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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

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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.**

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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

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CRC screening program (ColonCheck) for average risk individuals 50–74 years of age using the higher sensitive FOBT Hemoccult 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.

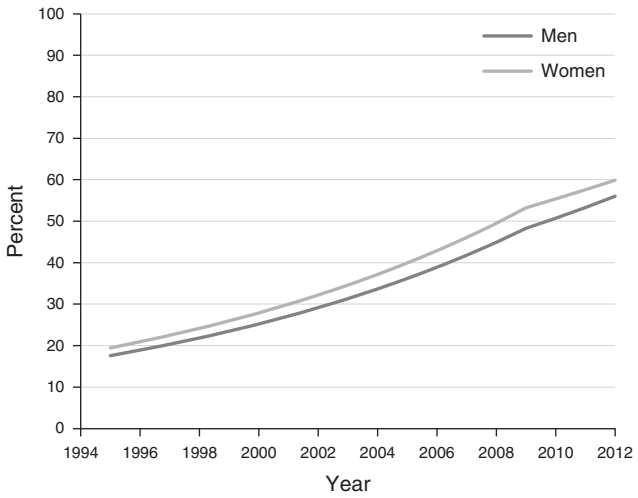

Figure 1. Age-standardized up-to-date CRC screening coverage rates for men and women, Winnipeg, Manitoba, 1995–2012. CRC, colorectal cancer.

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.

Table 2. Number and percentage of individuals who had up-to-date CRC screening coverage by year, sex, age group, and income quintile, Winnipeg, Manitoba

	1995	2001	2007	2012
Total (%)	26,964 (20.5)	42,162 (29.1)	72,591 (43.4)	109,488 (56.9)
Men	11,923 (19.4)	18,922 (27.4)	32,902 (40.9)	50,826 (54.6)
Women	15,041 (21.4)	23,240 (30.5)	39,689 (45.7)	58,662 (59.2)
Age group (years)				
50–54	4,968 (15.2)	9,479 (21.5)	15,960 (32.5)	23,202 (43.2)
55–59	4,919 (18.5)	9,007 (28.1)	17,252 (40.8)	25,298 (53.5)
60–64	5,531 (21.8)	7,872 (31.7)	15,891 (49.3)	24,440 (61.4)
65–69	5,728 (23.7)	7,938 (34.6)	12,537 (53.5)	20,904 (69.7)
70–74	5,818 (25.2)	7,866 (37.0)	10,951 (54.3)	15,644 (73.2)
Income quintile				
Q1: lowest	3,275 (14.7)	4,818 (21.1)	9,552 (32.8)	14,847 (45.4)
Q2	5,032 (19.2)	5,911 (24.3)	11,718 (38.5)	17,645 (51.7)
Q3	5,009 (20.8)	7,988 (30.0)	13,463 (43.6)	19,264 (56.4)
Q4	4,767 (23.6)	8,931 (30.8)	17,030 (46.9)	25,280 (59.9)
Q5: highest	3,988 (24.3)	10,365 (34.3)	18,947 (49.0)	29,338 (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).

