Variation across Canada in the economic burden attributable to excess weight, tobacco smoking and physical inactivity

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ABSTRACT

OBJECTIVES: Tobacco smoking, excess weight and physical inactivity contribute substantially to the preventable disease burden in Canada. The purpose of this paper is to determine the potential reduction in economic burden if all provinces achieved prevalence rates of these three risk factors (RFs) equivalent to those of the province with the lowest rates, and to update and address a limitation noted in our previous model.

METHODS: We used a previously developed approach based on population attributable fractions to estimate the economic burden associated with these RFs. Sex-specific relative risk and age-/sex-specific prevalence data were used in the modelling. The previous model was updated using the most current data for developing resource allocation weights.

RESULTS: In 2012, the prevalence of tobacco smoking, excess weight and physical inactivity was the lowest in British Columbia. If age- and sex-specific prevalence rates from BC were applied to populations living in the other provinces, the annual economic burden attributable to these three RFs would be reduced by \$5.3 billion. Updating the model resulted in a considerable shift in economic burden from smoking to excess weight, with the estimated annual economic burden attributable to excess weight now 25% higher compared to that of tobacco smoking (\$23.3 vs. \$18.7 billion).

CONCLUSION: Achieving RF prevalence rates equivalent to those of the province with the lowest rates would result in a 10% reduction in economic burden attributable to excess weight, smoking and physical inactivity in Canada. This study shows that using current resource use data is important for this type of economic modelling.

KEY WORDS: Economic burden of disease; populations at risk; risk factors; obesity; overweight; smoking

La traduction du résumé se trouve à la fin de l'article.

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In Canada, tobacco smoking, excess weight and physical inactivity are among the top five risk factors (RFs) in terms of their attributable disease burden in the population.¹ The annual economic burden in Canada ascribed to these three RFs was previously estimated at \$50.3 billion in 2012.² This previous analysis suggests that even a modest 1% annual relative reduction in the prevalence of tobacco smoking, excess weight and physical inactivity can have a substantial health and economic impact over time at the population level, resulting in an estimated \$8.5 billion annual reduction in the economic burden in Canada by 2031.²

The purpose of the current study is twofold: 1) to determine the potential reduction in economic burden if all provinces achieved prevalence rates of tobacco smoking, excess weight and physical inactivity equivalent to those of the province with the lowest rates, and 2) to update and address a limitation noted in our previous model.²

METHODS

The details of our base model have been previously published.^{2,3} In short, we used an approach based on population attributable fraction (PAF) to estimate the economic burden associated with the various RFs.

Relative risk

The sources and values for the relative risk (RR) associated with tobacco smoking,⁴ excess weight⁵ and physical inactivity⁶ remain the same as in the previously published model.

Risk factor exposure

The analysis of Canada's population exposure to tobacco smoking, physical inactivity and overweight/obesity used data from the 2012 Canadian Community Health Survey (CCHS).⁷ The territories were not included in our provincial-level analysis, but were included in our analysis of Canada as a whole. Individuals were considered overweight if their body mass index (BMI) was between 25 kg/m² and 29.99 kg/m² and obese if their BMI was ≥30 kg/m², calculated based on self-reported height and weight. For youth aged 12 to 17 years, the Cole system of BMI was used to determine overweight and obesity rates.⁸ Tobacco smokers were grouped into light (<10 cigarettes per day or occasional, non-daily smoking), moderate (10–19 cigarettes per day) or heavy (≥20 cigarettes per day) categories. Physical

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inactivity rates were based on those individuals categorized in the CCHS as 'inactive', based on average daily leisure energy expenditure over the past three months. Respondents were classified as physically inactive if their leisure energy expenditure was less than 1.5 kcal/kg/day.

We made one adjustment to this base CCHS data, namely estimating the rates of overweight, obesity and physical inactivity for children aged less than 12 years based on the sex-specific rates for 12–14 year olds in the CCHS. We assumed that children under the age of 12 did not smoke.

Multiple exposure levels

The PAF of physical inactivity was calculated using the formula $PAF = (E(RR - 1)) / (E(RR - 1) + 1)$, where E is the proportion of the population who are physically inactive and RR is the relative risk of disease developing in the physically inactive group.

