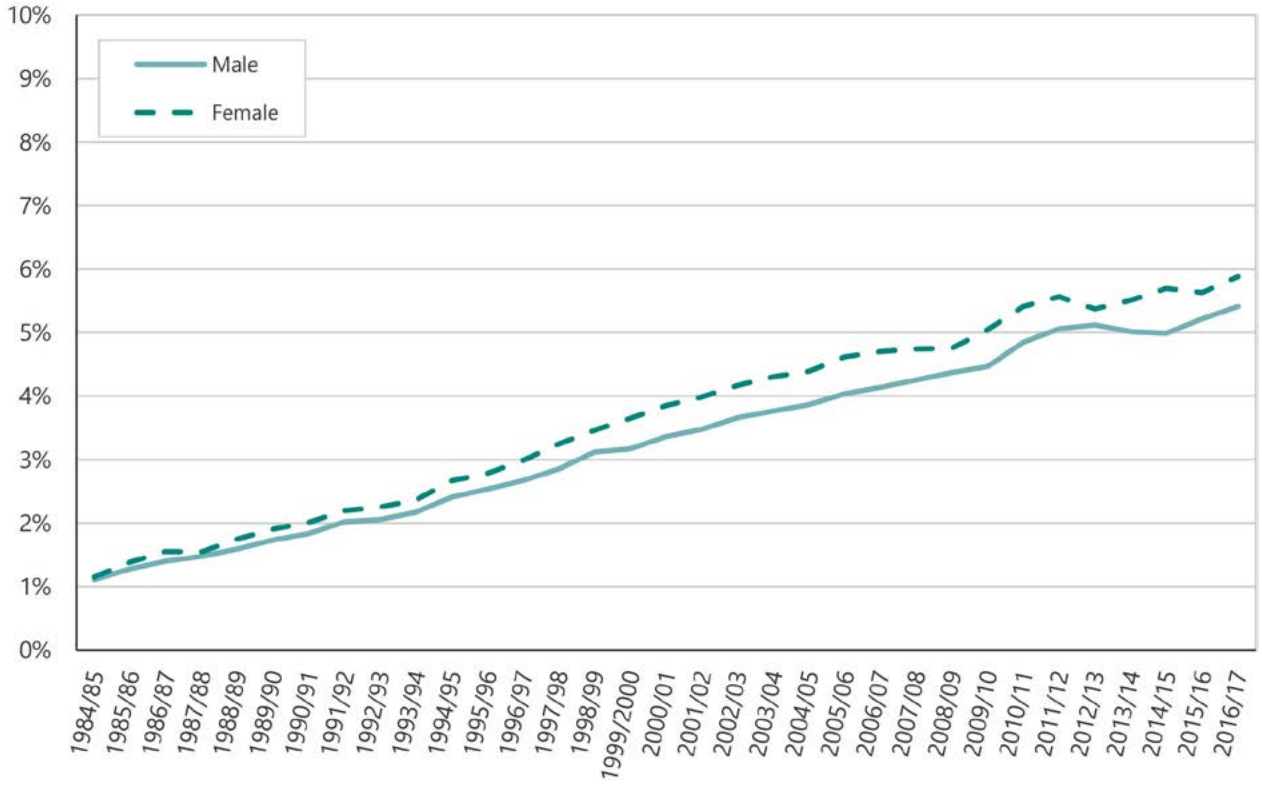


Figure 3.4: Rate of Gastrointestinal Endoscopy (GIE) Procedures by Region of Residence
Manitobans with 1 or more GIE procedures per year

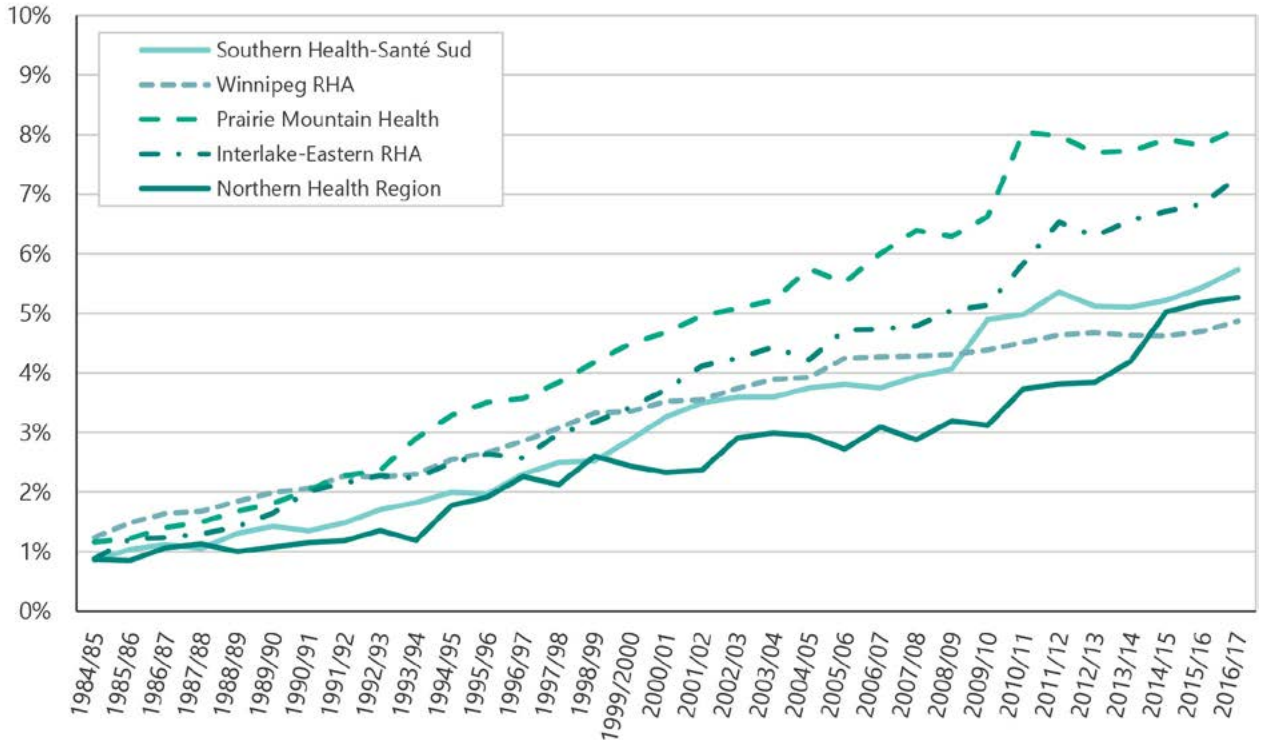
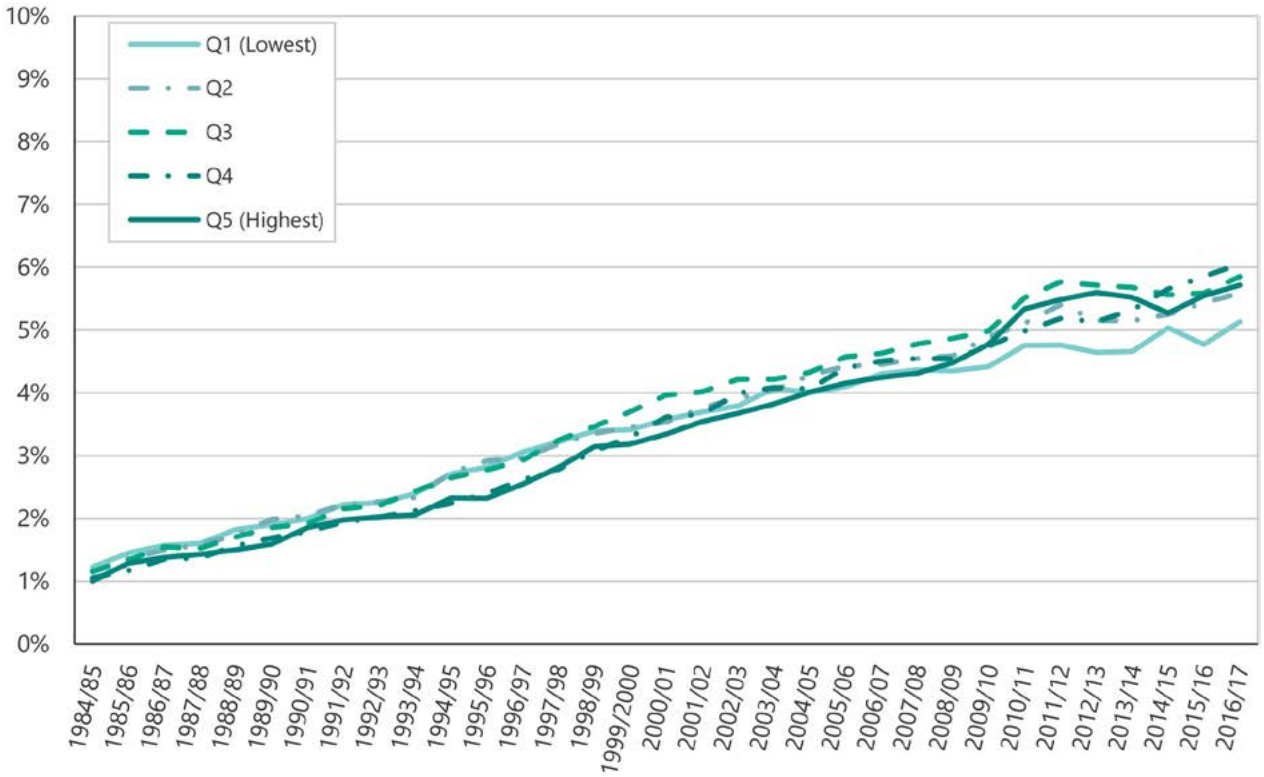


Table 3.10: Estimated Average Annual Increase in the Percent of the Population with at least One Gastrointestinal Endoscopy (GIE) Procedure, 1984/85 to 2016/17

Health Region	Average Annual Rate Increase (%)	95% Lower Confidence Limit	95% Upper Confidence Limit
Southern Health-Santé Sud	5.17	4.78	5.57
Winnipeg RHA	2.87	2.49	3.25
Prairie Mountain Health	5.75	5.42	6.08
Interlake-Eastern RHA	4.73	4.32	5.13
Northern Health Region	4.50	3.91	5.11

Note: Estimates are based on a negative binomial regression model, adjusted for age group and sex.

Figure 3.5: Rate of Gastrointestinal Endoscopy (GIE) Procedure by Income Quintile
Manitobans with 1 or more GIE procedures per year



Upper GIE Procedures

The percent of the population having one or more upper GIE procedures in a year is reported by age group (Figure 3.6), sex (Figure 3.7), health region of residence (Figure 3.8) and income quintile (Figure 3.9). There were increasing trends observed over time across these socio-demographic variables, though the rate of increase was variable among most groups.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 0.24% in 1984/85 and 0.61% in 2016/17, which represents a 154.2% increase.
  - For the 35-49 years age group, the rate was 0.56% in 1984/85 and 1.45% in 2016/17, which represents a 158.9% increase.
  - For the 50-74 years age group, the rate was 1.15% in 1984/85 and 3.13% in 2016/17, which represents a 172.2% increase
  - For the oldest age group (75 years and older), the rate was 1.55% in 1984/95 and 4.05% in 2016/17, which represents a 161.3% increase.
- **By Sex:**
  - Rates were higher for females than for males in the later years of the study observation period.
  - For males, the rate was 0.70 in 1984/85 and 1.85 in 2016/17, which represents a 164.3% increase.
  - For females, the rate was 0.65 in 1984/85 and 2.22 in 2016/17, which represents a 241.5% increase, showing that the rate rose much faster for females than for males.
- **By Health Region of Residence:**
  - The amount of the variation amongst the regions grew substantially over time. The ratio of the largest to the smallest rate was 1.44 in 1984/85 and 2.08 in 2016/17. The Winnipeg RHA, which had nearly the highest rate in 1984/85, became the region with the lowest rate in 2016/17.
  - For Southern Health-Santé Sud, the rate was 0.52% in 1984/85 and 2.01% in 2016/17, which represents a 286.5% increase.
  - For the Winnipeg RHA, the rate was 0.71% in 1984/85 and 1.64% in 2016/17, which represents a 131.0% increase.
  - For Prairie Mountain Health, the rate was 0.75% in 1984/85 and 3.41% in 2016/17, which represents a 354.7% increase.
  - For the Interlake-Eastern RHA, the rate was 0.54% in 1984/85 and 2.54% in 2016/17, which represents a 370.37% increase.
  - For Northern Health Region, the rate was 0.57% in 1984/85 and 2.39% in 2016/17, which represents a 319.3% increase.
  - After adjusting for age and sex in a negative binomial regression model (Table 3.10), the estimated average annual rate of increase was highest in Prairie Mountain Health and lowest in the Winnipeg RHA.
- **By Income Quintile:**
  - The results stratified by income quintile showed that the magnitude of variation was similar at both the beginning and end of the study observation period.
  - For Q1 (lowest income quintile), the rate was 0.76% in 1984/85 and 2.15% in 2016/17, which represents a 182.9% increase.
  - For Q5 (highest income quintile), the rate was 0.54% in 1984/85 and 1.79% in 2016/17, which represents a 231.5% increase.

Figure 3.6: Rate of Upper Gastrointestinal Endoscopy (GIE) Procedures by Age Group
Manitobans with 1 or more GIE procedures per year

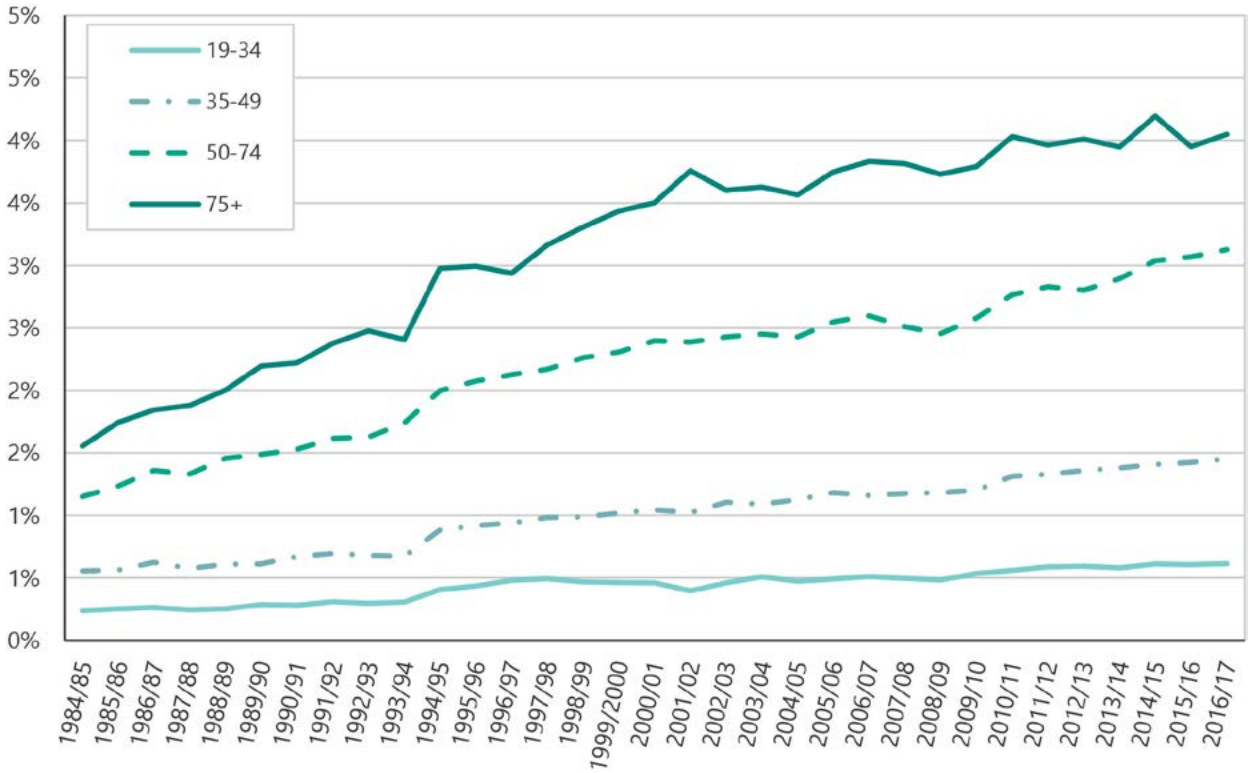


Figure 3.7: Rate of Upper Gastrointestinal Endoscopy (GIE) Procedures by Sex
Manitobans with 1 or more GIE procedures per year

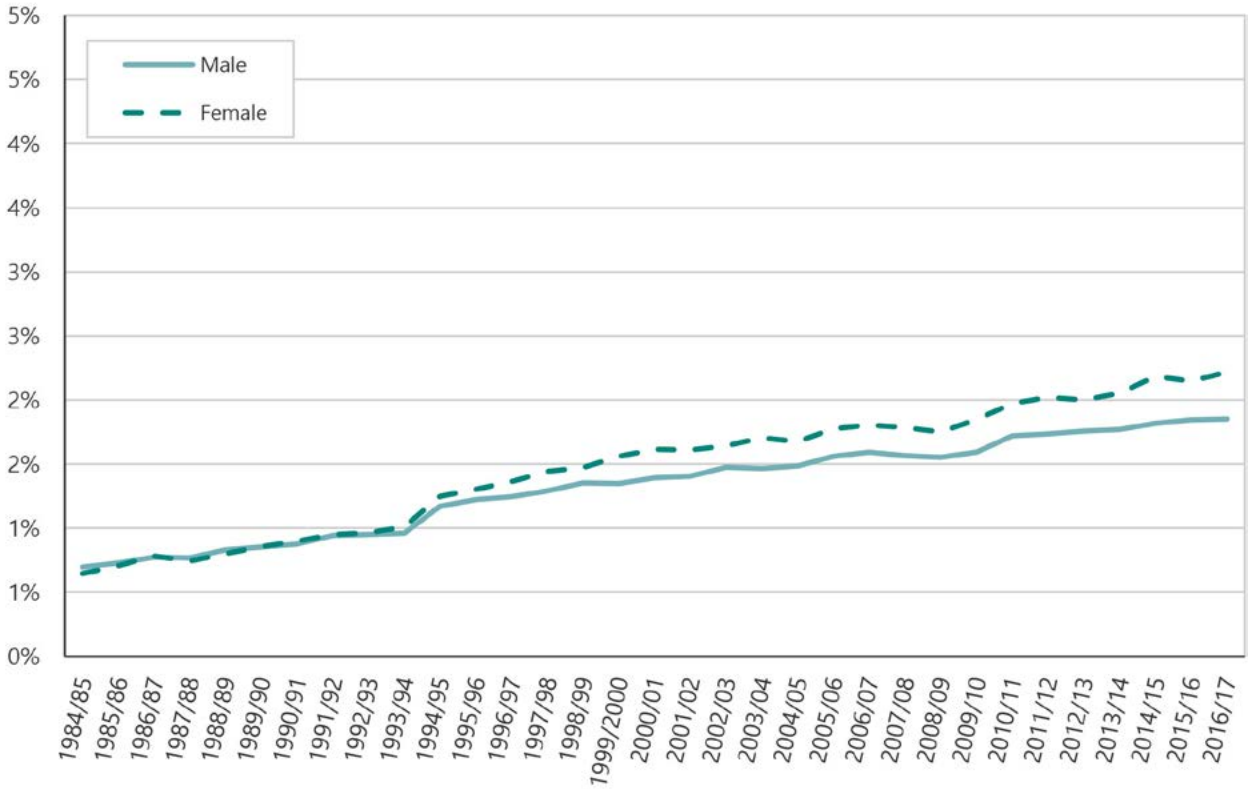


Figure 3.8: Rate of Upper Gastrointestinal Endoscopy (GIE) Procedures by Region of Residence
Manitobans with 1 or more GIE procedures per year

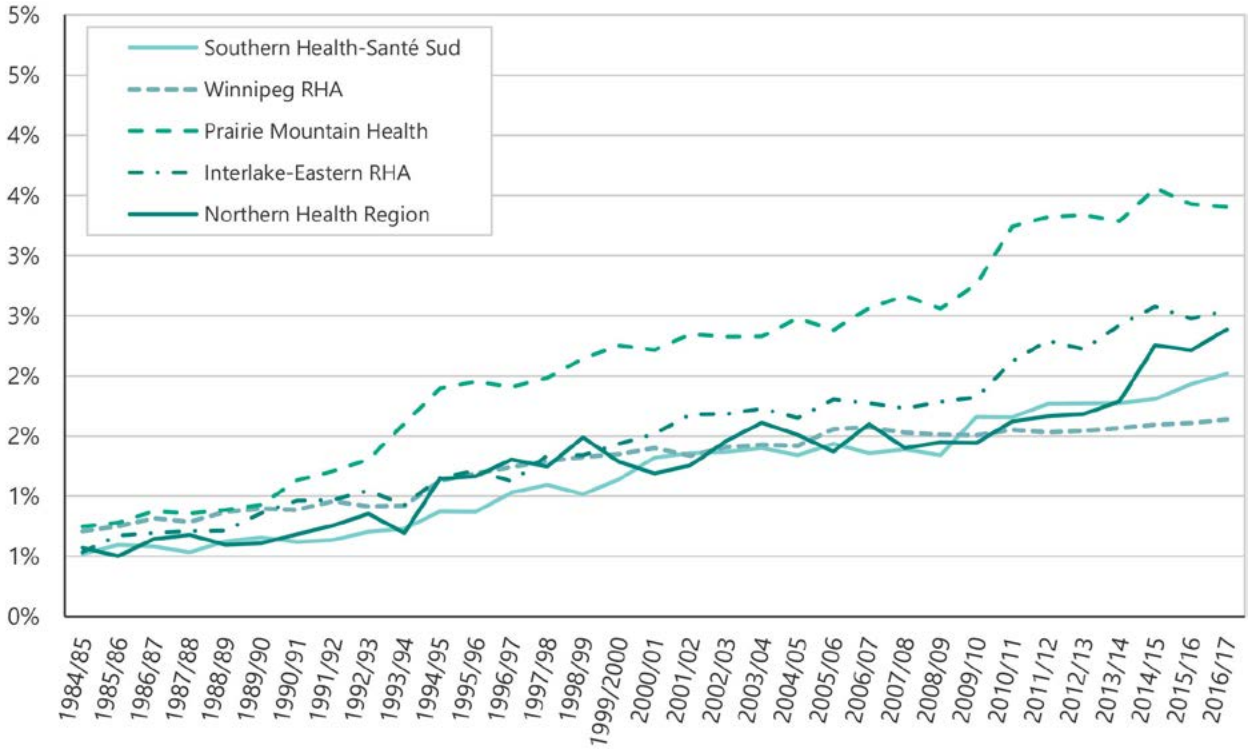
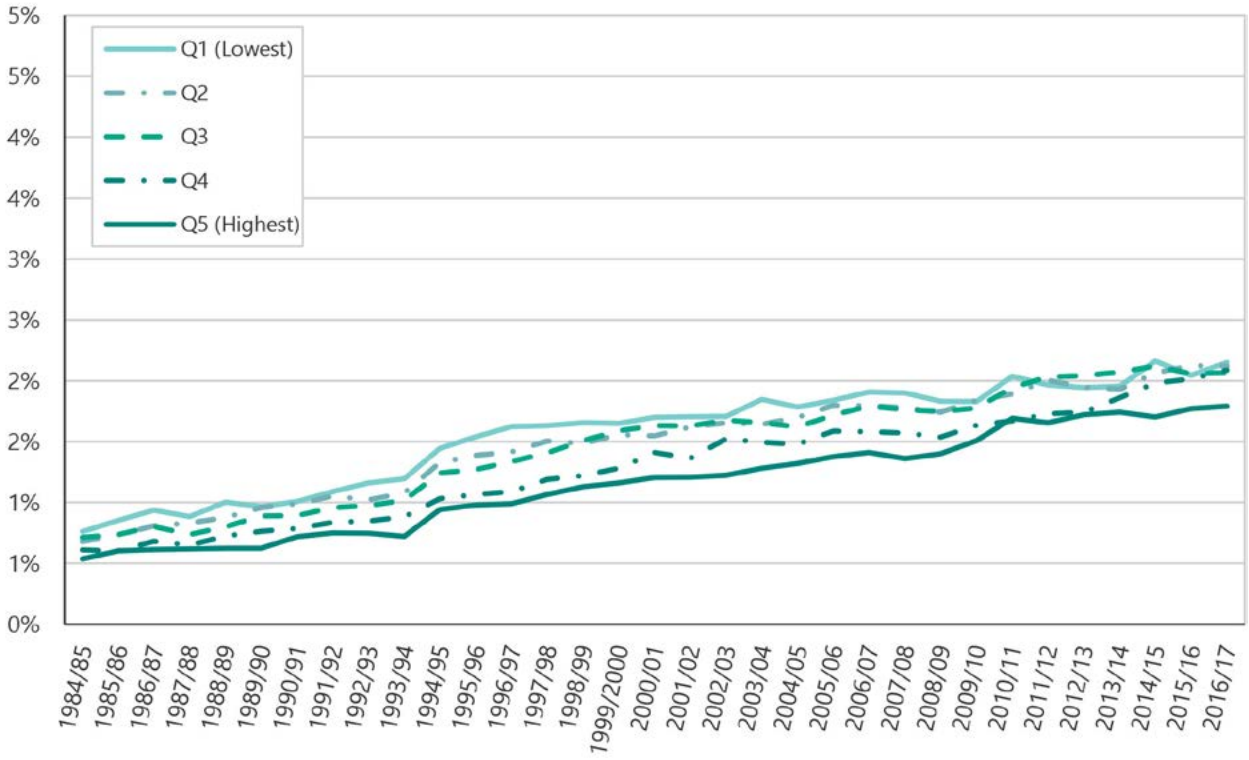


Table 3.11: Estimated Average Annual Increase in the Percent of the Population with at least One Upper Gastrointestinal Endoscopy (GIE) Procedure, 1984/85 to 2016/17

Health Region	Average Annual Rate Increase (%)	95% Lower Confidence Limit	95% Upper Confidence Limit
Southern Health-Santé Sud	4.11	3.68	4.55
Winnipeg RHA	1.89	1.63	2.16
Prairie Mountain Health	4.68	4.20	5.15
Interlake-Eastern RHA	3.61	3.40	3.82
Northern Health Region	3.35	2.93	3.77

Note: Estimates are based on a negative binomial regression model, adjusted for age group and sex. Modeling for 2-year fiscal year groups. The first year of data was excluded

Figure 3.9: Rate of Upper Gastrointestinal Endoscopy (GIE) Procedures by Income Quintile
Manitobans with 1 or more GIE procedures per year



Lower GIE Procedures

The percent of the population having one or more lower GIE procedure in a year is reported by age group (Figure 3.10), sex (Figure 3.11), health region of residence (Figure 3.12) and income quintile (Figure 3.13). There were increasing trends over time across all socio-demographic variables.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 0.16% in 1984/85 and 0.69% in 2016/17, which represents a 331.3% increase.
  - For the 35-49 years age group, the rate was 0.32% in 1984/85 and 2.11% in 2016/17, which represents a 559.4% increase.
  - For the 50-74 years age group, the rate was 0.86% in 1984/85 and 6.43% in 2016/17, which represents a 647.7% increase, the largest growth for any of the age groups.
  - For the oldest age group (75 years and older), the rate was 1.00% in 1984/95 and 5.49% in 2016/17, which represents a 449.0% increase.
- **By Sex:**
  - Rates were consistently higher for females than for males throughout the study observation period.
  - For males, the rate was 0.41 in 1984/85 and 3.51 in 2016/17, which represents a 756.1% increase.
  - For females, the rate was 0.50 in 1984/85 and 3.60 in 2016/17, which represents a 620.0% increase.
- **By Health Region of Residence:**
  - The amount of the variation amongst the regions decreased slightly over time. The ratio of the largest to the smallest rate was 1.77 in 1984/85 and 1.65 in 2016/17. The Winnipeg RHA, which had the highest rate in 1984/85, became the region with the near lowest rate in 2016/17.
  - For Southern Health-Santé Sud, the rate was 0.34% in 1984/85 and 3.67% in 2016/17, which represents a 979.4% increase.
  - For the Winnipeg RHA, the rate was 0.53% in 1984/85 and 3.17% in 2016/17, which represents a 498.1% increase.
  - For Prairie Mountain Health, the rate was 0.41% in 1984/85 and 4.63% in 2016/17, which represents a very substantial increase of 1029.3%.
  - For the Interlake-Eastern RHA, the rate was 0.34% in 1984/85 and 4.68% in 2016/17, which represents a very substantial increase of 1276.5%.
  - For Northern Health Region, the rate was 0.30% in 1984/85 and 2.84% in 2016/17, which represents a 846.7% increase.
  - After adjusting for age and sex in a negative binomial regression model (Table 3.11), the estimated average annual rate of increase was highest in Prairie Mountain Health and lowest in the Winnipeg RHA.
- **By Income Quintile:**
  - Compared to all GIE procedures and upper GIE procedures, there was more variation for lower GIE procedures at both the beginning and end of the study observation period across income quintiles.
  - For Q1 (lowest income quintile), the rate was 0.47% in 1984/85 and 2.93% in 2016/17, which represents a 523.4% increase.
  - For Q5 (highest income quintile), the rate was 0.47% in 1984/85 and 3.87% in 2016/17, which represents a more substantial increase of 723.4%.

Figure 3.10: Rate of Lower Gastrointestinal Endoscopy (GIE) Procedures by Age Group
Manitobans with 1 or more GIE procedures per year

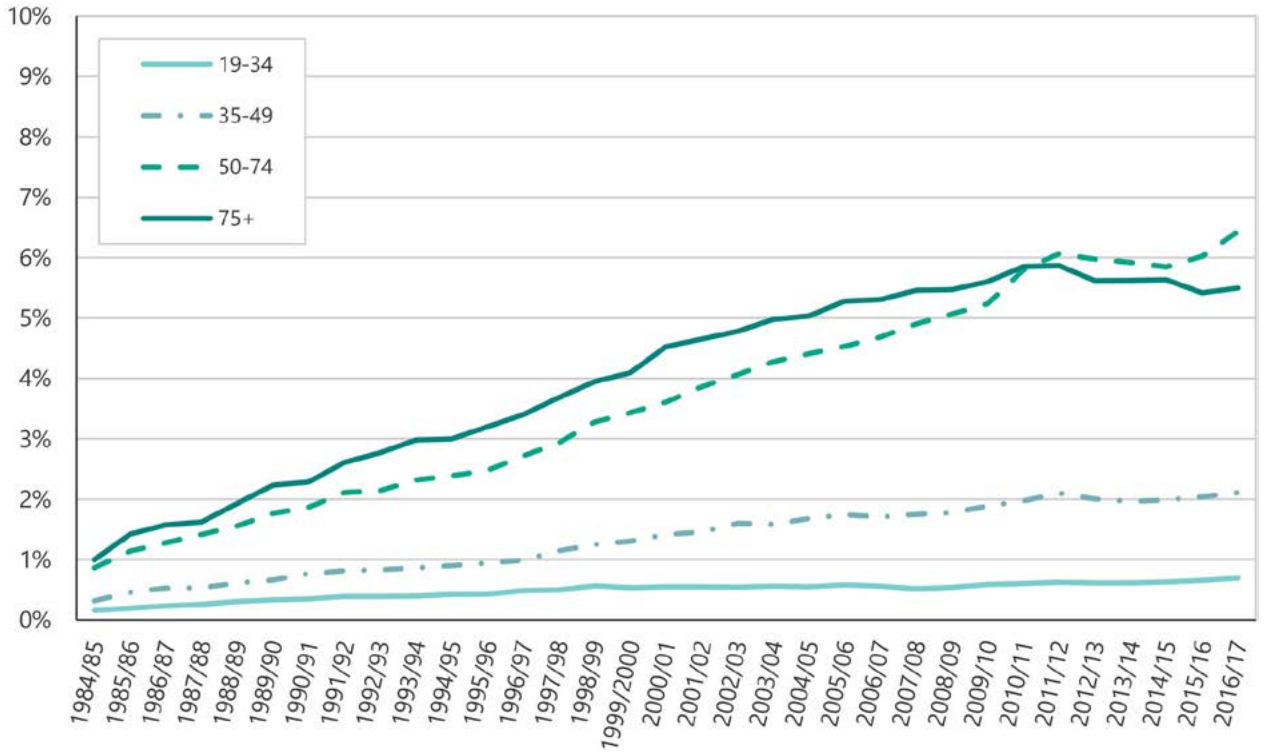


Figure 3.11: Rate of Lower Gastrointestinal Endoscopy (GIE) Procedures by Sex
Manitobans with 1 or more GIE procedures per year

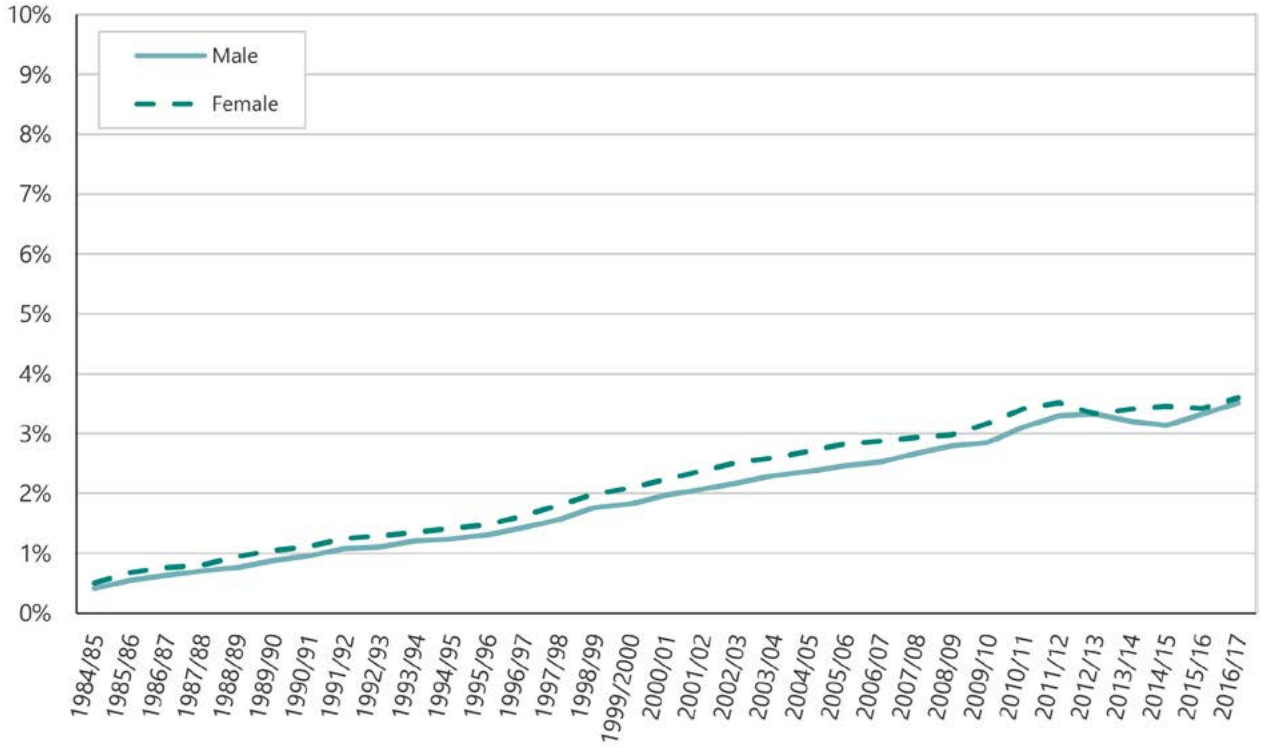


Figure 3.12: Rate of Lower Gastrointestinal Endoscopy (GIE) Procedures by Region of Residence
Manitobans with 1 or more GIE procedures per year

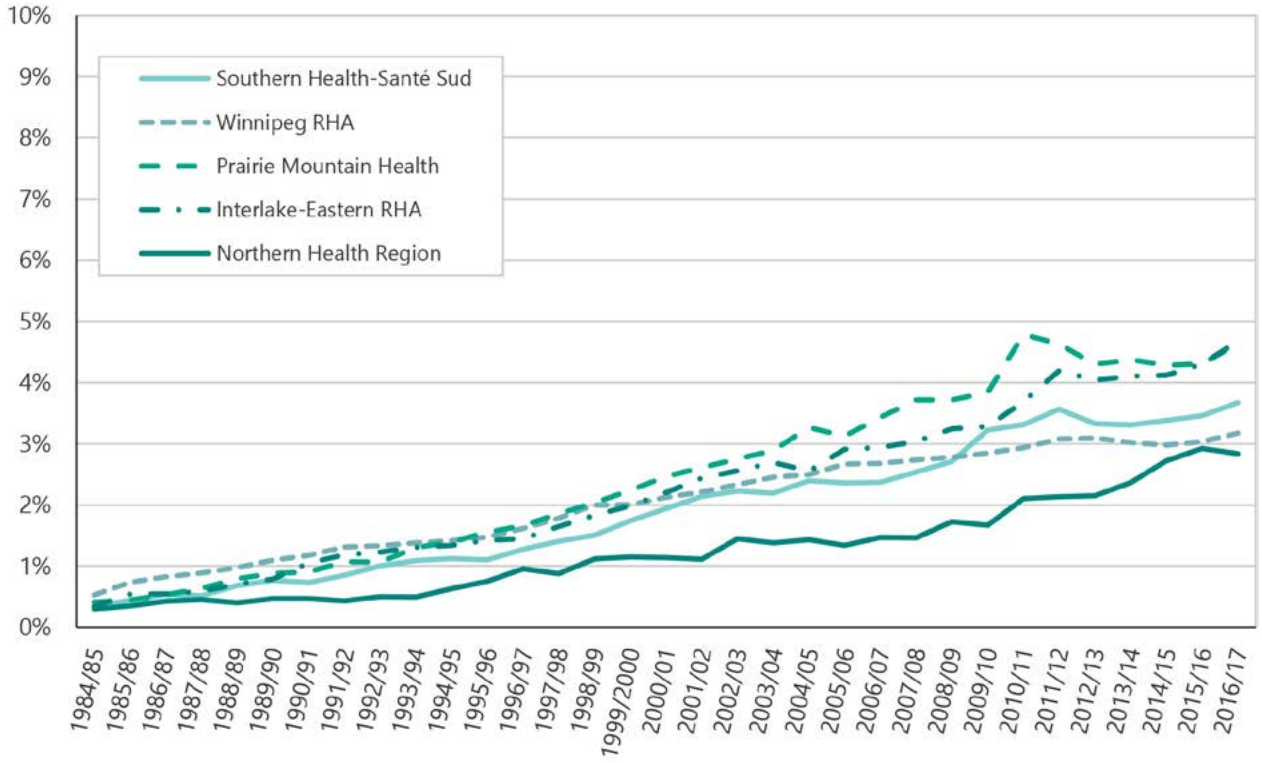
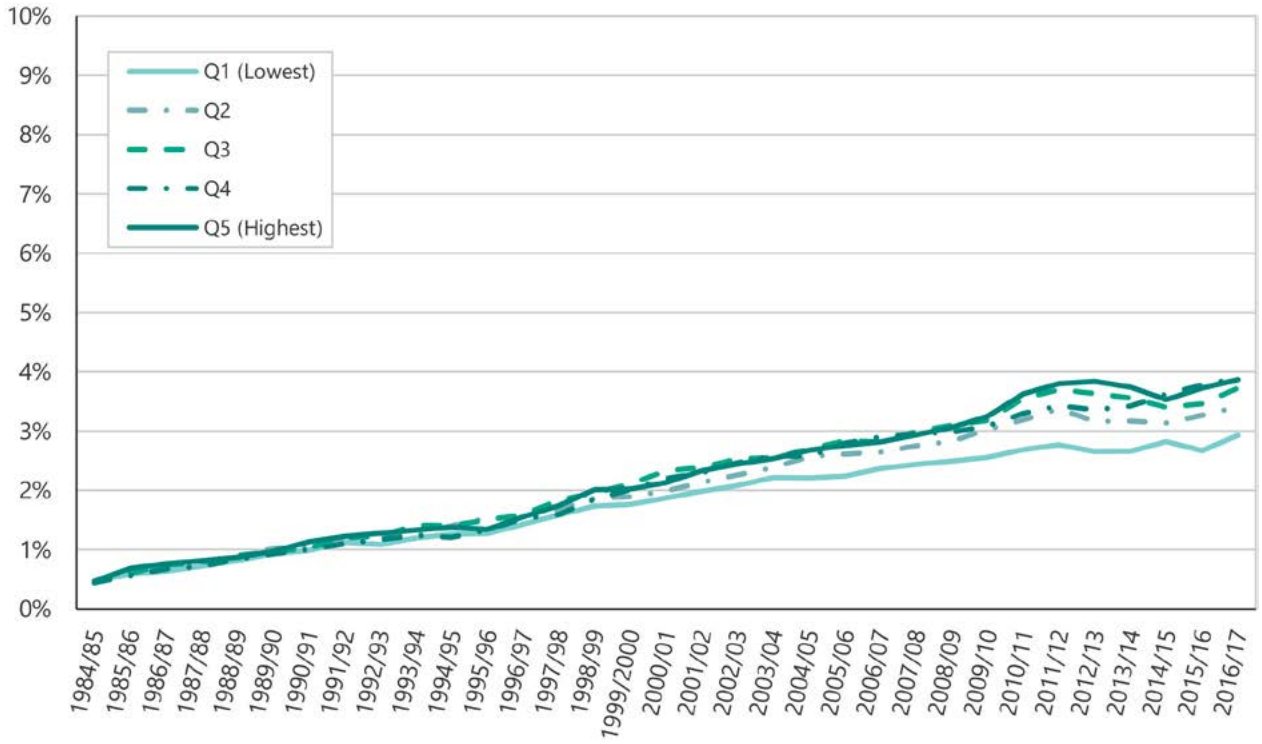


Table 3.12: Estimated Average Annual Increase in the Percent of the Population with at least One Lower Gastrointestinal Endoscopy (GIE) Procedure, 1984/85 to 2016/17

Health Region	Average Annual Rate Increase (%)	95% Lower Confidence Limit	95% Upper Confidence Limit
Southern Health-Santé Sud	5.86	5.12	6.61
Winnipeg RHA	3.47	2.87	4.08
Prairie Mountain Health	6.77	6.33	7.21
Interlake-Eastern RHA	5.55	4.87	6.23
Northern Health Region	5.71	4.69	6.73

Note: Estimates are based on a negative binomial regression model, adjusted for age group and sex. Modeling for 2-year fiscal year groups. The first year of data was excluded.

