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Area-level income disparities in colorectal screening in Canada: evidence to inform future surveillance

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ABSTRACT

Background Participation in colorectal screening remains low even in countries with universal health coverage. Area-level determinants of low screening participation in Canada remain poorly understood.

Methods We assessed the association between area-level income and two indicators of colorectal screening (having never been screened, having not been screened recently) by linking census-derived local area-level income data with self-reported screening data from urban-dwelling respondents to the Canadian Community Health Survey (50–75 years of age, cycles 2005 and 2007, n = 18,362) who reported no known risk factors for colorectal cancer. Generalized estimating equation Poisson models estimated the prevalence ratios and differences for having never been screened and having not been screened recently, adjusting for individual-level income, education, marital status, having a regular physician, age, and sex.

Results About 53% of the study population had never been screened. Among individuals who had ever been screened, 35% had been screened recently. Adjusting for covariates, lower area-level income was associated with having never been screened [covariate-adjusted prevalence ratios: 1.24 for quartile 1; 95% confidence limits (CL): 1.16, 1.34; 1.25 for quartile 2; 95% CL: 1.15, 1.33; 1.15 for quartile 3; 95% CL: 1.08, 1.23]. Among individuals who had been screened in their lifetime, area-level income was not associated with having not been screened recently.

Conclusions Lower area-level income is associated with having never been screened for colorectal cancer even after adjusting for individual socioeconomic factors. Those findings highlight the potential importance of socioeconomic contexts for colorectal screening initiation and merit attention in both future research and surveillance efforts.

Key Words Cancer prevention, screening, inequalities, epidemiology, public health, neighborhoods

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INTRODUCTION

Colorectal cancer is currently the 3rd most common cause of cancer death in Canada, and yet only 20% to 30% of average-risk adults (that is, Canadians with no known familial or medical risk factors) are up-to-date on colorectal screening—either by stool test in the preceding 2 years or by endoscopic testing in the preceding 5 or 10 years (sigmoidoscopies and colonoscopies, respectively)[1,2]. That screening participation rate is much lower than the rate observed for breast cancer (63% participation) or cervical cancer (79% participation) despite Canada's universal health care coverage[3].

In trying to understand the factors that operate to keep population-level colorectal screening participation so low, extant Canadian literature has identified several determinants, including social and demographic factors such as age, marital status, visible minority or immigration status, educational attainment, household income, and area of residence (rural vs. urban)[4,5]; health service–related factors such as having access to a regular physician or primary care service and receiving a screening recommendation

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from a health care provider[6,7]; and psychological factors such as fear, embarrassment, or anxiety about test results or procedures (especially related to the invasive nature and intensive preparation required for endoscopic procedures)[8]. However, missing from that list of determinants are potential factors that operate beyond the individual level. Indeed, the environments in which people live are known to affect many individual health behaviours, independent of (or above and beyond) individual-level characteristics[9]. Canadian studies have yet to examine the independent association of community- and local area–level factors with participation in colorectal cancer screening, as has been done in other countries[10–13]. Important studies in Ontario have set the groundwork in this area, observing associations between area-level income and colorectal screening uptake[14–17]. However, given limitations in data availability, those studies did not examine associations independent of individual-level confounding factors such as income.

Outside of Canada, independent associations have been observed between colorectal screening participation and area-level primary care provider density, educational attainment[13], income[18], perceived social and physical disorder[10], and neighbourhood satisfaction[11]. It is possible that the same independent associations exist in Canada but have yet to be shown. If underlying area-based disparities in screening do exist, that information will be relevant for future cancer prevention and control efforts. A better understanding of the association between area-based predictors and screening could be of relevance for Canadian provinces that have implemented or are planning to implement organized colorectal screening programs, particularly for guiding efforts to surveil for differential program effects depending on socioeconomic area profile and for identifying geographic targets for program adjustments.

In the present study, we examined the association between area-level income as a predictor of colorectal cancer screening above and beyond individual factors. Intersecting ecologic, materialist, and psychosocial theories[12] suggest that area-level income, a correlate of broader area-level material and social deprivation[19], could influence screening likelihood through pathways of weakened social ties and resource scarcity[9,20]. Low area-level income is often associated, for example, with lesser social support, lesser ability to cope with stress, and potential barriers to screening such as fewer infrastructure- and health-related resources[12,21].