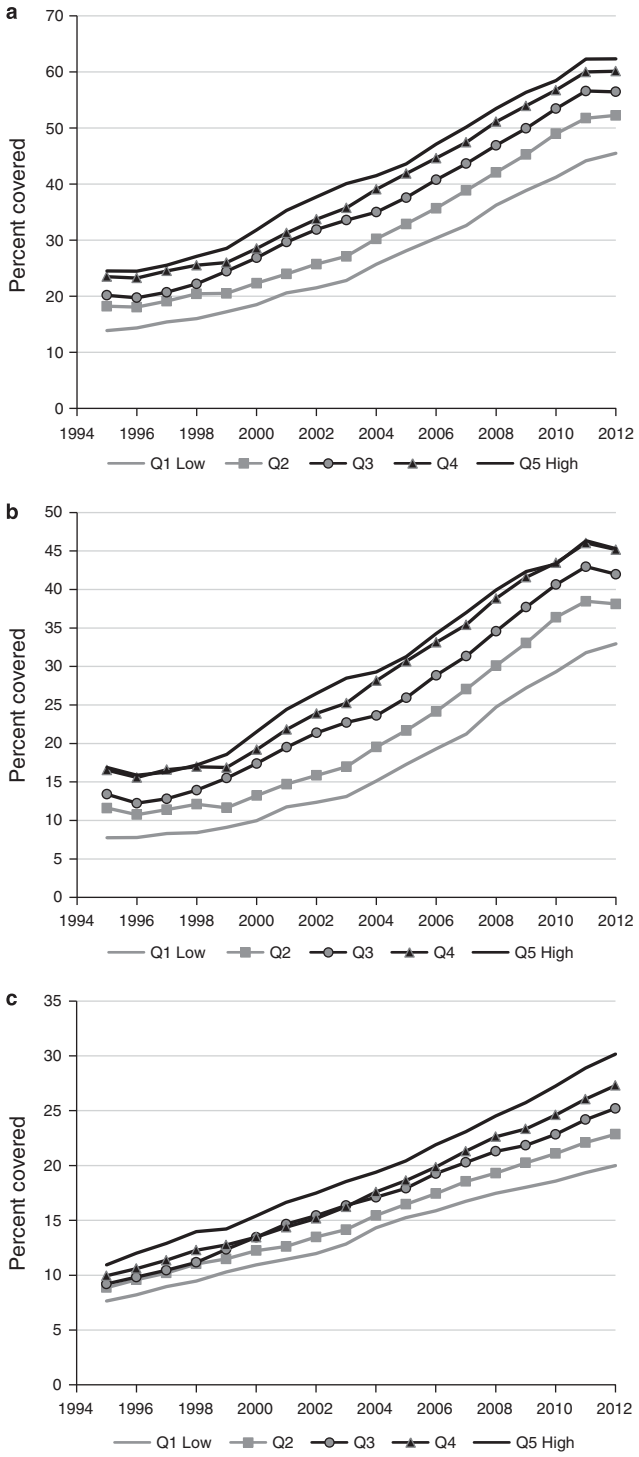

Figure 2. Age-standardized rates of up-to-date CRC screening, FOBT, and colonoscopy/FS coverage for men and women by income quintile, Winnipeg, 1995–2012: (**a**) up-to-date, (**b**) FOBT, and (**c**) colonoscopy/FS. CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy.

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

Table 3. Association between up-to-date CRC screening, FOBT, and colonoscopy/FS coverage and year of the study time period (1996 vs. 2012), stratified by income quintile*

	Income quintile				
	Q1: lowest	Q2	Q3	Q4	Q5: highest
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
1996 (reference)	1.00	1.00	1.00	1.00	1.00
2012					
Up-to-date	5.40 (5.16–5.64)	5.41 (5.20–5.63)	5.75 (5.53–5.99)	5.36 (5.16–5.58)	5.50 (5.27–5.73)
FOBT	6.12 (5.80–6.47)	5.44 (5.20–5.70)	5.50 (5.25–5.75)	4.68 (4.48–4.88)	4.54 (4.33–4.75)
Colonoscopy/FS	2.91 (2.75–3.07)	2.88 (2.74–3.02)	3.21 (3.06–3.37)	3.25 (3.10–3.42)	3.26 (3.10–3.43)

CI, confidence interval; CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy; 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). All are significant at $P<0.0001$.
*Adjusted for gender and age.

