

# The north–south and east–west gradient in colorectal cancer risk: a look at the distribution of modifiable risk factors and incidence across Canada

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## ABSTRACT

Colorectal cancer (CRC) is the 2nd most common cancer in Canada and the 2nd leading cause of cancer death. That heavy burden can be mitigated given the preventability of CRC through lifestyle changes and screening. Here, we describe the extent of the variation in CRC incidence rates across Canada and the disparities, by jurisdiction, in the prevalence of modifiable risk factors known to contribute to the CRC burden.

Findings suggest that there is a north–south and east–west gradient in CRC modifiable risk factors, including excess weight, physical inactivity, excessive alcohol consumption, and low fruit and vegetable consumption, with the highest prevalence of risk factors typically found in the territories and Atlantic provinces. In general, that pattern reflects the CRC incidence rates seen across Canada. Given the substantial interjurisdictional variation, more work is needed to increase prevention efforts, including promoting a healthier diet and lifestyle, especially in jurisdictions facing disproportionately higher burdens of CRC.

Based on current knowledge, the most effective approaches to reduce the burden of CRC include adopting public policies that create healthier environments in which people live, work, learn, and play; making healthy choices easier; and continuing to emphasize screening and early detection. Strategic approaches to modifiable risk factors and mechanisms for early cancer detection have the potential to translate into positive effects for population health and fewer Canadians developing and dying from cancer.

**Key Words** Colorectal cancer, disparities, equity, risk factors, prevention

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## INTRODUCTION

The burden of colorectal cancer (CRC) in Canada is substantial. Colorectal cancer is the 2nd most common cancer in Canada and the 2nd leading cause of cancer death<sup>1</sup>. In 2017, approximately 26,800 new cases of CRC were diagnosed, exceeding the number of new breast and prostate cancer diagnoses<sup>1</sup>. Furthermore, it is estimated that 1 in 13 men and 1 in 16 women will be diagnosed with CRC in their lifetime<sup>1</sup>.

That heavy burden can be mitigated, given that CRC is largely preventable<sup>2,3</sup>. Compelling evidence indicates that the risk of CRC is increased by excess body weight; physical inactivity; excessive alcohol consumption; a diet low in

dietary fibre, including fruits and vegetables; consumption of red and processed meat; and smoking<sup>4</sup>. Previous research has estimated that almost half of all CRC cases could be prevented through healthier diets and physically active lifestyles<sup>5</sup>.

The age-adjusted incidence rates for CRC show considerable jurisdictional variation—greater than the variation seen for many other cancers<sup>6</sup>. Those wide variations likely reflect differences in the prevalence of risk factors, screening participation, and genetic predispositions to CRC in certain populations. In the present article, we describe the extent of the variation in CRC incidence rates across Canada and the disparities, by jurisdiction, in the prevalence of modifiable risk factors known to contribute to the burden

of CRC. Such information can allow for the identification of jurisdictions that would benefit most from focused prevention efforts, which ultimately will have a large-scale positive effect on population health and could lead to a reduction in preventable cancer cases.

## METHODS

Incident cases of CRC were obtained from the Canadian Cancer Registry. Cases diagnosed in 2014 were used for most jurisdictions. The exceptions were Quebec, whose most recent available cases came from 2010, and the territories, whose cases diagnosed during 2012–2014 were combined to achieve more stable rates, given much smaller populations. The rates were age-standardized based on the 2011 Canadian population. Data for four known modifiable risk factors for CRC (excess weight, physical inactivity, excessive alcohol consumption, and low fruit and vegetable consumption) were obtained from the 2015–2016 combined Canadian Community Health Survey, a cross-sectional survey of the noninstitutionalized Canadian population 12 years of age and older. The estimates presented were adjusted using sampling weights to represent the overall population<sup>7</sup>.

For each jurisdiction, the prevalence of the four risk factors were summed. Subsequently, based on the summation range in the 13 jurisdictions, the jurisdictions were categorized into three groups: lower risk, middle risk, and higher risk. The higher-risk category represents jurisdictions that could benefit most from initiatives to reduce the prevalence of risk factors, potentially leading to lower CRC incidence rates over time.

## RESULTS

### CRC Incidence

Age-standardized CRC incidence rates varied across the country from 55.0 cases per 100,000 population in Ontario to 95.4 cases per 100,000 population in the Northwest Territories. The highest rates were observed in the Northwest Territories and Newfoundland and Labrador; the lowest rate was observed in Ontario (Figure 1).

### CRC Risk Factors

In general, a north–south and east–west gradient across Canada is evident in the prevalence of the included risk factors (excess weight, physical inactivity, excessive alcohol consumption, and low fruit and vegetable consumption). Jurisdictions with the highest combined prevalence of risk factors (those in the higher-risk category) were Newfoundland and Labrador, New Brunswick, the Northwest Territories, and Nova Scotia (Figure 1). More specifically,

- the percentage of adults with excess body weight (overweight or obesity) ranged from 56.8% in British Columbia to 73.1% in New Brunswick.
- the percentage of adults not meeting the physical activity guidelines ( $\geq 150$  minutes of exercise weekly) ranged from 31.8% in Yukon to 50.3% in New Brunswick.
- the percentage of individuals who reported, for the preceding year, drinking in excess of *Canada's*

*Low-Risk Alcohol Drinking Guidelines* as they pertain to cancer prevention ranged from 7.2% in New Brunswick to 16.2% in the Northwest Territories.

