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Longitudinal Rates of Colon Cancer Screening Use in Winnipeg, Canada: The Experience of a Universal Health-Care System with an Organized Colon Screening Program

Kathleen M. Decker, PhD1,2,3, Alain A. Demers, PhD3, Zoann Nugent, PhD1,4, Natalie Biswanger, BSc1 and Harminder Singh, MD, MPH1,4,5

OBJECTIVES: We examined trends in colorectal cancer (CRC) screening (fecal occult blood test (FOBT), colonoscopy, and flexible sigmoidoscopy (FS)) and differences in CRC screening by income in a population with an organized CRC screening program and universal health-care coverage.

METHODS: Individuals who had an FOBT, colonoscopy, or FS were identified from the provincial Physician Claims database and the population-based colon cancer screening registry. Trends in age-standardized rates were determined. Logistic regression was performed to explore the association between CRC screening and income quintiles by year.

RESULTS: Up-to-date CRC screening (FOBT, colonoscopy, or FS) increased over time for men and women, all age groups, and all income quintiles. Up-to-date CRC screening was very high among 65- to 69- and 70- to 74-year-olds (70% and 73%, respectively). There was a shift toward the use of an FOBT for CRC screening for individuals in the lower income quintiles. The disparity in colonoscopy/FS coverage by income quintile was greater in 2012 than in 1995. Overall, there was no reduction in disparities by income in up-to-date CRC screening nor did the rate of increase in up-to-date CRC screening or FOBT use change after the introduction of the organized provincial CRC screening program.

CONCLUSIONS: CRC screening is increasing over time for both men and women and all age groups. However, a disparity in up-to-date CRC screening by income persisted even with an organized CRC screening program in a universal health-care setting.

SUPPLEMENTARY MATERIAL is linked to the online version of the paper at http://www.nature.com/ajg

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Colorectal cancer (CRC) incidence in Canada has been declining since 2000 at least partly due to the removal of precancerous polyps identified through screening (1). The most commonly used CRC screening tests include fecal occult blood tests (FOBTs), flexible sigmoidoscopy (FS), and colonoscopy. In 2001, the National Committee of Health Canada recommended CRC screening using an FOBT test every 2 years for individuals aged 50–74 years (2). In 2004, the Canadian Association of Gastroenterology recommended an FOBT every 2 years, FS every 5 years, or colonoscopy every 10 years (3).

Until recently, CRC screening in Canada was provided opportunistically, which relies on the recommendation and provision of the screening test by a health-care provider. Since 2007, all Canadian provinces have launched, piloted, or are planning population-based CRC screening programs (4). In August 2007, the province of Manitoba started a population-based, organized...
CRC screening program (ColonCheck) for average risk individuals 50–74 years of age using the higher sensitive FOBT Hemocult II SENSA. The FOBT and instructions are mailed to eligible individuals and also distributed by health-care providers. One of the primary aims of organized screening is to reduce the impact of socioeconomic status disparities that can occur with opportunistic screening (5). Disparities in cancer screening participation by income level have been shown in several studies in countries both with and without universal health-care insurance (6–10). However, data are limited on the impact of organized screening on income groups. To date, up-to-date CRC screening over time in Canada has only been evaluated in Ontario (11). Moreover, the Ontario screening program requires individuals to visit their health-care providers to obtain an FOBT, a strategy not employed by most other CRC screening programs. We examined CRC screening time trends and differences in screening by income in a province with an established, organized CRC screening program.

Methods

Data sources

Four data sources were used: the Manitoba Health Population Registry, the Manitoba Health Medical Claims database, the ColonCheck registry, and Statistics Canada 2006 census data. Manitoba Health, the publically funded provincial health insurance agency, provides comprehensive health coverage for all hospitalizations, procedures, tests, and physician visits. The Population Registry contains demographic, migration, and vital status information. Unique personal health identification number for provincial residents allows the linking of provincial databases and tracking of individuals’ longitudinal health-care utilization.

Medical Claims was used to identify individuals who had non-ColonCheck FOBT, colonoscopy, or FS from 1 April 1984 to 31 December 2012. Medical Claims is generated by claims filed by physicians or laboratories for payment of services. The Population Registry and Medical Claims have been previously validated for accuracy and used to study many health outcomes (12,13). The ColonCheck Registry was used to identify individuals who completed a ColonCheck FOBT. Statistics Canada 2006 census data were used to estimate household income (categorized into quintiles from Q1, the lowest income quintile to Q5, the highest income quintile) based on the dissemination area (DA) of residence as a proxy measure for individual-level income.

