Regional variations in the economic burden attributable to excess weight, physical inactivity and tobacco smoking across British Columbia

H. Krueger, PhD (1, 2); J. M. Koot, BSc (2); D. P. Rasali, PhD (3, 4); S. E. Gustin, MPH (3); M. Pennock, MSc (5)

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Abstract

Introduction: Prevalence rates of excess weight, tobacco smoking and physical inactivity vary substantially by geographical region within British Columbia (B.C.). The purpose of this study is to determine the potential reduction in economic burden in B.C. if all regions in the province achieved prevalence rates of these three risk factors equivalent to those of the region with the lowest rates.

Methods: We used a previously developed approach based on population-attributable fractions to estimate the economic burden associated with the various risk factors. Sex-specific relative risk and age/sex-specific prevalence data was used in the modelling.

Results: The annual economic burden attributable to the three risk factors in B.C. was about $5.6 billion in 2013, with a higher proportion of this total attributable to excess weight ($2.6 billion) than to tobacco smoking ($2.0 billion). While B.C. has lower prevalence rates of the risk factors than any other Canadian province, there is significant variation within the province. If each region in the province were to achieve the best prevalence rates for the three risk factors, then $1.4 billion (24% of the $5.6 billion) in economic burden could be avoided annually.

Conclusion: There are notable disparities in the prevalence of each risk factor across health regions within B.C., which were mirrored in each region's attributable economic burden. A variety of social, environmental and economic factors likely drive some of this geographical variation and these underlying factors should be considered when developing prevention programs.

Keywords: *economic burden of disease, populations at risk, risk factors, tobacco smoking, physical activity, body weight*

Highlights

- In British Columbia in 2013, the economic burden due to excess weight ($2.6 billion) was higher than for tobacco smoking ($2.0 billion) or physical inactivity ($1.0 billion).
- The economic burden of excess weight, physical inactivity and tobacco smoking differs across the 16 health regions in British Columbia.
- Reducing the prevalence of excess weight, physical inactivity and tobacco smoking in all the health regions to that of the region with the lowest rates would lower the total annual economic burden by one quarter, from $5.6 billion to $4.2 billion.
- Variation in the prevalence of excess weight, physical inactivity and tobacco smoking is greater within B.C. (24%) than between provinces (10%).
- The geographical variations between the health regions may help decide which prevention efforts should be directed to which areas.

Introduction

The annual economic burden of excess weight, physical inactivity and tobacco smoking was about $52.8 billion in 2013 in Canada.[1] A modest 1% annual relative reduction in the prevalence of these three risk factors can have a substantial health and economic impact over time at the population level, resulting in an estimated $8.5 billion annual reduction in economic burden in Canada by 2031.[2]

With a land mass of almost 10 million square kilometres, Canada is the world's second largest country. The country is divided into 10 provinces and 3 territories. The total population was about 35.2 million in 2013, with the provinces ranging in population from 146 000 in Prince Edward Island to 13.6 million in Ontario.[3] British Columbia (B.C.), the westernmost province, has a population of 4.7 million.

Of all the provinces, the prevalence of tobacco smoking, excess weight and physical inactivity were the lowest in B.C. in 2012. If age- and sex-specific prevalence rates from B.C. were applied to the

Author references:

1. School of Population and Public Health, University of British Columbia, Vancouver, British Columbia, Canada
2. H. Krueger & Associates Inc., Delta, British Columbia, Canada
3. Population and Public Health, British Columbia Provincial Health Services Authority (PHSA), Vancouver, British Columbia, Canada
4. Faculty of Kinesiology and Health Studies, University of Regina, Regina, Saskatchewan, Canada
5. Population Health Surveillance and Public Health Planning, British Columbia Ministry of Health, Vancouver, British Columbia, Canada

Correspondence: Hans Krueger, H. Krueger & Associates Inc., 4554 48B Street, Delta, BC V4K 2R8; Tel: 604-946-5464; Email: hans@krueger.ca

populations in other provinces, the annual economic burden attributable to these three risk factors would be reduced by $5.3 billion, or 10.0% of the $52.8 billion total economic burden of the risk factors.[1]

While B.C. has lower prevalence rates of these risk factors than any other province, there is significant variation within the province. B.C. is divided into five health authorities: Fraser Health, Vancouver Coastal Health, Vancouver Island Health, Interior Health and Northern Health. The health regions range in population from 0.3 million (Northern Health) to 1.7 million (Fraser Health). Each health authority (HA) is further subdivided into three or four health service delivery areas (HSDAs), with a population of between 73 000 (Northeast HSDA) and 748 000 (Fraser South HSDA).