We assessed the association between area-level income and colorectal screening that existed for average-risk individuals before implementation of organized programs for colorectal cancer screening in Canada (that is, before 2007, at the latest). The aim was to assess baseline inequalities in screening before the interventions were put in place. We focused on two outcomes of colorectal cancer screening uptake: having never been screened and having not been screened recently (no stool-based test in the preceding 2 years and no endoscopy in the preceding 5 years). Those two outcomes allow for an assessment of the association of area-level income with two distinct screening-related events: initial screening participation and continued screening uptake. Divergence of predictors can inform public health interventions targeted either to those who have never been screened or to those who have been screened, but who are not up-to-date in their screening.

METHODS

Data Sources and Sample

We used individual-level data from years 2005 and 2007 of Statistics Canada's Canadian Community Health Survey (CCHS) and area-level income data from the 2006 Canadian census. The CCHS is a nationally-representative multiyear cross-sectional survey of individuals across Canada, with response rates in 2005 and 2007 of 79% and 78% respectively[22,23]. The CCHS, which is based on the Canadian census, covers approximately 98% of the Canadian population[22,23]. Data from the CCHS and the Canadian census were linked using census dissemination-area codes.

The study's target population was urban-dwelling adults 50–75 years of age without known familial or medical risk factors (for example, having a first-degree relative with, or a personal history of, colorectal cancer or inflammatory bowel disease)[2]. Thus, respondents were excluded from the study if they reported screening because of family history of colorectal cancer, follow-up for a problem, or follow-up of colorectal cancer treatment[22,23]. Individuals who reported screening because of age, race, or part of a regular check-up or routine screening were included. Application of those criteria resulted in the analysis of data for 18,362 CCHS respondents.

Measures

Dependent Variables

The outcomes of interest were having never been screened and having not been screened recently for colorectal cancer. Respondents were considered to have never been screened if they responded "no" to questions about whether they had ever had a fecal occult blood test or endoscopy (colonoscopy or sigmoidoscopy). Respondents were considered to have not been screened recently if they had been screened in their lifetime, but had neither completed a stool test in the preceding 2 years nor any form of endoscopy in the preceding 5 years (a conservative time cut-off used because the CCHS questionnaire does not distinguish between the types of endoscopy).

Independent Variable

The independent measure was income at the dissemination-area level, categorized into quartile groupings (quartile 1 representing the lowest income). Marked by their small population size (400–700 residents per dissemination area) and homogeneity[24], Canadian census dissemination areas are the smallest geographic divisions in the country and capture the immediate area-level socioeconomic resources available to residents.

Covariates

Covariates included age, marital status, immigration status, educational attainment, household income, and access to a primary care physician. All covariates were measured at the individual level. Age was dichotomized as 50–59 years and 60–75 years based on a cut-off (60 years) that approximates

the average age of retirement in Canada[25] and therefore a potential shift in discretionary time. Marital status was defined using three categories: being in a marriage or common-law relationship; being divorced, widowed, or separated; or being single. The immigration status measure compared people who had immigrated to Canada from the United States, Europe, or Oceania, and people who had immigrated from Central or South America, Africa, or Asia, with those who were Canadian-born. Country groupings were designed to roughly capture potential differences in sociocultural experiences of health care and colorectal screening environments (including policies, infrastructure) before immigration, with immigrants from the first group's "Western" nations assumed to be more likely to have been exposed to health care systems and colorectal cancer screening policies similar to those in Canadian provinces and territories[26,27]. Educational attainment was dichotomized as having obtained less than high school graduation or having reached high school graduation or above (including college attendance). Household income was separated into quartile groupings based on the overall sample's distribution of income.