- the percentage of individuals who reported consuming fruits and vegetables fewer than 5 times daily ranged from 61.4% in Quebec to 79.6% in Newfoundland and Labrador.

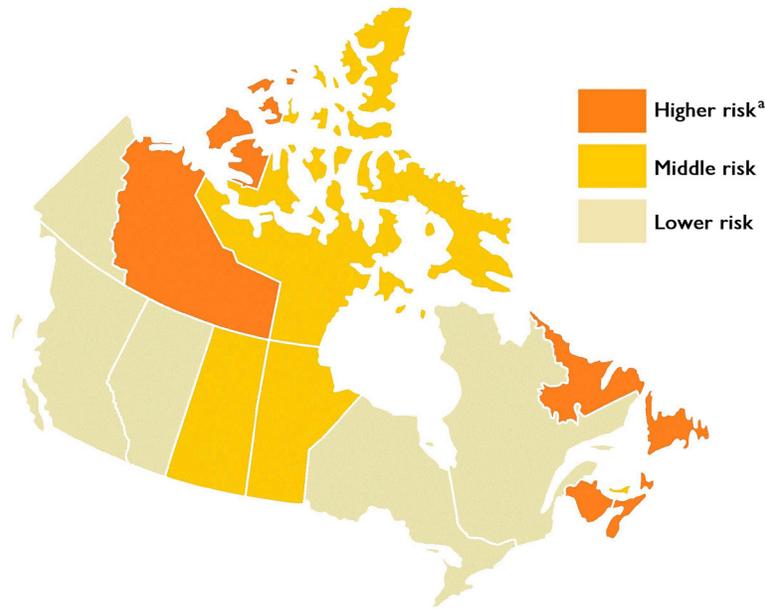
## DISCUSSION AND CONCLUSIONS

The present work provides a snapshot of the current landscape of modifiable risk factors for CRC across Canada and the existing disparities in risk factor prevalence and cancer incidence. For instance, the incidence of CRC in the provinces and territories with the highest rates is nearly double the incidence in jurisdictions with the lowest rates. The data also suggest that there is a north–south and east–west gradient in CRC modifiable risk factors. In general, that pattern reflects the CRC incidence rates seen across Canada. The highest prevalence of risk factors and rates of CRC are typically seen in the territories and Atlantic provinces. That pattern seems to be a reoccurring phenomenon in public health. Our findings further confirm that where people live influences their health behaviours, which can ultimately affect their risk of developing cancer<sup>8</sup>. Given that substantial interjurisdictional variation, more work is needed to increase prevention efforts, including promoting healthier diets and lifestyles, especially in jurisdictions facing a disproportionately higher burden of CRC.

All of the risk factors considered in this article, including overweight or obesity, physical inactivity, excessive alcohol consumption, and low consumption of fruits and vegetables, are well-established risk factors for CRC<sup>2–4,8,9</sup>. Those risk factors were considered in combination because it is unlikely that any single component could explain the large variation in CRC incidence observed. Additionally, it was previously shown that the more preventable risk factors an individual is exposed to, the greater their chance of developing CRC<sup>10</sup>. Despite smoking being an established risk factor, smoking was not included in the analysis because of the 20- to 30-year lag time required for declines in current smoking rates to translate into drops in cancer incidence<sup>11</sup>. Furthermore, smoking has been declining over time; in contrast, rates of obesity, physical inactivity, alcohol consumption, and inadequate consumption of fruits and vegetables have increased or remain high<sup>12–15</sup>.

Although the overall incidence rates for CRC have been declining since the mid-2000s, the decline appears to be confined to older adults; incidence rates are increasing among people less than 50 years of age in Canada and the United States<sup>1</sup>. It is speculated that the rising trend in younger Canadians is the result of changing trends in lifestyle, particularly the increasing prevalence of excess weight and physical inactivity in younger generations<sup>16</sup>. Furthermore, rising rates of CRC in low- and middle-income countries undergoing rapid economic growth correlate with the increasing prevalence of obesity and decreasing physical activity resulting from the adoption of a Western lifestyle<sup>17</sup>.