The purpose of our study is to determine the potential reduction in economic burden in B.C. if all HSDAs in the province achieved prevalence rates of excess weight, physical inactivity and tobacco smoking equivalent to those of the HSDAs with the lowest rates.

Methods

Details of our base model, together with an update, have been previously described.[1,2,4] Briefly, we used an approach based on population-attributable fraction to estimate the economic burden associated with the three risk factors. This involves the following seven steps:

(1) estimate the prevalence of the three risk factors in the geographical regions of interest;
(2) estimate the causal relationship between the risk factor and comorbidities based on relative risk;
(3) calculate the population-attributable fraction taking into account the continuous nature of excess weight (from no excess weight to overweight to obese) and tobacco smoking (no, light, moderate and heavy smoking);
(4) estimate the direct costs of treating the comorbidities associated with the risk factors in the geographical regions of interest;
(5) adjust the direct costs for overlapping risk factors in a given person;
(6) estimate indirect costs;
(7) disaggregate the total economic burden to provide an estimate of the economic burden of each risk factor.

Prevalence rates for tobacco smoking, overweight/obesity and physical inactivity were drawn from the 2011/12 Canadian Community Health Survey (CCHS). People were considered overweight if their body mass index (BMI) was between 25 kg/m^2 and 29.9 kg/m^2 and obese if their BMI was equal to or greater than 30 kg/m^2, 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.[5]

Tobacco smokers were grouped as light ($<$ 10 cigarettes per day), moderate (10–19 cigarettes per day) and heavy ($\geq$ 20 cigarettes per day) smokers based on the average number of cigarettes smoked per day according to the CCHS 2011/2012 Public Use Microdata File (PUMF).[6] All current smokers who identified themselves as occasional smokers were included in the ''light smoking'' category.

Physical inactivity rates were based on people categorized as ''inactive'' in the CCHS. Respondents were classified as active, moderately active or inactive based on an index of average daily leisure time physical activity over the past 3 months. For each leisure time physical activity the respondent engaged in, an average daily energy expenditure was calculated by multiplying the number of times the activity was performed by the average duration of the activity and the estimated energy cost (kilocalories per kilogram of body weight per hour) of the activity. The index was calculated as the sum of the average daily energy expenditures of all activities. 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 younger than 12 years based on the sex-specific rates for 12- to 14-year-olds from the CCHS. We assumed that no children under the age of 12 smoked tobacco.

The sources and values for the relative risks associated with tobacco smoking,[7] excess weight[8] and physical inactivity[9] remain the same as in the previously published model.[1,2,4]

Calculating and adjusting costs

We estimated the economic burden (direct and indirect costs) associated with the risk factors in B.C. and each HA/HSDA in the province using a prevalence-based cost-of-illness approach. The cost estimates are expressed in 2013 Canadian dollars.

In our model, direct costs include hospital care, physician services, other health care professionals (excluding dental services), drugs, health research, public health, administration and ''other'' health care expenditures. In B.C., these costs equal $22.0 billion of the $27.1 billion in total health care expenditures, based on data extracted from the National Health Expenditure Database.[10] Costs excluded from the $27.1 billion were for other institutions* ($1.7 billion), dental services ($2.1 billion) and capital ($1.3 billion).

Expenditures within the categories of ''other health care professionals'' (dental services, vision care services, other) and ''other health spending'' (research and other) were not detailed for B.C. We assumed a distribution of these expenditures equivalent to the distribution in Canada. To distribute these $27.1 billion to B.C. HAs and HSDAs, we first derived the volume of acute care cases and days by HA and HSDA based on the patient's residence.[11] Thus, we attributed the days spent by a patient in a hospital in another region back to the patient's home region. We then used the distribution of acute care patient days by HA and HSDA to distribute the $8.2 billion in hospital expenditures in B.C. We distributed all other costs to the HAs and HSDAs based on the proportion of hospital costs attributed to that region.