Statistical Analyses

Descriptive statistics were calculated to compare demographic, socioeconomic, and screening characteristics for the categories of area-level income. To accommodate the hierarchical data structure of the CCHS [that is, 6 individuals are, on average (minimum 1, maximum 68), nested within each area unit and are therefore more likely to be correlated] and the need to incorporate both sampling and bootstrap weights provided by Statistics Canada (500 weights for each participant), a macro-based analysis proposed by the SAS Institute was applied[28]. The macro looped through a generalized estimating equation log-link Poisson model (with an exchangeable covariance structure) 500 times—each time using a new, unique bootstrap weight to construct robust 95% confidence limits (CLs) for the prevalence ratio estimates of the exposure and covariates. Given that the screening outcomes of our study are known to be common in Canada (approximately 80% of individuals had not been screened recently in 2012)[3], we used Poisson models rather than logistic models to minimize overestimation of the associations[29]. To complement the measure of prevalence ratios, we also estimated prevalence differences, which refer to the difference in adjusted percentage prevalence of non-recent and never screening. Additionally, we assessed the potential effect measure modification of the absolute and relative associations by immigration status, physician access, and household income, and we used Ding and VanderWeele's bounding factor approach[30] to test the sensitivity of the principal findings to unmeasured confounding. Lastly, because colonoscopies are recommended to be repeated every 10 years[2], a 10-year cutoff for endoscopic screening was also applied in a sensitivity analysis that yielded similar results (data not shown). All analyses were conducted using the SAS software application (version 9.4: SAS Institute, Cary, NC, U.S.A.).

Ethics

The study received ethics approval from the Comité d'éthique de la recherche of the Centre Hospitalier de l'Université de Montréal.

RESULTS

Sample Characteristics

Overall, 53% of the study population had never been screened; 12% had been screened in their lifetime, but not recently; and 35% had been screened recently. We observed that people more likely to have never been screened for colorectal cancer were younger adults; people who were in neither a marriage nor a common-law relationship; people who had immigrated to Canada from countries in South and Central America, Africa, and Asia; people who had lower educational attainment; people who did not have a primary care physician; and people in the three poorest quartile groups of both individual- and area-level income (Table I). Among people who had been screened in their lifetime, those not screened recently were more likely to be people who were older, who were born in Canada, and who did not have a regular physician (Table I).

Association Between Area-Level Income and Having Never Been Screened

Adjusting for covariates, we observed an association between lower area-level income and having never been screened (Table II). The prevalence of having never been screened followed a gradient according to income quartile: covariate-adjusted prevalence differences were 12% (95% CL: 8%, 15%), 11% (95% CL: 8%, 14%), and 7% (95% CL: 3%, 10%) between the poorest areas (quartiles 1–3 respectively) and the wealthiest areas (quartile 4, Table II). Individuals who were born in Africa, Asia, or South or Central America, and individuals with a lower household income were also more likely to have never been screened (Table II).

Association Between Area-Level Income and Having Not Been Screened Recently

Considering only people who had been screened in their lifetime, we observed no association between area-level income and having not been screened recently (Table II). Instead, the strongest predictors of having not been screened recently were not having a regular physician [15% difference in recent screening prevalence between those with and without a regular physician (95% CL: 6%, 23%)] and being born Canada (Table II). Of people who had ever been screened, immigrants to Canada were more likely than those born in the country to have been screened recently (covariate-adjusted prevalence differences ranged from 5% to 8% according to region of origin, Table II).

Sensitivity Analyses

The direction of the associations between predictors and screening outcomes were similar when analyses were stratified by individual-level income (Supplementary Table 1). Analyses of potential unmeasured confounding indicated that the size of effect of any unmeasured factor, or matrix of factors, would have to have a prevalence ratio in the range of 1.4 to 1.6 to explain away the observed associations of area-level income and having never been screened (Supplementary Table 2). Unmeasured factors would therefore have to show stronger associations with the exposure and outcome than, for example, not having a primary care physician (for which the observed prevalence ratio was 1.31).