Excess weight was regarded as a trichotomous exposure to excess body weight because three categories of exposure were involved: 1) no excess weight, 2) overweight (prevalence E_{OW}), and 3) obesity (prevalence E_{OB}). The PAF calculation used was as follows:

$$PAF = E_{OW}(RR_{OW} - 1) + E_{OB}(RR_{OB} - 1) / E_{OW}(RR_{OW} - 1) + E_{OB}(RR_{OB} - 1) + 1$$

Tobacco smoking was regarded as a tetrachotomous exposure because four categories of exposure were involved: 1) non-smoking, 2) light smoking (prevalence E_{TSL}), 3) moderate smoking (prevalence E_{TSM}), and 4) heavy smoking (prevalence E_{TSH}). The PAF calculation is as follows:

$$PAF = E_{TSL}(RR_{TSL} - 1) + E_{TSM}(RR_{TSM} - 1) + E_{TSH}(RR_{TSH} - 1) / E_{TSL}(RR_{TSL} - 1) + E_{TSM}(RR_{TSM} - 1) + E_{TSH}(RR_{TSH} - 1) + 1$$

Calculating and adjusting costs

We estimated the economic burden (direct and indirect costs) associated with the RFs in each province using a prevalence-based cost-of-illness approach, and reported this in 2013 Canadian dollars.

Direct costs, including hospital care, physician services, other health care professionals (but excluding dental services), drugs, health research, and 'other' health care expenditures were extracted for each province from the National Health Expenditure Database.⁹ Hospital care, physician care and drug costs by sex were allocated to each of the co-morbidity categories based on data from the *Economic Burden of Illness in Canada* (EBIC) online tool for 2008.¹⁰ EBIC cost data were not sufficiently detailed for a number of co-morbidities, including ICD-10 codes E11-14, I26, I71, I80-82, K55, K80-82, M45-54. In each of these situations, we estimated the costs based on the proportion of sex-specific acute hospital days in 2011/12 for the disease of interest to the relevant co-morbidity with EBIC 2008 costs.¹¹

EBIC 2008 does not allocate costs for other health care professionals (excluding dental services), health research, or 'other' health care expenditures. These were estimated by calculating the proportion of total hospital, physician and drug costs allocated to each co-morbidity by EBIC 2008 and then

assuming that this proportion would be the same for unallocated costs.

These sex-specific direct care costs by co-morbidity were then multiplied by the calculated risk factor-, sex-, and co-morbidity-specific PAFs to calculate the direct care costs attributable to a given risk factor. By completing the analysis at this level of detail, we are able to segment the results from a number of perspectives, including an assessment of direct care costs by cost category, sex, level of risk factor exposure, province and specific diseases.

Adjusting direct costs in a multifactorial system

We then applied the following formula for calculating the combined PAF in a multifactorial system to the calculated crude direct costs attributable to each of tobacco smoking, overweight/obesity and physical inactivity³:

$$\text{Combined PAF} = 1 - [(1 - PAF_{TS})(1 - PAF_{EW})(1 - PAF_{PIA})]$$

where PAF_{TS} is the crude PAF of cost for tobacco smoking, PAF_{EW} is the crude PAF of cost for excess weight and PAF_{PIA} is the crude PAF of cost for physical inactivity.

A disaggregation step was applied at the end of the direct costing process to notionally distribute the adjusted economic burden to each RF according to the proportional distribution of crude costs.

Indirect costs

We calculated indirect costs following the method used in EBIC 1998 (a modified human capital approach*).¹² In order to do so, we determined the ratio of direct to indirect costs for each diagnostic category within EBIC 1998, stratified by the specific category of indirect cost (i.e., short-term disability, long-term disability and premature mortality).³ The pertinent ratios (by diagnostic category and specific indirect cost category) were applied to the previously identified direct costs within each diagnostic category attributable to individual RFs in order to generate the equivalent indirect cost data.

Provincial-level analysis

After calculating the adjusted economic burden attributable to the three RFs in each province, we took the sex- and age-specific prevalence rates for each RF from the province with the lowest overall prevalence rate per risk factor and applied those to the populations of each remaining province. This allowed us to calculate the difference in annual economic burden for each province based on actual prevalence rates and those based on the comparator province.