Figure 3.13: Rate of Lower Gastrointestinal Endoscopy (GIE) Procedures by Income Quintile
Manitobans with 1 or more GIE procedures per year



Small Bowel Endoscopy Procedures

The percent of the population having at least one small bowel endoscopy procedure in a year is reported by age group (Figure 3.14), sex (Figure 3.15), health region of residence (Figure 3.16) and income quintile (Figure 3.17). There were generally increasing trends observed over time across these socio-demographic variables.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 0.004% in 2004/05 and 0.019% in 2016/17, which represents a 375.0% increase.
  - For the 35-49 years age group, the rate was 0.009% in 2004/05 and 0.035% in 2016/17, which represents a 288.9% increase.
  - For the 50-74 years age group, the rate was 0.024% in 2004/05 and 0.089% in 2016/17, which represents a 270.8% increase.
  - For the oldest age group (75 years and older), the rate was 0.031% in 2004/05 and 0.144% in 2016/17, which represents a 364.5% increase.
- **By Sex:**
  - Rates were consistently higher for females than for males throughout the study observation period.
  - For males, the rate was 0.010% in 2004/05 and 0.047% in 2016/17, which represents a 261.5% increase.
  - For females, the rate was 0.010% in 2004/05 and 0.071% in 2016/17, which represents a 343.75% increase.
- **By Health Region of Residence:**
  - The amount of the variation amongst the regions grew over time. The ratio of the largest to the smallest rate in 2005/06 was 2.00, and it was 1.83 in 2016/17.
  - For Southern Health-Santé Sud, the rate was 0.014% in 2005/06 and 0.040% in 2016/17, which represents a 185.7% increase.
  - For the Winnipeg RHA, the rate was 0.016% in 2005/06 and 0.061% in 2016/17, which represents a 687.5% increase.
  - For Prairie Mountain Health, the rate was 0.010% in 2005/06 and 0.073% in 2016/17, which represents a 630.0% increase.
  - For the Interlake-Eastern RHA, the rate was 0.008% in 2005/06 and 0.063% in 2016/17, which represents a 687.5% increase.
  - For Northern Health Region, the rate was 0.016% in 2005/06 and 0.046% in 2016/17, which represents a 187.5% increase.
  - After adjusting for age and sex in a negative binomial regression model (Table 3.12), the estimated average annual rate of increase was highest in Prairie Mountain Health and lowest in the Interlake-Eastern RHA. The differential rate of increase is reflective of the locations in which small bowel endoscopies are provided. In particular, capsule endoscopy is performed only in the Winnipeg RHA and Prairie Mountain Health.
- **By Income Quintile:**
  - The results stratified by income quintile showed consistent variation at both the beginning and end of the study observation period.
  - For Q1 (lowest income quintile), the rate was 0.014% in 2005/06 and 0.051% in 2016/17, which represents a 264.3% increase.
  - For Q5 (highest income quintile), the rate was 0.015% in 2005/06 and 0.056% in 2016/17, which represents a 273.3% increase.

Figure 3.14: Rate of Small Bowel Gastrointestinal Endoscopy (GIE) Procedures by Age Group
Manitobans with 1 or more GIE procedures per year

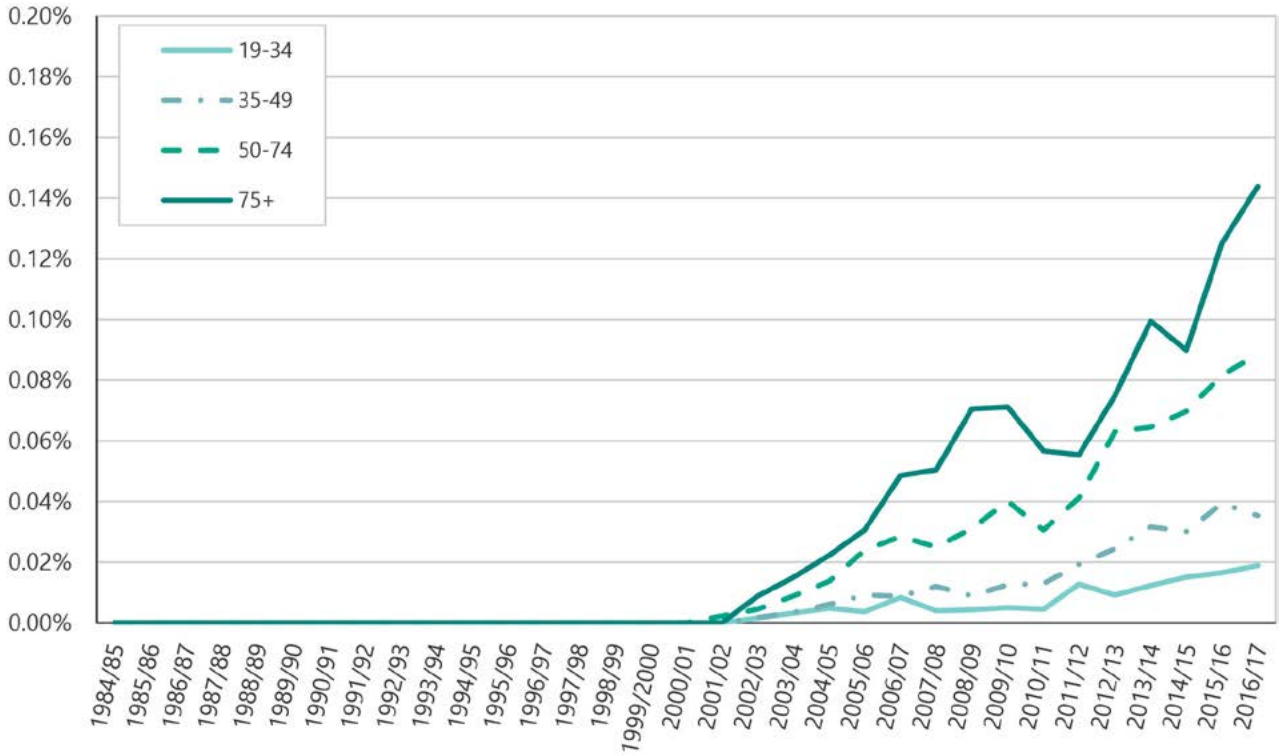


Figure 3.15: Rate of Small Bowel Gastrointestinal Endoscopy (GIE) Procedures by Sex
Manitobans with 1 or more GIE procedures per year

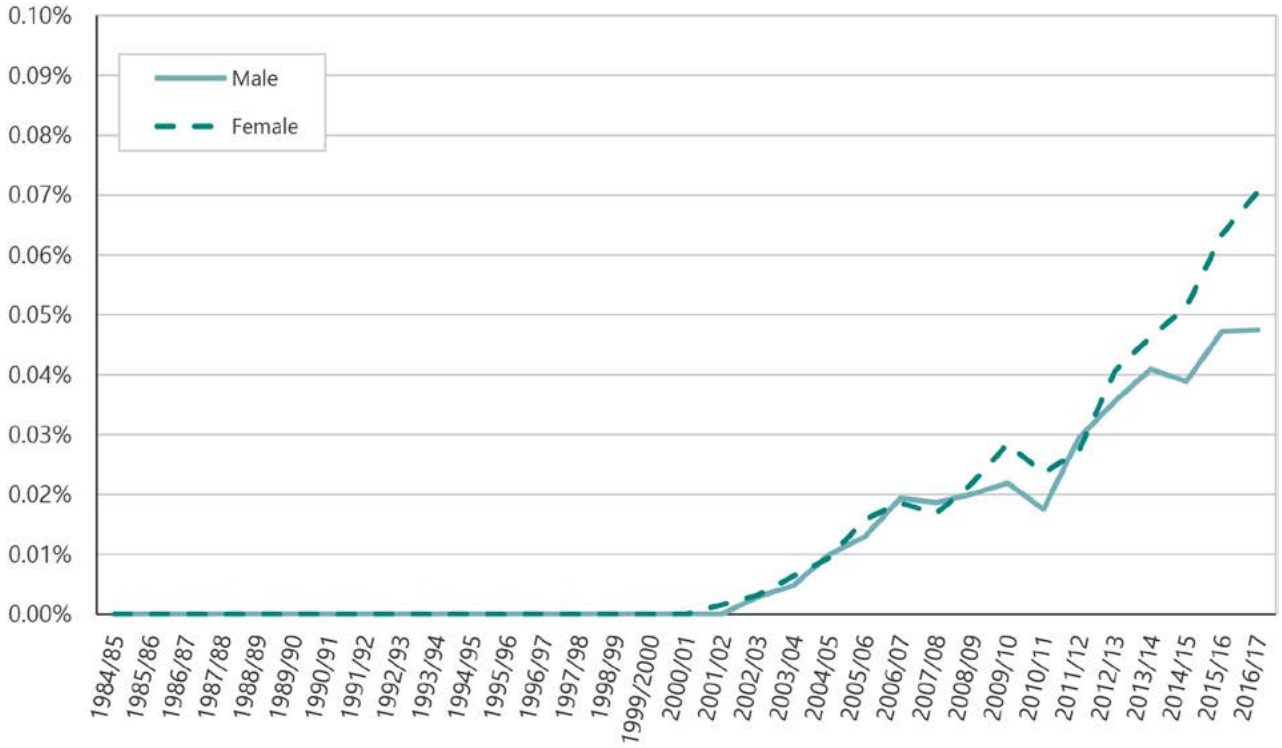


Figure 3.16: Rate of Small Bowel Gastrointestinal Endoscopy (GIE) Procedures by Region of Residence
Manitobans with 1 or more GIE procedures per year

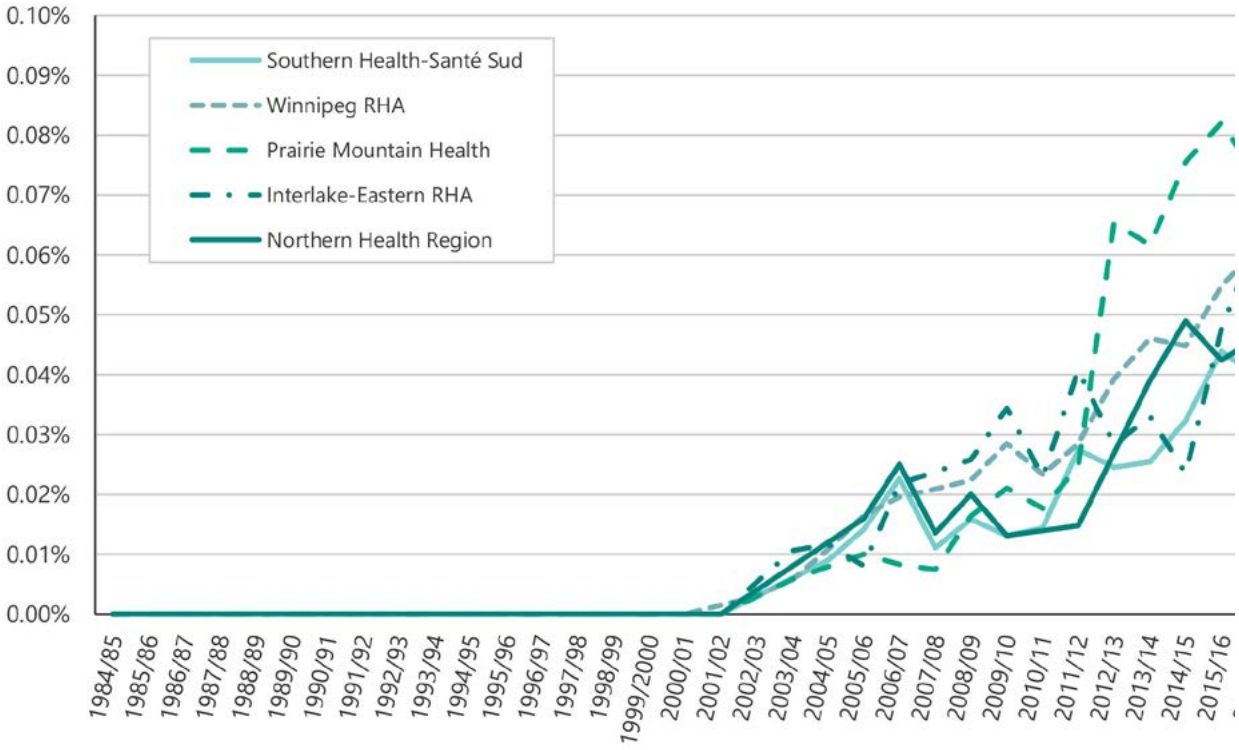
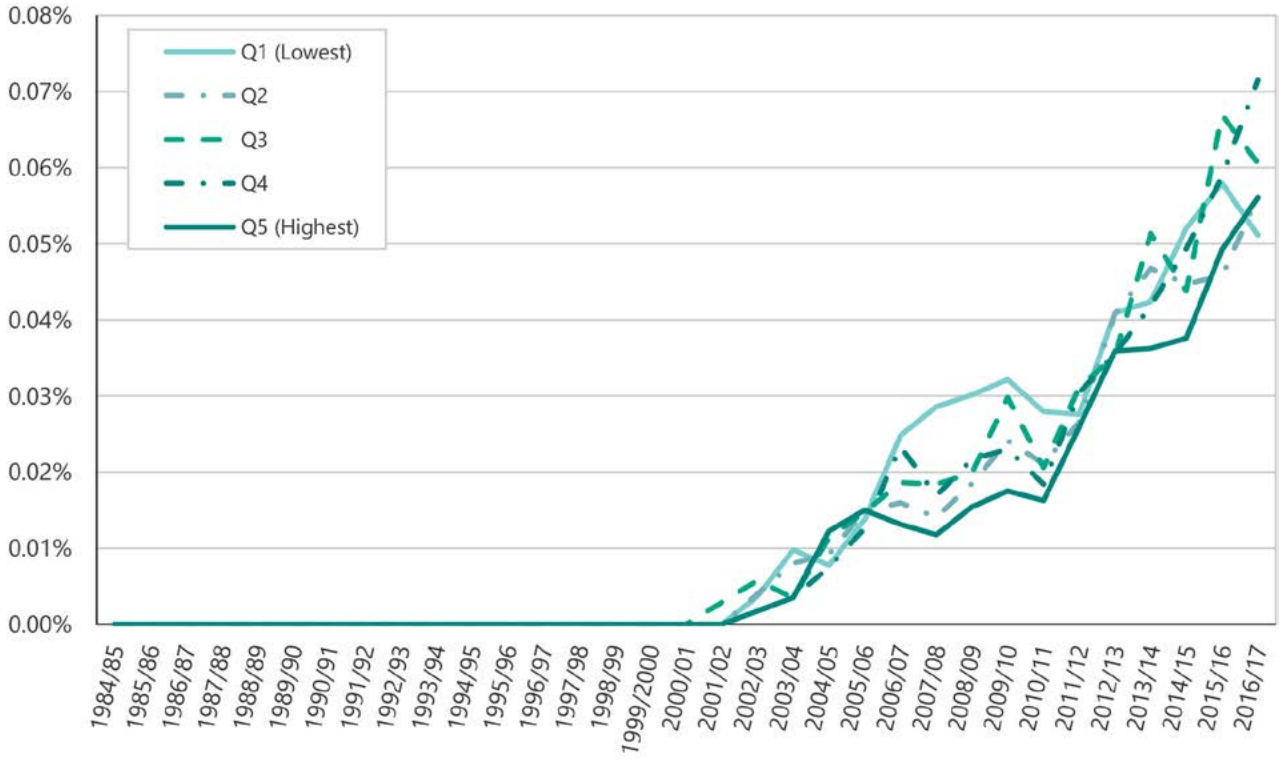


Table 3.13: Estimated Average Annual Increase in the Percent of the Population with at least One Small Bowel Gastrointestinal Endoscopy (GIE) Procedure, 2003/04 to 2016/17

Health Region	Average Annual Rate Increase (%)	95% Lower Confidence Limit	95% Upper Confidence Limit
Southern Health-Santé Sud	13.19	9.26	17.27
Winnipeg RHA	14.16	11.80	16.58
Prairie Mountain Health	28.84	22.52	35.48
Interlake-Eastern RHA	11.94	9.09	14.86
Northern Health Region	13.15	6.75	19.93

Note: Estimates are based on a negative binomial regression model, adjusted for age group and sex. Two years were combined to produce trend estimates.

Figure 3.17: Rate of Small Bowel Gastrointestinal Endoscopy (GIE) Procedures by Income Quintile
Manitobans with 1 or more GIE procedures per year



Both Upper and Lower GIE Procedure on the Same Day

Same-day scheduling of elective upper and lower endoscopic procedures can help reduce healthcare costs, avoid potential harms associated with preparatory procedures, such as repeated anesthesia and is more convenient for patients because it avoids repeated visits [49]. However, without information on indications for an upper GIE procedure and a lower GIE procedure, it is challenging to know the appropriateness of the procedures. de Jong, Lantinga, and Drenth (2019) reported, "Many upper gastrointestinal (GI) endoscopies worldwide are performed for inappropriate indications…Unfiltered open-access referrals feed upper GI endoscopy overuse" (p. 178) [50]. In this study, we examined trends in same-day procedures over time across age groups, sex, health region of residence, and income quintile.

The annual percent of the population having an upper and lower GIE procedure on the same day is reported by age group (Figure 3.18), sex (Figure 3.19), health region of residence (Figure 3.20) and income quintile (Figure 3.21). Rates increased substantially over time for each of these socio-demographic variables, and much faster than for upper GIE procedure or lower GIE procedures alone.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 0.01% in 1984/85 and 0.16% in 2016/17, which represents a 1,500.0% increase.
  - For the 35-49 years age group, the rate was 0.01% in 1984/85 and 0.48% in 2016/17, which represents a 4,700.0% increase.
  - For the 50-74 years age group, the rate was 0.03% in 1984/85 and 1.22% in 2016/17, which represents a 3,966.7% increase
  - For the oldest age group (75 years and older), the rate was 0.03% in 1984/95 and 1.38% in 2016/17, which represents a 4,500.0% increase.
- **By Sex:**
  - Rates were higher for females than for males throughout the study observation period, although at the beginning of the study period they were very low for both sexes. By the end of the study period, they were markedly different.
  - For males, the rate was 0.01% in 1984/85 and 0.65% in 2016/17, which represents a 6,400.0% increase.
  - For females, the rate was 0.02% in 1984/85 and 0.81 %in 2016/17, which represents a 3,950.0% increase.
- **By Health Region of Residence:**
  - The amount of the variation amongst the regions increased over time. The ratio of the largest to the smallest rate in 1984/85 was 2.33, and it was 2.73 in 2016/17.
  - For Southern Health-Santé Sud, the rate was 0.01% in 1984/85 and 0.87% in 2016/17, which represents a 8,600.0% increase.
  - For the Winnipeg RHA, the rate was 0.02% in 1984/85 and 0.48% in 2016/17, which represents a 2,300.0% increase.
  - For Prairie Mountain Health, the rate was 0.01% in 1984/85 and 1.32% in 2016/17, which represents a 13,100.0% increase.
  - For the Interlake-Eastern RHA, the rate was 0.02% in 1984/85 and 1.23% in 2016/17, which represents a 6,050.0% increase.
  - For Northern Health Region, the rate was 0.02% in 1984/85 and 0.87% in 2016/17, which represents a 4,250.0% increase.
  - After adjusting for age and sex in a negative binomial regression model (Table 3.13), the estimated average annual rate of increase was highest in Prairie Mountain Health and lowest in the Winnipeg RHA. The differences in rates of procedures between the Winnipeg RHA and other health regions in the last year of the study was the highest for same day procedures.
- **By Income Quintile:**
  - The results stratified by income quintile showed less variation at the beginning than at the end of the study observation period.
  - For Q1 (lowest income quintile), the rate was 0.02% in 1984/85 and 0.75% in 2016/17, which represents a 3,650.0% increase.
  - For Q5 (highest income quintile), the rate was 0.01% in 1984/85 and 0.62% in 2016/17, which represents a 6,100.0% increase.

Figure 3.18: Percent of Manitobans with Upper and Lower Gastrointestinal Endoscopy (GIE) Procedures Occurring on the Same Day by Age Group

Manitobans with at least 1 upper and 1 lower GIE procedure on the same day per year

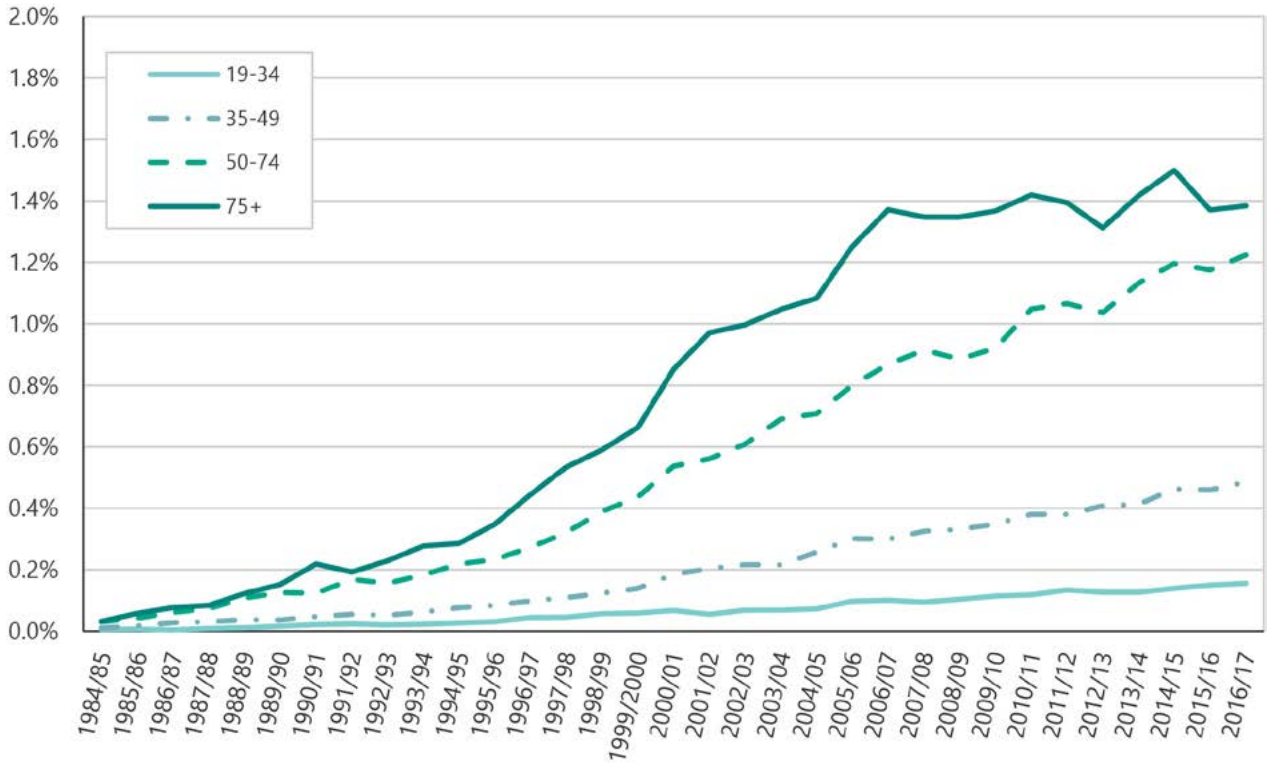


Figure 3.19: Percent of Manitobans with Upper and Lower Gastrointestinal Endoscopy (GIE) Procedures Occurring on the Same Day by Sex

Manitobans with at least 1 upper and 1 lower GIE procedure on the same day per year

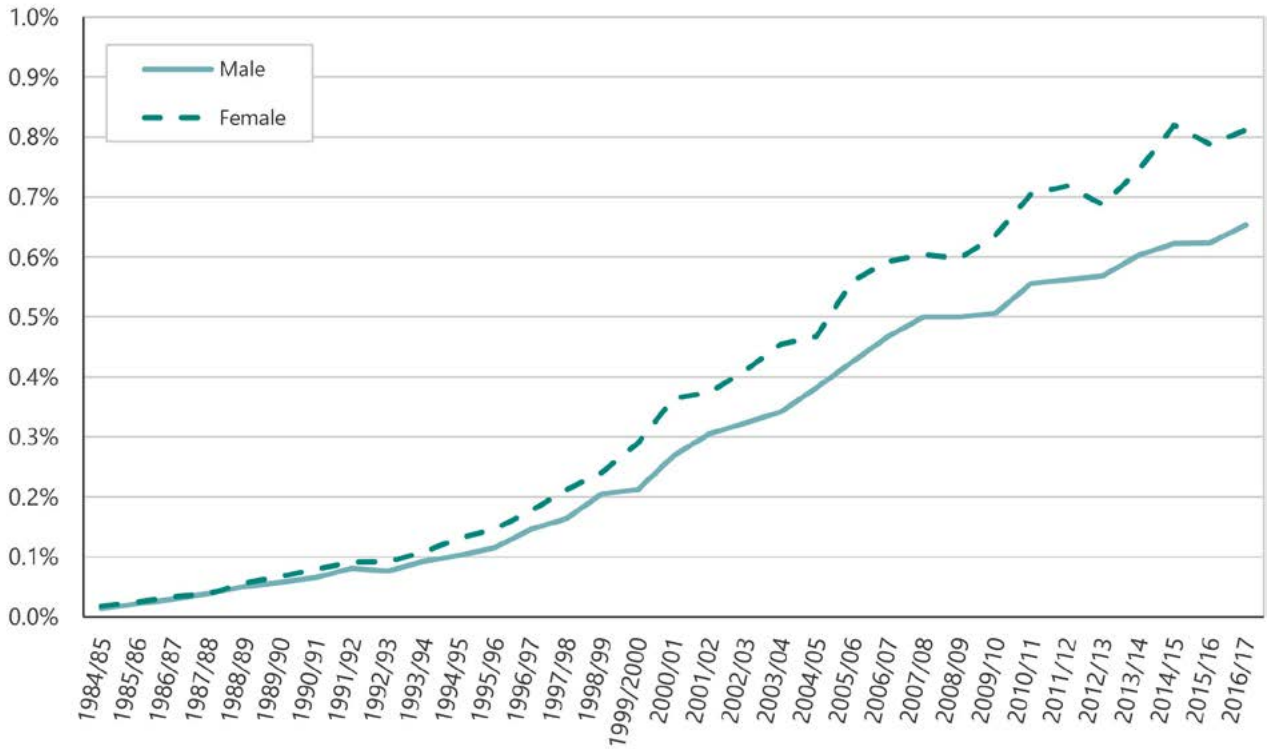


Figure 3.20: Percent of Manitobans with Upper and Lower Gastrointestinal Endoscopy (GIE) Procedures Occurring on the Same Day by Region of Residence

Manitobans with at least 1 upper and 1 lower GIE procedure on the same day per year

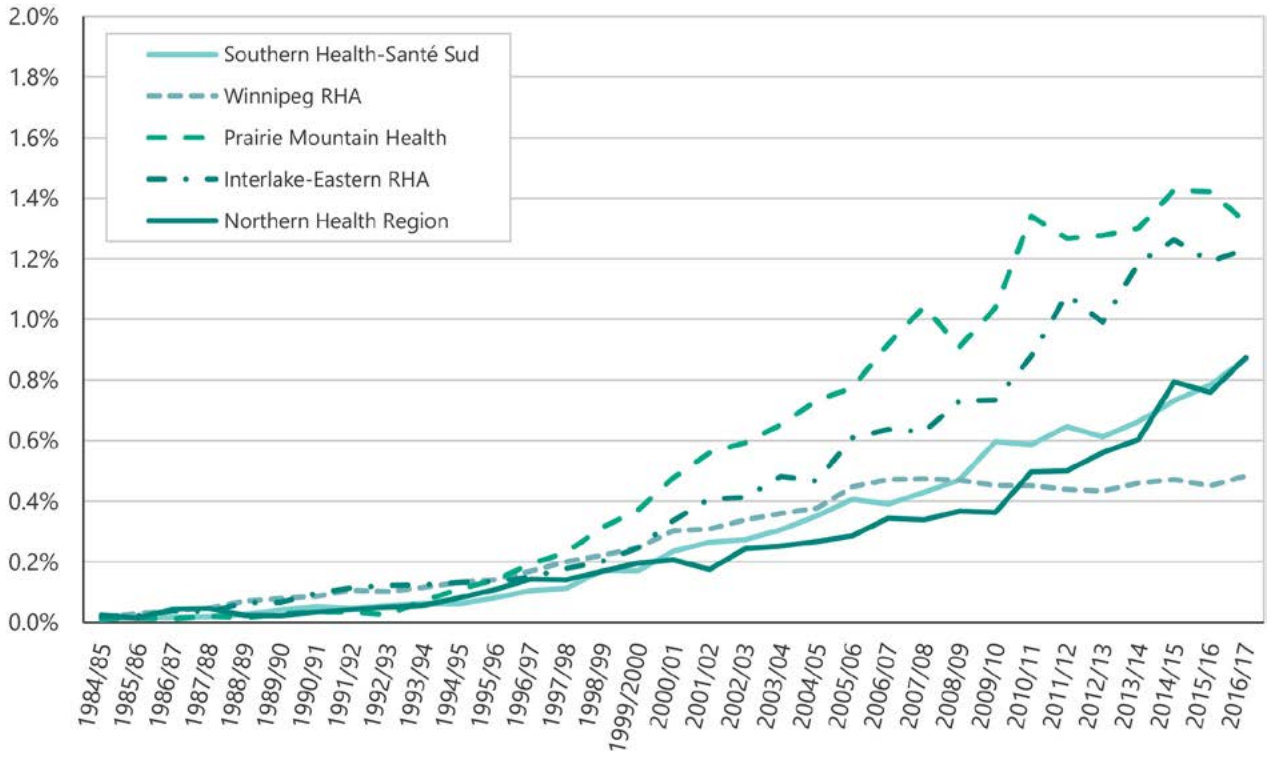


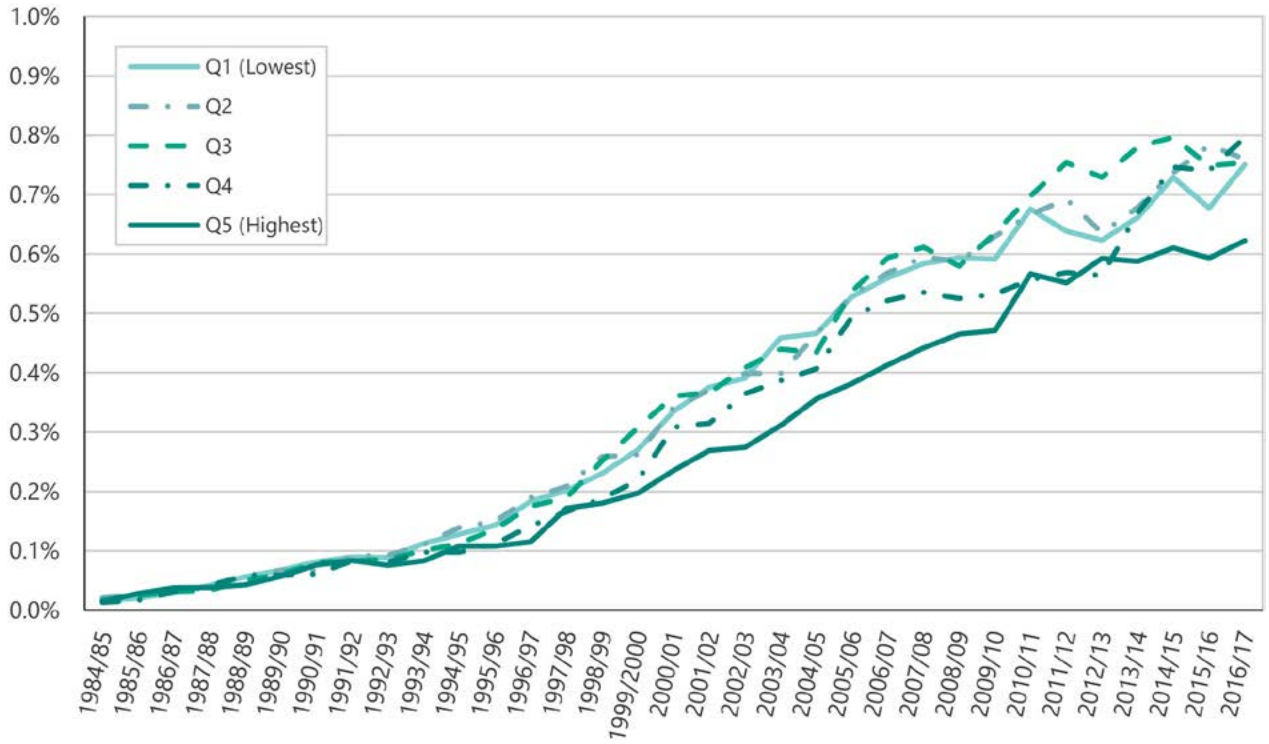
Table 3.14: Estimated Average Annual Increase in the Percent of the Population with Upper and Lower Gastrointestinal Endoscopy (GIE) Procedures Occurring on the Same Day, 1984/85 to 2016/17

Health Region	Average Annual Rate Increase (%)	95% Lower Confidence Limit	95% Upper Confidence Limit
Southern Health-Santé Sud	12.76	12.40	13.12
Winnipeg RHA	7.74	7.37	8.11
Prairie Mountain Health	16.45	16.09	16.81
Interlake-Eastern RHA	11.47	11.10	11.84
Northern Health Region	10.65	10.06	11.24

Note: Estimates are based on a negative binomial regression model, adjusted for age group and sex.