DISCUSSION

In the present study, we examined the association between local area–level income and both having never been screened and having not been screened recently (while adjusting for known individual predictors) in a sample of urban-dwelling Canadians without any known familial or medical risk factors for colorectal cancer. Lower

TABLE I Prevalence of participation or nonparticipation in screening by adults 50–75 years of age[a]

Variable	Population screening participation (%)						
	Overall[b]	Never (*n*=10,206)		Ever			
		Proportion[c]	95% CL	Not recently (*n*=2,359)		Recently (*n*=5,797)	
				Proportion[c]	95% CL	Proportion[c]	95% CL
Overall	100	53.3	52.4, 54.7	11.7	11.0, 12.4	34.8	33.6, 36.0
Age group							
50–59 Years	53.1	60.0	58.2, 61.8	9.7	8.8, 10.8	30.2	28.5, 32.0
60–75 Years	46.9	46.2	44.6, 47.7	13.9	12.9, 15.0	40.0	38.3, 41.5
Sex							
Women	50.7	53.3	52.6, 55.0	11.6	10.7, 12.5	35.2	33.5, 36.8
Men	49.3	53.8	52.0, 55.5	11.8	10.7, 13.0	34.4	32.7, 36.2
Marital status							
Married or common law	76.0	52.6	51.2, 53.9	11.7	10.9, 12.6	35.7	34.4, 37.1
Divorced, widowed, separated	17.8	55.9	53.6–58.2	11.8	10.5, 13.1	32.3	30.1, 34.6
Single	6.2	58.6	55.2, 62.0	11.1	9.1, 13.6	30.2	27.0, 33.6
Immigration							
Canadian-born	62.1	52.1	50.8, 53.3	13.0	12.2, 13.9	34.9	33.7, 36.2
Immigrant (Europe, United States, Oceania)	22.0	51.5	48.6, 54.4	11.1	9.5, 13.0	37.4	34.5, 40.4
Immigrant (Asia, Africa, S. or C. America)	15.9	62.8	58.7, 66.6	7.2	5.5, 9.4	30.3	26.4, 33.9
Education							
High school completion	83.0	52.6	51.3, 53.9	11.7	10.9, 12.5	35.7	34.4, 37.0
<High school completion	17.0	57.9	52.4, 54.7	11.8	10.2, 13.7	30.3	27.8, 32.9
Have a primary care physician							
Yes	94.0	52.5	51.3, 53.6	11.7	11.0, 12.5	35.9	34.7, 37.1
No	6.0	70.8	66.4, 74.8	11.9	9.3, 15.3	17.4	14.1, 21.2
Individual income							
Quartile 1 (lowest)	17.1	56.7	54.4, 58.8	12.5	10.8, 14.4	30.9	28.9, 33.0
Quartile 2	21.6	55.5	53.2, 57.8	11.5	10.3, 12.9	33.0	30.9, 35.2
Quartile 3	26.7	54.0	51.7, 56.3	10.8	9.6, 12.6	35.2	32.9, 37.6
Quartile 4 (highest)	34.6	50.4	48.2, 52.6	12.1	10.7, 13.6	37.5	33.6, 35.9
Area income							
Quartile 1 (lowest)	20.5	60.3	57.7, 62.9	10.7	9.4, 12.0	29.0	26.7, 31.5
Quartile 2	22.6	58.5	55.9, 61.0	11.3	9.9, 12.8	30.3	27.9, 32.7
Quartile 3	24.8	53.8	51.6, 56.0	11.5	10.1, 13.0	34.7	32.6, 36.8
Quartile 4 (highest)	32.1	45.5	43.2, 47.8	12.8	11.4, 14.4	41.7	39.4, 44.1

[a] Of 18,362 people interviewed in the 2005 and 2007 waves of Statistics Canada's Canadian Community Health Survey (weighted population: 4,838,342).
[b] Represents column percentages.
[c] Represents row percentages.
CL = confidence limits; S. or C. America = South or Central America.

TABLE II Associations, expressed as prevalence ratios (Ratio) and differences (Diff), between area-level income and participation or nonparticipation in screening by adults 50–75 years of age[a]