Summary of model updates

As noted in the introduction, a secondary purpose of this study was to update and address a limitation in our previous model.^{2,3} At the time, we used the most recent data available on resource utilization from EBIC 1998¹² and the CIHI Hospital Morbidity

*In the human capital approach, gender- and age-specific average earnings are combined with productivity trends and years of life lost due to a specific disease/condition to estimate unrealized lifetime earnings. An important criticism of this method is that it places a higher value on the years of life lost for someone with higher earning potential. In particular, unpaid work and leisure time are not explicitly accounted for. EBIC 1998 addressed this issue by explicitly valuing non-productive time.

Database for 2000/01.¹³ This required the assumption that the distribution of costs had not significantly changed for specific cost categories over time. Updated numbers have shown this to be a flawed assumption. The current version of the model uses 2008 EBIC data, including the distribution of costs by cost category (hospital care, physician care and drugs), co-morbidity, sex and province. The allocation of costs by bed-days is used only occasionally in the model and has been updated to 2011/12 CIHI data.¹¹ In addition, the prevalence of risk factors was updated based on 2012 CCHS data⁷ (from 2010) and direct costs from the National Health Expenditure Database were updated to 2013⁹ (from 2012).

RESULTS

The economic burden attributable to excess weight, tobacco smoking and physical inactivity in Canada in 2013 is \$52.8 billion, with \$23.3 billion (44.1%) attributable to excess weight, \$18.7 billion to tobacco smoking (35.4%) and \$10.8 billion (20.4%) to physical inactivity (see Table 1).

Overall, the results of the updates to the 2012 model increased the economic burden attributable to the three RFs from \$50.3 billion (in 2012) to \$52.8 billion (in 2013), a 4.9% increase (see Table 2).

Updating the model from 1998 to 2008 EBIC data had a negligible effect on the overall model results, with the annual economic burden in Canada remaining at \$50.3 billion. There was, however, a major shift to the distribution of the economic burden by risk factor and disease category (see Table 2). The economic burden attributable to smoking decreased from \$21.3 billion to \$18.4 billion (–13.4%). The economic burden attributable to excess weight and physical inactivity, on the other hand, increased from \$19.0 billion to \$21.3 billion (11.7%) and \$10.0 billion to \$10.6 billion (6.3%) respectively. The economic burden attributable to diseases more commonly associated with tobacco smoking declined substantially as a result of this update (e.g., cancers by –26.4% and respiratory diseases by –12.6%) while those more commonly associated with excess weight increased substantially (e.g., diabetes by +74.0% and musculoskeletal diseases by +15.3%).

Updating the prevalence of risk factors from 2010 to 2012 CCHS data resulted in a 1.8% increase in the overall economic burden for Canada, from \$50.3 to \$51.2 billion (see Table 2). Between 2010 and 2012, the prevalence of smoking and physical inactivity decreased from 17.9% to 17.5% and 44.3% to 43.6% respectively. The prevalence of overweight increased from 28.6% to 30.2% while

Table 1. Estimated prevalence of RFs, total economic burden for multifactorial system, and disaggregated costs by RF, Canada, 2013, by sex adjusted for multiple RFs in one individual