Based on current knowledge, the most effective approaches to further reduce the burden of CRC include adopting public policies that create healthier environments



Variable	Province or territory												
	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	YT	NT	NU
CRC incidence (per 100,000) <sup>b</sup>	63.5	62.7	72.1	62.9	55.0	68.4	60.6	70.5	77.3	94.9	56.7	95.4	86.9
Excess weight (%) <sup>c</sup>	56.8	65.1	69.7	64.6	61.4	60.7	73.1	69.4	70.8	73.0	67.4	72.6	62.4
Physical inactivity (%) <sup>d</sup>	34.3	40.3	45.0	46	42.6	45.1	50.3	43.5	46.6	50.2	31.8	38.7	44.7
Excessive alcohol consumption (%) <sup>e</sup>	8.5	8.4	7.5	7.7	7.8	9.7	7.2	8.0	7.6	8.7	11.7	16.2	8.0 <sup>f</sup>
Low fruit and vegetable consumption (%) <sup>g</sup>	69.2	70.0	71.8	72.7	72.2	61.4	73.0	75.9	71.2	79.6	71.5	75.1	74.8
Sum of risk factor prevalence <sup>h</sup>	168.8	183.8	194.0	191.0	184.0	176.9	203.6	196.8	196.2	211.5	182.4	202.6	189.9
Categorization	Lower risk	Lower risk	Middle risk	Middle risk	Lower risk	Lower risk	Higher risk	Higher risk	Middle risk	Higher risk	Lower risk	Higher risk	Middle risk

<sup>a</sup> Priority areas for focused prevention efforts.  
<sup>b</sup> Age-standardized to the 2011 Canadian population. The QC incidence rates for 2014 were duplicates of the 2010 values because of data availability.  
<sup>c</sup> Adults (≥18 years of age) with a body mass index of 25 or higher.  
<sup>d</sup> Adults (≥18 years of age) who participated in less than 150 minutes of moderate- to vigorous-intensity aerobic physical activity weekly (*Canadian Physical Activity Guidelines*).  
<sup>e</sup> Adults (≥18 years of age) who, if male, reported having 2 or more drinks daily or, if female, reported having more than 1 drink daily (*Canada's Low-Risk Alcohol Drinking Guidelines* as they pertain to cancer).  
<sup>f</sup> Interpret with caution because of large variability in the estimate.  
<sup>g</sup> Individuals (≥12 years of age) who reported consuming fruits and vegetables fewer than 5 times daily.  
<sup>h</sup> The prevalence for the four risk factors within each jurisdiction were summed, and based on the summation range, the jurisdiction was categorized into one of three groups: lower risk, middle risk, or higher risk.

Data sources: Statistics Canada, Canadian Community Health Survey and Canadian Cancer Registry.

**FIGURE 1** Priority jurisdictions for focused prevention efforts based on prevalence of modifiable risk factors for colorectal cancer (CRC) in Canada.

where people live, work, learn, and play; making healthy choices easier; and continuing to emphasize screening and early detection<sup>6,18</sup>. Screening for CRC can drive incidence rates because screening can not only identify early-stage cancers, but also precancerous polyps that can be removed before they develop into cancer<sup>19</sup>. As of 2017, all ten provinces had implemented or were in the process of implementing organized CRC screening programs; however, participation rates vary within and between existing programs, and no jurisdiction has reached the National Colorectal Screening

Network's programmatic participation target of 60%<sup>20</sup>. Ultimately, strategic approaches to addressing modifiable risk factors—and mechanisms for early cancer detection—have the potential to translate into positive effects for population health and fewer Canadians developing and dying from cancer.

An emerging strategy to detect CRC before it develops that warrants further exploration is genetic testing. Approximately 5% of CRC cases arise because of well-defined hereditary syndromes, providing opportunities for targeted

clinical interventions and prevention<sup>21</sup>. Advances in genetic testing have made it possible to establish whether individuals are at high risk of hereditary cancers; however, many patients and their family members are not being referred to a genetic counsellor or genetic testing even when eligible<sup>21</sup>. Early detection of a hereditary CRC syndrome such as Lynch syndrome would allow for early management through enhanced screening and surveillance. To prevent deepening the disparities in the CRC burden, efforts have to be made to increase physician knowledge about genetic testing and patient eligibility, and to ensure that genetic testing is available and accessible throughout Canada.

It is known that disparities in cancer incidence tend to be differentially distributed based on social determinants such as socioeconomic status, education level, and housing status, among others. People of lower socioeconomic status are more likely to have a higher alcohol intake, to experience food insecurity, to have meager access to healthy foods, and to lack opportunities for physical activity<sup>22</sup>. Notably, household food insecurity tends to be highest in Northern and Atlantic Canada<sup>23</sup>. Moreover, it has previously been shown that socioeconomic disparities influence CRC screening rates, with people of lower income and education being less likely to be screened in all provinces regardless of length of time since screening program implementation<sup>24</sup>. To ensure an equitable cancer control system for all, further work is needed to explore the extent of cancer incidence disparities and to develop policies that address modifiable risk factors and the social-determinant root causes of disparities.

Our study has some limitations. The prevalence of risk factors was based on self-reported survey data, and therefore could potentially underestimate the true proportion of risk factors in the various jurisdictions. Furthermore, representative data for other modifiable risk factors for CRC in the Canadian population, such as red and processed meat consumption, were not available and were not considered in the analysis. For the purposes of the present article, all risk factors were considered to be equal in their contribution to CRC risk. It is therefore possible that we might have overlooked some jurisdictions as priority areas for prevention efforts.

The System Performance Initiative at the Canadian Partnership Against Cancer will soon be releasing the *2018 Cancer System Performance Report*, which features the work presented in this article and further describes the extent to which the health system across Canada is providing high-quality, seamless, equitable, and sustainable cancer care. More information can be found at <http://www.systemperformance.ca/>.

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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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