Hospital care, physician care and drug costs by sex were allocated to each comorbidity based on 2008 data from the Economic Burden of Illness in Canada (EBIC) online tool.[12] The comorbidities associated with

*These are residential care facilities for the chronically ill or disabled who reside at the institution more or less permanently.

TABLE 1
Estimated prevalence of risk factors, total economic burden for multifactorial system, and disaggregated costs by risk factor[a]

	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, millions $	Total indirect cost of RF, millions $	Total cost of RF, millions $
Males								
Smokers								
Light	6.27	142 741	905	1655	2560	129.2	236.2	365.4
Moderate	3.90	88 701	1554	2830	4384	137.9	251.0	388.9
Heavy	3.91	89 029	2011	3635	5647	179.1	323.7	502.7
Subtotal-Male Smokers	14.07	320 471	1392	2530	3922	446.1	810.9	1257.0
Excess Weight								
Overweight	34.97	796 125	190	519	709	151.0	413.5	564.5
Obese	14.22	323 693	711	1592	2304	230.2	515.5	745.7
Subtotal-Male Excess Weight	49.18	1 119 818	340	830	1170	381.2	929.0	1310.2
Inactive	35.47	807 684	223	392	615	179.8	316.8	496.6
Subtotal-Males						1007.1	2056.7	3063.8
Females								
Smokers								
Light	6.48	149 275	636	1115	1750	94.9	166.4	261.3
Moderate	3.66	84 354	1132	1990	3122	95.5	167.9	263.4
Heavy	2.11	48 607	1794	3146	4940	87.2	152.9	240.1
Subtotal-Female Smokers	12.24	282 236	984	1726	2710	277.6	487.2	764.8
Excess Weight								
Overweight	23.05	531 239	280	685	965	148.8	363.7	512.5
Obesity	11.00	253 560	954	1940	2893	241.8	491.8	733.6
Subtotal-Female Excess Weight	34.05	784 799	498	1090	1588	390.6	855.5	1246.1
Inactive	40.36	930 262	183	383	566	169.8	356.7	526.5
Subtotal-Females						838.0	1699.3	2537.4
Both Sexes								
Smokers								
Light	6.37	292 016	767	1379	2146	224.1	402.7	626.7
Moderate	3.78	173 055	1349	2420	3769	233.4	418.9	652.2
Heavy	3.00	137 637	1935	3462	5397	266.3	476.6	742.8
Subtotal-Smokers	13.15	602 707	1201	2154	3355	723.7	1298.1	2021.8
Excess Weight								
Overweight	28.97	1 327 364	226	586	811	299.8	777.2	1 077.0
Obesity	12.60	577 253	818	1745	2563	472.0	1007.3	1479.3
Subtotal-Excess Weight	41.57	1 904 617	405	937	1342	771.8	1784.5	2 556.3
Inactive	37.93	1 737 946	201	388	589	349.6	673.5	1 023.1
Total						1845.1	3756.1	5601.2

Abbreviation: RF, risk factor.

[a] Adjusted for multiple RFs in one individual.

TABLE 2
Estimated prevalence of risk factors, total economic burden for multifactorial system, and disaggregated costs by risk factor, British Columbia Health Authorities, 2013, by sex adjusted for multiple risk factors in one individual