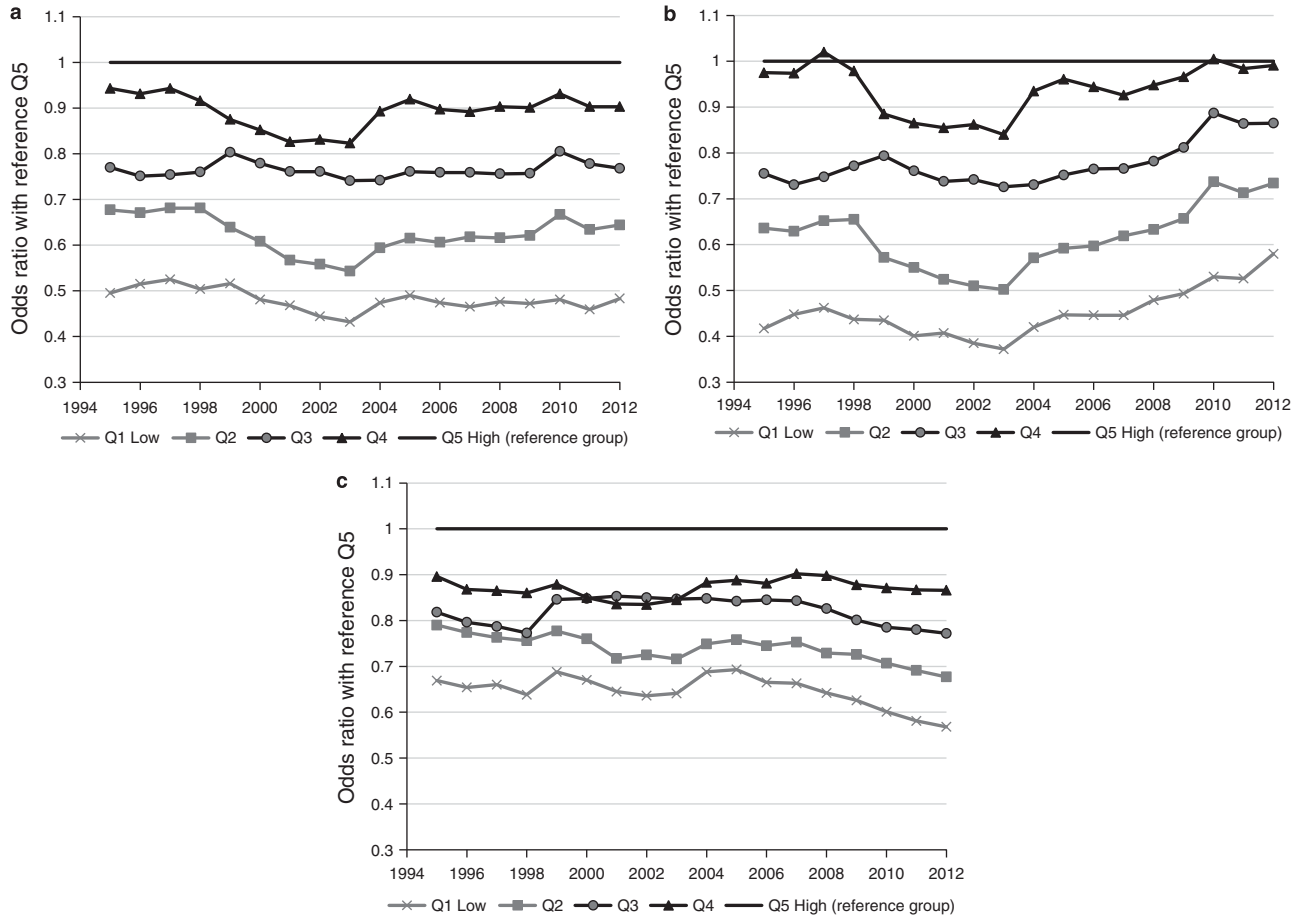

Figure 3. Change in the odds of up-to-date CRC screening, FOBT, and colonoscopy/FS coverage by income quintile, Winnipeg, Manitoba, 1995–2012: (**a**) up-to-date, (**b**) FOBT, and (**c**) colonoscopy/FS. CRC, colorectal cancer; FOBT, fecal occult blood test; FS, flexible sigmoidoscopy.

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 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

Guarantor of the article: Kathleen M. Decker, PhD.
Specific author contributions: Project conception, study design, acquisition of data, data interpretation, manuscript drafting, and critical revision: Kathleen M. Decker; project conception, study design, data interpretation, and critical revision: Alain A. Demers; study design, acquisition of data, data interpretation, technical support, and critical revision: Zoann Nugent; study design, acquisition of data, data interpretation, technical support, and critical revision: Natalie Biswanger; project conception, study design, data interpretation, manuscript drafting, and critical revision: Harminder Singh; all authors approved the final draft submitted.
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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.

REFERENCES

1. Canadian Cancer Society's Steering Committee on Cancer Statistics. Canadian Cancer Statistics 2014 Canadian Cancer Society: Toronto, ON, 2014.
2. Canadian Task Force on Preventive Health Care. Colorectal cancer screening. JAMC 2001;25:206–8.
3. Leddin DJ, Enns R, Hilsden R *et al.* Canadian association of gastroenterology position statement on screening individuals at average risk for developing colorectal cancer. Can J Gastroenterol 2010;24:705–14.
4. Canadian Partnership Against Cancer. Colorectal Cancer Screening in Canada: Program Performance Results Report, January 2009 to December 2011 Canadian Partnership Against Cancer: Toronto, ON, 2013.
5. Decker KM, Singh H. Reducing inequities in colorectal cancer screening in North America. J Carcinog 2014;13:1–9.
6. Liss DT, Baker DW. Understanding current racial/ethnic disparities in colorectal cancer screening in the United States; the contribution of socioeconomic status and access to care. Am J Prev Med 2014;46:228–36.
7. Wardle J, McCaffery K, Nadel M *et al.* Socioeconomic differences in cancer screening participation: Comparing cognitive and psychosocial explanations. Soc Sci Med 2004;59:249–61.
8. Wardle J, Steptoe A. Socioeconomic differences in attitudes and beliefs about healthy lifestyles. J Epidemiol Community Health 2003;57:440–3.
9. Katz S, Hofer TP. Socioeconomic disparities in preventive care persist despite universal coverage. JAMA 1994;272:530–4.
10. Canadian Partnership Against Cancer. Examining Disparities in Cancer Control. A System Performance Special Report Canadian Partnership Against Cancer: Toronto, ON, 2014.
11. Honein-AbouHaidar GN, Rabeneck L, Paszat LF *et al.* Evaluating the impact of public health initiatives on trends in fecal occult blood test participation in Ontario. BMC Cancer 2014;14:1–7.