Figure 3.21: Percent of Manitobans with Upper and Lower Gastrointestinal Endoscopy (GIE) Procedures Occurring on the Same Day by Income Quintile

Manitobans with at least 1 upper and 1 lower GIE procedure on the same day per year



Any GIE Procedure in Ten Years

The rate of one or more GIE procedures (i.e., percent of population) in a year is reported by age group (Figure 3.22), sex (Figure 3.23), health region of residence (Figure 3.24) and income quintile (Figure 3.26). Rates increased over time across these socio-demographic variables.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 3.90% in 1984/85 to 1993/94 and 7.32% in 2007/08 to 2016/17, which represents a 87.7% increase.
  - For the 35-49 years age group, the rate was 8.00% in 1984/85 to 1993/94 and 17.55% in 2007/08 to 2016/17, which represents a 119.4% increase.
  - For the 50-74 years age group, the rate was 16.80% in 1984/85 to 1993/94 and 41.38% in 2007/08 to 2016/17, which represents a 146.3% increase
  - For the oldest age group (75 years and older), the rate was 24.34% in 1984/85 to 1993/94 and 48.34% in 2007/08 to 2016/17, which represents a 98.6% increase.
- **By Sex:**
  - Rates were higher for females than for males throughout the study observation period.
  - For males, the rate was 9.47% in 1984/85 to 1993/94 and 24.29% in 2007/08 to 2016/17, which represents a 156.5% increase.
  - For females, the rate was 10.82% in 1984/85 to 1993/94 and 27.15% in 2007/08 to 2016/17, which represents a 150.9% increase.
- **By Health Region of Residence:**
  - The magnitude of variation amongst the health regions decreased over time. The ratio of the largest to the smallest rate in 1984/85 to 1993/94 was 1.61, and it was 1.11 in 2007/08 to 2016/17.
  - For Southern Health-Santé Sud, the rate was 8.14% in 1984/85 to 1993/94 and 26.11% in 2007/08 to 2016/17, which represents a 220.8% increase.
  - For the Winnipeg RHA, the rate was 10.85% in 1984/85 to 1993/94 and 24.22% in 2007/08 to 2016/17, which represents a 123.2% increase.
  - For Prairie Mountain Health, the rate was 10.57% in 1984/85 to 1993/94 and 32.07% in 2007/08 to 2016/17, which represents a 203.4% increase.
  - For the Interlake-Eastern RHA, the rate was 9.62% in 1984/85 to 1993/94 and 28.81% in 2007/08 to 2016/17, which represents a 199.5% increase.
  - For Northern Health Region, the rate was 6.74% in 1984/85 to 1993/94 and 20.15% in 2007/08 to 2016/17, which represents a 199.0% increase.
- **By Income Quintile:**
  - The results stratified by income quintile showed little difference in the magnitude of variation over time. However, rates were higher at the beginning of the study observation period in the lowest quintile but were 4% lower by the end of the study observation period, suggesting a higher rate of increase in the highest income quintile.
  - For Q1 (lowest income quintile), the rate was 10.39% in 1984/85 to 1993/94 and 23.21% in 2007/08 to 2016/17, which represents a 123.4% increase.
  - For Q5 (highest income quintile), the rate was 9.61% in 1984/85 to 1993/94 and 27.33% in 2007/08 to 2016/17, which represents a 184.4% increase.

Figure 3.22: Percent of Manitobans with one or more Gastrointestinal Endoscopy (GIE) Procedures in 10 years by Age Group

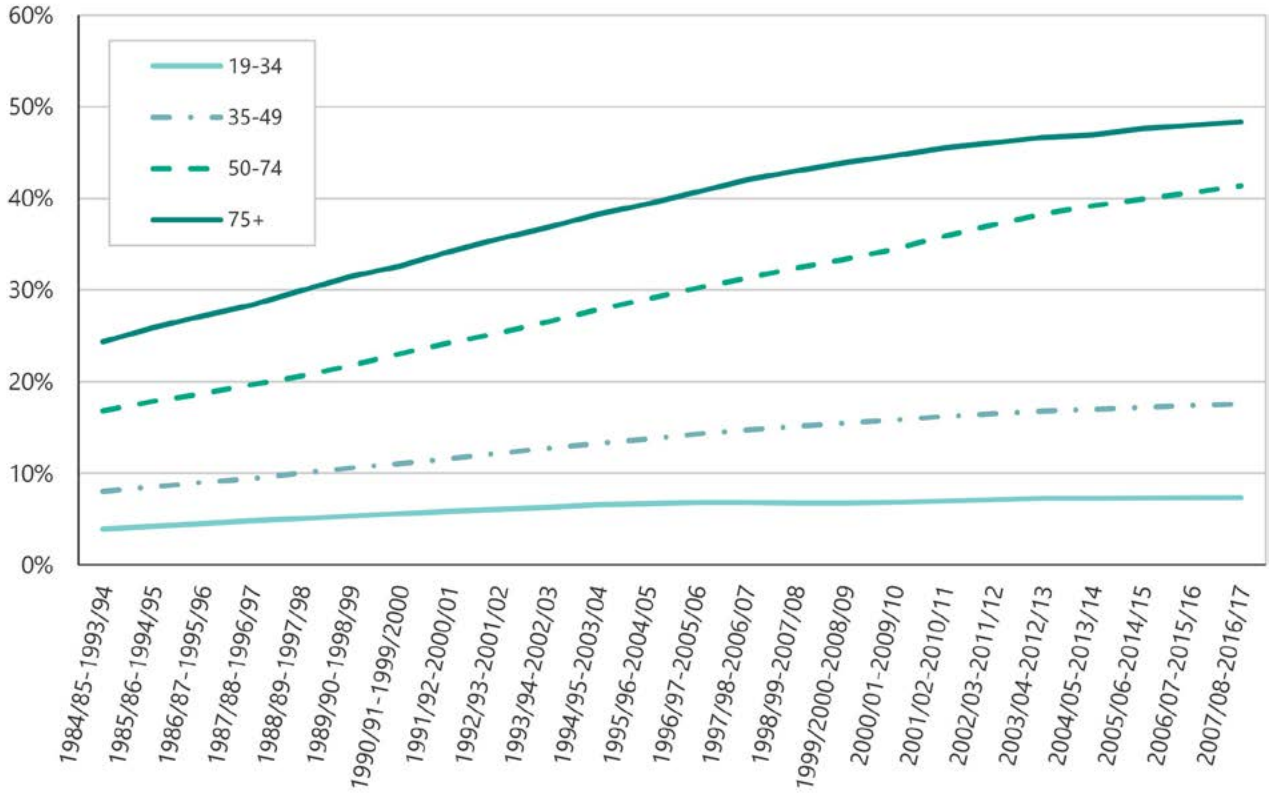


Figure 3.23: Percent of Manitobans with one or more Gastrointestinal Endoscopy (GIE) Procedures in 10 years by Sex

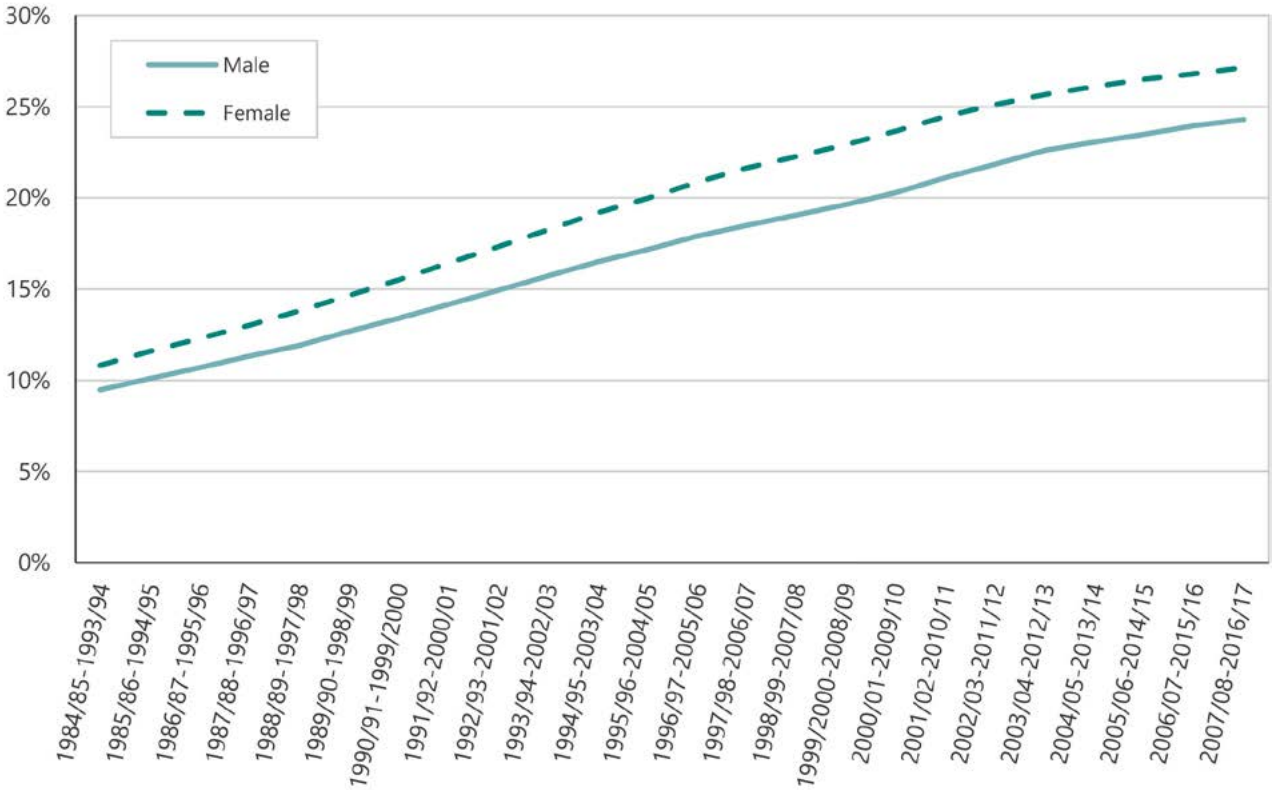


Figure 3.24: Percent of Manitobans with one or more Gastrointestinal Endoscopy (GIE) Procedures in 10 years by Region of Residence

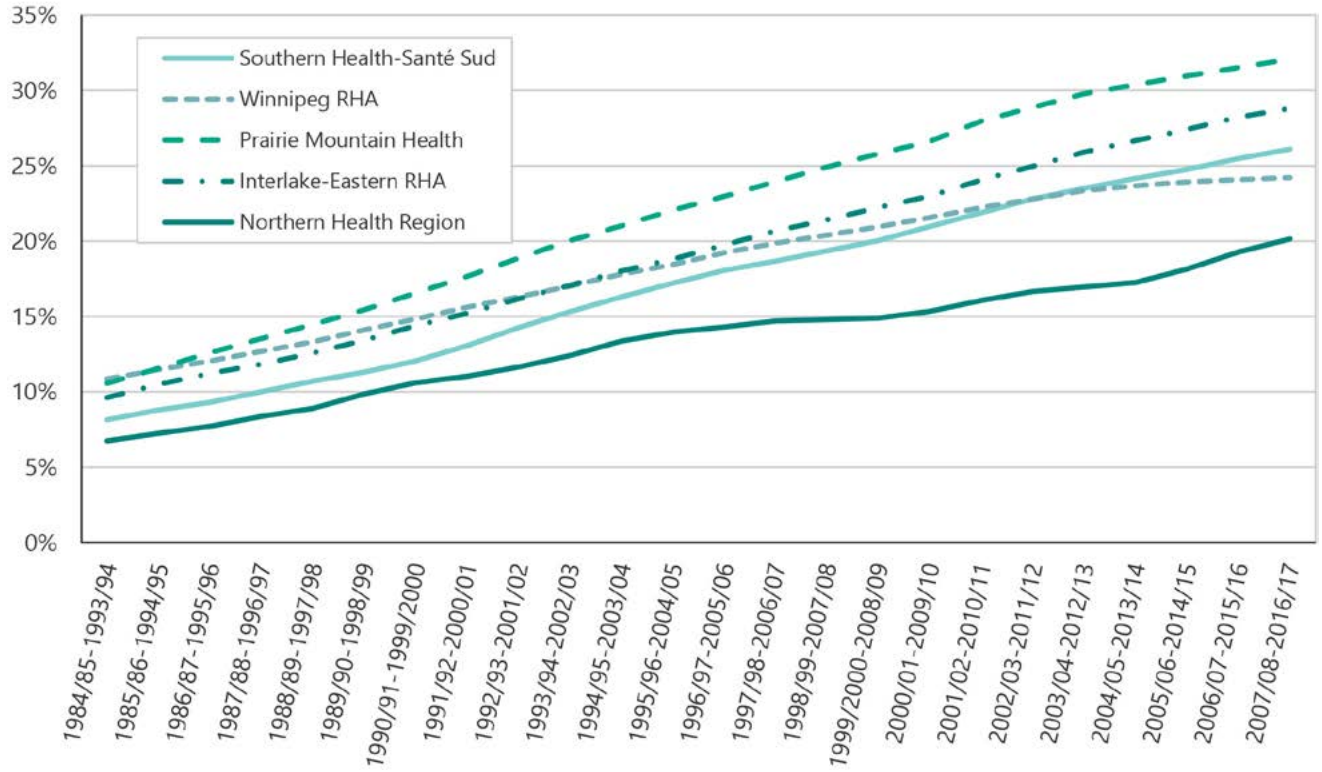


Figure 3.25: Percent of Manitobans with one or more Gastrointestinal Endoscopy (GIE) Procedures in 2007/08-2016/17 by Region of Residence

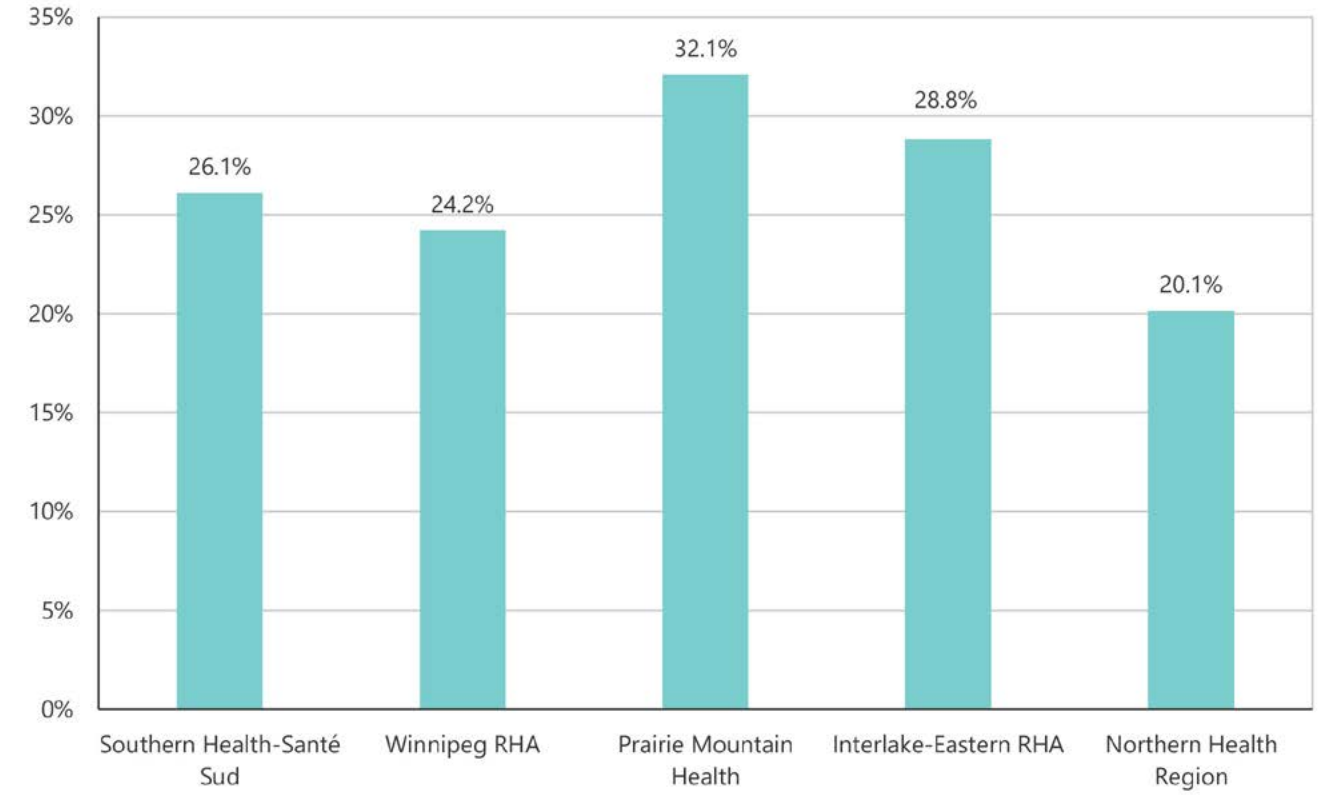
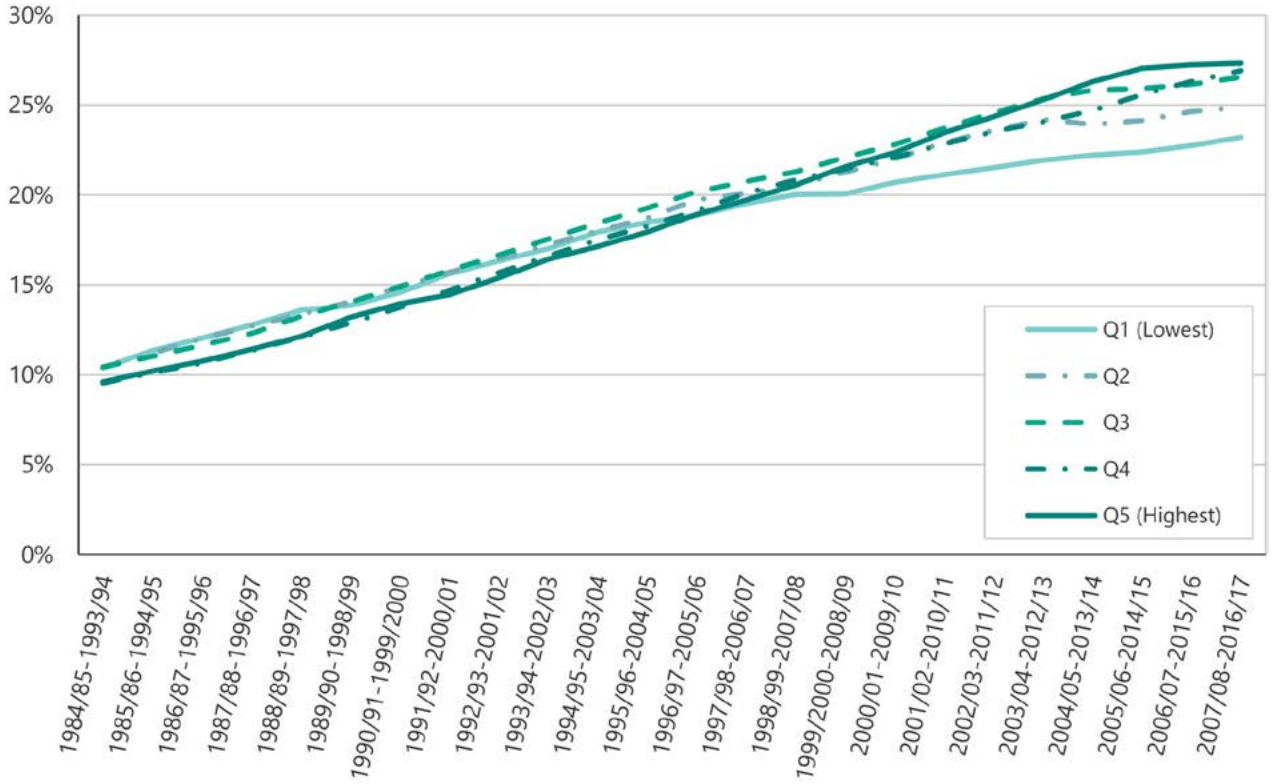


Figure 3.25 highlights the percent of the Manitoba population who had one or more GIE procedures in the last ten years of the study period. The values ranged from 20.1% of residents in Northern Health Region to almost one-third of residents in Prairie Mountain Health. Close to one quarter of residents of the Winnipeg RHA had one or more GIE procedures in this decade.

Figure 3.26: Percent of Manitobans with one or more Gastrointestinal Endoscopy (GIE) Procedures in 10 years by Income Quintile



Upper GIE Procedure in Ten Years

The percent of the population having one or more upper GIE procedures in a ten-year period is reported by age group (Figure 3.27), sex (Figure 3.28), health region of residence (Figure 3.29) and income quintile (Figure 3.30). There was an increasing trend observed over time across these socio-demographic variables.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 2.10% in 1984/85 to 1993/94 and 4.37% in 2007/08 to 2016/17, which represents a 108.1% increase.
  - For the 35-49 years age group, the rate was 4.32% in 1984/85 to 1993/94 and 9.38% in 2007/08 to 2016/17, which represents a 117.1% increase.
  - For the 50-74 years age group, the rate was 9.20% in 1984/85 to 1993/94 and 17.99% in 2007/08 to 2016/17, which represents a 95.5% increase.
  - For the oldest age group (75 years and older), the rate was 14.04% in 1984/85 to 1993/94 and 27.20% in 2007/08 to 2016/17, which represents a 93.7% increase.
- **By Sex:**
  - Rates were slightly higher for females than for males throughout the study observation period.
  - For males, the rate was 5.44% in 1984/85 to 1993/94 and 11.32% in 2007/08 to 2016/17, which represents a 108.1% increase.
  - For females, the rate was 5.74% in 1984/85 to 1993/94 and 13.73% in 2007/08 to 2016/17, which represents a 139.2% increase.
- **By Health Region of Residence:**
  - The amount of the variation amongst the regions grew over time. The ratio of the largest to the smallest rate in 1984/85 to 1993/94 was 1.56, and it was 1.78 in 2007/08 to 2016/17. Hence there were greater regional variations for upper GIE procedures than for lower GIE procedures.
  - For Southern Health-Santé Sud, the rate was 4.33% in 1984/85 to 1993/94 and 12.37% in 2007/08 to 2016/17, which represents a 185.7% increase.
  - For the Winnipeg RHA, the rate was 5.66% in 1984/85 to 1993/94 and 10.76% in 2007/08 to 2016/17, which represents a 90.1% increase.
  - For Prairie Mountain Health, the rate was 6.76% in 1984/85 to 1993/94 and 19.14% in 2007/08 to 2016/17, which represents a 183.1% increase.
  - For the Interlake-Eastern RHA, the rate was 5.44% in 1984/85 to 1993/94 and 15.00% in 2007/08 to 2016/17, which represents a 175.7% increase.
  - For Northern Health Region, the rate was 4.51% in 1984/85 to 1993/94 and 11.92% in 2007/08 to 2016/17, which represents a 164.3% increase.
- **By Income Quintile:**
  - The results stratified by income quintile showed little change in the amount of variation between the first and last years of the study observation period. This is in contrast to the results for lower GIE procedures, where much greater variation was observed.
  - For Q1 (lowest income quintile), the rate was 6.29% in 1984/85 to 1993/94 and 13.19% in 2007/08 to 2016/17, which represents a 109.7% increase.
  - For Q5 (highest income quintile), the rate was 4.52% in 1984/85 to 1993/94 and 11.34% in 2007/08 to 2016/17, which represents a 150.9% increase.

Figure 3.27: Percent of Manitobans with one or more Upper Gastrointenstinal Endoscopy (GIE) Procedures in 10 years by Age Group

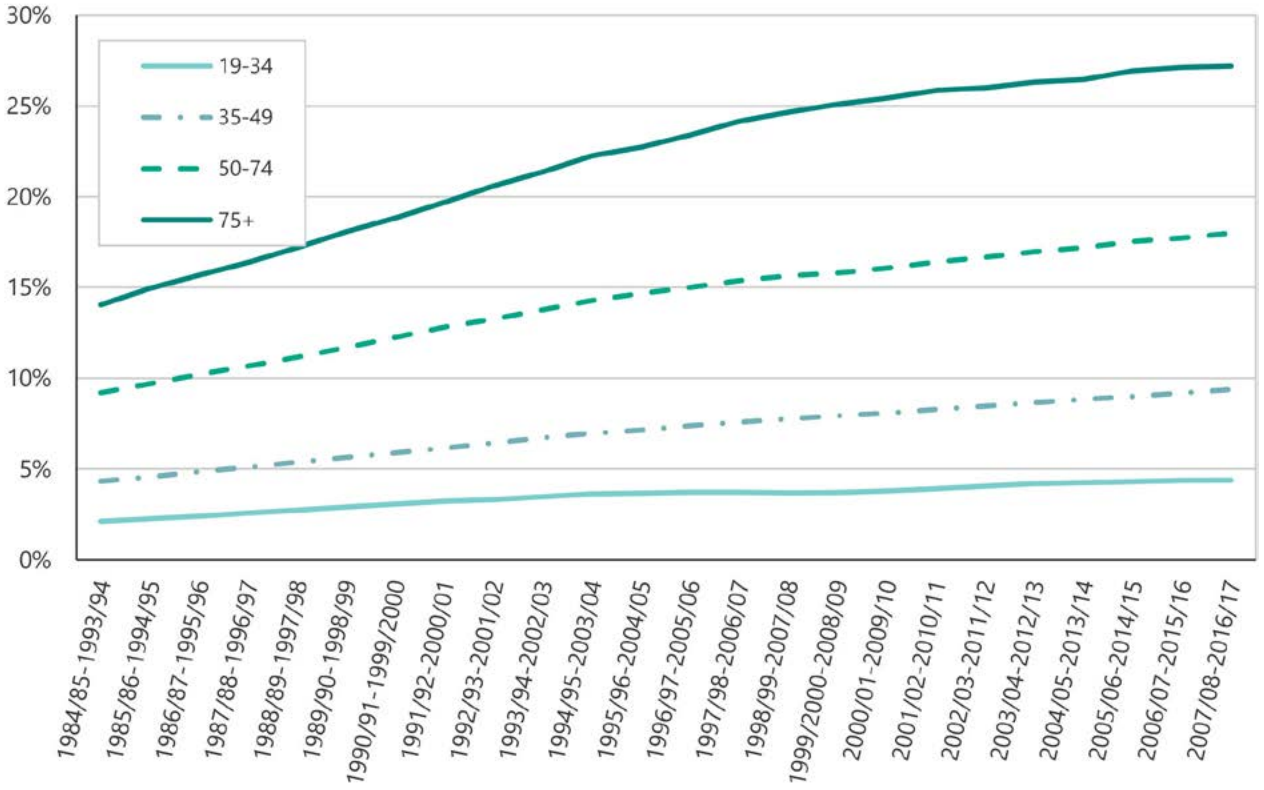


Figure 3.28: Percent of Manitobans with one or more Upper Gastrointenstinal Endoscopy (GIE) Procedures in 10 years by Sex

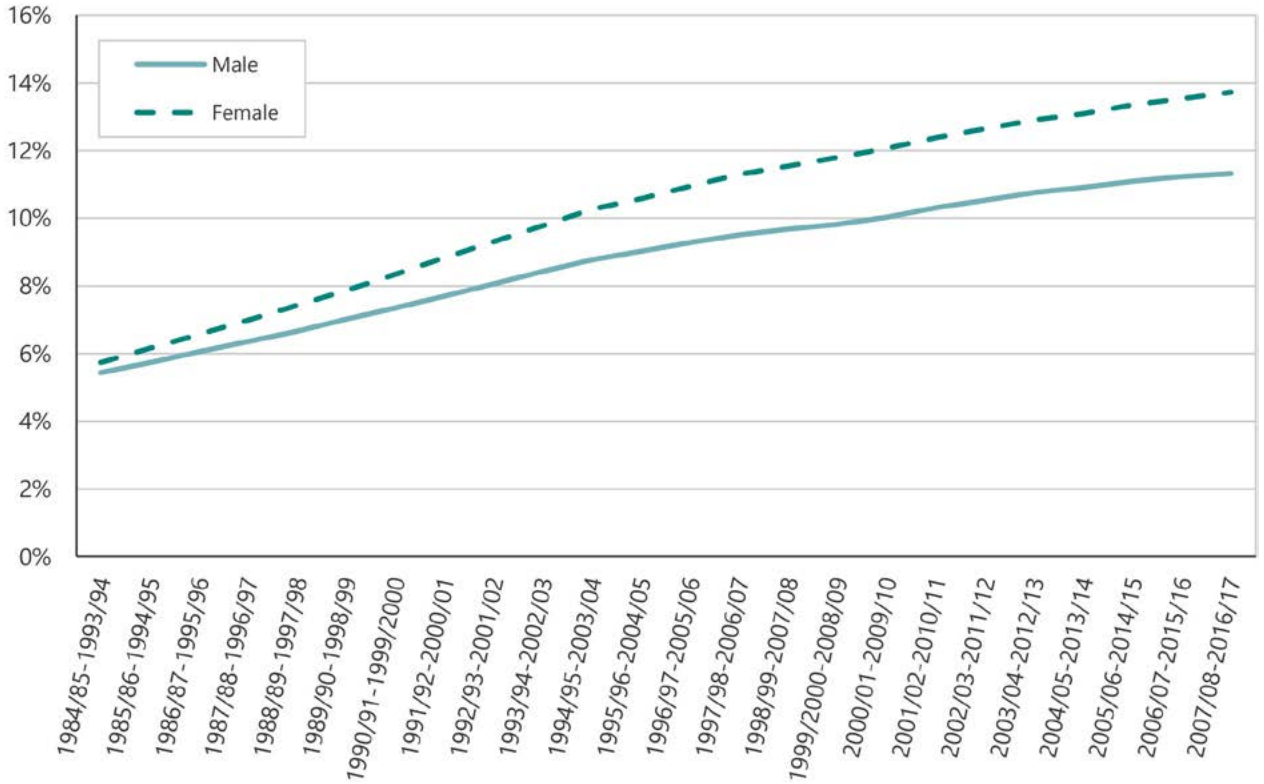


Figure 3.29: Percent of Manitobans with one or more Upper Gastrointenstinal Endoscopy (GIE) Procedures in 10 years by Region of Residence

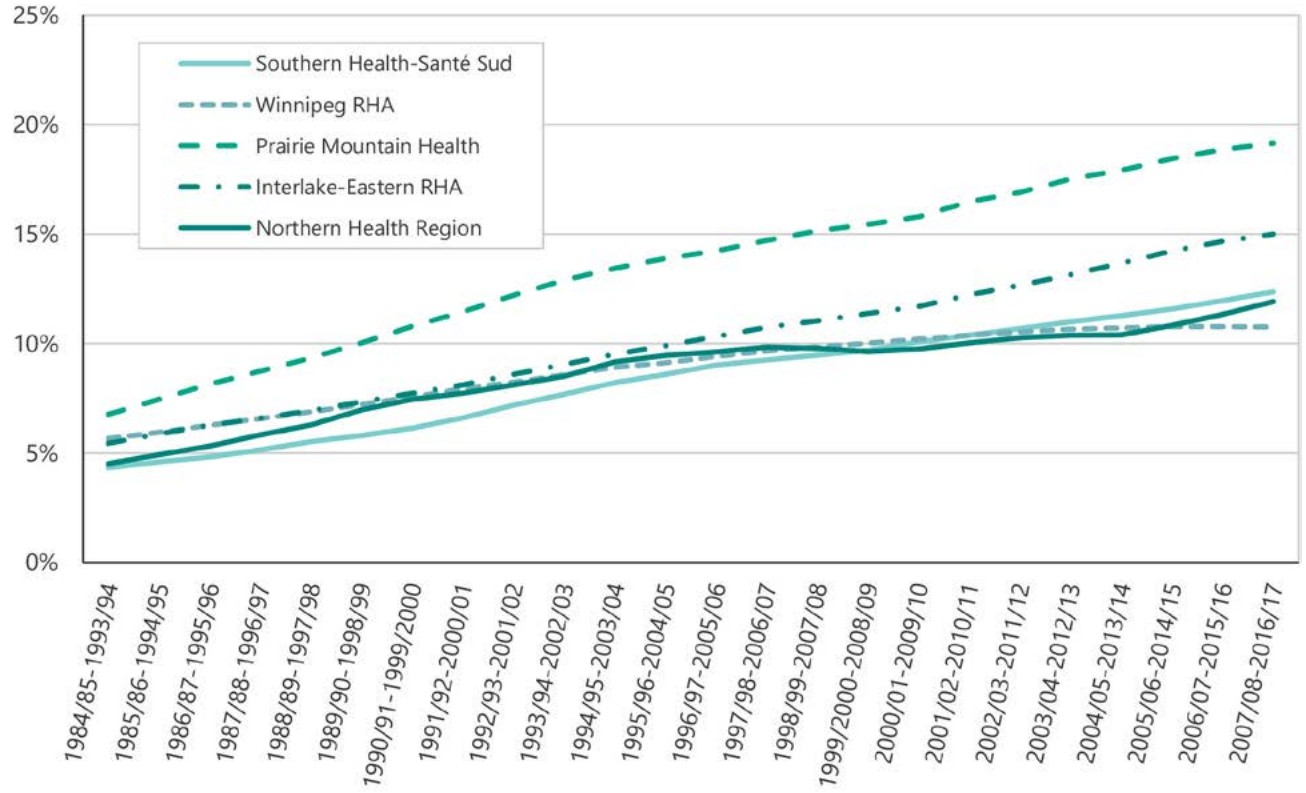
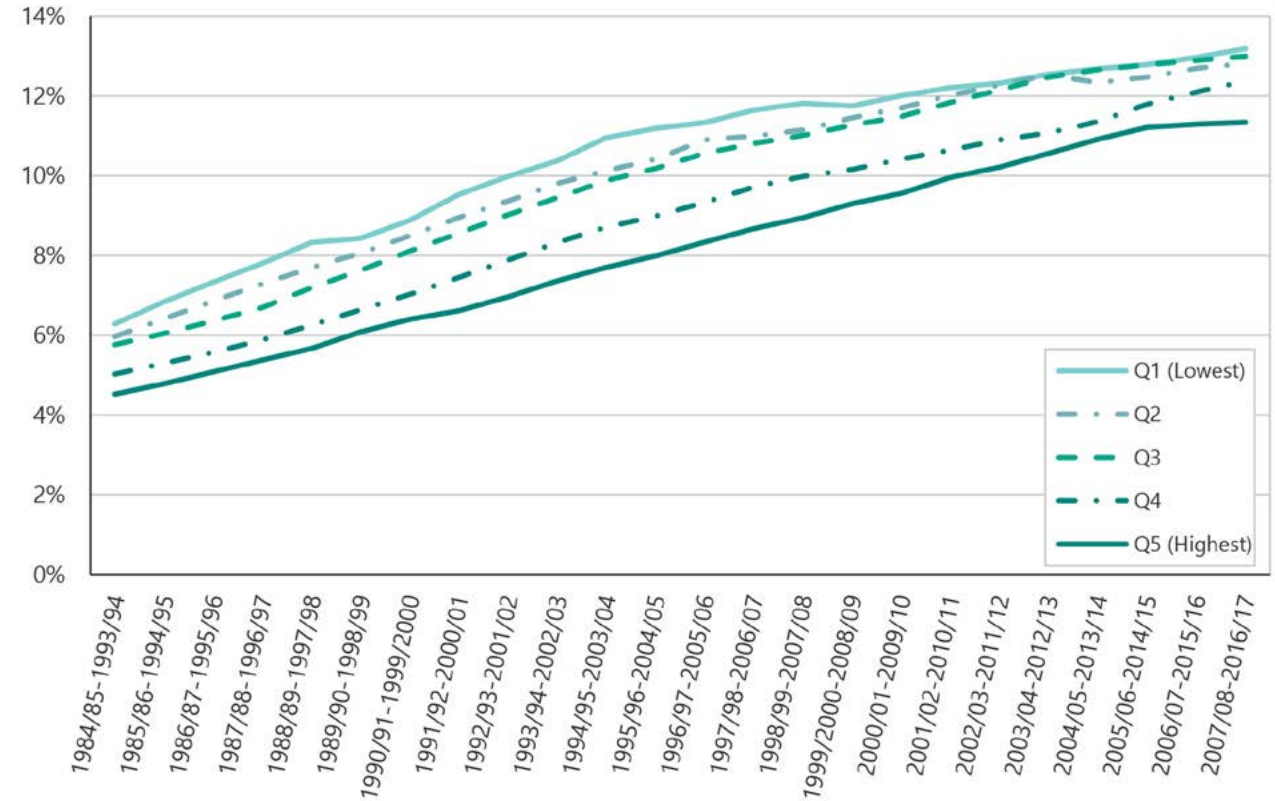


Figure 3.30: Percent of Manitobans with one or more Upper Gastrointenstinal Endoscopy (GIE) Procedures in 10 years by Income Quintile



Lower GIE Procedure in Ten Years

The percent of the population having one or more lower GIE procedures in a 10-year period is reported by age group (Figure 3.31), sex (Figure 3.32), health region of residence (Figure 3.33) and income quintile (Figure 3.34). There were increasing trends observed over time across these socio-demographic variables.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 2.16% in 1984/85 to 1993/94 and 4.58% in 2007/08 to 2016/17, which represents a 112.0% increase.
  - For the 35-49 years age group, the rate was 4.59% in 1984/85 to 1993/94 and 13.37% in 2007/08 to 2016/17, which represents a 191.3% increase.
  - For the 50-74 years age group, the rate was 10.32% in 1984/85 to 1993/94 and 36.39% in 2007/08 to 2016/17, which represents a 252.6% increase
  - For the oldest age group (75 years and older), the rate was 14.33% in 1984/85 to 1993/94 and 38.39% in 2007/08 to 2016/17, which represents a 167.9% increase.
- **By Sex:**
  - Rates were consistently higher for females than for males throughout the study observation period.
  - For males, the rate was 5.32% in 1984/85 to 1993/94 and 20.00% in 2007/08 to 2016/17, which represents a 275.9% increase.
  - For females, the rate was 6.68% in 1984/85 to 1993/94 and 22.34% in 2007/08 to 2016/17, which represents a 234.4% increase.
- **By Health Region of Residence:**
  - The amount of variation amongst the regions decreased over time, although the regions with largest and smallest rates changed. The ratio of the largest to the smallest rate in 1984/85 to 1993/94 was 2.22, and it was 1.71 in 2007/08 to 2016/17.
  - For Southern Health-Santé Sud, the rate was 4.74% in 1984/85 to 1993/94 and 21.68% in 2007/08 to 2016/17, which represents a 357.4% increase.
  - For the Winnipeg RHA, the rate was 6.80% in 1984/85 to 1993/94 and 19.91% in 2007/08 to 2016/17, which represents a 192.8% increase. This was the lowest percentage increase across all of the health regions.
  - For Prairie Mountain Health, the rate was 5.23% in 1984/85 to 1993/94 and 26.17% in 2007/08 to 2016/17, which represents a 400.4% increase.
  - For the Interlake-Eastern RHA, the rate was 5.57% in 1984/85 to 1993/94 and 24.52% in 2007/08 to 2016/17, which represents a 340.2% increase.
  - For Northern Health Region, the rate was 3.06% in 1984/85 to 1993/94 and 15.31% in 2007/08 to 2016/17, which represents a 400.3% increase.
- **By Income Quintile:**
  - The results stratified by income quintile showed little variation at the beginning of the study observation period and substantially more variation at the end of the study observation period.
  - For Q1 (lowest income quintile), the rate was 5.69% in 1984/85 to 1993/94 and 17.98% in 2007/08 to 2016/17, which represents a 216.0% increase.
  - For Q5 (highest income quintile), the rate was 6.36% in 1984/85 to 1993/94 and 23.35% in 2007/08 to 2016/17, which represents a 267.1% increase.