Covariate	Population screening participation											
	Never screened						Not recently screened					
	Bivariate analysis[b]		Adjusted[c]		Adjusted[d]		Bivariate analysis[b]		Adjusted[c]		Adjusted[d]	
	Ratio	95% CL	Ratio	95% CL	Diff	95% CL	Ratio	95% CL	Ratio	95% CL	Diff	95% CL
Age group												
50–59 Years	1		1		0		1		1		0	
60–75 Years	0.77	0.73, 0.80	0.73	0.70, 0.77	–0.16	–0.14, –0.19	1.06	0.93, 1.21	1.04	0.91, 1.19	0.01	–0.02, 0.04
Sex												
Women	1		1		0		1		1		0	
Men	1.01	0.96, 1.06	1.03	0.98, 1.08	0.01	–0.01, 0.04	1.04	0.92, 1.17	1.04	0.92, 1.18	0.01	–0.02, 0.05
Marital status												
Married or common-law	1		1		0		1		1		0	
Divorced, widowed, separated	1.06	1.01, 1.11	1.04	0.99, 1.10	0.03	–0.01, 0.06	1.07	0.95, 1.22	1.02	0.89, 1.18	0.01	–0.03, 0.04
Single	1.11	1.05, 1.19	1.02	0.96, 1.09	0.01	–0.02, 0.05	1.09	0.89, 1.34	1.03	0.83, 1.26	0.0	–0.05, 0.06
Immigration[d]												
Canadian–born	1		1		0		1		1		0	
Immigrant (Europe, United States, Oceania)	0.99	0.93, 1.06	1.04	0.98, 1.11	0.02	–0.01, 0.05	0.85	0.72, 1.00	0.85	0.72, 1.00	–0.05	–0.08, –0.01
Immigrant (Asia, Africa, S. or C. America)	1.21	1.13, 1.30	1.18	1.10, 1.26	0.09	0.05, 0.14	0.71	0.54, 0.95	0.72	0.54, 0.95	–0.08	–0.13, –0.02
Education												
High school completion	1		1		0		1		1		0	
<High school completion	1.10	1.04, –1.16	1.11	1.04, 1.18	0.05	0.02, 0.8	1.14	0.98, 1.33	1.09	0.92, 1.27	0.03	–0.02, 0.07
Have a primary care physician												
Yes	1		1		0		1		1		0	
No	1.35	1.27, 1.44	1.31	1.23, 1.38	0.17	0.12, 0.21	1.65	1.32, 2.06	1.58	1.27, 1.97	0.15	0.06, 0.23

TABLE II Continued

Covariate	Population screening participation											
	Never screened						Not recently screened					
	Bivariate analysis[b]		Adjusted[c]		Adjusted[d]		Bivariate analysis[b]		Adjusted[c]		Adjusted[d]	
	Ratio	95% CL	Ratio	95% CL	Diff	95% CL	Ratio	95% CL	Ratio	95% CL	Diff	95% CL
Individual income												
Quartile 1 (lowest)	1.12	1.06, 1.18	1.12	1.05, 1.21	0.07	0.02, 0.10	1.18	0.99, 1.40	1.08	0.86, 1.35	0.03	–0.04, 0.09
Quartile 2	1.10	1.03, 1.17	1.11	1.04, 1.18	0.05	0.02, 0.08	1.06	0.90, 1.23	1.00	0.84, 1.19	0.0	–0.05, 0.05
Quartile 3	1.07	1.01, 1.14	1.08	1.01, 1.14	0.04	0.01, 0.07	0.96	0.81, 1.13	0.93	0.79, 1.10	–0.02	–0.06, 0.02
Quartile 4 (highest)	1		1		0		1		1		0	
Area income												
Quartile 1 (lowest)	1.32	1.24, 1.42	1.24	1.16, –1.34	0.12	0.08, 0.15	1.16	0.99, 1.36	1.11	0.94, 1.30	0.02	–0.02, 0.06
Quartile 2	1.29	1.20, 1.38	1.25	1.15, 1.33	0.11	0.08, 0.14	1.16	0.98, 1.38	1.13	0.95, 1.36	0.03	–0.01, 0.07
Quartile 3	1.19	1.11, 1.27	1.15	1.08, 1.23	0.07	0.03, 0.10	1.10	0.93, 1.30	1.07	0.90, 1.27	0.02	–0.02, 0.06
Quartile 4 (highest)	1		1		0		1		1		0	

[a] Results of generalized estimating equation Poisson regression analyses examining 18,362 people interviewed in the 2005 and 2007 waves of Statistics Canada's Canadian Community Health Survey (weighted population: 4,838,342).
[b] Containing the outcome and each covariate.
[c] Adjusted for all covariates.
[d] Adjusted for all covariates; reference category for prevalence differences is always 0 (no difference), given that those associations are expressed on an additive rather than a multiplicative (ratio) scale.

area-level income was associated with having never been screened—a result that remained statistically significant after adjustment for individual-level covariates, including individual-level income, and that appeared robust to unmeasured confounding. Among people who had been screened in their lifetime, we did not observe a statistically significant association between area-level income and recent screening.