	% Population with RF	# Individuals with RF	Direct cost per individual with RF (\$)	Indirect cost per individual with RF (\$)	Total cost per individual with RF (\$)	Total direct cost of RF (million\$)	Total indirect cost of RF (million\$)	Total cost of RF (million\$)
Males								
<i>Smokers</i>								
Light	7.7%	1,321,342	\$769	\$1,497	\$2,266	\$1,016	\$1,978	\$2,994
Moderate	5.8%	1,005,588	\$1,274	\$2,456	\$3,730	\$1,281	\$2,469	\$3,751
Heavy	6.4%	1,105,548	\$1,559	\$2,984	\$4,543	\$1,723	\$3,299	\$5,023
Subtotal – Male smokers	19.9%	3,432,478	\$1,171	\$2,257	\$3,428	\$4,020	\$7,747	\$11,767
<i>Excess weight</i>								
Over weight	36.7%	6,326,997	\$199	\$554	\$753	\$1,258	\$3,505	\$4,763
Obese	16.1%	2,776,253	\$722	\$1,645	\$2,367	\$2,003	\$4,567	\$6,571
Subtotal – Male excess weight	52.9%	9,103,250	\$358	\$887	\$1,245	\$3,261	\$8,072	\$11,334
<i>Inactive</i>	40.8%	7,030,810	\$238	\$497	\$735	\$1,673	\$3,493	\$5,166
Subtotal						\$8,955	\$19,312	\$28,267
Females								
<i>Smokers</i>								
Light	7.6%	1,323,306	\$570	\$1,103	\$1,673	\$755	\$1,460	\$2,214
Moderate	4.8%	848,665	\$994	\$1,936	\$2,930	\$844	\$1,643	\$2,487
Heavy	2.8%	484,763	\$1,563	\$3,045	\$4,608	\$757	\$1,476	\$2,234
Subtotal – Female smokers	15.2%	2,656,735	\$887	\$1,723	\$2,610	\$2,356	\$4,579	\$6,935
<i>Excess weight</i>								
Over weight	23.7%	4,155,943	\$291	\$753	\$1,044	\$1,209	\$3,128	\$4,337
Obesity	15.8%	2,776,253	\$867	\$1,879	\$2,746	\$2,406	\$5,216	\$7,623
Subtotal – Female excess weight	39.6%	6,932,196	\$521	\$1,204	\$1,725	\$3,615	\$8,345	\$11,960
<i>Inactive</i>	46.3%	8,109,515	\$197	\$495	\$692	\$1,600	\$4,012	\$5,612
Subtotal						\$7,571	\$16,936	\$24,506
Both sexes								
<i>Smokers</i>								
Light	7.6%	2,644,648	\$669	\$1,300	\$1,969	\$1,771	\$3,438	\$5,208
Moderate	5.3%	1,854,254	\$1,146	\$2,218	\$3,364	\$2,125	\$4,112	\$6,237
Heavy	4.6%	1,590,311	\$1,560	\$3,003	\$4,563	\$2,481	\$4,775	\$7,256
Subtotal – Smokers	17.5%	6,089,212	\$1,047	\$2,024	\$3,071	\$6,376	\$12,325	\$18,702
<i>Excess weight</i>								
Over weight	30.2%	10,482,940	\$235	\$633	\$868	\$2,467	\$6,633	\$9,100
Obesity	16.0%	5,552,506	\$794	\$1,762	\$2,556	\$4,409	\$9,784	\$14,193
Subtotal – Excess weight	46.1%	16,035,446	\$429	\$1,024	\$1,453	\$6,876	\$16,417	\$23,293
<i>Inactive</i>	43.6%	15,140,325	\$216	\$496	\$712	\$3,273	\$7,505	\$10,778
Total						\$16,526	\$36,248	\$52,773

RF = Risk factor.

Table 2. Summary effect of updating the 2012 model for Canada, changes by risk factor and disease category

	2012 Model (million\$)	Update EBIC (million\$)	% Change	2012 CCHS (million\$)	% Change	2013 Costs (million\$)	% Change	% Change 2012 to 2013 Model
By risk factor								
<i>Smokers</i>								
Light	\$5,906	\$5,095	-13.7%	\$5,059	-0.7%	\$5,208	2.9%	-11.8%
Moderate	\$7,048	\$6,120	-13.2%	\$6,058	-1.0%	\$6,237	3.0%	-11.5%
Heavy	\$8,334	\$7,221	-13.4%	\$7,048	-2.4%	\$7,256	3.0%	-12.9%
Subtotal – Smokers	\$21,288	\$18,435	-13.4%	\$18,165	-1.5%	\$18,702	3.0%	-12.1%
<i>Excess weight</i>								
Over weight	\$7,522	\$8,523	13.3%	\$8,825	3.5%	\$9,100	3.1%	21.0%
Obesity	\$11,515	\$12,739	10.6%	\$13,759	8.0%	\$14,193	3.2%	23.3%
Subtotal – Excess weight	\$19,037	\$21,262	11.7%	\$22,584	6.2%	\$23,293	3.1%	22.4%
<i>Inactive</i>	\$9,988	\$10,619	6.3%	\$10,454	-1.5%	\$10,778	3.1%	7.9%
Total	\$50,313	\$50,316	0.0%	\$51,204	1.8%	\$52,773	3.1%	4.9%
By disease category								
Cardiovascular diseases	\$21,027	\$20,665	-1.7%	\$21,005	1.6%	\$21,656	3.1%	3.0%
Cancers	\$9,783	\$7,202	-26.4%	\$7,236	0.5%	\$7,445	2.9%	-23.9%
Musculoskeletal diseases	\$9,291	\$10,713	15.3%	\$11,120	3.8%	\$11,462	3.1%	23.4%
Respiratory Diseases	\$6,634	\$5,800	-12.6%	\$5,799	0.0%	\$5,971	3.0%	-10.0%
Diabetes	\$3,222	\$5,606	74.0%	\$5,691	1.5%	\$5,877	3.3%	82.4%
Other	\$354	\$330	-6.9%	\$352	6.5%	\$362	3.0%	2.1%
Total	\$50,313	\$50,316	0.0%	\$51,204	1.8%	\$52,773	3.1%	4.9%