Study population

The province of Manitoba has a population of ~1.27 million (in 2013). Two-thirds of the population lives in the capital city of Winnipeg. This study included all individuals 50–74 years of age who lived in Winnipeg from 1984 to 2012. Individuals who lived outside of Winnipeg were excluded from the analyses because many FOBTs in rural and northern areas of Manitoba are not registered in the Medical Claims database.

Outcomes

Rates of up-to-date CRC screening coverage, FOBT coverage, and colonoscopy/FS coverage were determined by sex, age group, and income quintile. Up-to-date CRC screening coverage was defined as any FOBT in the previous 2 years, a FS in the previous 5 years,

### Table 1. Characteristics of the population eligible for CRC screening in 1995, 2001, 2007, and 2012

| Characteristics | 1995 (n=131,751) | 2001 (n=145,131) | 2007 (n=167,159) | 2012 (n=192,285) |
|----------------|-----------------|-----------------|-----------------|-----------------|
| Gender, %      |                 |                 |                 |                 |
| Men            | 44.2            | 44.9            | 45.3            | 46.4            |
| Women          | 55.8            | 55.1            | 54.7            | 53.6            |
| Age group (years), % |       |                 |                 |                 |
| 50–54          | 18.4            | 22.5            | 22.0            | 21.2            |
| 55–59          | 18.2            | 21.4            | 23.8            | 23.1            |
| 60–64          | 20.5            | 18.7            | 21.9            | 22.3            |
| 65–69          | 21.1            | 18.8            | 17.3            | 19.1            |
| 70–74          | 21.6            | 18.7            | 15.1            | 14.3            |
| Income quintile, % |           |                 |                 |                 |
| Q1: lowest     | 12.2            | 11.4            | 13.2            | 13.6            |
| Q2             | 18.7            | 14.0            | 16.1            | 16.1            |
| Q3             | 18.6            | 19.0            | 18.6            | 17.6            |
| Q4             | 17.7            | 21.2            | 22.5            | 23.1            |
| Q5: highest    | 14.8            | 24.6            | 26.1            | 26.8            |
| Missing        | 18.2            | 9.8             | 2.6             | 2.8             |

CRC, colorectal cancer; Q1, income quintile level 1 (lowest); Q2, income quintile level 2; Q3, income quintile level 3; Q4, income quintile 4; Q5, income quintile 5 (highest).
and/or a colonoscopy in the previous 10 years. FOBT coverage was defined as any FOBT in the previous 2 years and colonoscopy/FS coverage as a colonoscopy in the previous 10 years and/or a FS in the previous 5 years.

**Statistical analysis**

Trends over time, the average percentage change, the average annual percentage change, and 95% confidence intervals were calculated using the Joinpoint Regression program version 4.1.1.1 (Surveillance Epidemiology and End Results, National Cancer Institute, Bethesda MD). Joinpoint regression is a statistical method that describes changing trends over successive segments of time. The average annual percentage change is a summary weighted measure of the trend over the entire time period. Rates were age standardized to the 2001 Canadian population.

Logistic regression was performed to assess differences in CRC screening between 1996 and 2012, stratified by income quintile and adjusted for sex and age, as CRC screening rates increase with age and are higher for women compared with men (10,14). Logistic regression was also performed to explore the association between CRC screening and income quintile in each study year. SAS version 9.2 (SAS Institute, Cary, NC) was used for data management and statistical analyses.

This study was approved by the University of Manitoba’s Health Research Ethics Board and Manitoba Health’s Health Information and Privacy Committee.