The observation that approximately 35% of respondents had been screened recently is slightly higher than estimates from previous studies, which used more recent data[3,31], and is likely associated with our combination of endoscopic and stool-based screening (previous prevalence estimates were based solely on stool-based screening). The observed association between area-level income and the outcome of having never been screened is aligned with at least one other study[18], which found that the odds of having never received endoscopic (odds ratio: 1.10; 95% CL: 1.01, 1.19) or stool-based screening (odds ratio: 1.19; 95% CL: 1.12, 1.27) increased with every 5% increase in the proportion of residents per census tract living below the U.S. federal poverty line. The authors hypothesized that area-level deprivation could influence screening likelihood through pathways such as lesser access to medical infrastructure and social capital[18]. They recommended that area-level poverty be given attention in future research and policy planning, but noted that targeting only high-poverty areas might miss low-income populations living in more affluent areas who are also in need of additional resources to overcome screening barriers. Further, in the broader context of cancer prevention across other cancer sites, our finding is also aligned with prior findings of an association between area-level income and having never undergone mammography or cervical cancer screening[32].

To our knowledge, there are no prior studies against which the null association between area-level income and having not been screened recently—specifically for people who had been screened in their lifetime—could be compared. Most existing studies assessed the outcome of having not been screened recently, regardless of lifetime screening uptake (that is, for those who had and had not been screened in their lifetime alike). Those previous studies found significant associations between area-level income and recent screening[33,34]. We too observed a significant, though attenuated, association between area-level income and having not been screened recently when all respondents were included regardless of whether they had been screened in their lifetime (data not shown).

For several reasons, future studies of determinants of colorectal screening might benefit from distinguishing between people who have not been screened recently, but who have been screened in their lifetime, and those who have not been screened recently or at any point in their lifetime. First, the outcome of having never been screened is particularly relevant in the Canadian context, where most age-eligible adults have never been screened and are therefore at elevated risk of being diagnosed at a more advanced stage[35]. Second, it is possible that people who have never been screened and those who have been screened, but not recently, have distinct risk-factor profiles—knowledge of which could benefit future public health interventions. Studies have observed, for example, that individuals who have pursued screening at least once in their lifetime might have overcome initial logistic and psychological barriers to screening[36] (that is, fear, lack of discretionary time, resources, or awareness of screening tests[6,8]), but might face new barriers to re-screening, such as having had a negative experience at initial screening (receiving an inconclusive test result, for instance) or perceiving screening services to be of inadequate quality[36]. It is possible that area-level income is less relevant to those new additional barriers. Minimizing barriers to re-screening (compared with initiation) might require distinct types of interventions (improved screening instructions or quality-control measures, for instance). Third, it is possible that previously observed associations between area-level income and recent screening are driven mainly by the large proportions of people who have never been screened, potentially meaning that area-level income is a less relevant predictor for continued screening participation than it is for screening initiation. That distinction could be relevant for provinces that have implemented or are planning to implement organized colorectal screening programs. Surveillance of program effects on screening initiation according to area-level income is warranted. If programs fail to reduce area-level screening disparities in screening initiation, program modifications or additional targeted interventions might be necessary.