Figure 3.31: Percent of Manitobans with one or more Lower Gastrointenstinal Endoscopy (GIE) Procedures in 10 years by Age Group

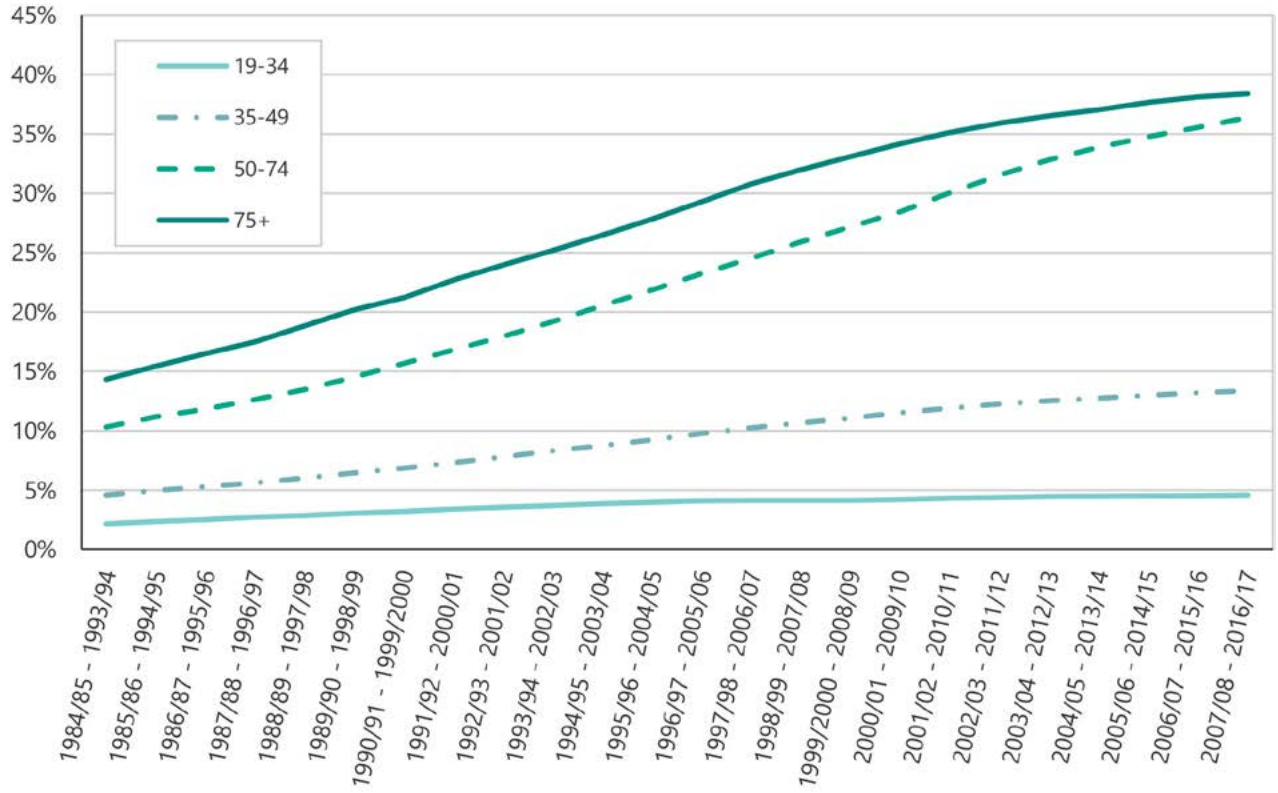


Figure 3.32: Percent of Manitobans with one or more Lower Gastrointenstinal Endoscopy (GIE) Procedures in 10 years by Sex

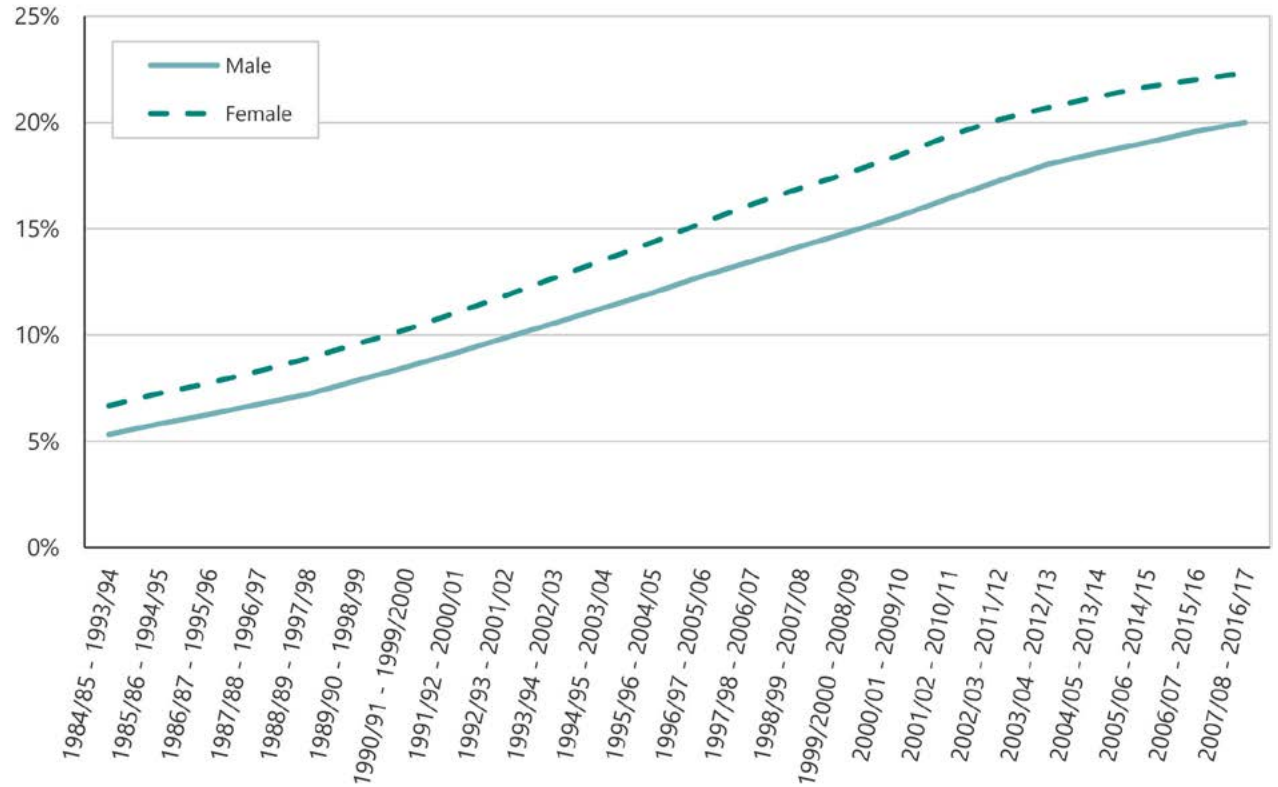


Figure 3.33: Percent of Manitobans with one or more Lower Gastrointenstinal Endoscopy (GIE) Procedures in 10 years by Region of Residence

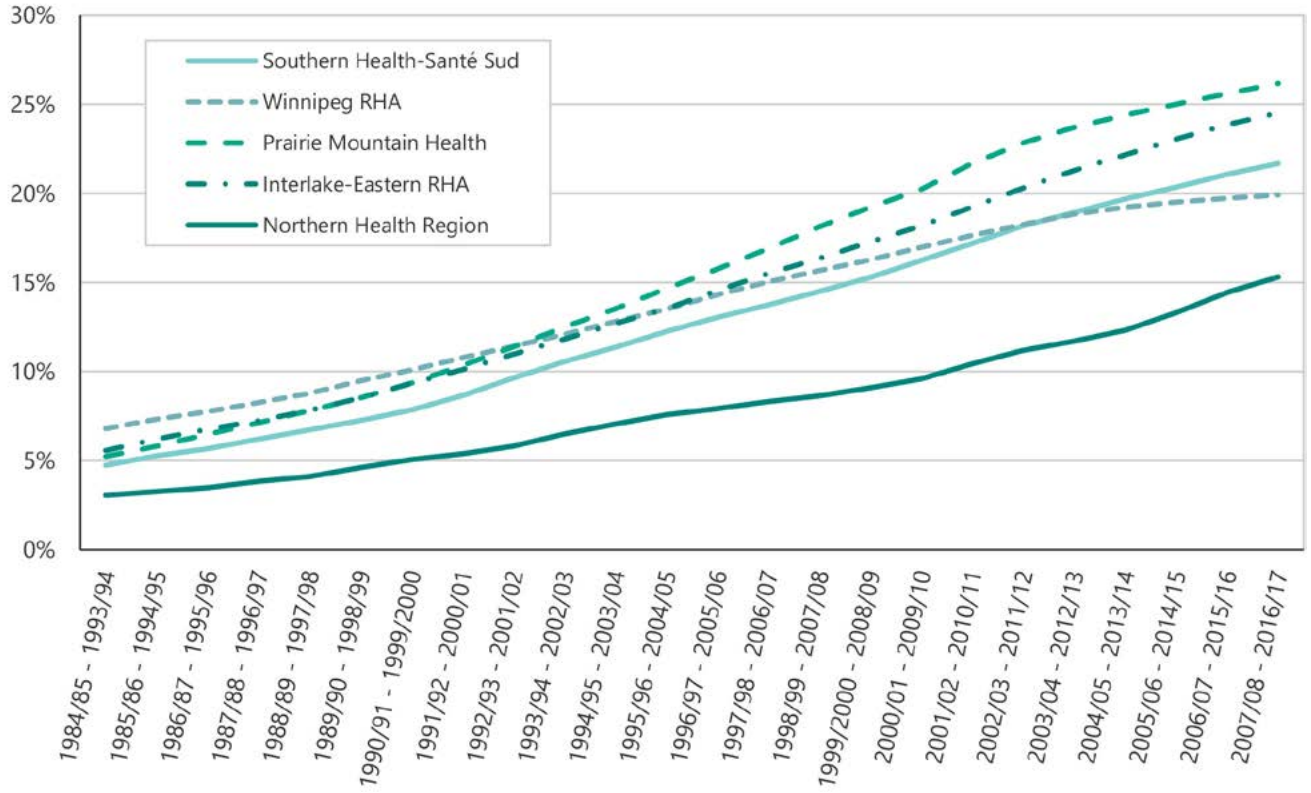
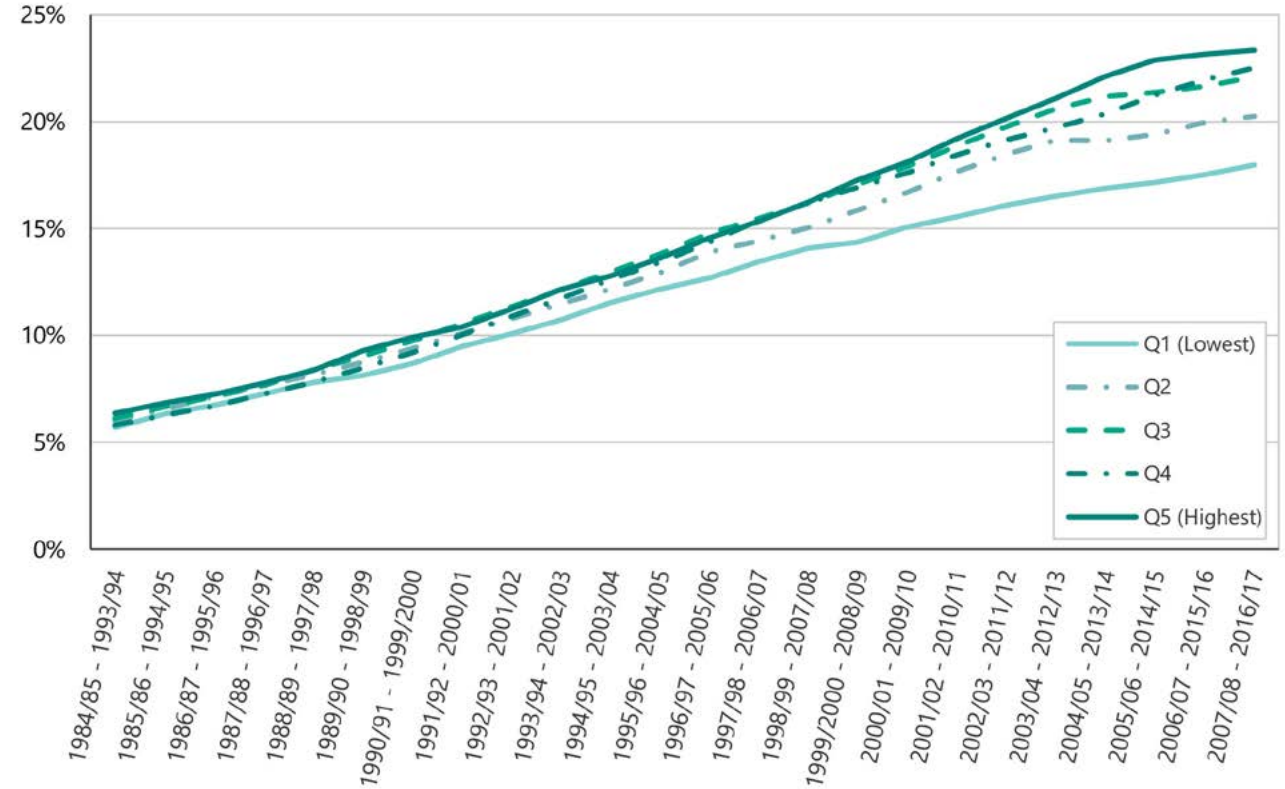


Figure 3.34: Percent of Manitobans with one or more Lower Gastrointenstinal Endoscopy (GIE) Procedures in 10 years by Income Quintile



Small Bowel Endoscopy Procedures in Ten Years

The percent of the population having one or more small bowel endoscopy procedures in a 10-year period is reported by age group (Figure 3.35), sex (Figure 3.36), and health region of residence (Figure 3.37). The analyses by income quintile were too small to produce reliable results and are therefore not presented. There were increases observed over time for each of these socio-demographic variables.

- **By Age Group:**
  - For the 19-34 years age group, the rate was 0.04% in 2002/03 to 2011/12 and 0.09% in 2007/08 to 2016/17, which represents a 125.0% increase.
  - For the 35-49 years age group, the rate was 0.08% in 2002/03 to 2011/12 and 0.18% in 2007/08 to 2016/17, which represents a 125.0% increase.
  - For the 50-74 years age group, the rate was 0.19% in 2002/03 to 2011/12 and 0.41% in 2007/08 to 2016/17, which represents a 115.8% increase.
  - For the oldest age group (75 years and older), the rate was 0.33% in 2002/03 to 2011/12 and 0.65% in 2007/08 to 2016/17, which represents a 96.97% increase.
- **By Sex:**
  - Rates were consistently higher for females than for males throughout the study observation period.
  - For males, the rate was 0.12% in 2002/03 to 2011/12 and 0.25% in 2007/08 to 2016/17, which represents a 108.3% increase.
  - For females, the rate was 0.13% in 2002/03 to 2011/12 and 0.31% in 2007/08 to 2016/17, which represents a 138.5% increase.
- **By Health Region of Residence:**
  - The amount of the variation amongst the health regions grew over time. The ratio of the largest to the smallest rate in 2002/03 to 2011/12 was 1.53, and it was 1.98 in 2007/08 to 2016/17.
  - For Southern Health-Santé Sud, the rate was 0.10% in 2002/03 to 2011/12 and 0.19% in 2007/08 to 2016/17, which represents a 90.0% increase.
  - For the Winnipeg RHA, the rate was 0.14% in 2002/03 to 2011/12 and 0.28% in 2007/08 to 2016/17, which represents a 100% increase.
  - For Prairie Mountain Health, the rate was 0.09% in 2002/03 to 2011/12 and 0.38% in 2007/08 to 2016/17, which represents a 322.2% increase.
  - For the Interlake-Eastern RHA, the rate was 0.14% in 2002/03 to 2011/12 and 0.25% in 2007/08 to 2016/17, which represents a 78.6% increase.
  - For Northern Health Region, the rate was 0.12% in 2002/03 to 2011/12 and 0.20% in 2007/08 to 2016/17, which represents a 66.7% increase.

Figure 3.35: Percent of Manitobans with one or more Small Bowel Gastrointestinal Endoscopy (GIE) Procedures in 10 years by Age Group

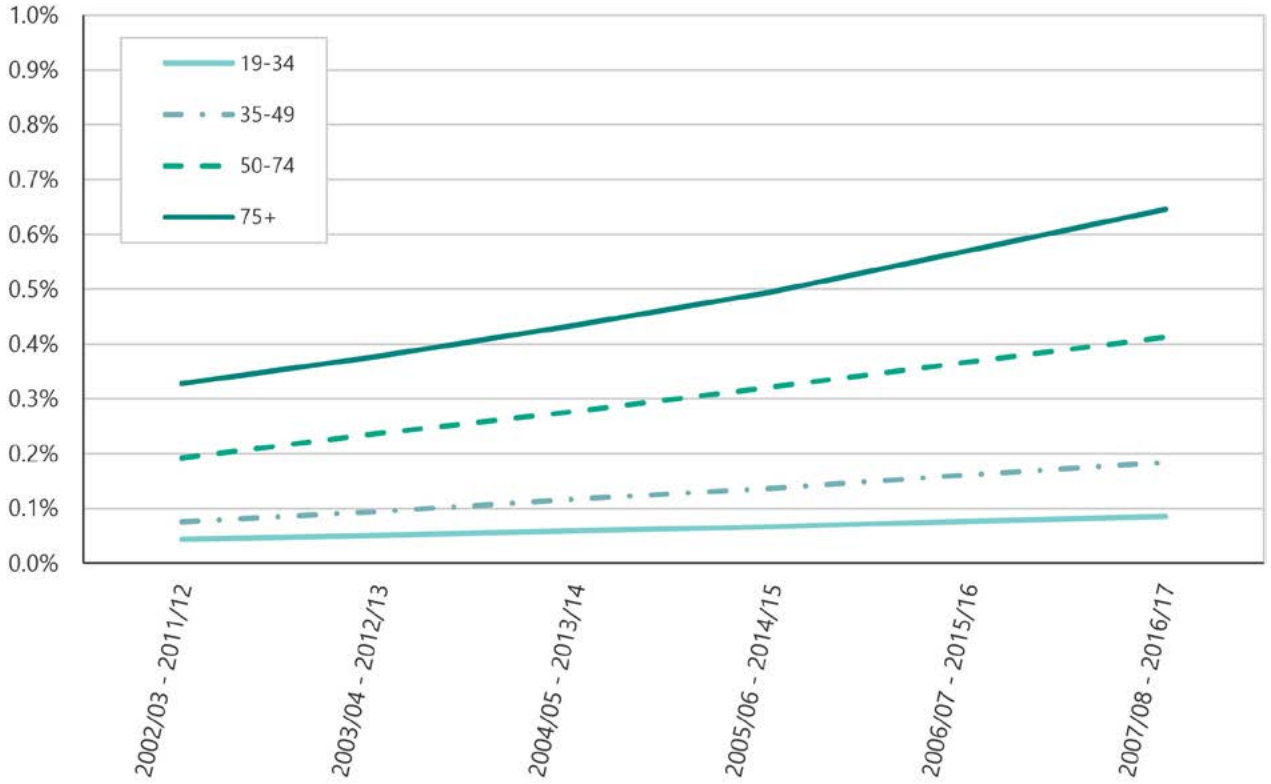


Figure 3.36: Percent of Manitobans with one or more Small Bowel Gastrointestinal Endoscopy (GIE) Procedures in 10 years by Sex

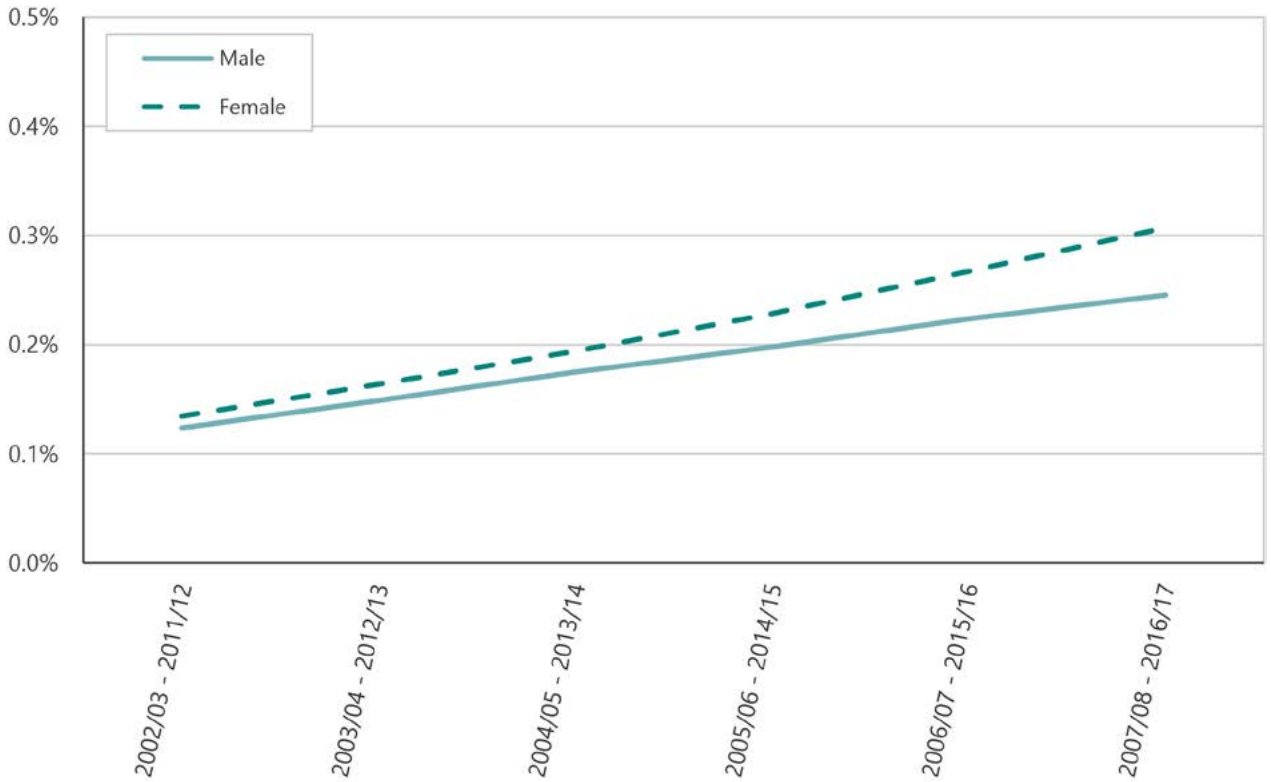
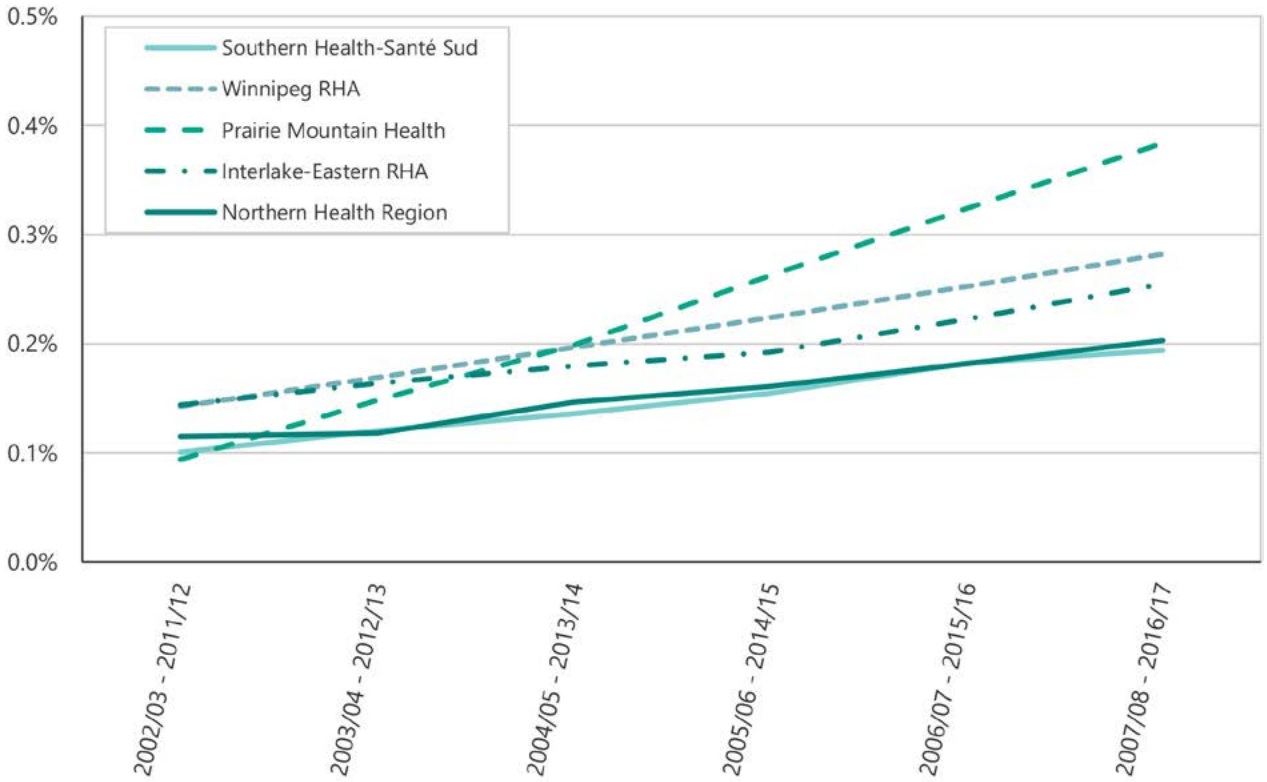


Figure 3.37: Percent of Manitobans with one or more Small Bowel Gastrointestinal Endoscopy (GIE) Procedures in 10 years by Region of Residence



Presence of an Anesthesiologist for GIE Procedures

The percent of the population for which an anesthesiologist was present for a GIE procedure is reported over time by age group (Figure 3.38), sex, (Figure 3.39), health region of residence (Figure 3.40) and income quintile (Figure 3.41).

- **By Age Group:**
  - For the 19-34 years age group, the rate was 2.61% in 1984/85 and 16.71% in 2016/17, which represents a 540.2% increase.
  - For the 35-49 years age group, the rate was 2.63% in 1984/85 and 16.44% in 2016/17, which represents a 525.1% increase.
  - For the 50-74 years age group, the rate was 1.63% in 1984/85 and 15.16% in 2016/17, which represents a 830.1% increase.
  - For the oldest age group (75 years and older), the rate was 2.45% in 1984/85 and 14.58% in 2016/17, which represents a 495.1% increase.
- **By Sex:**
  - Rates were similar for females and males throughout the study observation period.
  - For males, the rate was 2.44% in 1984/85 and 15.39% in 2016/17, which represents a 530.7% increase.
  - For females, the rate was 1.74% in 1984/85 and 15.37% in 2016/17, which represents a 783.3% increase.
- **By Health Region of Residence:**
  - The amount of the variation amongst the regions increased over time. The ratio of the largest to the smallest health region rate in 1984/85 was 9.04, and it was 25.77 in 2016/17.
  - For Southern Health-Santé Sud, the rate was 9.58% in 1984/85 and 57.22% in 2016/17, which represents a 497.3% increase.
  - For the Winnipeg RHA, the rate was 1.06% in 1984/85 and 2.22% in 2016/17, which represents a 109.4% increase.
  - For Prairie Mountain Health, the rate was 2.30% in 1984/85 and 25.02% in 2016/17, which represents a 987.8% increase.
  - For the Interlake-Eastern RHA, the rate was 1.50% in 1984/85 and 5.45% in 2016/17, which represents a 263.3% increase.
  - For Northern Health Region, the rate was 2.14% in 1984/85 and 25.86% in 2016/17, which represents a 1,108.4% increase.
- **By Income Quintile:**
  - There was little variation by income quintile at both the beginning and end of the study observation period.
  - For Q1 (lowest income quintile), the rate was 2.13% in 1984/85 and 22.14% in 2016/17, which represents a 939.4% increase.
  - For Q5 (highest income quintile), the rate was 1.40% in 1984/85 and 9.99% in 2016/17, which represents a 613.6% increase.

We also analyzed data about the presence of an anesthesiologist separately for upper GIE procedures and lower GIE procedures. Similar trends were observed to those obtained for all GIE procedures and therefore are not presented in this report.

Figure 3.38: Percent of Gastrointestinal Endoscopy (GIE) Procedures with an Anesthesiologist Present by Age Group

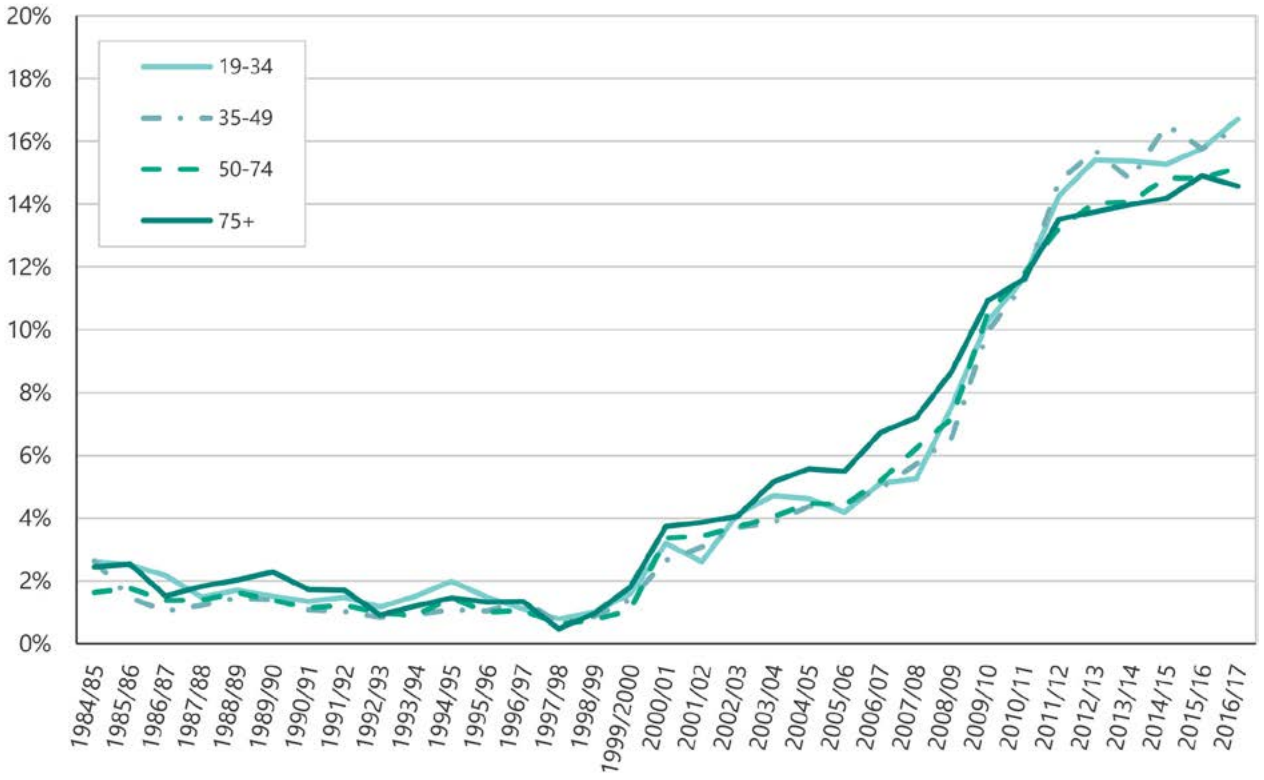


Figure 3.39: Percent of Gastrointestinal Endoscopy (GIE) Procedures with an Anesthesiologist Present by Sex

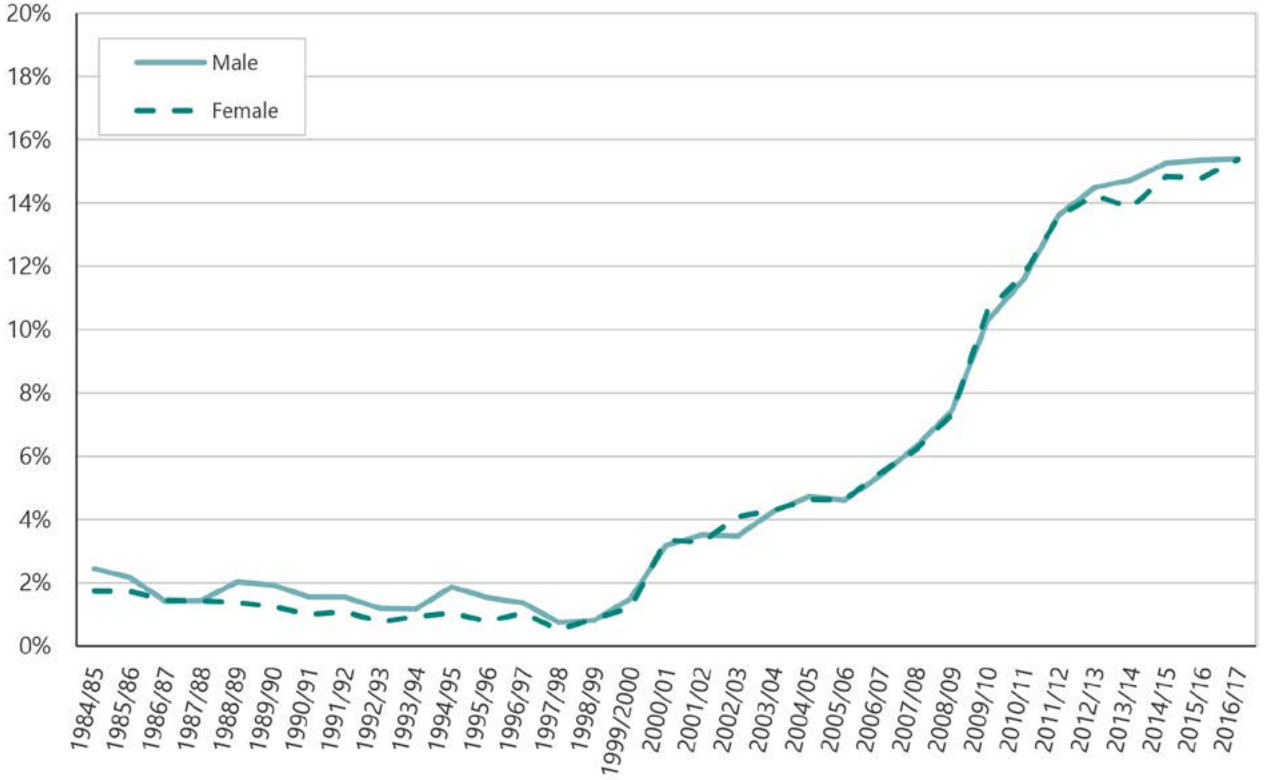


Figure 3.40: Percent of Gastrointestinal Endoscopy (GIE) Procedures with an Anesthesiologist Present by Region of Residence

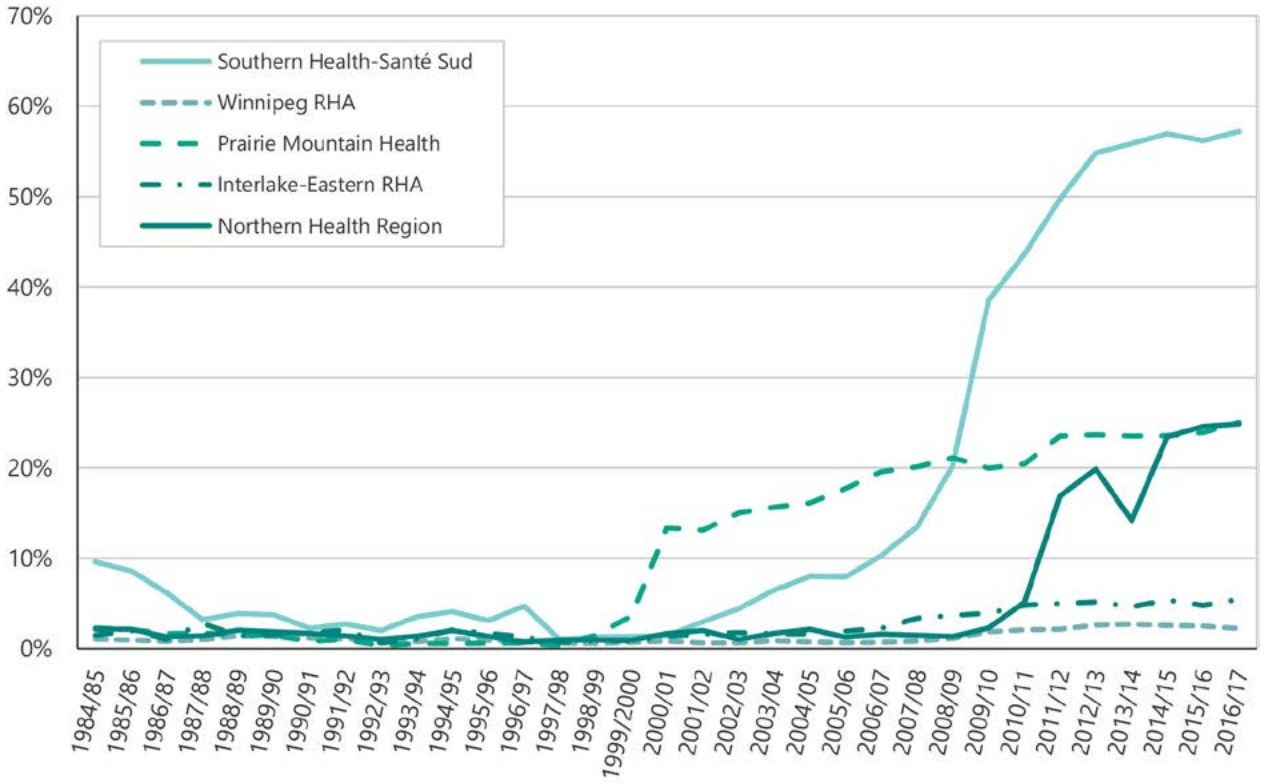
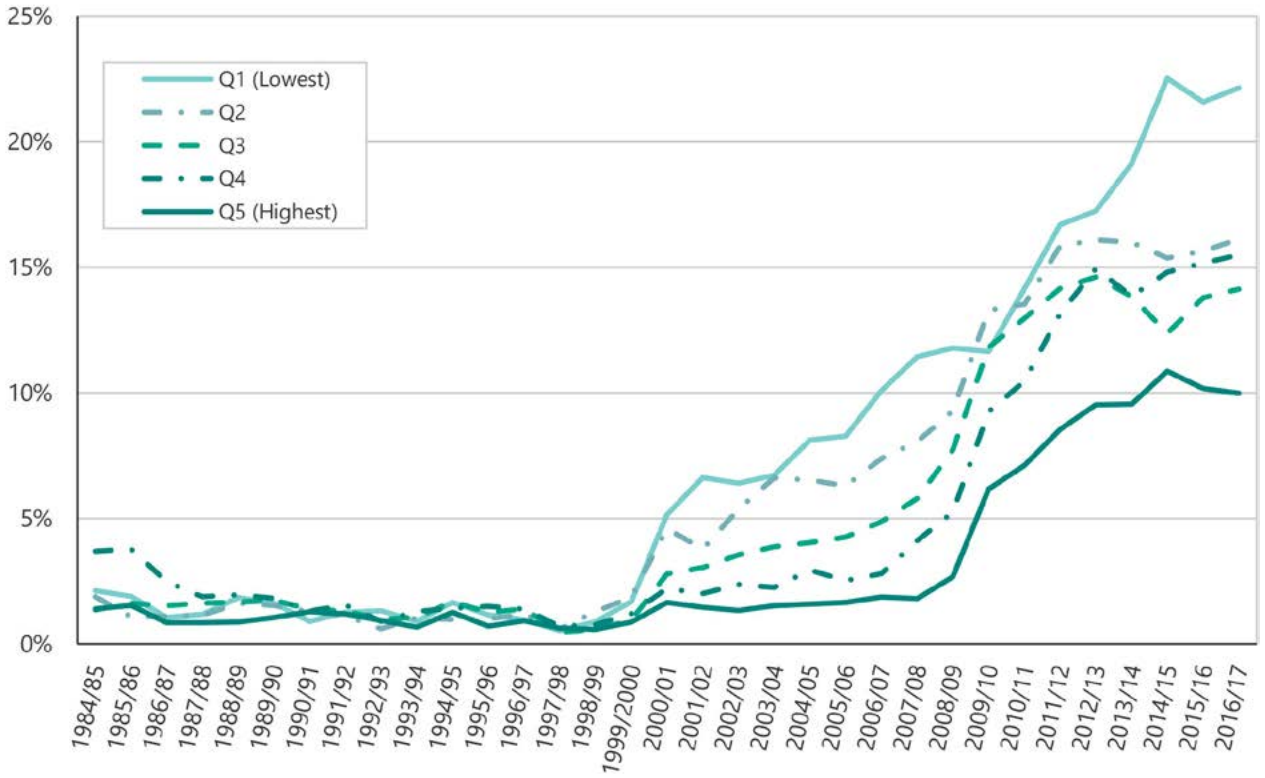


Figure 3.41: Percent of Gastrointestinal Endoscopy (GIE) Procedures with an Anesthesiologist Present by Income Quintile



Logistic regression models were fit to the data to investigate patient, provider, and procedure characteristics associated with presence of an anesthesiologist for a GIE procedure (Table 3.14). This analysis was conducted separately for residents of urban areas (Winnipeg RHA) and rural areas (non-Winnipeg health regions). There were a number of similarities between the Winnipeg and non-Winnipeg models in terms of the patient and provider characteristics associated with presence of an anesthesiologist. The odds of having an anesthesiologist present were lower for the older age group when compared the youngest age group (19 to 34 years). For Winnipeg RHA residents, females had lower odds of having an anesthesiologist present than males, but for non-Winnipeg RHA residents, there was no association between presence of an anesthesiologist and patient sex. Greater comorbidity was associated with greater odds of the presence of an anesthesiologist amongst Winnipeg RHA residents, but this was not consistently the case for non-Winnipeg RHA residents. The odds of anesthesia use tended to be lower for patients in higher income quintiles than for patients in the lowest income quintile.