	Population with RF, %	Number of individuals with RF, n	Direct cost per individual with RF, $	Indirect cost per individual with RF, $	Total cost per individual with RF, $	Total direct cost of RF, millions $	Total indirect cost of RF, millions $	Total cost of RF, millions $
Interior Health								
Smokers								
Light	7.78	55 791	682	1228	1910	38.0	68.5	106.5
Moderate	6.57	47 159	1114	2001	3115	52.5	94.4	146.9
Heavy	4.02	28 809	1693	3028	4721	48.8	87.2	136.0
Subtotal - Smokers	18.36	131 759	1058	1898	2956	139.3	250.1	389.4
Excess Weight								
Overweight	31.42	225 430	227	586	813	51.1	132.2	183.3
Obesity	15.12	108 516	793	1701	2494	86.1	184.6	270.7
Subtotal - Excess Weight	46.55	333 946	411	949	1359	137.2	316.7	454.0
Inactive	33.02	236 878	211	406	616	49.9	96.1	146.0
Total						326.4	663.0	989.4
Fraser Health								
Smokers								
Light	5.72	96 722	807	1448	2255	78.1	140.1	218.1
Moderate	2.84	47 920	1431	2560	3990	68.6	122.7	191.2
Heavy	2.78	47 053	1999	3586	5586	94.1	168.7	262.8
Subtotal - Smokers	11.34	191 696	1256	2251	3506	240.7	431.5	672.1
Excess Weight								
Overweight	30.12	509 054	216	561	777	110.2	285.4	395.6
Obesity	12.83	216 835	782	1670	2452	169.5	362.1	531.6
Subtotal - Excess Weight	42.96	725 889	385	892	1277	279.7	647.5	927.2
Inactive	41.62	703 405	193	372	565	135.9	261.9	397.7
Total						656.3	1340.8	1997.1
Vancouver Coastal Health								
Smokers								
Light	6.10	69 486	782	1402	2184	54.3	97.4	151.8
Moderate	2.46	28 029	1545	2779	4324	43.3	77.9	121.2
Heavy	1.49	16 920	2387	4255	6642	40.4	72.0	112.4
Subtotal - Smokers	10.05	114 436	1206	2161	3368	138.0	247.3	385.4
Excess Weight								
Overweight	24.65	280 721	223	583	806	62.5	163.8	226.3
Obesity	7.13	81 208	900	1892	2792	73.1	153.6	226.7
Subtotal - Excess Weight	31.79	361 929	375	877	1252	135.7	317.4	453.1
Inactive	38.35	436 704	188	362	550	82.0	158.2	240.2
Total						355.7	723.0	1078.7

Continued on the following page

TABLE 2 (continued)

Estimated prevalence of risk factors, total economic burden for multifactorial system, and disaggregated costs by risk factor, British Columbia Health Authorities, 2013, by sex adjusted for multiple risk factors in one individual

	Population with RF, %	Number of individuals with RF, n	Direct cost per individual with RF, $	Indirect cost per individual with RF, $	Total cost per individual with RF, $	Total direct cost of RF, millions $	Total indirect cost of RF, millions $	Total cost of RF, millions $
Island Health								
Smokers								
Light	6.67	50 179	827	1489	2316	41.5	74.7	116.2
Moderate	4.57	34 377	1363	2444	3807	46.9	84.0	130.9
Heavy	3.35	25 196	1981	3536	5517	49.9	89.1	139.0
Subtotal - Smokers	14.59	109 752	1260	2258	3518	138.3	247.9	386.1
Excess Weight								
Overweight	28.86	217 084	251	649	901	54.5	141.0	195.5
Obesity	14.99	112 728	862	1849	2711	97.2	208.4	305.6
Subtotal - Excess Weight	43.85	329 812	460	1059	1519	151.7	349.4	501.1
Inactive	32.64	245 496	227	437	664	55.8	107.3	163.0
Total						345.8	704.5	1050.2
Northern Health								
Smokers								
Light	7.10	20 154	749	1352	2101	15.1	27.3	42.4
Moderate	5.95	16 902	1172	2101	3273	19.8	35.5	55.3
Heavy	7.17	20 357	1406	2518	3924	28.6	51.3	79.9
Subtotal - Smokers	20.23	57 413	1106	1986	3092	63.5	114.0	177.5
Excess Weight								
Overweight	31.61	89 713	234	602	836	21.0	54.0	75.0
Obesity	18.72	53 135	781	1683	2464	41.5	89.4	130.9
Subtotal - Excess Weight	50.33	142 847	437	1004	1441	62.5	143.4	205.9
Inactive	38.66	109 736	217	416	634	23.8	45.7	69.5
Total						149.8	303.2	453.0

Abbreviation: RF, risk factor.