12. Roos LL, Mustard CA, Nicol JP *et al.* Registries and administrative data: organization and accuracy. Med Care 1993;31:201–12.
13. Robinson JR, Young TK, Roos LL *et al.* Estimating the burden of disease. Comparing administrative data and self-reports. Med Care 1997;35:932–47.
14. Javanparast S, Ward P, Young G *et al.* How equitable are colorectal cancer screening programs which include FOBTs? A review of qualitative and quantitative studies. Prev Med 2010;50:165–72.
15. Tools & Resources – 80% by 2018: National Colorectal Cancer Round Table; 2015. Available from http://nccrt.org/tools/80-percent-by-2018/
16. Steinwachs D, Allen JD, Barlow WE *et al.* National institutes of health state-of-the-science conference statement: Enhancing use and quality of colorectal cancer screening. Ann Intern Med 2010;152:667.
17. Potter MB. Strategies and resources to address colorectal cancer screening rates and disparities in the United States and globally. Annu Rev Public Health 2013;34:413–29.
18. Grubbs SS, Polite BH, Carney J Jr *et al.* Eliminating racial disparities in colorectal cancer in the real world: it took a village. J Clin Oncol 2013;31:1928–30.
19. Wardle J, Jarvis MJ, Steggles N *et al.* Socioeconomic disparities in cancer-risk behaviours in adolescence: baseline results from the health and behaviours in teenagers study (HABITS). Prev Med 2003;36:721–30.
20. Marmot M, Friel S, Bell R *et al.* Closing the gap in a generation: health equity through action on the social determinants of health. Lancet 2008;372:1661–9.
21. Hatch SL, Dohrenwend BP. Distribution of traumatic and other stressful life events by race/ethnicity, gender, SES and age: a review of the research. Am J Community Psychol 2007;40:313–32.
22. Born W, Engelman K, Greiner KA *et al.* Colorectal cancer screening, perceived discrimination, and low-income and trust in doctors: a survey of minority patients. BMC Public Health 2009;9:363.
23. Lee HY, Im H. Colorectal cancer screening among korean american immigrants:unraveling the influence of culture. J Health Care Poor Underserved 2013;24:578–98.
24. Levesque J-F, Harris MF, Russell G. Patient-centred access to health care: conceptualizing access at the interface of health systems and populations. Int J Equity Health 2013;12:18.
25. Torabi M, Green C, Nugent Z *et al.* Geographical variation and factors associated with colorectal cancer mortality in a universal health care system. Gastroenterol Hepatol 2014;28:191–7.
26. U.S. Preventive Services Task Force. Screening for Colorectal Cancer: Clinical Summary of U.S. Preventive Services Task Force Recommendation AHRQ publication no. 08-05124-EF-4 U.S. Preventive Services Task Force: Rockville, MD, 2008.
27. Levin B, Lieberman DA, McFarland B *et al.* Screening and surveillance for the early detection of colorectal cancer and adenamatous polyps, 2008: a joint guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. CA Cancer J Clin 2008;58:130–60.
28. Thosani N, Guha S, Singh H. Colonoscopy and colorectal cancer incidence and mortality. Gastroenterol Clin North Am 2013;42:619–37.
29. Roos LL, Traverse D, Turner D. Delivering prevention: the role of public programs in delivering care to high-risk populations. Med Care 1999;37:JS264–78.
30. McPhee SJ, Nguyen TT, Shema SJ *et al.* Validation of recall of breast and cervical cancer screening by women in an ethnically diverse population. Prev Med 2002;35:463–73.
31. Schenck AP, Klabunde CN, Warren JL *et al.* Data sources for measuring colorectal endoscopy use among Medicare enrollees. Cancer Epidemiol Biomarkers Prev 2007;16:2118–27.
32. Southern DA, Ghali WA, Faris PD *et al.* Misclassificaton of income quintiles derived from area-based measures. Can J Public Health 2002; 93:465–9.
33. Kim H-J, Fay MP, Yu B *et al.* Comparability of segmented line regression models. Biometrics 2004;60:1005–14.
34. Statistics Canada. 2006 Census of Population. Available from www.statcan.gc.ca.
35. Mustard CA, Derksen S, Berthelot J-M *et al.* Assessing ecologic proxies for household income: a comparison of household and neighourhood level income measures in the study of population health status. Health Place 1999;5:157–71.
36. Chateau D, Metge C, Prior H *et al.* Leaning from the census: The socio-economic factor index (SEFI) and health outcomes in Manitoba. Can J Public Health 2012;103(suppl. 2):S23–7.