In terms of the characteristics of the providers who conducted the GIE procedures, in Winnipeg RHA there were much lower odds of having an anesthesiologist present when a family physician performed the GIE procedure, as well as when an internal medicine specialist or a gastroenterologist performed the GIE procedure compared to when a surgeon performed the GIE procedure. However, for non-Winnipeg RHA residents, patients who had a procedure conducted by a family physician had, on average, much higher odds of having an anesthesiologist present than patients who had a procedure conducted by a surgical specialist. In the Winnipeg RHA, patients of physicians who were in the lowest tertile in terms of volume of GIE procedures in the prior year had high odds of having an anesthesiologist present when compared to patients of physicians with a high volume of GIE procedures in the prior year. In contrast, in the non-Winnipeg health regions, patients of low-volume physicians were no more or less likely to have an anesthesiologist present than patients of high-volume physicians.

For GIE procedures conducted in the non-Winnipeg health regions, the odds of having an anesthesiologist present were much greater for patients from Southern Health-Santé Sud and much lower for patients from the northern part of the province and the Interlake-Eastern RHA.

The results also show that in all parts of the province the odds of having an anesthesiologist present were lower for patients with a GIE procedure in earlier than in later years of the study period. Finally, the odds of having an anesthesiologist present were lower for patients having a lower GIE procedure than for patients having an upper GIE procedure in the Winnipeg RHA, but the converse was true for non-Winnipeg health regions.

Table 3.15: Patient and Physician Characteristics Associated with Presence of an Anesthesiologist for Gastrointestinal Endoscopy (GIE) Procedures by Patient's Region of Residence

Odds ratios and 95% confidence intervals

Patient and Physician Characteristic	Odds Ratio and 95% Confidence Interval	
	Residents of Winnipeg RHA	Residents of non-Winnipeg Health Regions
Age Group (Years; Ref: 19-34):		
35-49	0.84 (0.67-1.06)	0.91 (0.86-0.96)
50-74	0.55 (0.44-0.68)	0.86 (0.82-0.91)
75+	0.55 (0.42-0.71)	0.82 (0.77-0.87)
Sex (Ref: Male):		
Female	0.79 (0.70-0.90)	1.03 (1.00-1.06)
Charlson Comorbidity Index Score (Ref: 0):		
1	1.45 (1.26-1.68)	1.03 (1.00-1.06)
2	1.72 (1.40-2.10)	1.03 (0.99-1.07)
3+	2.13 (1.68-2.72)	1.12 (1.05-1.19)
Income Quintile (Ref: Q1):		
Q2	0.84 (0.70-1.02)	0.49 (0.47-0.51)
Q3	0.84 (0.70-1.01)	0.39 (0.37-0.41)
Q4	0.80 (0.67-0.96)	0.44 (0.42-0.46)
Q5 (Highest)	0.66 (0.55-0.80)	0.41 (0.39-0.43)
Physician Specialty (Ref: Surgery):		
Family Medicine	0.15 (0.04-0.56)	3.26 (3.15-3.37)
Internal Medicine	0.29 (0.23-0.38)	0.60 (0.56-0.65)
Gastroenterology	0.74 (0.64-0.86)	0.14 (0.13-0.15)
Physician Volume (Ref: High):		
Low	16.15 (11.74-22.23)	1.00 (0.84-1.19)
Medium	1.84 (1.60-2.12)	1.80 (1.74-1.86)
Procedure Date (Ref: 2010/11-2016/17):		
2005/06-2009/10	0.65 (0.57-0.74)	0.34 (0.33-0.35)
Procedure Location (Ref: Prairie Mountain Health):		
Southern Health-Santé Sud	N/A	7.28 (7.05-7.52)
Interlake-Eastern RHA	N/A	0.04 (0.04-0.05)
Northern Health Region	N/A	0.57 (0.53-0.60)
Procedure Type (Ref: Upper GI):		
Lower Gastrointestinal Tract	0.66 (0.58-0.75)	3.41 (3.32-3.51)

Summary

In this chapter, we presented trends in GIE procedure rates over time. The analyses were stratified by age group, sex, region of residence, and income quintile. The results revealed increases in rates for all types of GIE procedures, which is consistent with studies conducted in other Canadian provinces and internationally [2,16,48].

The age-specific analyses revealed a similar magnitude of rate increase across most age groups, although the rate of increase was greatest for the 50-74 age group. Thus, it does not appear that increases in procedure rates are driven solely by cancer or chronic disease screening, which is typically targeted at older age groups. Rather, increases in GIE procedure rates reflect multiple indications, including screening, surveillance, treatment, and management. However, the highest rates were found in the 50-74 age group, which suggests that screening is a common reason for having a GIE procedure.

The region-specific results revealed wide variations in rates of increase, with the largest increases found in non-Winnipeg health regions regardless of the type of GIE procedure. These findings suggest that GIE procedures are accessible on a regional basis. Greater rates of increase in non-Winnipeg health regions may be due to greater availability of providers who can perform these procedures as well as greater availability of endoscopy equipment.

The analyses by income quintile reveal less substantial variations than for region of residence. For some procedures, rates were higher in lower income quintiles than in higher income quintiles, which suggests that GIE procedures are accessible regardless of income level. Higher rates in the later years of the study period in the highest income group for procedures associated with CRC screening is reflective of income discrepancies in CRC screening, which is concerning as those disparities appear to be increasing.

Finally, our analysis on the presence of an anesthesiologist for GIE procedures revealed an increase in anesthesia use over time, which is consistent with studies in other jurisdictions [51]. This previous research has documented wide regional variations in anesthesia use, which is also consistent with our findings [51]. We identified a multiplicity of patient, physician, and procedure characteristics associated with the presence of an anesthesiologist for a GIE procedure. However, we also found that the factors associated with presence of an anesthesiologist were not always the same for urban and rural regions of the province. For example, while the physician volume of GIE procedures was strongly associated with the odds of anesthesia in Winnipeg RHA, this was not the case in non-Winnipeg health regions. Since the rate of having an anesthesiologist present is much higher in rural areas, factors associated with use in rural areas should be investigated in future analyses. One factor to consider with respect to the presence of an anesthesiologist is that a GIE procedure may be conducted as an interoperative procedure, that is, during another procedure that may require an anesthesiologist. This may not have a large effect, as a very small proportion of GIE procedures are performed as intraoperative procedures. Our discussions with the advisory group for this report revealed that certain regions of the province have adopted a policy of having an anesthesiologist present for most procedures. In a meta-analysis of randomized clinical trials, use of propofol (which is mostly used by anesthesiologists in North America) was associated with greater patient satisfaction with care [52]. Any attempts to decrease anesthesiology use will require concomitant monitoring of patient outcomes, including patient-reported satisfaction with care.

Chapter 4:
Wait Times for Gastrointestinal Endoscopy (GIE) Procedures

Overview and Background

Wait times for medical procedures can be a source of dissatisfaction for patients and a marker of timely access to care for providers and decision makers. In Manitoba, only limited research about wait times for GIE procedures has been conducted. Specifically, wait times were reported to increase for colonoscopies that occurred before a cancer diagnosis for those diagnosed with colon cancer between 2004 and 2009 in Manitoba [7]. However, there have been no comprehensive or recent published reports of endoscopy wait times in Manitoba.

In 2006, the Canadian Association of Gastroenterology Wait Times Group released consensus statements on maximum recommended wait times for healthcare provided by digestive disease specialists [8]. These consensus statements were informed by existing evidence and clinical expertise. They provide benchmarks against which to evaluate wait times for a variety of services, including endoscopy procedures for various indications.

A primary goal in establishing central intake registries in the Winnipeg RHA and Southern Health-Santé Sud was to optimize care for patients undergoing endoscopy, including potential reductions in wait times. In this chapter, we report on wait times from these two registries, from referral to the scheduled case date. A copy of the data quality report for these registries is available in Appendix 2 in the online supplement.

Study data for this part of the report were from fiscal years 2014/15 to 2018/19. We included intake records for individuals 19 years of age and older.

Descriptive analyses of wait times captured in all intake records in the central intake registries were conducted. Wait times were reported separately for upper GIE and lower GIE procedures. The analyses include the 25th, 50th, and 75th percentiles. A percentile represents the percentage of wait times (in days) that is equal to or below a certain value in the entire distribution of scores. For example, the 50th percentile represents the wait time value that half of all the wait times fall below.

In some central intake registry records, the procedure date was not provided. This date was imputed using the date of the GIE procedure recorded in physician billing claims. Some records included both upper GIE and lower GIE procedures on the same date; these records were included twice in the analysis, once for each type of procedure. We included records for procedures that were cancelled and for procedures for which the individual did not show up; there were very few of these records (central intake registries do not consistently record cancellations and “no shows”). All descriptive analyses were stratified by health region (i.e., Winnipeg RHA, Southern Health-Santé Sud).

Then we constructed study cohorts to use in quantile regression analyses to test the patient and provider characteristics associated with different percentiles of wait times, including the 25th, 50th, and 75th percentiles. Quantile regression is useful for analyses of data where the assumptions of linear regression are not met and where there is interest in predicting a value other than the mean. For wait times, there is limited value in predicting the mean wait time, because wait times tend to have a skewed distribution (i.e., a few people will have very long wait times, which tends to pull the mean toward these higher values). In wait time analyses, we are more interested in predicting which individuals are likely to have median (i.e., middle) wait times than the mean (i.e., average) wait time. Further details of the methods for the descriptive analyses and the quantile regression analyses are provided in Chapter 2.

Results

Description of Wait Times

A total of 118,309 GIE procedure records were identified from the central intake registries for the descriptive wait time analysis; this included 17,999 records for GIE procedures from the central intake registry in Southern Health-Santé Sud and 100,310 records for GIE procedures from the central intake registry in the Winnipeg RHA. These records were for fiscal years 2014/15 to 2018/19; however, less than 0.01% of the records were from 2014/15 for the Winnipeg RHA and only 6.0% were from 2014/15 for Southern Health-Santé Sud.

In each health region, approximately two-thirds of these records were for individuals between ages 50 and 74, while 12.5% of these records were for individuals 75+ years of age in Southern Health-Santé Sud and 13.9% were for individuals 75+ years of age in the Winnipeg RHA.

As Figure 4.1 reveals, a higher percentage of GIE procedures were categorized as semi-urgent in Southern Health-Santé Sud compared to the Winnipeg RHA (31.5% versus 25.8%). A higher percentage of GIE procedures were categorized as elective in the Winnipeg RHA as compared to Southern Health-Santé Sud (70.8% versus 61.9%; see Figure 4.1). It is important to note that differences exist in the indications used to classify urgency of GIE procedures in the two health regions. Therefore, it is not possible to discern whether the differences in percentages between the regions are due to differences in patient characteristics or differences in indications.

Figure 4.1: Percent of Central Intake Registry Records by Priority Level

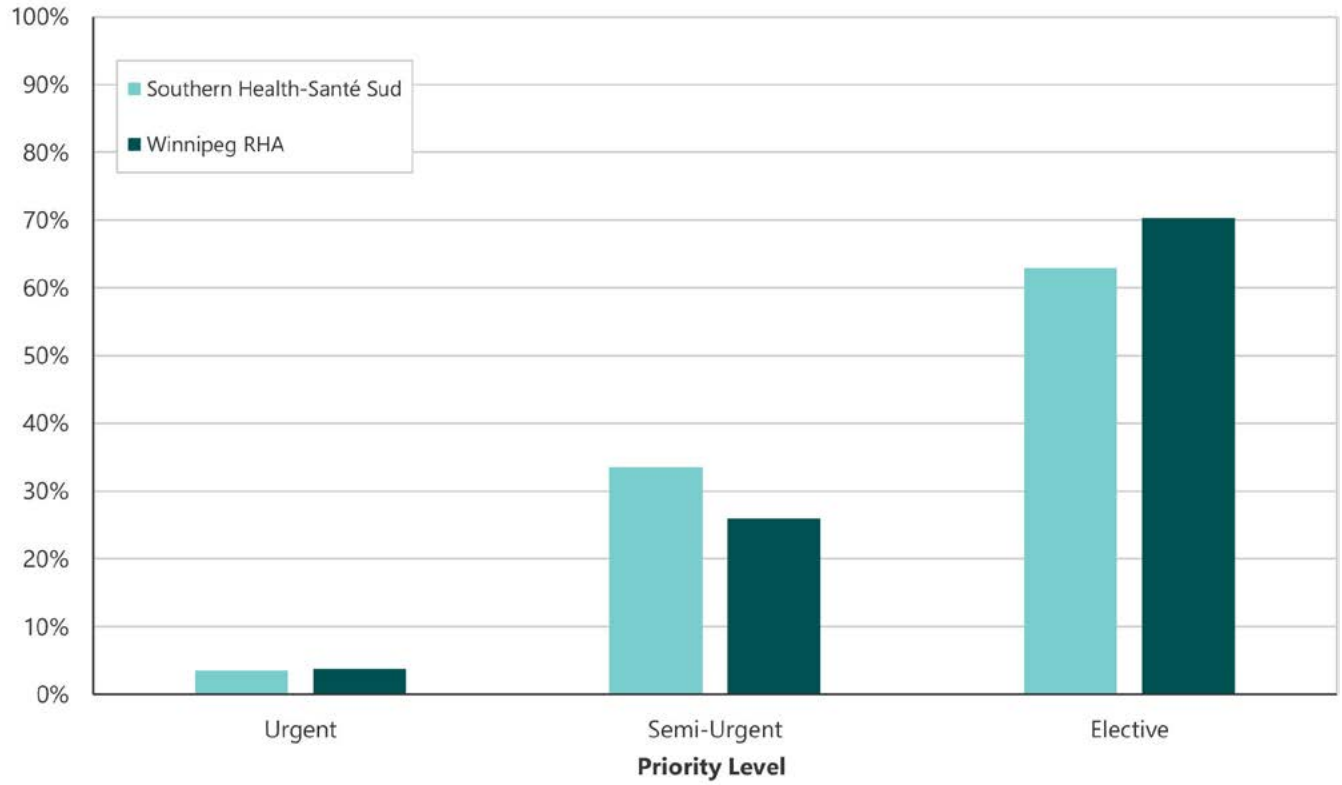


Table 4.1 reports the 25th, 50th (median), and 75th percentiles of wait times for all GIE procedures ascertained from the two central intake registries. Overall, the percentiles of wait times were higher in the Winnipeg RHA than in Southern Health-Santé Sud. We observed that the 25th and 50th percentiles of GIE procedure wait times changed very little over time. However, the 75th percentile of wait times for GIE procedures decreased over time. For the GIE procedures captured in the Winnipeg RHA central intake registry, there was almost no difference in the 25th percentile of wait times for residents of the rural health regions, although this percentile was slightly lower for residents of Prairie Mountain Health. Median wait times for GIE procedures from the central intake registry of Winnipeg RHA were similar for residents of Southern Health-Santé Sud, the Winnipeg RHA, and the Interlake-Eastern RHA; they were slightly lower for residents of Prairie Mountain Health and Northern Health Region. The same pattern was evident for the 75th percentile of wait times. In the central intake registries for both regions, individuals in the lowest income quintile had slightly lower median and 75th percentile wait times when compared with individuals in higher income quintiles. Individuals with an urgent status waited the shortest amount of time, as expected.

Table 4.1: Percentiles of Gastrointestinal Endoscopy (GIE) Procedure Wait Times from Physician Referral to Scheduled Procedure Date
Number of days

Cohort Characteristics	Southern Health-Santé Sud			Winnipeg RHA		
	25th	50th	75th	25th	50th	75th
Year of Referral						
2015/16	24	49	105	48	91	168
2016/17	27	52	94	48	92	174
2017/18	28	57	98	48	96	148
2018/19	28	51	88	43	84	132
Region of Residence at Referral						
Southern Health-Santé Sud	27	52	93	47	95	161
Winnipeg RHA	33	73	115	47	91	153
Prairie Mountain Health	26	44	84	39	83	146
Interlake-Eastern RHA	29	59	96	47	92	158
Northern Health Region	40	51	119	46	85	144
Income Quintile						
Q1 (Lowest)	27	50	89	43	82	142
Q2	27	52	96	44	89	149
Q3	28	55	98	46	91	153
Q4	28	56	98	47	93	157
Q5 (Highest)	28	55	97	51	98	162
Priority Level						
Elective	50	78	117	77	119	181
Semi-Urgent	19	27	35	26	42	62
Urgent	10	14	22	7	12	19

Characteristics of the Study Cohort for Regression Analyses

There were 10,303 individuals in the study cohort for the quantile regression analyses of wait times for Southern Health-Santé Sud and 44,216 individuals in the study cohort for the quantile regression analyses for the Winnipeg RHA. Table 4.2 describes the characteristics of the individuals in these two cohorts.

The age and sex distribution of individuals in the study cohorts was similar for the two regions; almost two-thirds of cohort members were in the 50-74 years age group. The distribution by sex was also similar in the two regions. A total of 84.2% of individuals in the study cohort for Southern Health-Santé Sud were residents of that region; another 10.1% were residents of the Winnipeg RHA. Similarly, 80.3% of individuals in the study cohort for the Winnipeg RHA were residents of that region; another 9.4% were residents of the Interlake-Eastern RHA.

CCI scores were more likely to be greater than zero (indicating greater comorbidity) for cohort members from the Winnipeg RHA central intake registry than for cohort members from the Southern Health-Santé Sud central intake registry. The distribution of income quintiles by health region was also dissimilar between the two health regions; almost one-quarter of cohort members from the Winnipeg RHA were in the highest income quintile, compared to only 15.6% of those from the Southern Health-Santé Sud.

A similar percentage of individuals were classified as urgent cases in both study cohorts. However, one-third of cohort members from Southern Health-Santé Sud were classified as semi-urgent, compared to approximately one-quarter of cohort members from the Winnipeg RHA. Cohort members from Southern Health-Santé Sud were more likely than cohort members from the Winnipeg RHA to have had a GIE procedure in the last five years.

Table 4.2: Characteristics of the Study Cohorts for the Wait Times Analysis, by Health Region

Cohort Characteristics	Southern Health-Santé Sud (n= 10,303)		Winnipeg RHA (n= 44,216)	
	Count	Percent	Count	Percent
Age Group (Years)				
19-34	731	7.1	3,164	7.2
35-49	1,762	17.1	7,586	17.2
50-74	6,509	63.2	27,406	62.0
75 and older	1,301	12.6	6,060	13.7
Sex				
Male	5,042	48.9	20,172	45.6
Female	5,261	51.1	24,044	54.4
Region of Residence at Referral				
Southern Health-Santé Sud	8,679	84.2	2,823	6.4
Winnipeg RHA	1,036	10.1	35,521	80.3
Prairie Mountain Health	416	4.0	378	0.9
Interlake-Eastern RHA	168	1.6	4,133	9.4
Northern Health Region	s	-	1,361	3.1
Income Quintile				
Q1 (Lowest)	1,484	14.4	7,541	17.1
Q2	2,378	23.1	7,794	17.6
Q3	2,022	19.6	8,614	19.5
Q4	2,746	26.7	9,159	20.7
Q5 (Highest)	1,602	15.6	10,941	24.7

GIE = Gastrointestinal Endoscopy
s indicates suppression due to small values

Table 4.2. Cont'd: Characteristics of the Study Cohorts for the Wait Times Analysis, by Health Region

Cohort Characteristics	Southern Health-Santé Sud (n= 10,303)		Winnipeg RHA (n= 44,216)	
	Count	Percent	Count	Percent
Charlson Comorbidity Index Score				
0	6,860	66.6	24,488	55.4
1	2,523	24.5	12,642	28.6
2	677	6.6	4,495	10.2
3+	243	2.4	2,591	5.9
Priority Level				
Elective	6,481	62.9	31,070	70.3
Semi-Urgent	3,457	33.6	11,473	26.0
Urgent	365	3.5	1,673	3.8
Procedure Type				
Lower GIE Procedure	7,456	72.4	30,619	69.3
Upper GIE Procedure	2,847	27.6	13,597	30.8
Previous GIE Procedure in Last 5 Years				
Yes	7,411	71.9	28,495	64.4
No	2,569	24.9	14,401	32.6
Fiscal Year				
2014/15	681	6.6	7	0.0
2015/16	2,451	23.8	9,118	20.6
2016/17	4,125	40.0	24,141	54.6
2017/18	3,046	29.6	10,950	24.8

GIE = Gastrointestinal Endoscopy
s indicates suppression due to small values

Table 4.3 provides the 25th, 50th, and 75th percentiles of wait times for the study cohorts, stratified by priority level for upper and lower GIE procedures. As expected, urgent procedures had much shorter wait times than semi-urgent or elective procedures in both health regions. Median wait times for urgent procedures were the same (13 days) for lower GIE procedures in both health regions. For upper GIE procedures, they were similar (14 days in Southern Health-Santé Sud; 13 days in the Winnipeg RHA).

Table 4.3: Percentiles of Gastrointestinal Endoscopy (GIE) Procedure Wait Times from Physician Referral to Scheduled Procedure Date by Procedure Type and Priority Level
Number of Days

Cohort Characteristics	Southern Health-Santé Sud (n= 10,303)				Winnipeg RHA (n= 44,216)			
	Count	25th Percentile	50th Percentile	75th Percentile	Count	25th Percentile	50th Percentile	75th Percentile
Upper GIE Procedures								
Elective	1,540	43	69	110	8,823	56	94	149
Semi-Urgent	1,173	17	26	35	4,150	24	41	63
Urgent	134	9	14	23	624	7	13	20
Lower GIE Procedures								
Elective	4,941	48	74	118	22,247	73	124	187
Semi-Urgent	2,284	15	25	32	7,323	27	43	64
Urgent	231	8	13	21	1,049	7	13	22

GIE = Gastrointestinal Endoscopy

Table 4.4 reports information about the 25th, 50th, and 75th percentiles for wait times by health region for upper and lower GIE procedures for cohort members in different diagnostic groups. Recall that incident diagnoses were those identified on the index date (i.e., scheduled procedure date) or up to 90 days following the index date. Incident cancer cases having an upper GIE procedure had a median wait time that was 10 days shorter than prevalence cancer cases in the Winnipeg RHA. Similarly, both incident colorectal and IBD cases having a lower GIE procedure had much shorter wait times than prevalent cases, as expected.

Table 4.4: Percentiles of Gastrointestinal Endoscopy (GIE) Procedure Wait Times from Physician Referral to Scheduled Procedure Date by Procedure Type and Diagnostic Group

Number of Days

Cohort Characteristics	Southern Health-Santé Sud (n= 10,303)				Winnipeg RHA (n= 44,216)			
	Count	25th Percentile	50th Percentile	75th Percentile	Count	25th Percentile	50th Percentile	75th Percentile
Upper GIE Procedures								
Incident Gastric, Esophageal, or Gastroesophageal Cancer	20	15	23	47	114	10	25	54
Prevalent Gastric, Esophageal, or Gastroesophageal Cancer	s	s	s	s	145	14	35	87
Other	2,825	24	42	79	13,338	36	68	121
Lower GIE Procedures								
Incident Colorectal Cancer	128	12	25	50	528	14	34	64
Incident IBD	78	13	32	56	329	29	59	105
Prevalent Colorectal Cancer	222	28	56	98	1,526	44	94	158
Prevalent IBD	55	29	64	109	1,679	52	105	174
Other	6,973	27	53	97	26,557	49	94	165

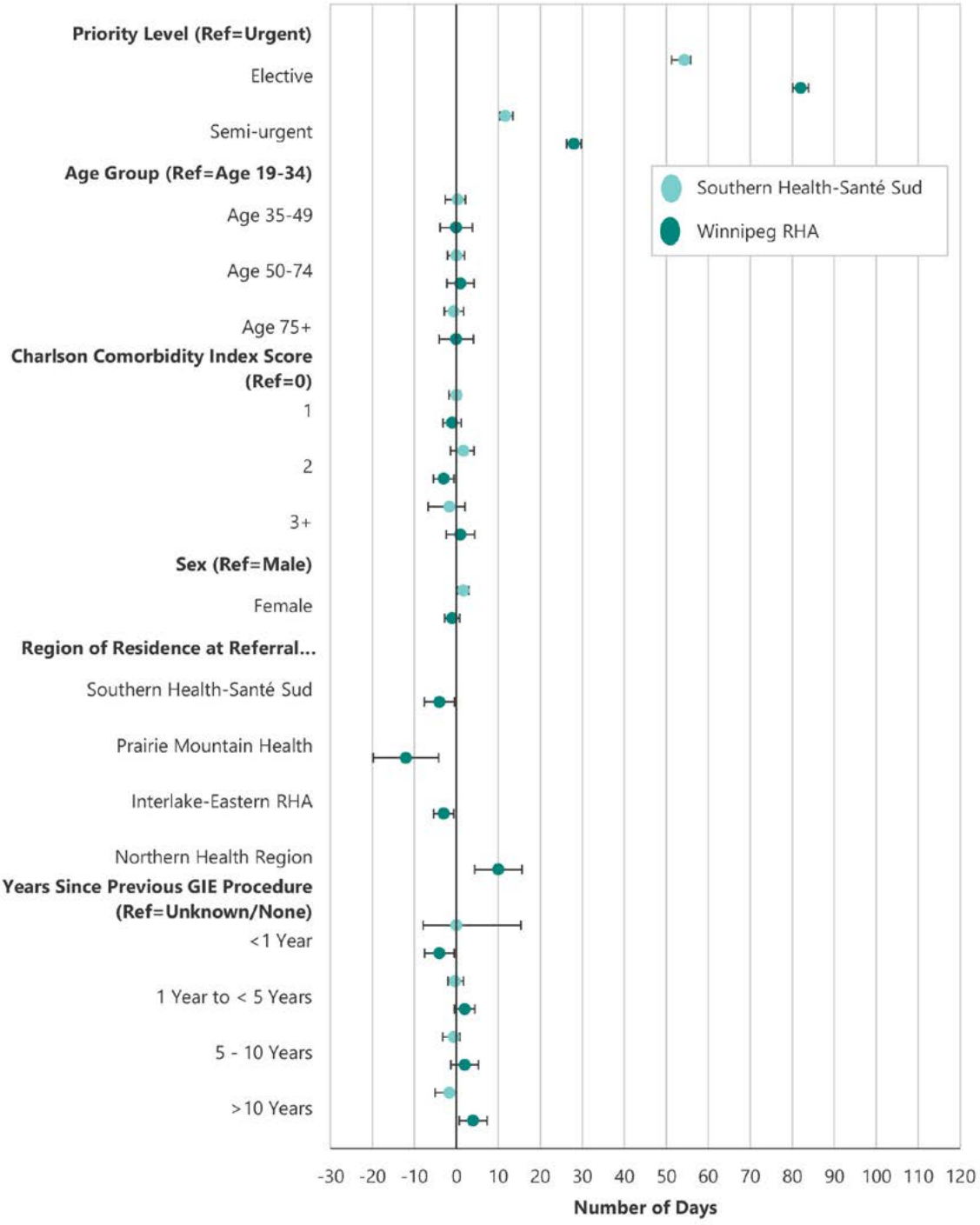
s indicates suppression due to small values
GIE = Gastrointestinal Endoscopy

Quantile Regression Analysis Results

Multivariable quantile regression models were used to test the cohort characteristics associated with variation in median (i.e., 50th percentile) wait times. Models were also fit to the data for the 25th and 75th percentiles of wait times; these are reported in the Data Extras in the online supplement.

Figure 4.2 depicts the association of priority level with median wait times for upper GIE procedures amongst study cohort members from Southern Health-Santé Sud and the Winnipeg RHA, after adjusting for age, sex, CCI score, region of residence, and length of time since a prior GIE procedure. As expected, compared with urgent procedures, elective procedures resulted in median wait times that were 54 days longer in Southern Health-Santé Sud and slightly more than 80 days longer in the Winnipeg RHA. Compared to urgent procedures, those that were semi-urgent resulted in median wait times that were about 12 days longer in Southern Health-Santé Sud and about 28 days longer in the Winnipeg RHA.

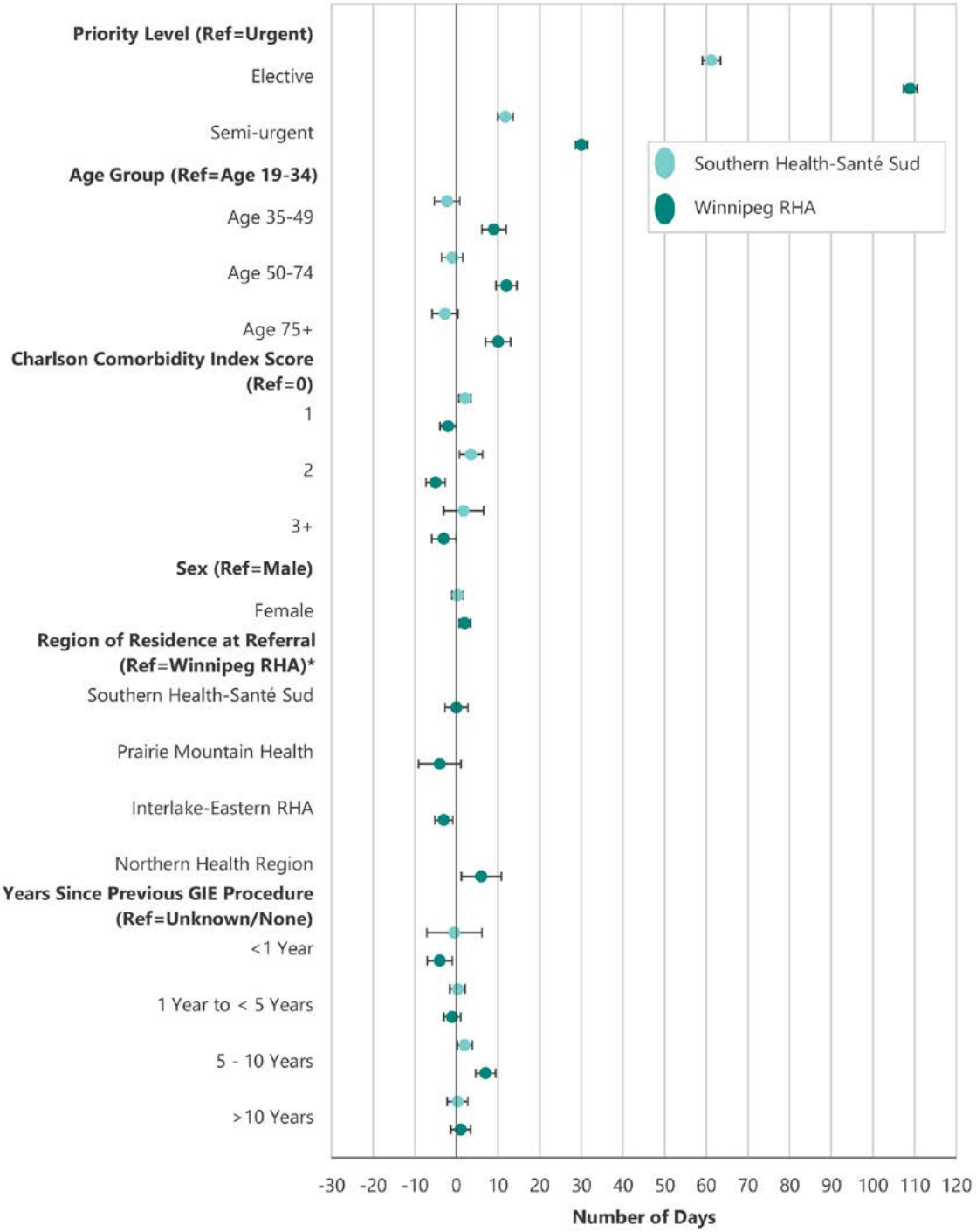
Figure 4.2: Results for Quantile Regression Models of Patient and Procedure Characteristics Associated with Median Wait Times for Upper Gastrointestinal Endoscopy (GIE) Procedures by Health Region (Priority Level Included in Model)



* Region of residence at referral were not included in the models for Southern Health-Santé Sud because of small numbers for some regions.

Figure 4.3 depicts the association of priority level with median wait times for lower GIE procedures amongst study cohort members from Southern Health-Santé Sud and the Winnipeg RHA, after adjusting for age, sex, CCI score, region of residence, and time since prior procedure. As expected, compared with urgent procedures, elective procedures resulted in median wait times that were 61 days longer in Southern Health-Santé Sud and 109 days longer in the Winnipeg RHA. Compared to urgent procedures, those that were semi-urgent resulted in median wait times that were 13 days longer in Southern Health-Santé Sud and about 30 days longer in the Winnipeg RHA.