**Results**

The number of individuals eligible for CRC screening increased from 131,751 in 1995 to 192,285 in 2012 (Table 1). The percentage of the population in different age groups and income quintiles remained relatively stable over time. Overall, up-to-date CRC screening increased steadily over time from 20.5% in 1995 to 56.9% in 2012 (Figure 1, Table 1). The average annual percentage change from 1995 to 2012 was 7.0% for men and 6.8% for women.

| Year | Men | Women |
|------|-----|-------|
| 1994 | 0   | 0     |
| 1995 | 10  | 20    |
| 1996 | 20  | 30    |
| 1997 | 30  | 40    |
| 1998 | 40  | 50    |
| 1999 | 50  | 60    |
| 2000 | 60  | 70    |
| 2001 | 70  | 80    |
| 2002 | 80  | 90    |
| 2003 | 90  | 100   |

**Figure 1.** Age-standardized up-to-date CRC screening coverage rates for men and women, Winnipeg, Manitoba, 1995–2012. CRC, colorectal cancer.

| Year | Men | Women |
|------|-----|-------|
| 1995 | 20.5 | 21.4 |
| 2001 | 29.1 | 30.5 |
| 2007 | 43.4 | 45.7 |
| 2012 | 56.9 | 59.2 |

| Age group (years) | 1995 | 2001 | 2007 | 2012 |
|-------------------|------|------|------|------|
| 50–54             | 15.2 | 21.5 | 32.5 | 43.2 |
| 55–59             | 18.5 | 28.1 | 40.8 | 53.5 |
| 60–64             | 21.8 | 31.7 | 49.3 | 61.4 |
| 65–69             | 23.7 | 34.6 | 53.5 | 69.7 |
| 70–74             | 25.2 | 37.0 | 54.3 | 73.2 |

| Income quintile | 1995 | 2001 | 2007 | 2012 |
|-----------------|------|------|------|------|
| Q1: lowest      | 14.7 | 21.1 | 32.8 | 45.4 |
| Q2              | 19.2 | 24.3 | 38.5 | 51.7 |
| Q3              | 20.8 | 30.0 | 43.6 | 56.4 |
| Q4              | 23.6 | 30.8 | 46.9 | 59.9 |
| Q5: highest     | 24.3 | 34.3 | 49.0 | 61.9 |

CRC, colorectal cancer; Q1, income quintile level 1 (lowest); Q2, income quintile level 2; Q3, income quintile level 3; Q4, income quintile 4; Q5, income quintile 5 (highest).
However, the rate of increase slowed down in 2009 (Men: pre-2009 average percentage change 9.8%, post-2009 4.6%; Women: pre-2009 average percentage change 9.0%, post-2009 4.1%).

Up-to-date CRC coverage increased over time for men and women, all age groups, and all income quintiles (Table 2). By 2012, up-to-date coverage was 69.7% and 73.2% for individuals 65–69 and 70–74 years of age, respectively. Additional data describing FOBT and colonoscopy/FS coverage are available in Supplementary Table 1 online. The age-standardized rate of up-to-date, FOBT, colonoscopy/FS coverage increased for all income quintiles (Figure 2). The change in FOBT coverage was highest for Q1 and lowest for Q5 and leveled off for all income quintiles in 2010. Colonoscopy/FS coverage by income quintile diverged over time: beginning in 2007, there was a slight increase in the rate of colonoscopy/FS coverage (i.e., slope) for individuals in Q5 and a slight decrease in the rate for individuals in Q1 (average percentage change, average annual percentage change, and 95% confidence interval are available in Supplementary Table 2).

There was little variation among the income quintiles in odds ratio for up-to-date coverage between 2012 and 1996 (Table 3). Odds ratios by year are available in Supplementary Table 3. However, the odds ratios for FOBT coverage (2012 vs. 1996) were highest for Q1 and for colonoscopy/FS coverage highest among Q5. The odds of up-to-date coverage comparing income quintiles Q1–Q4 with Q5 (reference) remained almost uniform from 2004 onward (Figure 3). However, the difference for FOBT for individuals in Q1–Q3 vs. Q4 was less pronounced in 2012 than in 1995 or 2004. The change in the odds ratios for colonoscopy/FS coverage suggested a widening difference by income quintile (Figure 3), so that by 2012 the likelihood of an individual in Q1–Q4 having had a colonoscopy/FS was lower than in previous years.

Discussion
We found that up-to-date CRC screening increased significantly from 1995 to 2012. These rates, particularly for older individuals, are among the highest reported in Canada, comparable to high rates reported from elsewhere, and close to the goal of 80% coverage by 2018 set by the US National Colorectal Cancer Round Table (15–19). FOBT coverage also increased and by 2012 approached the Canadian target of 60% (4). Importantly, individuals in the lowest income quintile showed the greatest increase in FOBT coverage. Nevertheless, individuals with lower income levels continued to be less likely to be screened with no reductions in up-to-date coverage disparity. We also did not observe a change in the increase in the rate of up-to-date or FOBT coverage after the introduction of the provincial CRC screening program.