Update EBIC = EBIC 2008 (including EBIC cost distribution) updated from EBIC 1998 (cost distribution based on patient bed-days).

2012 CCHS = 2012 CCHS prevalence data updated from 2010 CCHS.

2013 Costs = 2013 CIHI NHEX expenditures updated from 2012 CIHI NHEX.

the prevalence of obesity increased from 14.4% to 16.0%. These changes in risk factor prevalence are mirrored in the resulting economic burden (see Table 2). That is, the economic burden attributable to smoking and physical inactivity each *decreased* by 1.5%, while the economic burden attributable to obesity *increased* by 6.2%.

Finally, updating health care expenditures from 2012 (\$205.9 billion in total expenditures) to 2013 (\$211.2 billion in total expenditures)⁹ resulted in a 3.1% increase in the annual economic burden attributable to the three RFs in Canada.

In 2012, the province of British Columbia had the lowest prevalence of tobacco smoking, excess weight and physical inactivity in Canada. The prevalence of tobacco smoking ranged from 12.7% in British Columbia to 22.8% in Newfoundland and Labrador (see Figure 1). The prevalence of excess weight ranged

from 43.0% in British Columbia to 59.3% in Newfoundland and Labrador (see Figure 2). The prevalence of physical inactivity ranged from 36.1% in British Columbia to 48.5% in Quebec (see Figure 3). The resulting annual economic burden per capita attributable to the three RFs in British Columbia in 2013 was lower (\$1,249) than any other Canadian province (ranging from \$1,454 in Quebec to \$1,932 in Newfoundland and Labrador) (see Figure 4).

Applying the sex- and age-specific prevalence rates for each RF from British Columbia to the population of all other provinces would result in a reduced annual economic burden *per capita* ranging between \$130 (in Ontario) and \$405 (in Newfoundland and Labrador) (see Figure 5). The *total* annual reduction in economic burden would range between \$43.2 million in Prince Edward Island to \$1,756.8 million in Ontario (see Figure 6). If all provinces were to achieve BC prevalence rates for the three

Figure 1. Prevalence of tobacco smoking in Canada (%), by province and smoking intensity, 2012
Source: Canadian Community Health Survey: Public Use Microdata File, 2011/2012

Figure 2. Prevalence of excess weight in Canada (%), by province and overweight/obesity, 2012
Source: Canadian Community Health Survey: Public Use Microdata File, 2011/2012

Figure 3. Prevalence of physical inactivity in Canada (%), by province, 2012
Source: Canadian Community Health Survey: Public Use Microdata File, 2011/2012

Figure 6. Changes in annual economic burden in Canada (million\$) based on BC risk factor prevalence, by province and direct/indirect costs, 2013

Figure 4. Annual economic burden per capita in Canada (\$) attributable to tobacco smoking, excess weight and physical inactivity, by province and direct/indirect costs, 2013

Figure 5. Changes in annual per capita economic burden in Canada (\$) based on BC risk factor prevalence, by province and direct/indirect costs, 2013

risk factors, then \$5.3 billion in economic burden could be avoided annually (\$1.7 billion in direct costs and \$3.6 billion in indirect costs). Of this \$5.3 billion, \$2.8 billion (52.7% of the total economic burden avoided) would be attributable to a decrease in tobacco smoking, \$1.5 billion (28.0%) to a decrease in physical inactivity and \$1.0 billion (19.4%) to a decrease in excess weight.