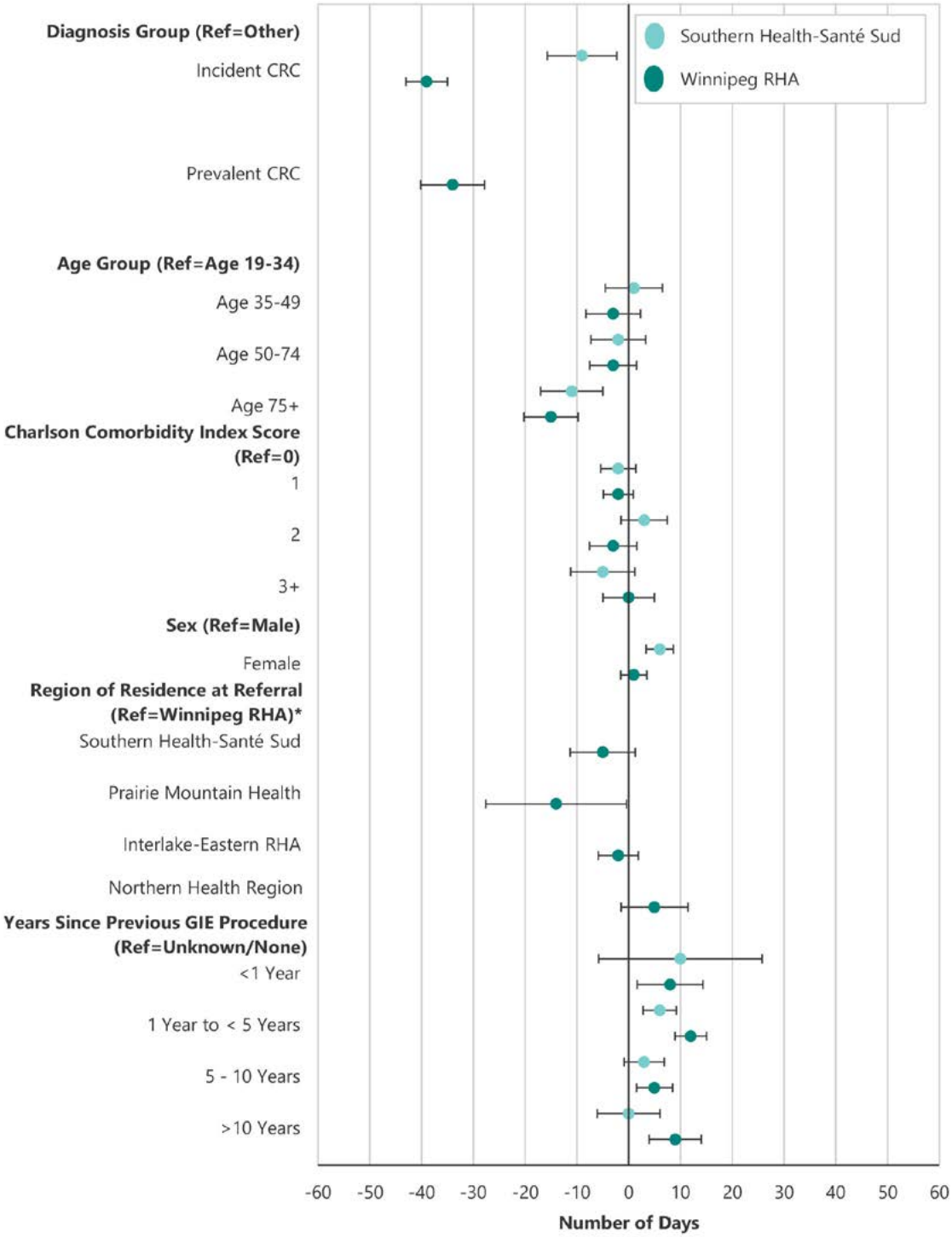
Figure 4.3: Results for Quantile Regression Models of Patient and Procedure Characteristics Associated with Median Wait Times for Lower Gastrointestinal Endoscopy (GIE) Procedures by Health Region (Priority Level Included in Model)



* Region of residence at referral were not included in the models for Southern Health-Santé Sud because of small numbers for some regions.

Figure 4.4 depicts the association of diagnosis groups with median wait times for upper GIE procedures amongst study cohort members from Southern Health-Santé Sud and the Winnipeg RHA, after adjusting for age, sex, CCI score, region of residence, and years since prior procedure. Compared with individuals who did not have a new diagnosis of gastric, esophageal, or gastroesophageal cancer either before or after the GIE procedure, those who did have a new diagnosis of gastric, esophageal, or gastroesophageal cancer had a substantially shorter wait time in the Winnipeg RHA; it was almost 40 days shorter. For those who had previously been diagnosed with gastric, esophageal, or gastroesophageal cancer, wait times were about 35 days shorter in the Winnipeg RHA. For cohort members in the central intake registry for Southern Health-Santé Sud, the median wait time was about 40 days longer for individuals in the "other" category when compared to those who had a new diagnosis of gastric, esophageal, or gastroesophageal cancer.

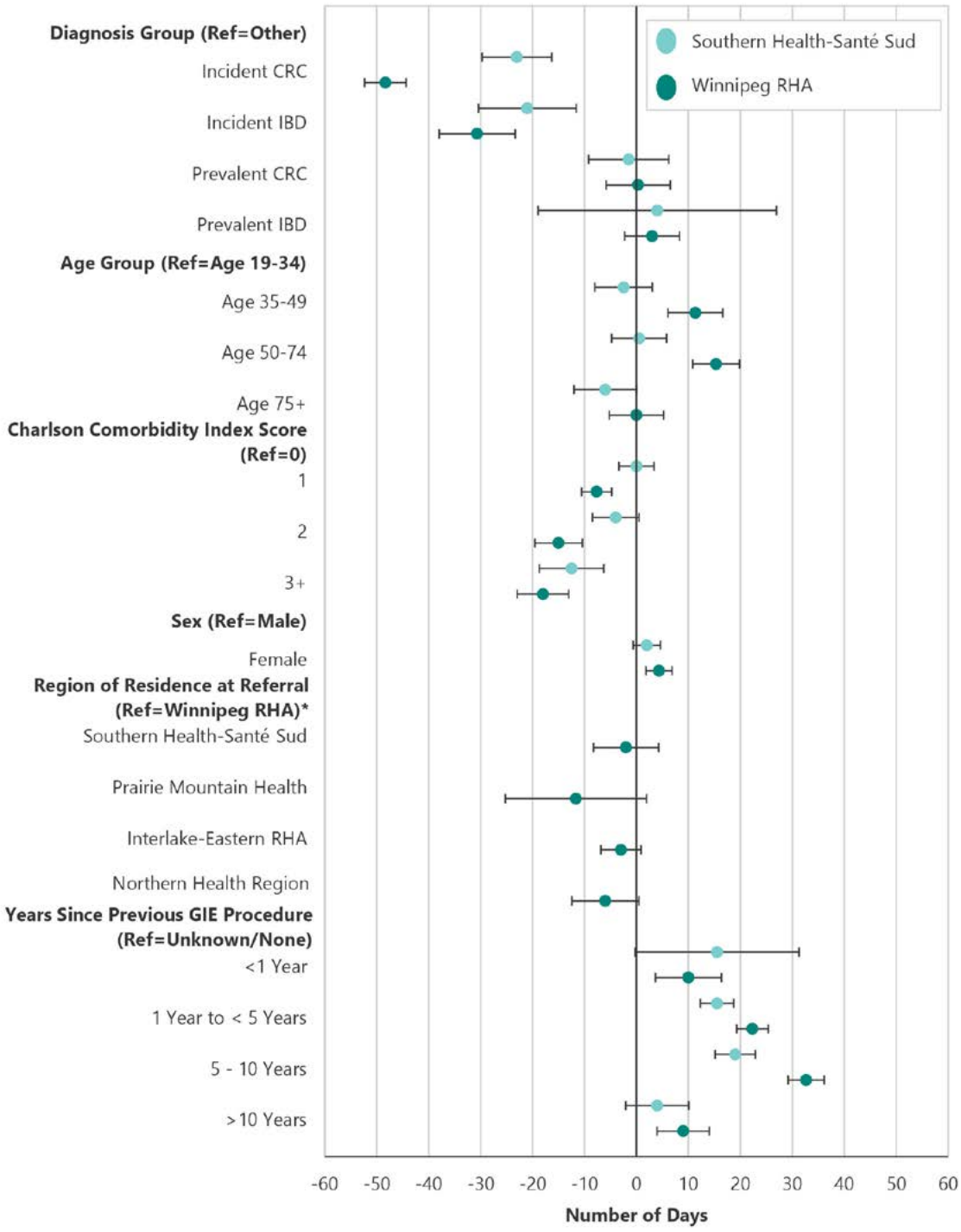
Figure 4.4: Results for Quantile Regression Models of Patient and Procedure Characteristics Associated with Median Wait Times for Upper Gastrointestinal Endoscopy (GIE) Procedures by Health Region (Diagnosis Group Included in Model)



* Data for region of residence at referral, and prevalent cancer are not available for Southern Health-Santé Sud
GIE = Gastrointestinal Endoscopy

Figure 4.5 depicts the association of diagnosis group with median wait times for lower GIE procedures amongst study cohort members from Southern Health-Santé Sud and the Winnipeg RHA, after adjusting for age, sex, comorbidity, region of residence, and years since a prior GIE procedure. Compared with study cohort members have a diagnosis in the "other" category, cohort members who had a new diagnosis of IBD or colorectal cancer had substantially shorter median wait times. However, cohort members who had previously been diagnosed with IBD or colorectal cancer did not have a median wait time that was significantly different from the median wait time of cohort members in the "other" category.

Figure 4.5: Results for Quantile Regression Models of Patient and Procedure Characteristics Associated with Median Wait Times for Lower Gastrointestinal Endoscopy (GIE) Procedures by Health Region (Diagnosis Group Included in Model)



* Data for region of residence at referral are not available for Southern Health-Santé Sud
GIE = Gastrointestinal Endoscopy

Summary

Wait times for medical procedures are often used as an indicator of healthcare accessibility and efficiency of service delivery. Increases in wait times may be concerning to the public and healthcare providers because of the possibility that longer wait times will be associated with poorer outcomes [53]. Little clarity exists regarding the threshold(s) of wait time that correspond with appropriate versus inappropriate or potentially harmful delays in care. Many factors beyond the availability of GIE procedure time slots may influence colonoscopy wait times [54]. While the Canadian Gastroenterology Association has provided benchmarks for wait times, these are linked to specific indications (i.e., reasons) for endoscopy procedures, which are not available for a large proportion of the cases in the data used for this study. The reasons are not collected in the Southern Health-Santé Sud registry and are collected electronically for only some cases in the Winnipeg RHA.

It is encouraging to note that wait times from referral to the scheduled procedure date for individuals with a new (i.e., incident) diagnosis of cancer or IBD were substantially shorter than for individuals with other conditions. This finding provides evidence that the triage process for scheduling GIE procedures is effective. As well, although median wait times did not change substantially during the study observation period from 2015/16 to 2018/19, the 75th percentile of wait times decreased for individuals in the central intake registries in both health regions. In addition, there was no difference in median wait times for urgent procedures among the two health regions. However, marked intra-provincial variation in wait times for elective and semi-urgent cases was evident; wait times for the Winnipeg RHA had the tendency to be higher than wait times for Southern Health-Santé Sud for non-urgent cases.

Both health regions performed GIE procedures for residents of other health regions that also have endoscopy services. Further research might examine if this is because of proximity of the services, referral for speciality procedures, or patient characteristics. For example, some health regions will not perform GIE procedures for patients who have excessively high body mass index values, suggesting that patient comorbidity may influence the locations where a GIE procedure is performed.

The results in this chapter suggest there is value associated with streamlining delivery of endoscopy services in all regions of the province; the creation of centralized intake registries generates comprehensive wait time information that, when linked to other sources of patient information, can be used to address a variety of questions about scheduling of procedures. Wait time information is essential for monitoring the delivery of care, and for conducting studies to better understand patient, procedure, and physician characteristics associated with variations in wait times.

Chapter 5:
Post-Gastrointestinal Endoscopy (GIE) Procedure Outcomes

Overview and Background

This chapter examines outcomes of GIE procedures. We focus on selected healthcare use events that could be considered adverse outcomes: emergency department visits, hospitalization, and intensive care unit admissions. We also investigate all-cause mortality. Finally, gastrointestinal and non-gastrointestinal complications are reported.

We examine a number of different outcome measures because there is no single post-GIE procedure outcome that can best inform quality improvement initiatives. Healthcare use measures are important because of their cost implications for the healthcare system. All-cause mortality is an outcome that is easily compared across jurisdictions. Complication rates are important for describing the potential risks to a patient of having a GIE procedure, as well as their costs to the healthcare system.

The study cohorts for all of these analyses included individuals (i.e., cases) who had a GIE procedure (upper or lower) between April 1, 1985 and February 28, 2017 and who were at least 19 years of age at the time of the GIE procedure. We also created a matched cohort (i.e., non-cases), so that we could compare the likelihood of occurrence of the outcomes in a general segment of the population; matching was undertaken on age group, sex, and location of residence. While cases could have had more than one GIE procedure in the study observation period, we limited our attention to the first GIE procedure for an individual in this period. The analyses were conducted using multivariable Cox proportional hazards regression and logistic regression (for complications).

Note that the analysis for emergency department visits was conducted only for the Winnipeg RHA, because emergency department data are not available for other health regions in Manitoba. As well, individuals in hospital on the day of the procedure were excluded for the healthcare use analysis, as we could not distinguish whether hospitalization occurred before or after the procedure. This exclusion was not applied to the analysis for GI complications, as it is unlikely that an individual would have a procedure if the perforation occurred before the procedure. A complete description of the methodology is provided in Chapter 2.

At the outset, it is important to note that the risk of many of the investigated outcomes was, as expected, higher for individuals having an upper GIE procedure than for individuals having a lower GIE procedure. Cases who undergo an upper GIE procedure are more likely to have had a diagnosis of gastrointestinal cancer or are suspected of having a gastrointestinal cancer. These cancers are more aggressive than CRC or chronic health conditions such as IBD, which are common reasons for having a lower GIE procedure.

Description of Study Cohort

Table 5.1 describes the GIE procedure cases and the matched non-cases on sociodemographic and comorbidity measures; the cohort is stratified by the type of GIE procedure (i.e., upper, lower). Overall, the cohort was composed of 388,981 cases and an equal number of matched non-cases. The equivalence of the two groups on age group, sex, and region of residence demonstrates the success of the matching process. The distribution of the cases and matched non-cases was similar across income quintiles. As expected, a larger percentage of the GIE procedure cases than non-cases had CCI scores greater than zero (i.e., indicating greater comorbidity).

Table 5.1: Sociodemographic and Comorbidity Characteristics of Gastrointestinal Endoscopy (GIE) Procedure Cases and Matched Non-Cases, 1985/86 to 2016/2017*

Characteristic	Cases		Matched Non-Cases	
	Count	Percent	Count	Percent
Upper GIE Procedure				
Total	174,711		174,711	
Age Group				
19-34	27,330	15.6	27,330	15.6
35-49	44,620	25.5	44,620	25.5
50-74	75,878	43.4	75,878	43.4
75+	26,883	15.4	26,883	15.4
Sex				
Female	93,546	53.5	93,546	53.5
Male	81,165	46.5	81,165	46.5
Region of Residence				
Winnipeg RHA	93,399	53.5	93,399	53.5
Non-Winnipeg Health Regions	81,312	46.5	81,312	46.5
Income Quintile				
Q1 (Lowest)	37,515	21.5	36,341	20.8
Q2	37,408	21.4	36,968	21.2
Q3	36,072	20.7	35,853	20.5
Q4	32,218	18.4	32,212	18.4
Q5 (Highest)	29,313	16.8	30,354	17.4
Procedure Decade				
1985/86 – 1989/90	21,474	12.3	21,474	12.3
1990/91 – 1999/2000	49,327	28.2	49,327	28.2
2000/01 – 2009/10	58,197	33.3	58,197	33.3
2010/11 – 2016/17*	45,713	26.2	45,713	26.2
Charlson Comorbidity Index Score				
0	92,203	52.8	132,973	76.1
1	55,344	31.7	31,736	18.2
2	18,184	10.4	7,168	4.1
3+	8,980	5.1	2,834	1.6

*April 1, 2016-February 28, 2017
GIE = Gastrointestinal Endoscopy

Table 5.1. Cont'd: Sociodemographic and Comorbidity Characteristics of Gastrointestinal Endoscopy (GIE) Procedure Cases and Matched Non-Cases, 1985/86 to 2016/2017*

Characteristic	Cases		Matched Non-Cases	
	Count	Percent	Count	Percent
Lower GIE Procedure				
Total	214,270		214,270	
Age Group				
19-34	24,604	11.5	24,604	11.5
35-49	50,927	23.8	50,927	23.8
50-74	114,583	53.5	114,583	53.5
75+	24,156	11.3	24,156	11.3
Sex				
Female	114,339	53.4	114,339	53.4
Male	99,931	46.6	99,931	46.6
Region of Residence				
Winnipeg RHA	131,194	61.2	131,194	61.2
Non-Winnipeg Health Regions	83,076	38.8	83,076	38.8
Income Quintile				
Q1 (Lowest)	33,679	15.7	37,603	17.6
Q2	40,748	19.0	42,148	19.7
Q3	44,602	20.8	43,913	20.5
Q4	44,565	20.8	43,204	20.2
Q5 (Highest)	49,327	23.0	44,728	20.9
Procedure Decade				
1985/86 – 1989/90	19,835	9.3	19,835	9.3
1990/91 – 1999/2000	52,709	24.6	52,709	24.6
2000/01 – 2009/10	75,991	35.5	75,991	35.5
2010/11 – 2016/17*	65,735	30.7	65,735	30.7
Charlson Comorbidity Index Score				
0	144,727	67.5	164,870	76.9
1	52,455	24.5	38,144	17.8
2	12,626	5.9	8,193	3.8
3+	4,462	2.1	3,063	1.4

*April 1, 2016-February 28, 2017
GIE = Gastrointestinal Endoscopy

Healthcare Use and All-Cause Mortality Outcomes

As Table 5.2 reveals, healthcare use and mortality were higher for cases than matched non-cases. A total of 2.0% of upper GIE procedure cases had an emergency department visit within 7 days of a GIE procedure, compared to 0.4% of matched non-cases; for lower GIE procedure cases, 1.0% of cases and 0.4% of matched non-cases had an emergency department visit within 7 days. The rate of death within 30 days of an upper GIE procedure was 1.8% and for a lower GIE procedure it was 0.4%.

Table 5.2: Potentially Adverse Outcomes for Gastrointestinal Endoscopy (GIE) Procedure Cases and Matched Non-Cases, 1985/86 to 2016/2017*

Outcome	Cases	Matched Non-Cases
	Percent	Percent
Upper GIE Procedure (N=174,711)		
Emergency Department Visit within 7 Days	2.0	0.4
Emergency Department Visits within 30 Days	5.2	1.7
Hospitalization within 7 Days	2.8	0.2
Hospitalization with 30 Days	5.7	0.9
Intensive Care Unit Admission within 7 Days	1.2	0.0
Intensive Care Unit Admission within 30 Days	2.0	0.1
Death within 30 Days	1.8	0.0
Lower GIE Procedure N=214,270)		
Emergency Department Visit within 7 Days	1.0	0.4
Emergency Department Visits within 30 Days	2.9	1.5
Hospitalization within 7 Days	1.5	0.2
Hospitalization with 30 Days	4.5	0.8
Intensive Care Unit Admission within 7 Days	0.3	0.0
Intensive Care Unit Admission within 30 Days	0.8	0.1
Death within 30 Days	0.4	0.0

Note: for the outcome of emergency department visits, the number of cases was 101,674 and the number of matched non-cases was 101,674 because the analysis was limited to individuals from the Winnipeg RHA. For the outcome of hospitalization, the number of cases was 342,867 and the number of matched non-cases was 342,867 because individuals who had a GIE procedure during the hospitalization were excluded.
Death within 7 Days was suppressed due to small numbers, therefore, it is not presented in this table.
*April 1, 2016-February 28, 2017

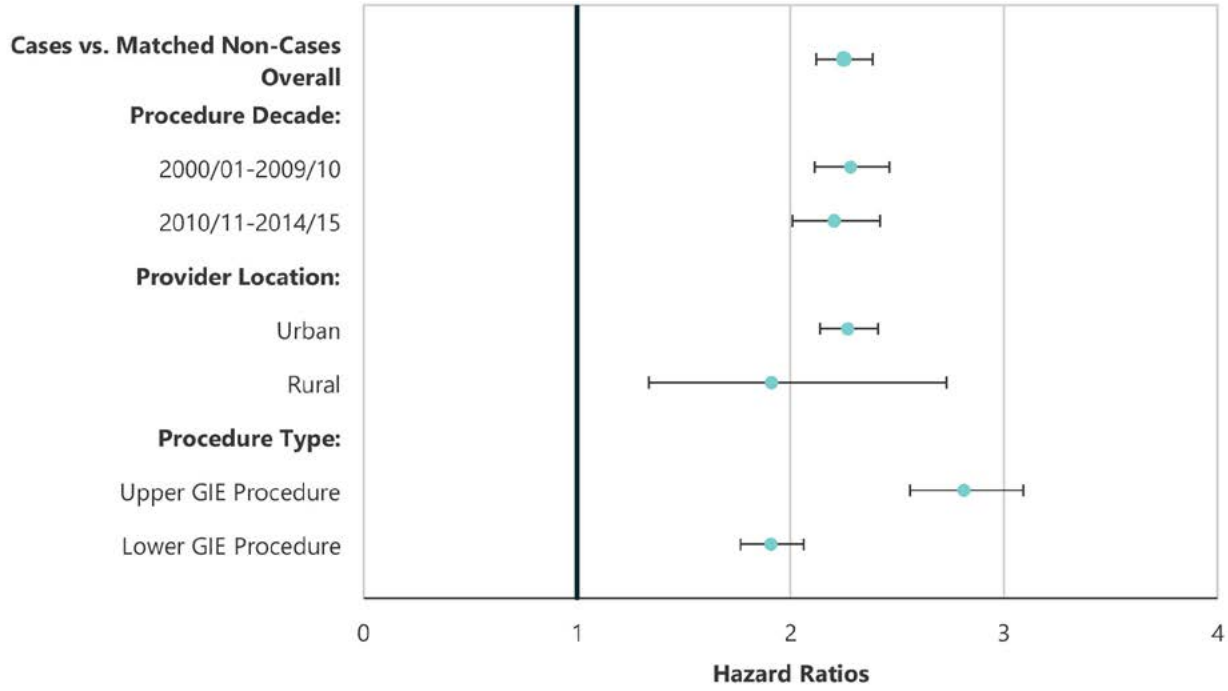
The results from the Cox proportional hazards regression models are provided for emergency department visits (Figure 5.1), hospitalization (Figure 5.2), ICU admission (Figure 5.3), and mortality within 30 days of the procedure (Figure 5.4). We did not conduct analyses for outcomes within 7 days of the GIE procedure, because of sparse numbers of events amongst the matched non-cases. In addition to controlling for differences in age, sex and region of residence, the analysis also controlled for comorbidity and income quintile.

Overall, cases had an elevated risk for each potentially adverse outcome when compared to matched non-cases. The magnitude of the overall difference depended on the outcome of interest. For emergency department visits, the risk for GIE procedure cases was slightly more than two times greater than for matched non-cases, while for hospitalization, it was 5.58 times greater, and for mortality, it was more than 70 times greater. This reflects underlying health conditions (such as CRC for lower GIE procedures) with a significant impact on the likelihood of a potentially adverse outcome.

We repeated the analyses after stratifying the cases and matched non-cases by GIE procedure date (in decades), physician practice location, and procedure type. In general, we found that the risk for each of the outcomes was similar over time and for urban and rural physicians who performed GIE procedures. The latter is a reassuring finding, as it indicates that the risk of outcomes does not depend on where a physician is practicing. For the former, the results indicate that GIE procedures have not become more or less risky over time.

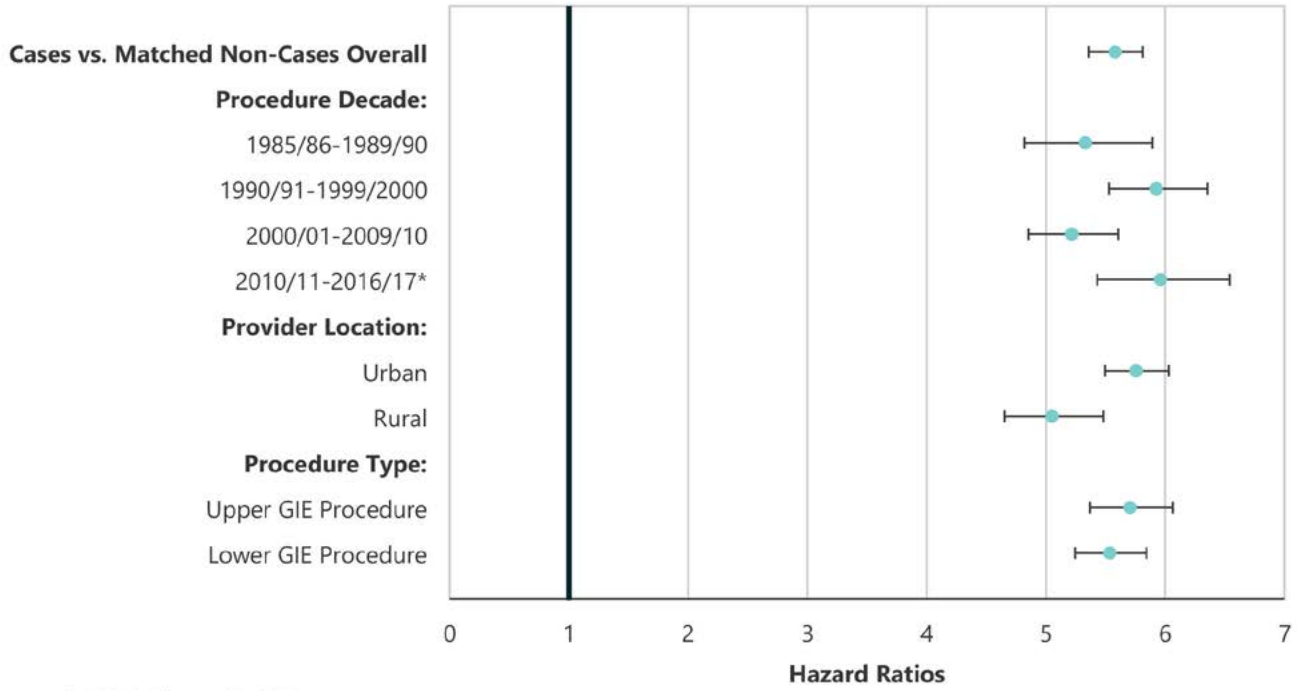
Figure 5.1: Risk of Emergency Department Visit* Within 30 Days of a Gastrointestinal Endoscopy (GIE) Procedure in Cases vs. Matched Non-Cases

Hazard ratios and 95% confidence intervals



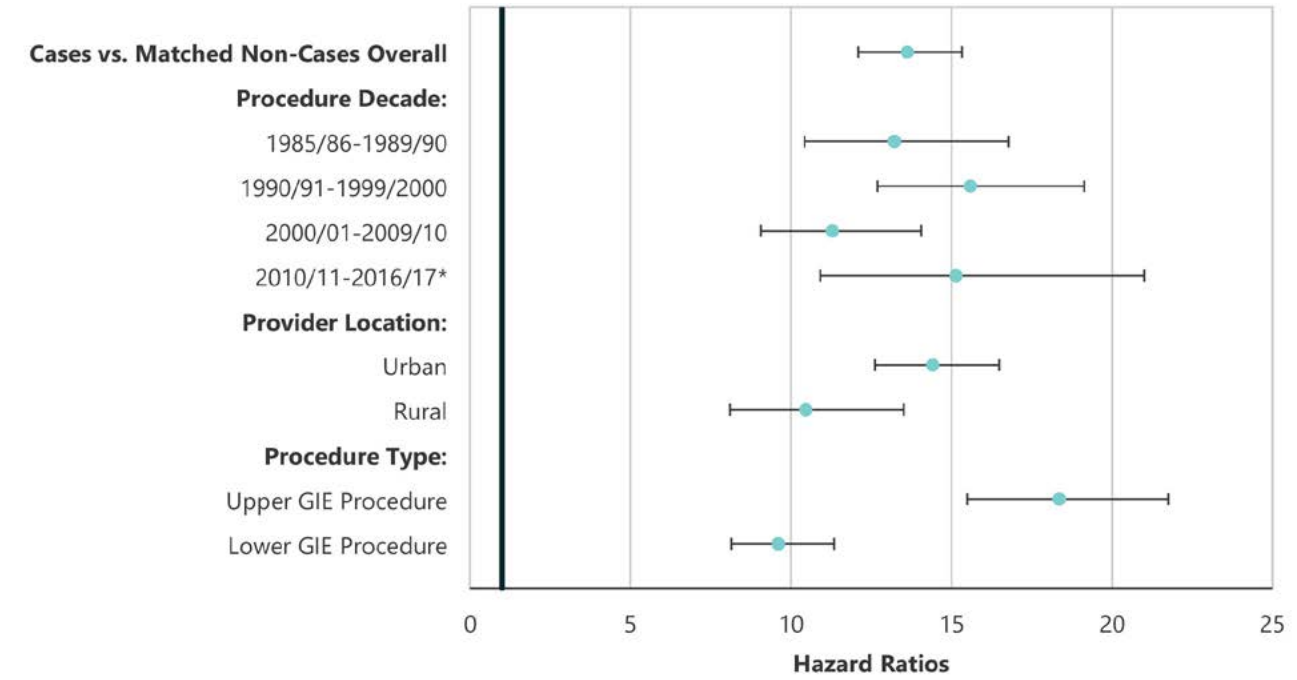
* Excludes Emergency Department visits on the same day as the endoscopy procedure.
GIE = Gastrointestinal Endoscopy

Figure 5.2: Risk of Hospitalization Within 30 Days of a Gastrointestinal Endoscopy (GIE) Procedure in Cases vs Matched Non-Cases
Hazard ratios and 95% confidence intervals



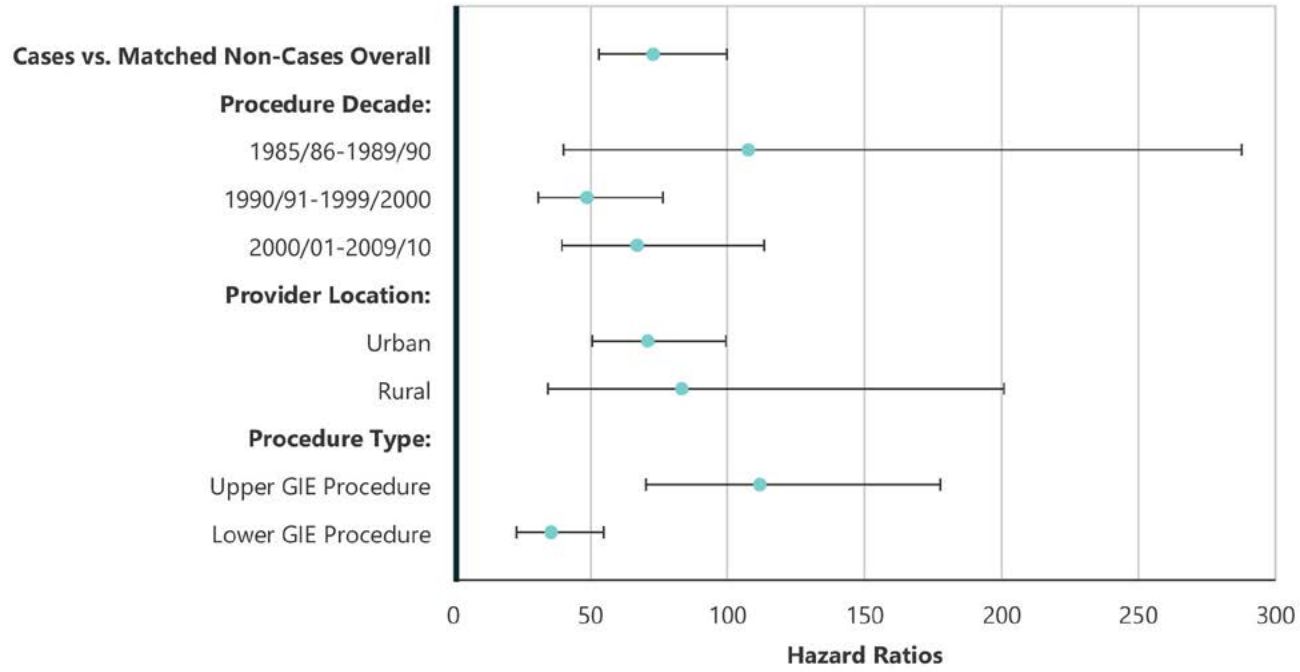
* April 1, 2016-February 28, 2017
GIE = Gastrointestinal Endoscopy

Figure 5.3: Risk of Admission into the Intensive Care Unit Within 30 Days of a Gastrointestinal Endoscopy (GIE) Procedure in Cases vs. Matched Non-Cases
Hazard ratios and 95% confidence intervals



* April 1, 2016-February 28, 2017
GIE = Gastrointestinal Endoscopy

Figure 5.4: Risk of Death Within 30 Days of a Gastrointestinal Endoscopy (GIE) Procedure in Cases vs. Matched Non-Cases
Hazard ratios and 95% confidence intervals



* April 1, 2016-February 28, 2017
Note: Hazard Ratio (95% Confidence Intervals) for procedure decade 2010/11 to February 28, 2017 were: 279.15 (69.67-1,118.42).
GIE = Gastrointestinal Endoscopy

Gastrointestinal Perforations and Non-Gastrointestinal Complications

The frequencies of hospitalization for gastrointestinal complications (i.e., intestinal perforations) and non-gastrointestinal complications (cardiac, cerebrovascular, infection, pulmonary) within 30 days after a GIE procedure are presented in Table 5.3. We examined complications for both cases and non-cases.

The descriptive analysis was conducted separately for upper GIE procedures, all lower GIE procedures, and then for colonoscopies only. Overall, the rate of gastrointestinal perforations was low; it was slightly higher in lower GIE cases than in upper GIE cases. Of the non-gastrointestinal complications, cardiac complications were the most common; they were experienced by 2.7% of upper GIE procedure cases and 1.1% of lower GIE procedure cases. For individuals who had a colonoscopy, only 1.0% had cardiac complications within 30 days.

Table 5.3: Hospitalizations for Complications Within 30 Days of a Gastrointestinal Endoscopy (GIE) Procedure, 1985/86 to September 30, 2016

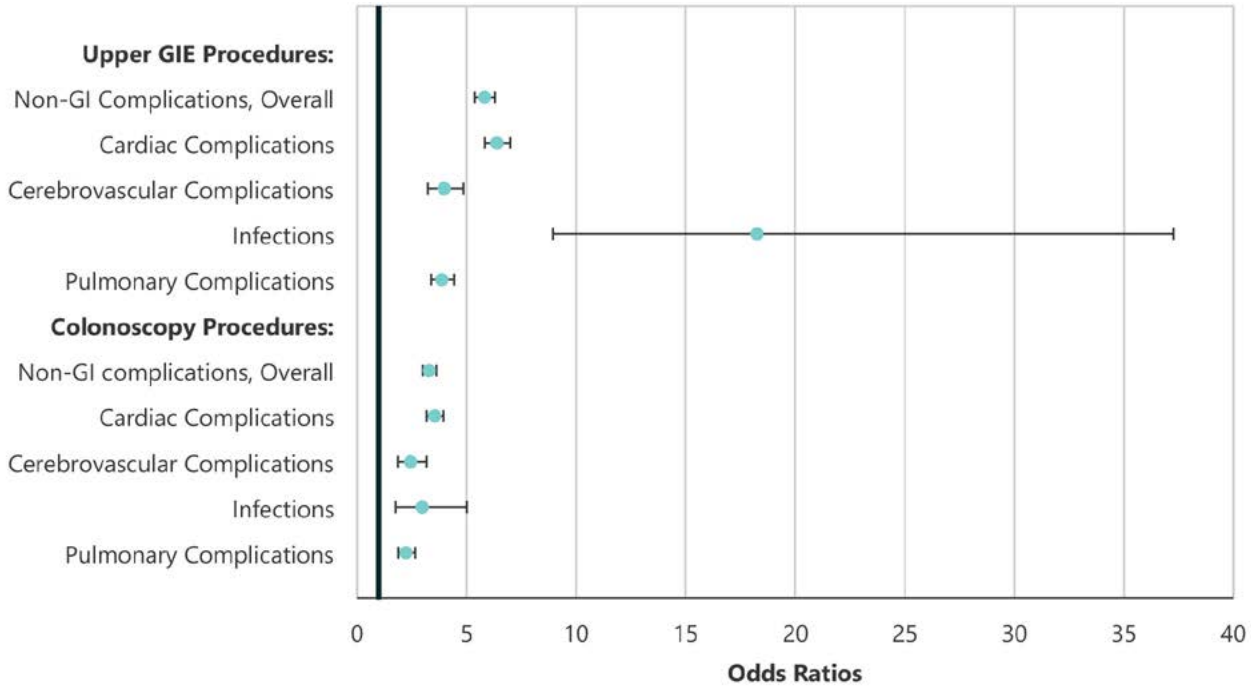
Reason for Hospitalization by Endoscopy Type	Cases		Matched Non-Cases	
	Count	Percent	Count	Percent
Upper GIE Procedure	174,711	100.0	174,711	100.0
GI Complication	243	0.1	s	s
Non-GI Complication	5,992	3.4	732	0.4
Infection	192	0.1	8	0.0
Cardiac	4,772	2.7	526	0.3
Cerebral	713	0.4	114	0.1
Pulmonary	1,596	0.9	265	0.2
Lower GIE Procedure	214,264	100.0	214,264	100.0
GI Complication	350	0.2	6	0.0
Non-GI Complication	3,009	1.4	760	0.4
Infection	103	0.1	24	0.0
Cardiac	2,378	1.1	550	0.3
Cerebral	339	0.2	117	0.1
Pulmonary	742	0.4	248	0.1
Colonoscopy Only	169,216	100.0	169,216	100.0
GI Complication	263	0.2	s	s
Non-GI Complication	2,161	1.3	561	0.3
Infection	62	0.0	19	0.0
Cardiac	1,747	1.0	417	0.3
Cerebral	227	0.1	74	0.0
Pulmonary	499	0.3	185	0.1

s Indicates suppression due to small numbers
GI = Gastrointestinal
GIE = Gastrointestinal Endoscopy

Figure 5.5 reports the results of a logistic regression analysis to estimate the difference between GIE procedure cases and non-cases in the odds of having a non-gastrointestinal complication. We did not conduct this analysis for gastrointestinal complications because they were rare amongst the matched non-cases. In addition, for lower GIE procedures, we focused only on colonoscopy because this was the most frequent lower GIE procedure. The results show that the greatest risk amongst upper GIE procedure cases was for infections and cardiac complications; it was of a similar magnitude for cerebrovascular and pulmonary complications. For colonoscopy cases, the risk was similar for all types of non-gastrointestinal complications.