There are two plausible explanations for the finding of a direct association between area-level income and lifetime screening. First, it is possible that the observed association could be an artefact of reverse causation[37]. Individuals who have less intention to pursue screening might also be more likely to move to, or stay, in areas where health-related resources, including screening, are not available. The cross-sectional design of our study does not allow for that possibility to be ruled out. However, the fact that the associations were consistent for the individual-level income and education groups offers some, albeit incomplete, evidence against the reverse-causation hypothesis. Further, our findings are aligned with those of a longitudinal study of area-level deprivation concerning screening behaviour in the United States[34], which found, in 36 U.S. states, a negative association between baseline exposure to area-level poverty and a lower probability of any endoscopic screening 4 years later. Our findings are therefore in line with alternative theoretical explanations. Specifically, intersecting ecologic, materialist, and psychosocial theories suggest that area-level income can have a direct influence on screening uptake through several social, physical, and economic pathways. Low-income areas are believed to expose residents to a multitude of concurrent barriers to screening uptake, including physical barriers, unreachable or inadequate resources, social stressors, and lowered social support[12]. Those concurrent exposures are thought to shape health beliefs and practices and to limit health service utilization. Further, because lower-income areas are known to shape people's abilities to cope with stress[21], they might weaken the ability of residents to manage concerns and discomfort about the test and test results or about fear of pain or injury from the test procedures—leading to lower screening uptake[8]. Our use of the smallest possible area-level census unit (dissemination area), which

captures the immediate social environment around one's residence rather than a larger geographic delineation (for example, broader administrative health regions), make these psychosocial hypotheses more plausible, insofar as social norms and social capital shared between residents might be more likely to be captured for a smaller, more homogenous area-level unit[38].

The findings of the present study have several implications for public health. Foremost, overall low screening participation requires attention. The fact that most people who have not been screened recently have also never been screened in their lifetime is relevant for cancer prevention in Canada and abroad. Second, the association between income at the dissemination area (a geographic unit that captures the immediate area-level socioeconomic resources available to residents) and having never been screened has implications for public health planning and surveillance. As of 2015, all Canadian provinces except Quebec have implemented province-wide organized colorectal screening programs, which are thought to modify the pathways through which colorectal screening services are accessed. In Ontario, initial pre–post comparisons in stool screening after implementation of the province's screening program, unadjusted for individual-level socioeconomic factors, suggested only modest declines in area-level income disparities[39]. Continued surveillance of the program's effect on area-level screening disparities can suggest whether complementary targeted interventions might be necessary to reach all segments of society. Targeted interventions potentially include the use of nurse navigators[40], the addition of instructional or reminder calls (or both) to the usual invitation letters and written information packages[41], and peer-education programs[42]. Insofar as low area-level income might influence access to resources and exposure to social stressors, those types of targeted interventions in low-income areas (within community or clinical settings) might enable residents to overcome known barriers to screening initiation. However, as noted in earlier studies[18], additional considerations might be needed to reach socioeconomically vulnerable individuals living in more affluent areas.

The study findings are bound by certain limitations. Namely, the cross-sectional nature of CCHS data prevented us from assessing any potential lag in effect between area-level exposures and screening outcomes, or from drawing conclusions about the causal relationship between area-level income and screening. Future longitudinal studies are needed to address those concerns. Second, the definition of "non-recent screening" using a 5-year cut-off was therefore potentially conservative for people receiving colonoscopy. However, when a 10-year cut-off was applied, results for lifetime and non-recent screening were similar. Third, we cannot discount the possibility of residual confounding. However, our sensitivity analyses suggest that an unmeasured factor would have to be strongly associated with area-level income and lifetime screening (as strong as not having a regular physician) to cause the lowest bound of the 95% confidence limits to cross the null. Fourth, all data were self-reported. On average, respondents tend to over-report preventive cancer screening [that is, sensitivity is 77.4% and specificity is 89.8% for a report of fecal occult blood testing in the preceding 2 years, and the record-to-record ratio is 1.18 (95% CL: 1.16, 1.20)][43,44], which suggests that the CCHS might underestimate screening gaps. Although, to our knowledge, no studies have assessed differences in self-reported colorectal screening by socioeconomic status, evidence for other cancer sites suggest that self-reported data could also lead to an underestimation of socioeconomic disparities in screening[45].

CONCLUSIONS

In the present study, we observed a gradient in never-screening according to local area-level income in a country with universal health care coverage. That finding highlights the potential influence of social and environmental contexts above and beyond individual-level factors on colorectal screening uptake. The role of socioeconomic contexts with respect to screening behaviour merits attention in both future research and surveillance. Persistent area-level disparities in screening initiation might indicate a need for program modifications or additional targeted interventions.

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood *Current Oncology*'s policy on disclosing conflicts of interest, and we declare that we have none.

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