As there are no deductibles or co-payments for health-care visits or investigations in Manitoba, there are no direct economic barriers for CRC screening in the province. Other potential barriers include a lack of knowledge about the importance of CRC screening, cultural barriers, and new immigration (14,17,20–23). Providing CRC screening as part of an organized program should take care of some barriers by addressing all five dimensions of service accessibility (approachability, acceptability, availability and accommodation, affordability, and appropriateness) (24). However, a study that examined trends in FOBT participation found
the increase in FOBT coverage among individuals in the lowest income quintile may be due to the screening program mailing an FOBT to eligible individuals. Nevertheless, it remains a matter of concern that the groups with higher CRC mortality (i.e., lower a similar lack of enhanced increase after the start of Ontario’s organized CRC screening program (11). It is possible that, without these organized screening programs, there might have been a more pronounced leveling off of FOBT coverage. In addition, the increase in FOBT coverage among individuals in the lowest income quintile may be due to the screening program mailing an FOBT to eligible individuals. Nevertheless, it remains a matter of concern that the groups with higher CRC mortality (i.e., lower
income) have persistently lower CRC screening rates, with minimal reduction in overall CRC screening disparities so far (25). It is likely that more targeted efforts are required to improve CRC screening for low-income individuals.

Although colonoscopy/FS coverage increased for all age groups, the disparity between income groups increased over time. During most of the study years, organizations from both Canada and the US recommended colonoscopy every 10 years or FS every 5 years as an option for CRC screening (3,26,27). It is possible that individuals with higher income levels were more aware of these recommendations. The shift toward the use of an FOBT rather than colonoscopy/FS for individuals in the lower income quintiles is another potential explanation for the increase in colonoscopy/FS coverage disparity by income quintile over time. However, given that only one-third of individuals were covered by colonoscopy/FS by 2012, a massive increase in resources would be required to preferentially promote and provide endoscopic-based CRC screening to the entire population. Increasing CRC screening using an FOBT, or the potentially more effective fecal immunochemical test, is a more feasible and a practical approach, especially given current budgetary constraints. Importantly, any implications of preferential endoscopy-based CRC screening among the higher socioeconomic status will only be known after the randomized controlled trials comparing colonoscopy with FOBT are published (28).

The results of this study should be interpreted in the context of its strengths and limitations. Unlike previous studies that used survey data, which are subject to recall and response bias, this study used data from several previously validated administrative health databases (12,13,29,30). This is an observational study and therefore may be prone to bias from unrecognized or unmeasured factors. As some FOBTs performed in rural and northern Manitoba are not captured by Medical Claims, the analysis was limited to Winnipeg, which may limit the generalizability of the results. We were not able to distinguish between colonoscopies/FS performed for diagnostic purposes vs. those performed for the screening of asymptomatic individuals—prior studies suggest that the indication for endoscopy cannot be reliably discerned in higher administrative health-care data or even from reports by patients (31). We used DA-level income as a proxy measure for individual-level income, which may have attenuated the association between individual income and CRC screening due to the misclassification of a few individual’s actual income. However, DAs are the smallest unit for which census data are collected (2,100 DAs in Manitoba with ~700 persons per DA), are more homogeneous than other units, and prior provincial studies have shown a substantial correlation between a person’s neighborhood (DA) average income and a self-reported household income (32–35). Finally, in 1995, more individuals were missing income data because, at that time, census data were reported by an enumeration area, and 29.6% of enumeration areas in Manitoba were below the minimum required for reporting and thus suppressed (36). This improved in 2001 when DAs were implemented.

In conclusion, in a universal health-care setting with an organized screening program, CRC screening increased over time, although disparities by income persisted. Tailored CRC screening materials may be required to improve CRC participation. Resource implications dictate that FOBT be the preferred test for population-based CRC screening in Canada.

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CONFLICT OF INTEREST
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DISCLAIMER
The results and conclusions presented are those of the authors. No official endorsement by Manitoba Health is intended or should be inferred.

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