DISCUSSION

In 2011–2012, the prevalences of excess weight, tobacco smoking and physical inactivity were lower in BC than in any other Canadian province. If these age- and sex-specific prevalence rates were achieved in all other provinces, the annual economic burden attributable to these three RFs would be reduced by 10.0%. The majority of this reduction would result from lower smoking rates.

By comparison, our previous analysis suggested that a 1% annual relative reduction in the three RFs would result in an \$8.5 billion annual reduction in economic burden in Canada by 2031, or 14.3% of the estimated \$59.2 billion (in 2012 constant dollars) total economic burden that year.²

The reasons for lower risk factor rates in BC are complex and impossible to entirely unravel. For example, BC's culture of health, together with favourable weather patterns in the southwest of the province, make outdoor physical activity more possible year-round than in most other parts of Canada. However, a number of key initiatives and leaders also have played an important role in helping BC residents to adopt healthier behaviours. In 2003, BC was awarded the 2010 Winter Olympics and the government of the day used the opportunity to launch ActNow BC, "a bold intersectoral initiative that integrates the actions of the whole-of-government with those of civil society ... intending to make BC the healthiest jurisdiction to ever host the Games."¹⁴ The initiative had strong support from the premier of the province. The BC Healthy Living Alliance (BCHLA), also formed in 2003, released a report titled *The Winning Legacy*¹⁵ in February of 2005, an evidence-based position paper outlining 27 recommendations to address the risk factors of excess weight, smoking and physical inactivity. ActNow BC provided \$25.2 million to the BCHLA to pursue

Table 3. Economic burden of illness in Canada by diagnostic category, indirect costs as percent of direct costs

Diagnostic category	EBIC 1998 (Human capital)			EBIC 2008 (Friction)		
	Mortality	Morbidity	Total	Mortality	Morbidity	Total
Malignant and other neoplasms	431%	46%	478%	3.5%	8.8%	12.3%
Endocrine, nutritional and metabolic diseases	64%	55%	119%	0.4%	2.5%	2.9%
Cardiovascular diseases	121%	50%	171%	0.8%	2.3%	3.1%
Respiratory diseases/infections	48%	99%	146%	0.3%	46.8%	47.1%
Digestive diseases	32%	33%	65%	0.4%	2.7%	3.2%
Musculoskeletal diseases	5%	514%	519%	0.0%	24.1%	24.2%

these initiatives.¹⁶ The BC government continues to focus on primary prevention.^{17–19} The province has also benefitted from the visionary leadership of individuals such as Barbara Kaminsky, the CEO of the Canadian Cancer Society BC/Yukon Division. She served as the inaugural leader of the BCHLA and the Primary Prevention Action Group of the Canadian Partnership against Cancer. More recently, she has spearheaded the implementation of the Cancer Prevention Centre in BC and is instrumental in leading its expansion across the country. A report produced by the Institute for Clinical Evaluative Sciences (ICES)²⁰ addressed the question *What Does It Take to Make a Healthy Province?* and found that strong political leadership, solutions that can be applied across governments with the participation of the larger civil society, timely action even if all evidence is not yet in, and enhanced funding are all critical.

Although updating our model to include more current data on resource use and costs had little impact on the overall economic burden attributable to the three risk factors, the update did produce a considerable change in the distribution of the economic burden by risk factor and disease category, resulting in substantially higher costs attributable to excess weight and lower costs attributable to smoking. This analysis calls into question our previous assumption that the distribution of costs have not changed significantly for specific disease categories over time, suggesting that it is important for data to be continually updated for this type of economic modelling. A comparison of acute care days in 2000/01¹³ and 2011/12¹¹ similarly indicates a decrease in the proportion of days treating neoplasms (–16.3%) and diseases of the circulatory system (–28.3%), and an increase in the proportion of days treating diseases of the musculoskeletal system and connective tissue (+9.6%), and endocrine, nutritional and metabolic diseases (+3.6%). A corresponding shift in mortality has also been noted globally, with age-standardized death rates due to cancers, cardiovascular and respiratory diseases declining between 1990 and 2013 and death rates due to diabetes and musculoskeletal disorders increasing.²¹