Figure 5.5: Odds Ratio Estimates for Non-Gastrointestinal Complications for Gastrointestinal Endoscopy (GIE) Procedure Cases vs. Matched Non-Cases

Hazard ratios and 95% confidence intervals



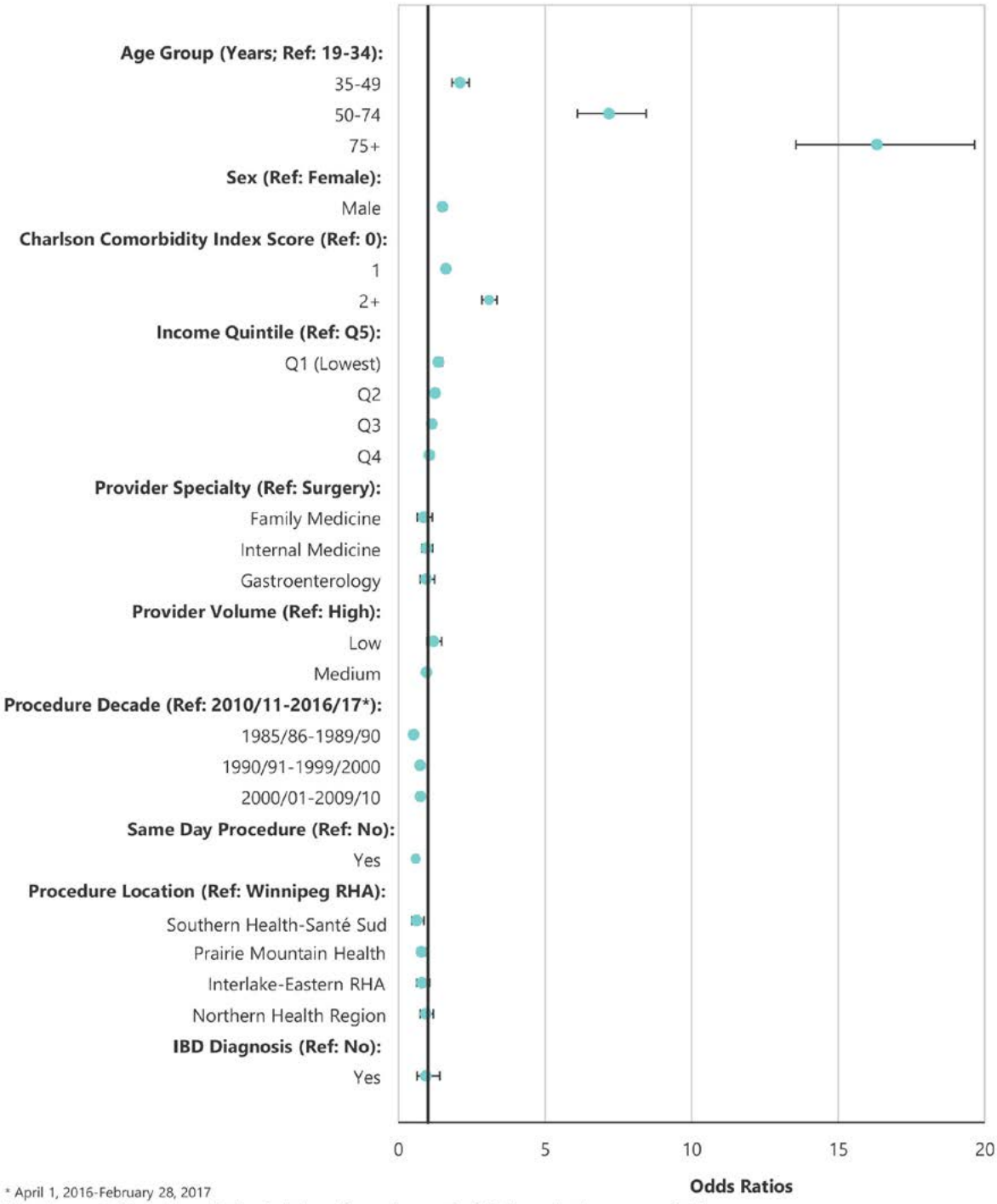
GIE = Gastrointestinal Endoscopy

The results of the logistic regression analyses for factors associated with hospitalization for complications amongst GIE procedure cases are shown in Figures 5.6 to 5.9. For all complications, older age and higher level of comorbidity resulted in elevated odds. A dose-response effect was evident; the magnitude of the odds ratio estimate increased as age and level of comorbidity increased.

For non-gastrointestinal complications after an upper GIE procedure, there was a small effect of income quintile, in that the odds of hospitalization were higher amongst individuals in lower than in higher income groups. As well, the odds of hospitalization were slightly lower in Southern Health-Santé Sud and in Prairie Mountain Health than in the Winnipeg RHA. The odds were also lower in earlier than in later time periods. The specialty of the physician who performed the GIE procedure and the volume of GIE procedures performed by physicians were not associated with the odds of a non-gastrointestinal complication. The odds were higher for males than for females.

Figure 5.6: Risk of Hospitalization for Non-Gastrointestinal Complications Within 30 Days of an Upper Gastrointestinal Endoscopy (GIE) Procedure

Odds ratios and 95% confidence intervals



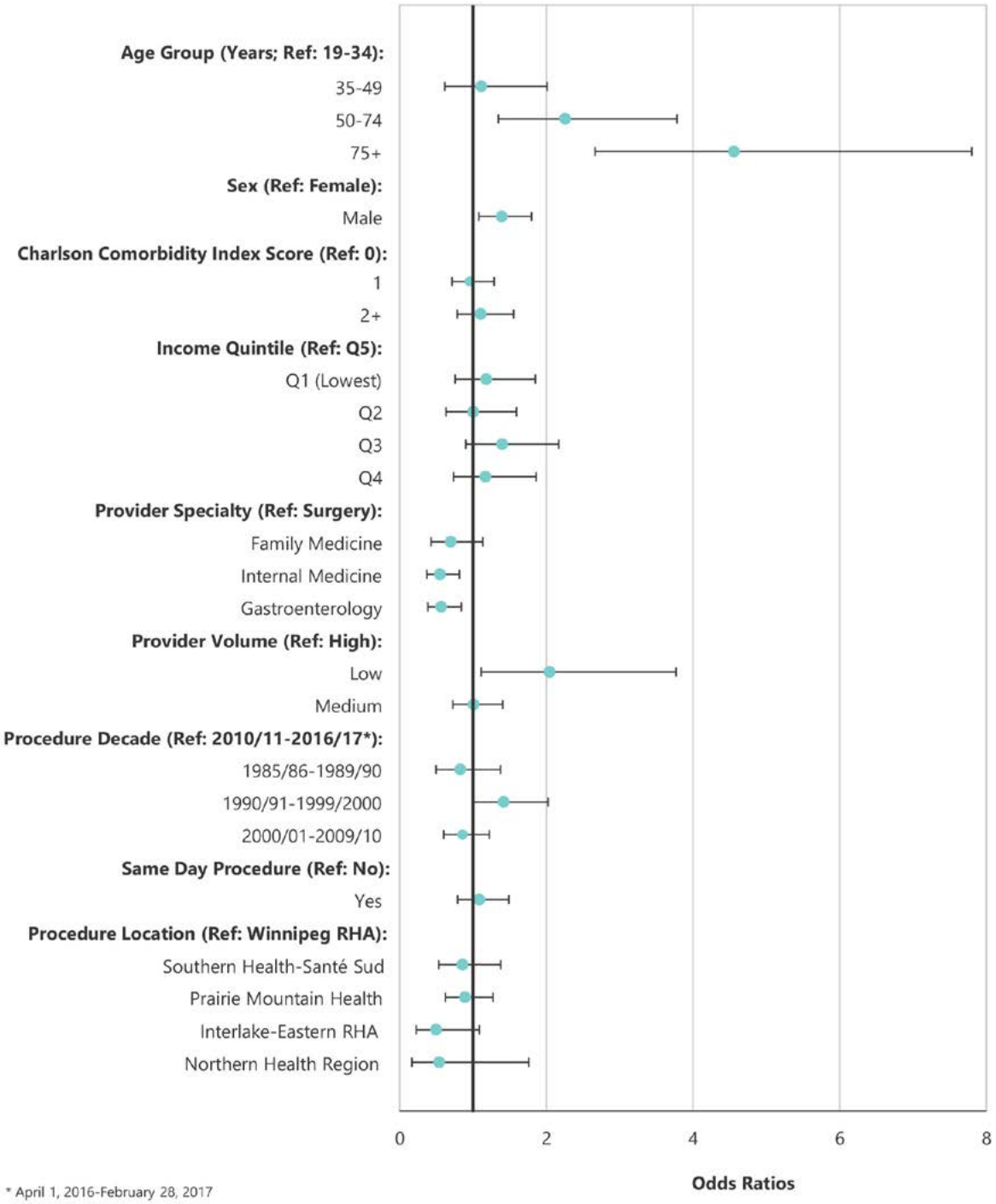
* April 1, 2016-February 28, 2017

Note: Non-gastrointestinal complications include cardiac, cerebrovascular, infection, and pulmonary complications.

The odds of hospitalization for gastrointestinal complications (i.e., perforations) amongst individuals having an upper GIE procedure was higher for males and for cases being treated by a physician with a low volume of GIE procedures.

Figure 5.7: Risk of Hospitalization for Gastrointestinal Complications Within 30 Days of an Upper Gastrointestinal Endoscopy (GIE) Procedure

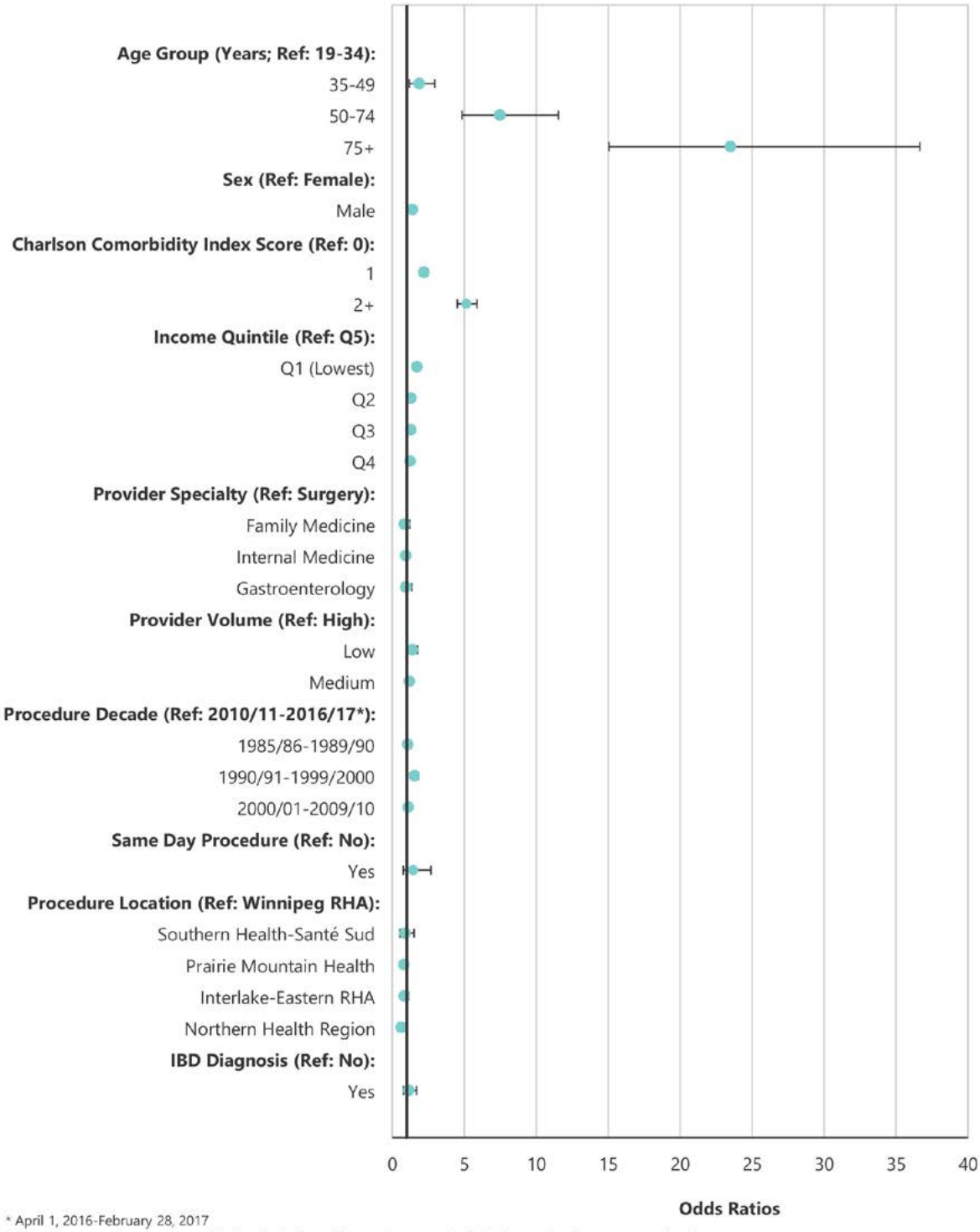
Odds ratios and 95% confidence intervals



* April 1, 2016-February 28, 2017

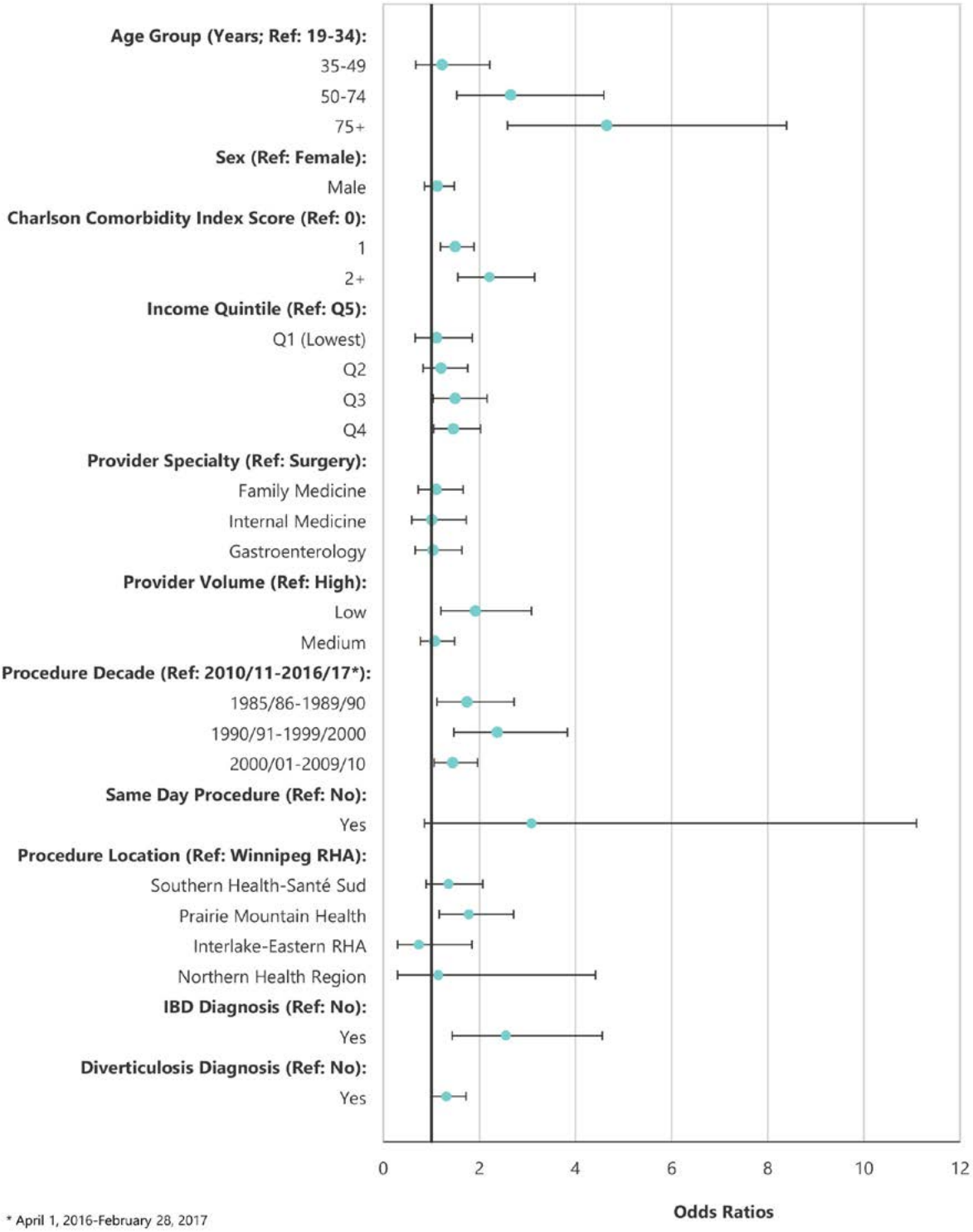
When we focused on colonoscopies and investigated the factors associated with the odds of hospitalization for non-gastrointestinal complications, we found that (besides age and comorbidity score) male sex and lower income quintile were associated with increased odds. However, for gastrointestinal complications following a colonoscopy, a physician with a lower volume of GIE procedures resulted in increased odds, as did an earlier decade for the procedure and an IBD diagnosis. For lower GIE procedures, the median number of procedures amongst physicians in the lowest tertile in the most recent study year was 3 (IQR: 2, 72). The median number of procedures in the middle tertile was 292 (IQR: 197, 354), while the median number of procedures in the highest tertile was 531 (IQR: 485, 623). This latter finding is significant because perforations are more closely associated with the performance of the procedures, while non-GI complications are more likely to be influenced by the health of the patient.

Figure 5.8: Risk of Hospitalization for Non-Gastrointestinal Complications Within 30 Days of a Colonoscopy
Odds ratios and 95% confidence intervals



* April 1, 2016-February 28, 2017
Note: Non-gastrointestinal complications include cardiac, cerebrovascular, infection, and pulmonary complications

Figure 5.9: Risk of Hospitalization for Gastrointestinal Complications Within 30 Days of a Colonoscopy
Odds ratios and 95% confidence intervals



* April 1, 2016-February 28, 2017

Summary

In this chapter, we reported on analyses of healthcare use, mortality, and complications following a GIE procedure. To provide context for the analyses, we compared individuals who had undergone a GIE procedure to matched individuals from the general population, using age, sex, and region of residence as matching variables.

The results reveal that potential adverse outcomes and complications following a GIE procedure are relatively rare. However, there is likely to be heterogeneity in the rates of adverse events and outcomes. The risk of some complications may be higher for GIE procedures that are conducted for reasons other than screening. Unfortunately, as noted in Chapter 1, it is not possible to identify the indication (i.e., reason) for a GIE procedure using administrative health data. Thus, this important explanatory variable is missing from our data. This limits the scope of the assessment that can be undertaken. As well, we did not examine the diagnoses associated with emergency department visits, hospitalization, or ICU admissions. The events were relatively rare, even after compiling information across multiple years; the power to detect differences between cases and matched non-cases on specific reasons for an emergency department visit, hospitalization, or ICU admission would have been very low.

Comparisons between GIE procedure cases and matched non-cases revealed that the risk of potentially adverse healthcare use outcomes for GIE procedure cases was higher than for non-cases, even after controlling for multiple characteristics, including age, sex, region of residence, income quintile, and comorbidity. Over time, however, the risk ratio remained stable. As well, it did not vary with the provider location (i.e., urban/rural).

Knowledge of potential endoscopic complications, their expected frequency, and the risk factors associated with their occurrence may help to minimize the incidence of complications. When we focused on the characteristics of GIE procedure cases that were associated with complications, we found age and comorbidity to be the most important factors. Other characteristics, such as region of the provider, were not associated with risk of a complication, suggesting a lack of geographic and income-related differences in the risk of complications following a GIE procedure. An important caveat of our analysis is the exclusion of GI hemorrhage. Less important is the exclusion of cases not requiring hospital admission.

Chapter 6:
Post-Colonoscopy Colorectal Cancer Diagnosis

Overview and Background

Post-colonoscopy CRC, defined as CRC diagnosed more than six months but within three years after a colonoscopy, has been proposed as a quality indicator for healthcare systems that offer colonoscopy services [13]. There are a number of reasons why CRC may be diagnosed subsequent to a colonoscopy in which no cancer is found, including a missed CRC diagnosis, missed pre-cancer, polyps, and new pre-cancer polyps that grow quickly after the colonoscopy. Research suggests that most CRC diagnoses after colonoscopy are due to findings that are missed or not completely removed after being detected on colonoscopy. Accordingly, many (some researchers estimate most) post-colonoscopy CRC diagnoses are preventable. Therefore, guidelines recommend healthcare systems delivering colonoscopy should make serious efforts to decrease post-colonoscopy CRC diagnosis rates.

Wide variations in post-colonoscopy CRC rates have been reported in previous studies. These variations have been attributed to a number of factors, including lack of a standard definition of post-colonoscopy CRC and variations in the quality of the data and the quality of colonoscopies that are performed by providers. As well, patient characteristics have been found to contribute to variation in post-colonoscopy CRC rates. A few years ago, an international consensus on standard definition was published and is now widely used [13]. Many places outside Manitoba have recently reported using the standard definition. Importantly, many places have also reported a decrease in post colonoscopy-CRC rates by improving colonoscopy services delivery.

A recent population-based study from England reported that the unadjusted rate of post-colonoscopy CRC was 7.4%; the data in this study were from 2005 to 2013 [55]. The rate decreased over time, from 9.0% in 2005 to 6.5% in 2013. Rates were lower for colonoscopies performed under the National Health Service (NHS) bowel cancer-screening program (3.6%); they were higher for colonoscopies that were conducted by non-NHS providers (9.3%). Most importantly, substantial variations in rates among colonoscopy providers remained after controlling for the level of complexity (i.e., case mix) of patients. Rates were higher for women, older age groups, individuals with IBD or diverticular disease diagnoses, individuals with higher comorbidity scores, and individuals with a prior cancer diagnosis.

A recent study from New Zealand reported a post-colonoscopy CRC rate of 4.4% between 2009 and 2019 [56], while a Danish study reported a rate that fell from 22.5% in 2001 to 7.9% in 2012 [57]. Finally, a study from Belgium reported that the rate between 2002 and 2010 was 7.6% [58].

Previous estimates of post-colonoscopy CRC diagnoses in Manitoba focused on people in the recommended age group for CRC screening (i.e., 50 to 80 years) and excluded individuals with IBD and a previous CRC diagnosis [31]. A rate of 7.9% was reported between 1992 and 2008, and it remained relatively stable over this period.

For this study, we identified a cohort of individuals with a CRC diagnosis between April 1, 1990 and December 31, 2016 using data from the Manitoba Cancer Registry. We included those who had a colonoscopy within three years before the CRC diagnosis; approximately 30% of CRC cases were excluded because they did not have a colonoscopy in the previous three years. We then classified included individuals as colonoscopy-detected CRC (i.e., CRC diagnosed on day of or within 6 months of a colonoscopy) or post-colonoscopy CRC (i.e., CRC diagnoses after 6 months and up to 36 months after colonoscopy). The latter group of individuals was used to calculate the rate (%) of post-colonoscopy CRC.

We conducted several analyses. Descriptive analyses, including frequencies and percentages, describe the characteristics of patients with a CRC diagnosis who had a post-colonoscopy CRC diagnosis and those who had a colonoscopy-detected CRC diagnosis. We tested for a change in the odds of post-colonoscopy CRC over three decades: 1990/91-1999/2000, 2000/01-2009/10, and 2010/11-December 31, 2016, after controlling for patient, colonoscopy procedure, and physician characteristics. Finally, we tested the patient, colonoscopy procedure, and physician characteristics associated with post-colonoscopy CRC using multivariable logistic regression models. We report the ORs and 95% CIs for these characteristics. Additional details are provided in Chapter 2.

Results

A total of 24,429 individuals had a CRC diagnosis in the study period from April 1, 1990 to December 31, 2016. More than two thirds of these individuals (68.1%) had a colonoscopy within three years prior to the CRC diagnosis. These individuals were the focus of subsequent analyses.

Overall, 10.5% of the 16,639 individuals with a CRC diagnosis (and colonoscopy at or just before CRC diagnosis) in the study period had post-colonoscopy CRC (Table 6.1). The highest percentage (19.9%) of post-colonoscopy CRC diagnoses was for individuals for whom the CRC colon site was not specified and the lowest percentage (7.2%) of post-colonoscopy CRC diagnoses was for individuals with distal colon CRC.

Table 6.1: Post-Colonoscopy Colorectal Cancer (CRC) and Colonoscopy-Detected CRC, Overall and by CRC Site, April 1, 1990 to December 31, 2016

Site	Post-Colonoscopy CRC		Colonoscopy-Detected CRC		Total
	Count	Percent	Count	Percent	Count
Overall	1,753	10.5	14,886	89.5	16,639
Distal Colon	283	7.2	3,634	92.8	3,917
Proximal Colon	965	14.6	5,631	85.4	6,596
Rectum	423	7.4	5,290	92.6	5,713
Not Specified	82	19.9	331	80.1	413

Table 6.2 shows that the rate of post-colonoscopy CRC did not decrease from fiscal years 1990/91-1999/2000 to the last study period. The rate remained close to 10%.

Table 6.2: Post-Colonoscopy Colorectal Cancer (CRC) and Colonoscopy-Detected CRC, by Time of Diagnosis, April 1, 1990 to December 31, 2016

Time of Diagnosis	Post-Colonoscopy CRC		Colonoscopy-Detected CRC		Total
	Count	Percent	Count	Percent	Count
Overall	1,753	10.5	14,886	89.5	16,639
1990/91 - 1999/2000	442	9.8	4,061	90.2	4,503
2000/01 - 2009/10	789	11.2	6,234	88.8	7,023
2010/11 - December 31, 2016	522	10.2	4,591	89.8	5,113

Table 6.3 describes the characteristics of patients and Table 6.4 describes the site of performance of the initial colonoscopy for people with post-colonoscopy CRC diagnoses and colonoscopy-detected CRC diagnoses. Crude post-colonoscopy CRC rates varied by age group and sex, with rates being highest in the oldest age group (75+ years) and in females. Rates were almost identical in the lowest and highest income quintile groups. Rates did not vary by Charlson comorbidity scores, but they did vary by many other clinical characteristics of patients, such as whether IBD had been previously diagnosed. Rates were slightly higher for individuals who had a procedure in a rural facility than those who had a procedure in an urban setting. Post-colonoscopy CRC rates varied across the health region in which the procedure was performed; they were lowest for the Northern Health Region, which is likely a reflection of lower complexity of patients residing in the north compared to patients who had procedures in other rural health regions.

Table 6.3: Characteristics of Individuals with Post-Colonoscopy Colorectal Cancer (CRC) and Colonoscopy-Detected CRC Diagnoses, April 1, 1990 to December 31, 2016

Patient Characteristics	Post-Colonoscopy CRC		Colonoscopy-Detected CRC		Total
	Count	Percent	Count	Percent	Count
Demographic Characteristics					
Age Group					
19-34	10	9.3	98	90.7	108
35-49	83	8.3	912	91.7	995
50-74	908	10.1	8,080	89.9	8,988
75+	752	11.5	5,796	88.5	6,548
Sex					
Male	877	9.6	8,220	90.4	9,097
Female	876	11.6	6,666	88.4	7,542
Income Quintile					
Q1 (Lowest)	340	9.9	3,095	90.1	3,435
Q2	417	11.2	3,310	88.8	3,727
Q3	399	11.0	3,233	89.0	3,632
Q4	311	10.4	2,681	89.6	2,992
Q5 (Highest)	268	10.1	2,379	89.9	2,647
Clinical Characteristics					
IBD Diagnosis					
Yes	88	34.0	171	66.0	259
No	1,665	10.2	14,715	89.8	16,380
Charlson Comorbidity Index Score					
0	728	10.3	6,347	89.7	7,075
1	661	10.9	5,402	89.1	6,063
2+	364	10.4	3,137	89.6	3,501
Prior Colectomy					
Yes	480	16.5	2,433	83.5	2,913
No	1,273	9.3	12,453	90.7	13,726
Prior Colorectal Cancer Diagnosis					
Yes	375	35.7	674	64.3	1,049
No	1,378	8.8	14,212	91.2	15,590
Prior Colonoscopy					
Yes	861	19.6	3,530	80.4	4,391
No	892	7.3	11,356	92.7	12,248
Prior Diverticulosis					
Yes	714	20.2	2,819	79.8	3,533
No	1,039	7.9	12,067	92.1	13,106

Table 6.4: Site of Performance of Initial Colonoscopy for Individuals with Post-Colonoscopy Colorectal Cancer (CRC) and Colonoscopy-Detected CRC, April 1, 1990 to December 31, 2016

Procedure Characteristics	Post-Colonoscopy CRC		Colonoscopy-Detected CRC		Total
	Count	Percent	Count	Percent	Count
Facility Type					
Urban Inpatient	1,305	10.2	11,436	89.8	12,741
Urban Outpatient	24	9.9	218	90.1	242
Rural	423	11.6	3,229	88.4	3,652
Procedure Location					
Southern Health-Santé Sud	150	9.7	1,399	90.3	1,549
Winnipeg RHA	1,114	10.1	9,969	89.9	11,083
Prairie Mountain Health	353	12.1	2,555	87.9	2,908
Interlake-Eastern RHA	104	13.0	694	87.0	798
Northern Health Region	17	8.4	185	91.6	202

In Table 6.5, crude post-colonoscopy CRC rates are reported by characteristics of physicians who performed the initial colonoscopy procedure. Rates were slightly higher for individuals who had a procedure performed by a family physician than for individuals who had a procedure performed by a specialist. Crude rates were higher for physicians with low volumes of GIE procedures, but the numbers are very small and should be interpreted with caution.

Table 6.5: Post-Colonoscopy Colorectal Cancer (CRC) and Colonoscopy-Detected CRC by Physician Characteristics, April 1, 1990 to December 31, 2016

Physician Characteristics	Post-Colonoscopy CRC		Colonoscopy-Detected CRC		Total
	Count	Percent	Count	Percent	Count
Physician Specialty					
Surgery	1,035	10.2	9,162	89.9	10,197
Family Medicine	170	14.2	1,028	85.8	1,198
Internal Medicine	258	10.7	2,146	89.3	2,404
Gastroenterology	275	10.0	2,466	90.0	2,741
Volume of Procedures					
Low	12	15.6	65	84.4	77
Medium	311	10.7	2,590	89.3	2,901
High	1,415	10.4	12,147	89.6	13,562

Figures 6.1 and 6.2 report OR estimates of post-colonoscopy CRC diagnosis associated with characteristics of patients and physicians, as well as across decades of the study observation period. After controlling for patient and physician characteristics, we found that the odds of an individual being diagnosed with a post-colonoscopy CRC were marginally greater between fiscal years 2000/01-2009/10 than between 2010/11-December 31, 2016 (OR 1.18; 95% CI 1.02-1.37; see Figure 6.1). However, there was no statistically significant difference in the odds for the earliest decade and the last decade (i.e., between 1990/91-1999/2000 and between 2010/11-December 31, 2016; OR 1.08; 95% CI 0.90-1.29).

Figure 6.1: Association of Post-Colonoscopy Colorectal Cancer (CRC) Diagnosis with Patient Characteristics, April 1, 1990 to December 31, 2016.

Odds ratios and 95% confidence intervals

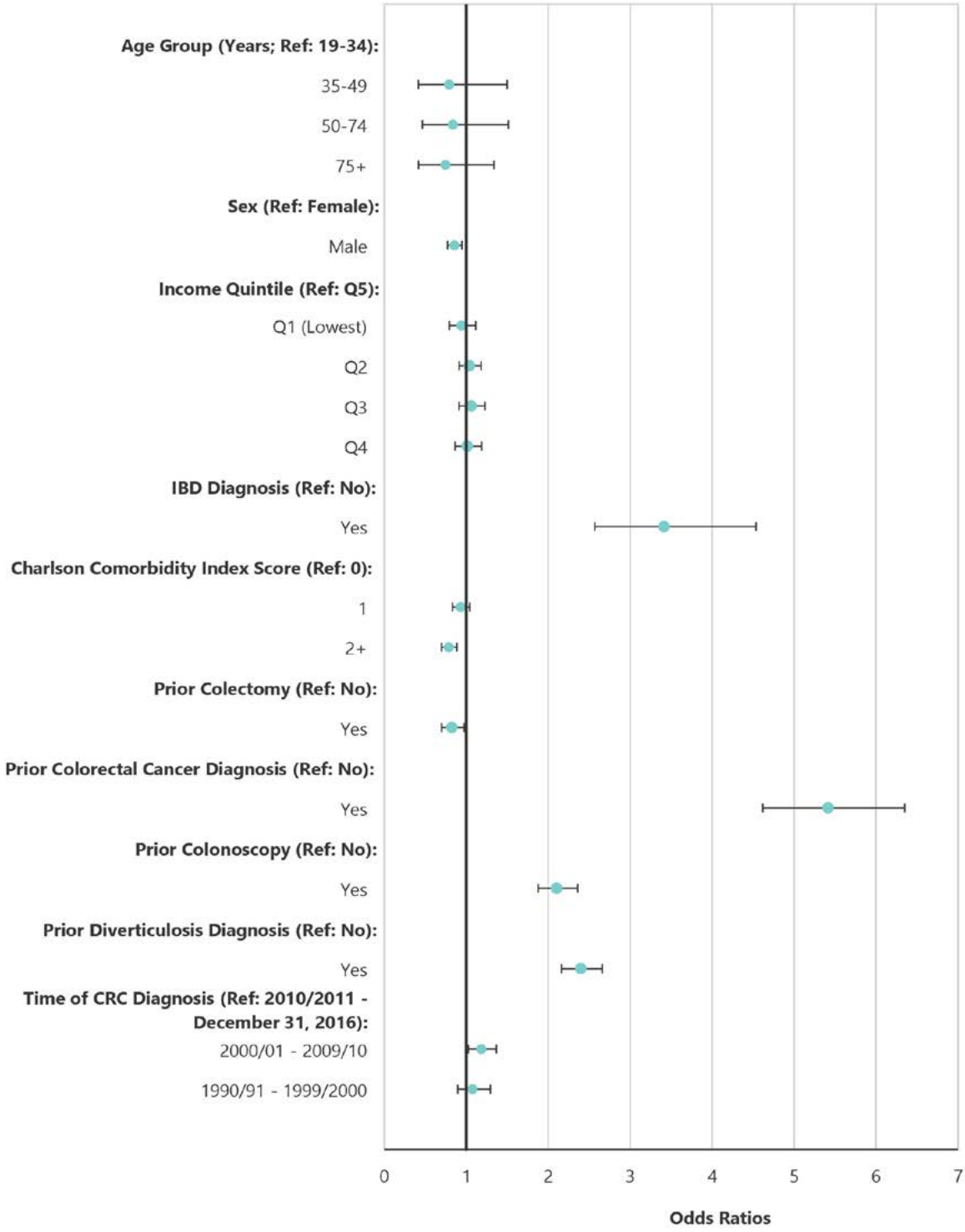
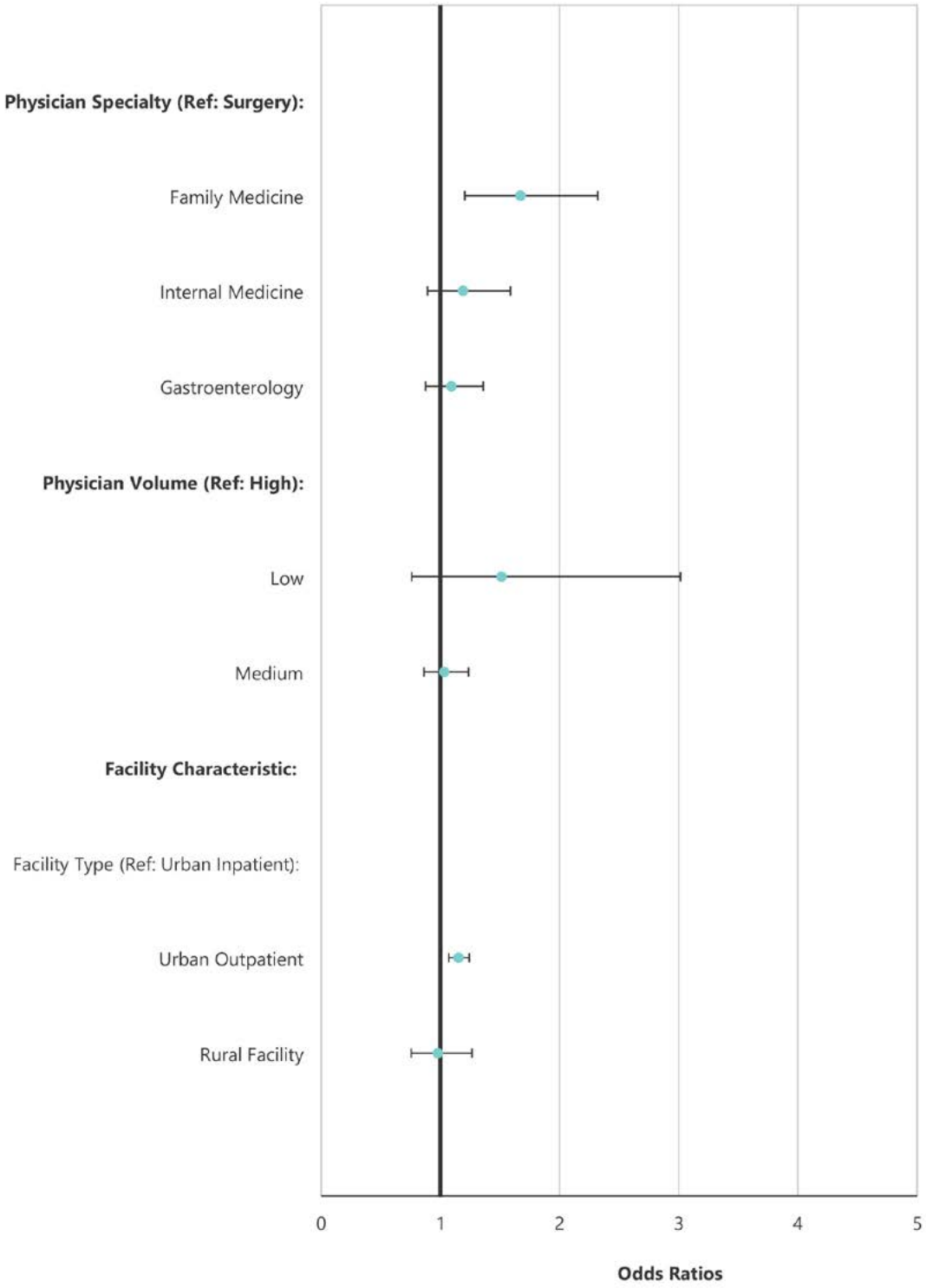


Figure 6.2: Association of Post-Colonoscopy Colorectal Cancer (CRC) Diagnosis with Physician and Facility Characteristics, April 1, 1990 to December 31, 2016.