The result of this update also has important policy implications. From an economic perspective, the impact of excess weight in Canada is now more substantial than that of tobacco smoking. In addition, the continuing decline in smoking prevalence between 2010 and 2012, together with the increasing prevalence of excess weight, resulted in a widened gap between the economic burdens attributable to these two risk factors. Our

updated model suggests that in 2013, the annual economic burden attributable to excess weight in Canada was 25% higher than that attributable to tobacco smoking (\$23.3 vs. \$18.7 billion). Similar results have been observed in the United Kingdom, where the economic burden attributable to excess weight is 65% higher than that attributable to smoking.²²

The inclusion of indirect costs in any economic analysis is controversial, given that a variety of approaches exist, all of which generate very different results.^{23–26} In 1998, EBIC used a modified human capital approach, changing to the friction cost method[†] in 2008. The resulting indirect costs vary substantially (see Table 3).

If the friction cost method were applied to the current model, the indirect economic burden attributable to the three risk factors in Canada would be reduced from \$36.2 to \$2.1 billion. The focus of the friction cost method is on lost production from the “perspective of firms, consumers and society, without accounting for the potential income lost on an individual basis,”²⁷ nor does it value potential *time* lost due to morbidity or mortality. That is, while smoking may reduce a person’s life by an average of 11–12 years,²⁸ the friction cost method only applies a value on the time period that it takes to replace this individual in the workforce. Placing an economic value on time lost due to disability and premature mortality (as in the modified human capital approach) allows us to compare the broader effect of the risk factors on society as a whole, rather than from a narrow focus on production losses.

While we have addressed an important limitation in our original model, other limitations continue to exist. Most importantly, the method of scaling up from direct to indirect costs depends on the assumption that the ratios of costs have not changed over time. In addition, the source for the RRs associated with smoking⁴ and physical inactivity⁶ adjust for known confounding factors in generating disease-specific RRs. The meta-analyses for the RRs associated with overweight and obesity, however, did not include physical inactivity as a potentially confounding RF,⁵ which may lead to an overestimate of the economic burden attributable to excess weight. Previous sensitivity analysis also suggests that the true economic burden may vary by $\pm 17\%$ of our best estimate.²

†The friction cost method attempts to measure only actual production losses to society during the friction period between the start of an absence from work (resulting from short-term absence, long-term absence, disability and mortality) and when original productivity levels are restored.

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RÉSUMÉ

OBJECTIFS : La cigarette, la surcharge pondérale et l'inactivité physique contribuent sensiblement au fardeau des maladies pouvant être prévenues au Canada. L'objectif du présent document est de déterminer la réduction possible du fardeau économique si toutes les provinces atteignaient un taux de prévalence de ces trois facteurs de risque (FR) équivalent à celui de la province ayant le taux le plus bas, et de mettre à jour et de traiter une limite soulignée dans notre précédent modèle.

MÉTHODES : Nous avons eu recours à une démarche déjà élaborée fondée sur les fractions attribuables de la population pour estimer le fardeau économique lié à ces FR. Les données sur le risque relatif propre à l'âge et sur la prévalence propre à l'âge et au sexe ont servi à monter le modèle. Le modèle antérieur a été mis à jour au moyen des données les plus courantes pour déterminer le poids de l'allocation des ressources.

RÉSULTATS : En 2012, c'est en Colombie-Britannique que la prévalence de la cigarette, de la surcharge pondérale et de l'inactivité physique était la plus faible. Si le taux de prévalence propre à l'âge et au sexe de la C.-B. était appliqué aux populations qui vivent dans les autres provinces, le fardeau économique annuel attribuable à ces trois FR serait réduit de 5,3 milliards \$. La mise à jour du modèle a suscité un glissement considérable du fardeau économique de la cigarette à la surcharge pondérale avec le fardeau économique estimé attribuable à la surcharge pondérale maintenant de 25 % supérieur à celui de la cigarette (23,3 milliards \$ c. 18,7 milliards \$).

CONCLUSION : L'atteinte des taux de prévalence des FR équivalents à ceux de la province ayant les taux les plus bas entraîne une réduction de 10 % du fardeau économique attribuable à la surcharge pondérale, à la cigarette et à l'inactivité physique au Canada. Cette étude montre que le recours aux données sur l'utilisation actuelle des ressources est important pour ce genre de modèle économique.

MOTS CLÉS : fardeau économique de la maladie; populations à risque; facteurs de risque; obésité; surcharge pondérale; cigarette