Odds ratios and 95% confidence intervals



We found that multiple patient and physician characteristics were associated with the odds of a post-colonoscopy CRC diagnosis over the entire study period, as well as in the most recent period (i.e., from April 2010 to December 2016; see Figure 6.3 and 6.4). IBD diagnosis (OR 4.59; 95% CI 2.89-7.30), prior CRC (OR 4.08; 95% CI 3.15-5.28), prior colonoscopy (OR 1.90; 95% CI 1.52-2.37), diverticulosis (OR 2.48; 95% CI 2.03-3.03), and colonoscopy in urban outpatients (OR 1.96; 95% CI 1.65-2.33) were associated with increased odds of a post-colonoscopy CRC diagnosis over the entire study period in the analysis adjusted for other factors. There was no effect of colonoscopy volume or age greater than 75 (or lower than 50) in the adjusted analysis. For post-colonoscopy CRCs diagnosed in the most recent time period, the results were similar to the main analysis, other than that there was no significant difference by physician speciality, previous colectomy was associated with increased risk, and colonoscopy in urban outpatients was associated with higher risk for post-colonoscopy CRC between April 2010 and December 2016.

Figure 6.3: Association of Post-Colonoscopy Colorectal Cancer (CRC) Diagnosis with Patient Characteristics, April 1, 2010 to December 31, 2016.
Odds ratios and 95% confidence intervals

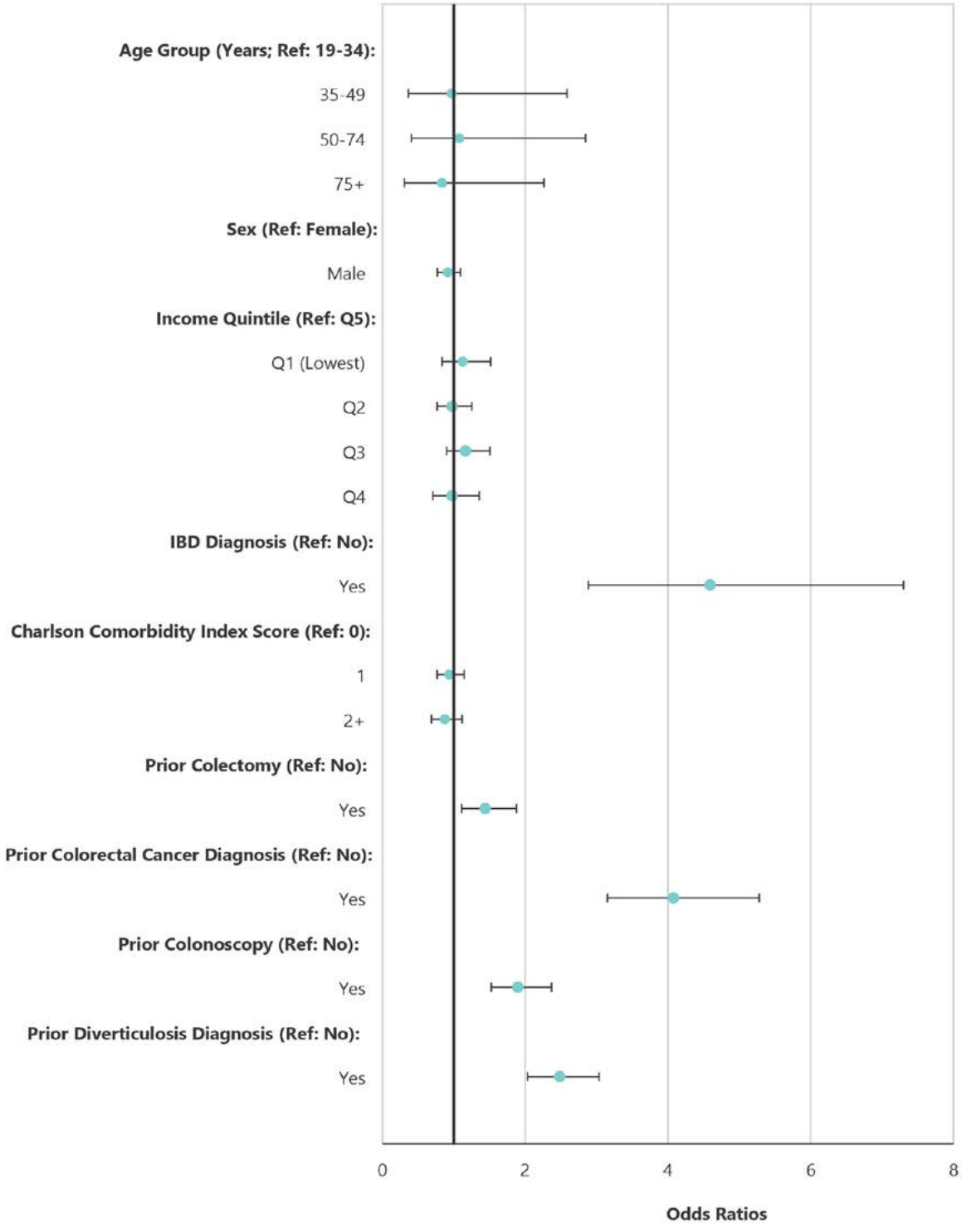
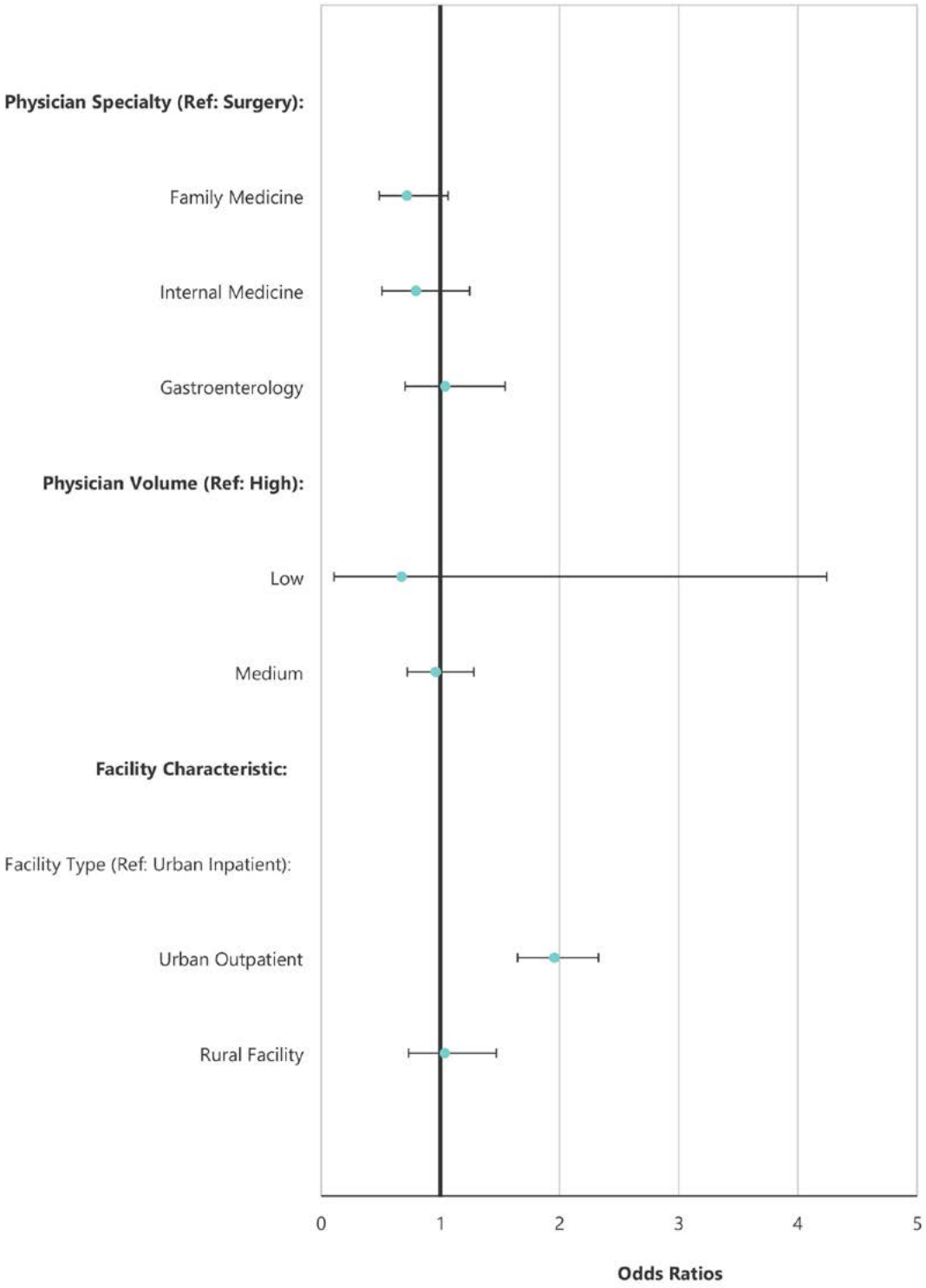


Figure 6.4: Association of Post-Colonoscopy Colorectal Cancer (CRC) Diagnosis with Physician and Facility Characteristics, April 1, 2010 to December 31, 2016

Odds ratios and 95% confidence intervals



Summary

In Manitoba, the rate of post-colonoscopy CRC diagnoses has not decreased over the years. Overall, colonoscopy by a family physician and in an urban outpatient setting is associated with post-colonoscopy CRC diagnosis but colonoscopy volume has no effect. An Ontario study also found that physician characteristics were associated with post-colonoscopy CRC, including physician speciality (defined as gastroenterologist, surgeon, and other) and setting (academic hospital, community hospital, nonhospital) [59]. However, the definition of specialty was different than those that were used in the current study and was based on data from just a five-year time period.

In our study, the strongest risk factors for post-colonoscopy CRC were patient comorbidities (diverticulosis, IBD, previous colonoscopy, previous CRC), which is also consistent with previous studies from other places [15,59]. We also found a consistent slightly higher risk among female patients. The results are reassuring in that no differences based on income quintile were observed.

At the same time, overall rates were higher than those that have been reported by other jurisdictions in comparable time periods. While reductions in rates for Manitoba have not yet occurred, other jurisdictions in Europe have reported large reductions over time (discussed earlier in the background section of this chapter). This suggests that concerted efforts for quality improvement, if implemented, have the potential to lead to large reductions in rates of post-colonoscopy CRC in Manitoba. The patient, physician, and facility factors we identified can be the focus of efforts to reduce post-colonoscopy CRC. These could include participation in colonoscopy performance improvement programs for endoscopy physicians, ensuring excellent bowel preparation for colonoscopies, especially for those with higher likelihood of having a post-colonoscopy CRC and colonoscopy for those with high risk factors such as previous CRC by higher performing colonoscopy physicians. For example, we reported very high post-colonoscopy CRC rates in those with IBD, similar to that reported previously (between 28% and 41%) [60]. Multiple reports suggest post-colonoscopy CRCs are preventable [14,15]. Therefore, efforts to reduce them in Manitoba can be successful. There is an urgency to initiate such efforts.

As reported in this analysis and in a recent meta-analysis, volume of colonoscopies performed is not an adequate marker to identify physicians with lower post-colonoscopy CRC rates [61]. Therefore, there is need to use other markers of higher performing colonoscopy physicians. For example, in studies from other places, rates of adenomatous polyps documented during colonoscopy identifies colonoscopy physicians who have lower rates of post-colonoscopy CRC, whereas physician experience (i.e., time in practice) does not [62]. It is therefore important that Manitoba start recording adenomatous polyp detection rates for colonoscopy physicians as one of the most reliable ways of identifying high performing colonoscopy physicians.

Chapter 7:
Summary, Conclusions and Recommendations

This report provides detailed information about the characteristics and outcomes of GIE procedures in Manitoba over more than three decades. Worldwide, both upper and lower GIE procedures have become increasingly common, due to greater emphasis within the healthcare system on population screening and surveillance, aging of the population, increasing population rates of cancer and chronic conditions such as IBD, and improvements in technologies. GIE procedures have become common medical procedures. Given their frequency, the associated healthcare system costs, and the potential for both benefits and risks to patients, it is timely to explore the use, associated wait times, and outcomes of GIE procedures in the Manitoba population.

To conduct this research, we relied on comprehensive population-based administrative health data housed at MCHP. We linked multiple de-identified databases to explore healthcare use patterns, wait times, and outcomes of GIE procedures, and examined a variety of patient, physician, and GIE procedure characteristics. A key innovation in this research was the linkage of central intake registry data from the Winnipeg RHA and Southern Health-Santé Sud to other administrative health databases to describe and test patient characteristics associated with wait times.

By linking physician billing claims with ColonCheck Screening Program data, which contains confirmed information about screening colonoscopies, we were able to ascertain that physician billing claims accurately capture information on colonoscopies, including the date of the colonoscopy. This is consistent with studies from Ontario and Alberta, as well as international studies, that have demonstrated the validity and reliability of administrative health data for identifying GIE procedures.

We emphasize that some important information about GIE procedures cannot be ascertained from administrative health data. The reason (i.e., indication) for a GIE procedure is not included in physician billing claims or hospital records. It is not possible to ascertain why a patient has a GIE procedure. As well, the findings from a GIE procedure are not captured in administrative data. Electronic health data that captures the indication for a GIE procedure and the results (i.e., findings) of an examination are essential to ensure that comprehensive information about GIE procedures is available to researchers, clinicians, and healthcare decision makers.

Summary of Key Findings

We found a substantial increase in rates of GIE procedures over the study years, which is consistent with previous national and international studies. A key finding was that these increases were not limited to a specific socio-demographic segment of the population. Rising rates of GIE procedures were observed for all age groups, males and females, health regions, and income groups. However, the magnitude of increase was greater for older individuals and in health regions outside of Winnipeg. In addition, disparities by income groups were evident in the last year of the study, suggesting higher use of GIE procedures for cancer screening and surveillance among the highest income group. This finding is consistent with previously-reported disparities in CRC screening by income groups in Manitoba.

Another key finding is that 25-30% of the population is likely to have at least one GIE procedure in a ten-year period, making it one of the most common procedures performed within Manitoba's healthcare system. This finding underscores the importance of gathering information about the use, wait times, examination findings, and outcomes of GIE procedures to inform decision making about the delivery of GIE procedure services. This should be done on an ongoing basis.

Substantial variations in GIE procedure rates were observed across the health regions. This is despite the fact that rates of cancer and chronic health conditions, such as IBD, do not show such large variations across the health regions. The differences in rates across regions remained when we excluded people with these medical conditions and did not count their GIE procedures. The differences also remained after we adjusted for any potential differences in age and sex characteristics of populations. Regional variations are a function of decisions made by healthcare providers about who should have a GIE procedure and how frequently GIE procedures should be performed. As well, regional variations will also be a result of decisions made by the province about providing services closer to home for non-Winnipeg residents, to reduce the inconvenience and cost associated with travel to receive services. The analyses we conducted also revealed substantial variations in the use of anesthesiologists for GIE procedures across the health regions, again reflecting differences in decisions of healthcare providers about the need for anesthesiologists with GIE procedures and availability of resources.

Triaging for GIE procedures, via lists of patients waiting for a procedure, appears to be working. Wait times were lowest for individuals with new cancer and IBD diagnoses and for urgent procedures. However, variations did exist in the duration of wait times for non-urgent procedures in the two regions of the province for which centralized patient intake registries exist. This latter finding may arise for a number of reasons, including a greater diversity of people from across the province having a GIE procedure in the Winnipeg RHA than in Southern Health-Santé Sud, availability of infrastructure (equipment and per capita number of endoscopy physicians), differences in rates of procedures in the two regions' populations, and assignment of level of urgency. Whether there is a difference in the indications of the procedures in the two regions will need to be investigated in a future study.

Potentially negative outcomes of GIE procedures and complications of GIE procedures are rare. However, the total number of individuals affected by negative outcomes is substantial because of the large number of procedures performed on an annual basis. Rates of potentially negative outcomes, including hospitalization, emergency department visits, and intensive care unit admissions, have not changed appreciably over time. This reflects the fact that people who are the sickest gain access to the healthcare system when they need it, and this essential access is not subject to variations over time in the same way that discretionary access is likely to vary. Mortality rates amongst those who have had a GIE procedure are higher than in the general population, but this is because GIE procedures are used, in part, to detect cancers and evaluate symptoms. Because the databases we used do not contain information of indications, we were not able to examine outcomes when the procedures were performed for screening among people who do not have symptoms.

Complication rates are more common in older individuals and those who have other risk factors such as comorbid health conditions. Hospitalizations for gastrointestinal perforations were more common among older individuals, those with greater numbers of comorbid health conditions, IBD, diverticulosis and when the procedure was performed by physicians who performed a low volume of GIE procedures. This finding is consistent with previous research.

Finally, we found no decrease in rates of post-colonoscopy CRC diagnosis over time, which is concerning. We identified a few provider/facility characteristics (colonoscopy by family physicians and urban outpatient facilities) and a large number of patient characteristics associated with post-colonoscopy CRC; these factors could be the focus of efforts to reduce post-colonoscopy CRC rates. These efforts could include encouraging the performance of GIE procedures by high performing or specialized endoscopy physicians for patients with a higher likelihood of developing a post-colonoscopy CRC, such as those with IBD. Multiple reports suggest the majority of post-colonoscopy CRCs are preventable [14,15]. Therefore, efforts to reduce them in Manitoba can be successful and are urgently needed.

Recommendations

The recommendations that arise from this report pertain to: (a) data availability and reporting, (b) training and feedback for physicians, and (c) potential approaches to address

increasing rates of GIE procedures. The high frequency of GIE procedures, large variations in rates of GIE procedures across Manitoba health regions, and variations in outcomes after GIE procedures by different endoscopy physicians create the urgent need for information and training to ensure consistent quality across all healthcare providers.

Recommendations about Data Availability and Reporting

Recommendation #1: Implement a Province-Wide Standardized Endoscopy Reporting System

To ensure the delivery of comparable, high-quality service across all regions of the province, we recommend implementation of a province-wide standardized endoscopy reporting system. Data from a reporting system can be used to investigate factors associated with variations in healthcare use rates, wait times, examination findings and outcomes across patients, physicians, and regions of the province.

The Canadian Association of Gastroenterology has published a listing of key elements of a standardized reporting system [63]. This listing includes elements pertaining to:

- identification of the procedure,
- timing,
- procedural personnel,
- patient demographics and history,
- indication(s) for procedure,
- comorbidities,
- type of bowel preparation,
- consent for the procedure,
- pre-endoscopic administration of medications,
- type and dose of sedation used,
- extent and completeness of examination,
- quality of bowel preparation,
- relevant findings and pertinent negatives,
- adverse events and resulting interventions,
- patient comfort during the procedure,
- diagnoses,
- endoscopic interventions performed,
- details of pathology specimens,
- details of follow-up arrangements,
- appended pathology report(s), and
- management recommendations (when available).

The Canadian Association of Gastroenterology has noted that “it is well established in the literature that a well-structured reporting system leads to improved completeness in endoscopy reports, and this can be achieved with a standardized electronic reporting system. The value of electronic reporting also lies in its ability to establish a method and process of increased standardization facilitating timely audits, benchmarking and data archiving.” (p. 289) [63].

In Manitoba, linkage of reporting system data to administrative health data could be used to investigate procedure attributes, such as the indications (i.e., reasons) for a GIE procedure, examination findings on GIE procedures, and their association with outcomes. Improved access by physicians to complete examination findings in a standardized synoptic reporting system will reduce the number of repeat procedures for a patient and lead to improvements in quality of care and reduction in healthcare delivery costs. A standardized reporting system can be used to monitor various aspects of the quality of procedures, such as procedure completion rates, quality of bowel preparation/examination, rate of detection of findings such as colonic polyps. Feedback of these findings to endoscopy physicians will lead to improvements in quality of care (including decrease in post colonoscopy CRC), an expectation based on results of GIE procedures quality assessment and improvement initiatives in other jurisdictions. Such a system will also help harmonize indications (i.e., reasons) for procedures in different health and thereby improve comparability of data.

Skilled expertise (for example, database manager, ongoing IT support, easy-to-read report production) is essential to process and report the data in standardized systems [64]. Such systems can provide more clinical details (i.e., more granular information) than is available in administrative data. Functional data systems are essential for audit and feedback to individual providers and regions as well as to determine the effect on any implemented change. Another consideration is the infrastructure required to follow up on findings from this report and improve GIE procedure delivery. This infrastructure includes, for example, personnel to review and extract information from medical records, conduct patient surveys, and prepare reports to share with physicians and managers.

Recommendation #2: Implement a Province-Wide Uniform Endoscopy Wait List System or Use Same Definitions in the Endoscopy Wait List Systems in all the Health Regions in the Province

We recommend that a standardized and comprehensive endoscopy wait list system be implemented in Manitoba and that this system be used to routinely produce wait time reports. Alternatively, the wait lists in different regions need to be harmonized to use the same definitions (e.g., for procedure urgency) so that wait times in different regions can be compared consistently and easily. In this study, in

which we examined wait times for Southern Health-Santé Sud and the Winnipeg RHA, we saw that the systems used in these regions have multiple wait time categories, but these categories are not exactly the same. Even more importantly, procedure indications are not captured in the electronic database of Southern Health-Santé Sud and are captured for only a proportion of cases in the Winnipeg RHA databases. It is essential that a wait list system capture indications for all procedures.

A province-wide system will help to ensure that GIE procedure wait times can be collected and reported in a consistent way, irrespective of where procedures are conducted. Currently it is impossible to determine if wait times for a particular indication are similar in the different parts of the province and/or whether they are within national recommended time intervals. Information on specific indications can be used to determine whether there are differences amongst providers in the selection of indications.

A uniform system is essential to ensure all individuals across the province have similar access to GIE procedures. Services and resources could potentially be redistributed when there is wide variation. Other jurisdictions have successfully used online booking system to prioritize patients and facilitate timely cancer diagnosis [65].

A single point of entry model (SEM) for all gastroenterology referrals was instituted in Calgary in 2005 and in Edmonton in 2008 [54]. The goal of the SEM is to improve access and wait times. A uniform intake system and associated database is essential to understand total demand and system bottlenecks. Others have identified critical success factors for SEM implementation and management [66].

Recommendation #3: Adopt and Routinely Report on Standardized Indicators for Key Outcomes

We recommend the routine use of quality measures to monitor and improve the quality of GIE procedure service delivery. More specifically, we recommend an emphasis on colonoscopy in these quality metrics because it is a common procedure and plays an important role in reducing the incidence of CRC and associated morbidity and mortality [67]. Measures commonly used in other jurisdictions include colonoscopy completion rates, complication rates, colorectal adenomatous polyps detection rates and documentation of use of procedures for accepted indications. These quality measures focus on procedure process; their use is intended to support reductions in the occurrence of disease outcomes such as post-colonoscopy CRC. In order to produce measures that are comparable across jurisdictions, standardized information is needed. This will enable assessments of Manitoba's performance relative to that of other provinces and countries.

We recommend that standardized measures of post-colonoscopy CRC be adopted. The World Endoscopy Organization has proposed standardized terminology and indicators for post-colonoscopy CRC [13]. This terminology and the associated measures can be adopted in Manitoba. Post-colonoscopy CRC has been identified as an important outcome indicator about the quality of care. Most diagnoses of CRC after colonoscopy are preventable. Regular monitoring of provincial post-colonoscopy CRC diagnoses can provide information on the success of initiatives to improve CRC screening and detection in Manitoba.

In studies from other jurisdictions, rates of adenomatous polyps documented during colonoscopy identify endoscopy physicians who have low rates of post-colonoscopy CRC [68,69]. Following normal colonoscopy by endoscopy physicians with high volumes of GIE procedures, the risk of CRC consistently remained low for more than 17 years, eliminating the need for repeat colonoscopy in most patients undergoing colonoscopy with these physicians [70]. In addition to colonoscopy polyp findings, endoscopy physician performance is an important contributor to CRC risk after colonoscopy [71]. Therefore, it is important to collect and report on adenomatous polyps detection rates for endoscopy physicians. This has become a key quality process measure used in many jurisdictions [72]. The British National Health Service, a leader in ensuring high quality of endoscopy services, uses the following colonoscopy quality indicators: adenoma polyp detection rate, polyp detection rate, measures of total adenoma detection, colonoscopy withdrawal time, caecal intubation rate, rectal retroversion rate, polyp retrieval rate, mean sedation doses, patient comfort scores, bowel preparation quality and adverse event incidence [72]. Manitoba has the opportunity to follow the lead of other jurisdictions.

Recommendation #4: Collect and Report on Patient-Reported Outcome Measures or Patient-Reported Experience Measures for GIE Procedures

We recommend the routine collection of patient-reported outcome measures (PROMs) and/or patient-reported experience measures (PREMs) to complement objective measures of GIE procedure outcomes, such as potentially adverse events. High-quality, patient-centred care is a priority for Manitoba's health system as it undergoes transformation. PROMs and PREMs are key metrics in a patient-centred care environment. They can provide invaluable insights about opportunities to improve the delivery of care [73].

Examples of patient-reported measures that have been collected in prior research about screening colonoscopies include experiences of pain during and after the procedure, level of anxiety before and after the procedure, level of satisfaction with the information provided before the procedure, level of satisfaction with healthcare facilities, attitudes of staff, and the way that test results are explained [73]. A previous Winnipeg study found that factors associated with the overall rating of the GIE procedure visit included information provided pre- and post-procedure, wait time

before and on the day of the procedure visit, and satisfaction with the physical environment [36]. Information on side affects associated with having a GIE procedure could also be collected, including nausea and vomiting, abdominal pain and cramps, soreness, and sleep disturbances.

PROMs and PREMs are also important to assess when there are changes in the delivery of services. For example, if anesthesiologists are used less often for GIE procedures in the future, it will be important to ensure that there is no worsening of patient experiences (e.g., pain during the procedure) associated with these changes. If there is, actions such as retraining of involved endoscopy physicians and nurses may be necessary. Similarly, whenever there are attempts to improve colonoscopy completion, colonoscopy preparation, and polyps detection, efforts to avoid negative impacts on patient perceptions about their care may be warranted.

Previous research has shown it is important to assess anxiety towards specific components of the endoscopy process and that unclear instructions are a driver of high procedure anxiety [74]. However, a recent systematic review about the measurement of anxiety for patients having a colonoscopy or flexible sigmoidoscopy identified a diverse range of available measurement instruments [75]. This diversity of instruments may make it challenging to know which instrument to adopt.

Recommendations about Training and Feedback for Physicians

Recommendation #5: Create Processes for Audit and Feedback and Root Cause Analysis

We recommend the development of processes for conducting audits and providing feedback about GIE procedures. In particular, we recommend focusing on those that result in patient complications such as bowel perforation and/or bleeding, that lead to a post-colonoscopy CRC diagnosis and that result in delayed diagnosis of medical conditions including cancers. Root cause analysis is an important component of this process. Previous research has found that audit and feedback is associated with improvements in adenoma detection rates at colonoscopy [76]. Educational interventions directed at practicing endoscopy physicians lead to improved adenoma detection rates and colonoscopy quality outcomes [77–79]. Higher adenoma detection rates have led to reductions in post-colonoscopy CRCs [68,69] and decreased need for repeat procedures for those with normal colonoscopy. Hence, such initiatives should be implemented for all physicians who perform GIE procedures in Manitoba.

With respect to post-colonoscopy CRC, we have noted the importance of audit and feedback because many of these diagnoses are likely to be preventable. An initial focus in the audit process could be on patient groups at increased risk. As suggested by others [13], root cause analysis of each case of post-colonoscopy CRC should be performed. This analysis could be undertaken by an existing standards and quality committee in Manitoba.

When implementing audit and feedback, we emphasize the need to consider their underlying principles [80,81]. Many initiatives to improve provider performance fail because quality improvement interventions are sub-optimally implemented or inadequately evaluated [82,83].

Wait times for a substantial minority of individuals diagnosed with serious conditions such as cancer or IBD are long. Indications for urgent and semi-urgent procedures need to be re-evaluated. In addition, root cause analysis for a sample of cases with prolonged wait times should be undertaken to examine reasons for delay. While it might take some time to collect information about indications, sampling for those with prolonged wait times can be a short-term measure to determine factors that can be acted upon soon.

Recommendation #6: Follow-Up on Regional Variations in Anesthesiology Use and Ensure All Endoscopy Providers Undergo Training in the Administration of Endoscopic Sedation

We recommend follow-up discussions with endoscopy providers to explore the reasons for marked regional variation in anesthesiology use and for the potential for reduced use in regions with high use. However, any efforts to reduce anesthesiology use must be accompanied by assessment of impact on patient outcomes.

Potential benefits of anesthesia use involving the sedative agent propofol have been reported to be higher patient satisfaction and shorter recovery times after endoscopy [52]. Patient satisfaction and recovery times should be assessed in a sample of the procedures in the regions with high and low anesthesiology use.

Leads from different units should also discuss potential reasons for the variation documented, including whether some use can be decreased to decrease costs of care. A provincial advisory committee should be established to develop a list of provincial indications for anesthesia use. Members of our advisory committee who reviewed the results that demonstrated marked variation suggested that care maps might inform the need for anesthesia. Given that there are no existing policies or care maps for anesthesiology use for GIE procedures, there is an opportunity to explore the development of polices and practices for anesthesiology use across the provinces. However, in doing so, it is important to allow for regional variation as it may be warranted.

A recent review from Ontario that summarized the use of sedation in routine hospital-based colonoscopies concluded: “There were no statistically significant differences in rates of hospital admission, major complications (death, aspiration, splenic injury, myocardial infarction, stroke), polyp detection, caecal intubation,

or patient satisfaction between anaesthesia and non-anaesthesia provider-administered sedation; however, results of studies reporting aspiration and bleeding rates were conflicting. There were no differences in cardiorespiratory events between patients sedated with propofol versus traditional sedatives. There were small improvements in patient satisfaction and recovery time with propofol versus midazolam and fentanyl" (pp. 3–4) [84]. Importantly, the authors recommended that all endoscopists should be able to perform colonoscopy with moderate sedation, that an endoscopist and a single trained nurse are sufficient for performing colonoscopy with moderate sedation, and that anesthesia-provided deep sedation be used for select patients.

However, there is a wide variation in anesthesia use among different providers and jurisdictions [85–88] and increasing use elsewhere also [89,90]. A recent review concluded "propofol sedation is becoming more popular because its unique pharmacokinetic properties make endoscopy almost painless, with a very predictable and rapid recovery process. There is controversy as to whether propofol should be administered only by anesthesia professionals (monitored anesthesia care) or whether properly trained non-anesthesia personnel can use propofol safely via the modalities of nurse-administered propofol sedation, computer-assisted propofol sedation or nurse-administered continuous propofol sedation. The deployment of non-anesthesia administered propofol sedation for low-risk procedures allows for optimal allocation of scarce anesthesia resources, which can be more appropriately used for more complex cases. This can address some of the current shortages in anesthesia provider supply, and can potentially reduce overall healthcare costs without sacrificing sedation quality" (p. 456) [91].

Changes in practice to reduce wide regional variations in the use of anesthesia should include concomitant monitoring of PREMs and PROMs. It is also important to remember that there is no controversy for use of anesthesia for long and complicated procedures. As recommended in recent guidelines, it is important that in all regions "providers undergo specific training in the administration of endoscopic sedation and possess the skills necessary for the diagnosis and management of sedation-related adverse events, including rescue from a level of sedation deeper than that intended" (p. 334) [88].

Recommendation #7: Assess Indications for Procedures and Explore Alternative Testing Options

We recommend the exploration of approaches to reduce the rate of increase in GIE procedures.

The American Society for Gastrointestinal Endoscopy appropriateness guideline and the European Panel on Appropriateness of Gastrointestinal Endoscopy guidelines have recommended appropriate indications [92]. Inappropriate indications, in comparison to these guidelines, have been reported by others in as high as 30% of cases [93]. Others have commented: "Many upper gastrointestinal (GI) endoscopies worldwide are performed for inappropriate indications…Unfiltered open-access referrals feed upper GI endoscopy overuse" (p. 178) [50]. Previous research has reported marked overuse (and underuse) of GIE procedures for indications such as follow-up of people with colorectal polyps. Both healthcare providers and patients need to be reminded of the most current relevant guidelines. Other jurisdictions have reported reductions in overuse with education initiatives [94]. Guidelines, which list reasons where endoscopy is not usually helpful and therefore not indicated should be disseminated to endoscopy and non-endoscopy physicians. Allowance will of course need to be made for individual cases, but overall indications should be similar to those in the guidelines and across the province for patients referred from primary care. A recent review concluded, "Several strategies may decrease overuse of endoscopy, including careful attention to risk stratification when choosing patients to screen, adherence to guidelines for surveillance intervals for colonoscopy, the use of quality indicators to identify outliers in endoscopy utilization, and education on appropriate indications and the risks of overuse" (p. 1993) [94].

Choosing Wisely Canada, which focuses on actions to reduce unnecessary tests and treatments in healthcare, recommends that physicians "avoid performing an endoscopy for dyspepsia without alarm symptoms for patients under the age of 65 years" and "avoid performing a colonoscopy for constipation in those under the age of 50 years without family history of colon cancer or alarm features" [95]. We recommend highlighting these recommendations to healthcare providers and patients.

In addition, there are tests that can be used in place of GIE procedures. The Fecal Immunochemical Test (FIT) is now recognized as a better CRC screening test than guaiac FOBT (currently used for testing in Manitoba) and is much more acceptable to patients and physicians as a CRC screening test, as an alternative test to colonoscopy [96–99]. We are aware that the province is already planning to implement FIT, which is now available in all other provinces in Canada, in some for over a decade. Though FIT may increase the need for colonoscopy initially (as more FITs are positive than guaiac FOBTs), over the long term this transition will almost certainly lead to a reduction in colonoscopy use for CRC screening. It is also being investigated for use for evaluation of symptoms [100]. However, FIT is not currently recommended to investigate symptoms and will therefore have limited impact on current GIE procedures wait list patients for whom an investigation of symptoms has been recommended.

Fecal calprotectin is an established test that can be used instead of colonoscopy to investigate inflammation in the large bowel due to IBD (a major reason for colonoscopy

among people with symptoms such as abdominal pain) as well as to monitor treatment of IBD [101]. It is “a potentially reliable negative test to be used in primary care settings for patients with symptoms suggestive of IBD” (p. 1176) [102].

Opportunities for Further Research

While this report has provided a substantial amount of information about GIE procedures, several opportunities for further research exist. First, there is opportunity to study the use and outcomes of other GIE procedures, particularly specialized procedures such as endoscopic retrograde cholangiopancreatography (ERCP), endoscopic ultrasound, and balloon enteroscopy. Some of these procedures, such as ERCP, have substantially higher rates of complications, which is why they are important to consider.

Second, the impact of quality improvement and education initiatives that are implemented in Manitoba affords an opportunity for further research. Provincial investments in quality and standardization improvement efforts should be accompanied by rigorous systematic examination of the effects of such efforts and interventions.

Although indications are not captured in administrative data, linkage of administrative data to other data sources could be used to examine GIE procedures for selected indications. For example, linkage of ColonCheck program data to administrative data could facilitate exploration of procedure utilization for individuals who are being screened for CRC. Similarly, GIE procedures for individuals with a confirmed clinical diagnosis of IBD could be examined by linkage with clinical registry data.

Conclusions

The recommendations we have made with respect to GIE procedure provision and monitoring can be viewed broadly as quality of care improvement initiatives. These initiatives can lead to reductions in use of healthcare services and cost savings for health regions, as well as improved patient outcomes and satisfaction with care. These initiatives require consideration of care providers, facilities and equipment [103]. Quality improvement requires the right mix of people and infrastructure to ensure success. This infrastructure includes, for example, personnel to review and extract information from medical records, conduct patient surveys, and prepare reports to share with physicians and managers. This infrastructure also includes high-quality databases from which information can be readily extracted and shared, while preserving the privacy of patient information.

Others have concluded that an ongoing increase in endoscopy use is unavoidable [104]. Hence, it may be impossible to halt the increasing numbers of GIE procedures in Manitoba. The emphasis must be on slowing the increase, ensuring optimal use, monitoring patient outcomes, improving the quality of services delivered and reducing variations amongst physicians in the provision of services.

Programs in other health systems may point to directions that can be taken in Manitoba. For example, the British National Health Service has been the leader in ensuring high quality of endoscopy services. Manitoba could follow their lead to examine opportunities to improve GIE procedure service delivery in Manitoba [72]. Colonoscopy quality indicators (adenoma detection rates, polyp detection rate, colonoscopy withdrawal time, caecal intubation rate, rectal retroversion rate, polyp retrieval rate, mean sedation doses, patient comfort scores, bowel preparation quality and adverse event incidence) are being followed in that jurisdiction, along with measures of total adenoma detection.

In 2016, Alberta launched the Digestive Health Strategic Clinical Network (www.ahs.ca/dhscn) to “improve the quality of care, analyze and eliminate unwarranted variation in care across the province and optimize cost efficiencies associated with caring for patients with digestive diseases” [105]. The Digestive Health Strategic Clinical Network is reportedly responsible for “engendering innovation in the delivery of healthcare in line with six dimensions of quality of care: acceptability, accessibility, appropriateness, effectiveness, efficiency and safety”. Findings from our report support the need for efforts to achieve similar goals in Manitoba.

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University of Manitoba
Max Rady College of Medicine
Rady Faculty of Health Sciences

408-727 McDermot Avenue
Winnipeg, Manitoba, Canada
R3E 3P5

Tel: (204) 789-3819
Fax: (204) 789-3910
Email: reports@cpe.umanitoba.ca

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