excess weight include some cancers (esophagus [ICD-10 code C15], colorectal [C18–20], pancreas [C25], postmenopausal breast [C50], corpus uteri, including endometrium [C54–55], ovary [C56] and kidney [C64]), type 2 diabetes (E11–14), hypertension (I10–15), ischemic heart disease (I20–25), pulmonary embolism (I26), cerebrovascular disease (I60–69), asthma (J45), gallbladder disease (K80–82), osteoarthritis (M15–19) and chronic back pain (M45–54). Comorbidities associated with physical inactivity include colorectal cancer (C18–20), breast cancer (C50), type 2 diabetes (E11–14), hypertension (I10–15), ischemic heart disease (I20–25), cerebrovascular disease (I60–69) and osteoporosis (M80–82). Comorbidities associated with tobacco smoking include cancers of the lip, oral cavity, pharynx, larynx [C00–14, 30–32], esophagus [C15], stomach [C16], colorectal [C18–20], liver [C22], pancreas [C25], trachea, bronchus, lung [C33–34], kidney [C64] and urinary bladder [C67]) as well as ischemic heart disease (I20–25), pulmonary embolism (I26), venous thromboembolism (I80–82), cerebrovascular disease (I60–69), aortic aneurism (I71), pneumonia (J12–18), chronic lung disease (J40–44), intestinal ischemia (K05) and cirrhosis of the liver (K70,74).

EBIC cost data was not sufficiently detailed for a number of these comorbidities, including type 2 diabetes (E11–14), pulmonary embolism (I26), aortic aneurysm (I71), venous thromboembolism (I80-82), intestinal ischemia (K55), gallbladder disease (K80–82) and chronic back pain (M45–54). In each of these situations, we estimated the costs based on the proportion of acute hospital days in 2011/12 for the disease of interest to the relevant comorbidity with EBIC 2008 costs. For example, hospital days for chronic back pain (M45–54) make up 21.6% and 19.6% (for men and women, respectively) of all hospital days for diseases of the musculoskeletal system and connective tissue (M00–99) in Canada in 2011/12. We therefore assumed that 21.6% and 19.6% of EBIC 2008 costs allocated to diseases of the musculoskeletal system and connective tissue (M00–99) for hospital care, physician care and drugs would be allocated to chronic back pain (M45–54).

These sex-specific direct care costs by comorbidity were then multiplied by the calculated risk factor–specific, sex-specific, and comorbidity-specific population-attributable fractions to calculate the direct care costs attributable to a given risk factor. We adjusted these direct costs in a multifactorial system to address double counting (previously described[4]).

Indirect costs

We calculated indirect costs (premature mortality, short- and long-term disability) following the method used in EBIC 1998 (a modified human-capital approach).[13]

Indirect costs attributable to premature mortality are based on the discounted present value of future production lost, including both the valuation of paid and unpaid work. Indirect costs attributable to short- and long-term disability are also based on lost production, taking into account both the severity and duration of the disability. Short-term disability is defined as a restriction of activity that is expected to last less than 6 months.

Specifically, the steps involved in estimating indirect costs were as follows:

(1) The diagnostic categories within EBIC 1998 that cover the comorbidities/diseases of interest were identified, and the direct and indirect costs for these categories were extracted.
(2) The extracted costs were used to determine a ratio between direct and indirect costs for each of the diagnostic categories, 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 attributable to each risk factor to generate the equivalent indirect cost data.

HA- and HSDA-level analysis of risk factor reduction

After calculating the adjusted economic burden attributable to the three risk factors in B.C. and each HA and HSDA, we determined which region in the province had the lowest overall prevalence rate for each risk factor. The sex- and age-specific prevalence rates from each of these three lowest-prevalence regions were applied to the population of each remaining region. This allowed us to calculate the difference in annual economic burden for each region using actual prevalence rates and hypothetical prevalence rates from those in the comparator regions.

Results

We estimated the economic burden attributable to excess weight, tobacco smoking and physical inactivity in B.C. in 2013 at $5.6 billion, with $2.6 billion (45.6%) attributable to excess weight, $2.0 billion to tobacco smoking (36.1%) and $1.0 billion (18.3%) to physical inactivity (see Table 1).

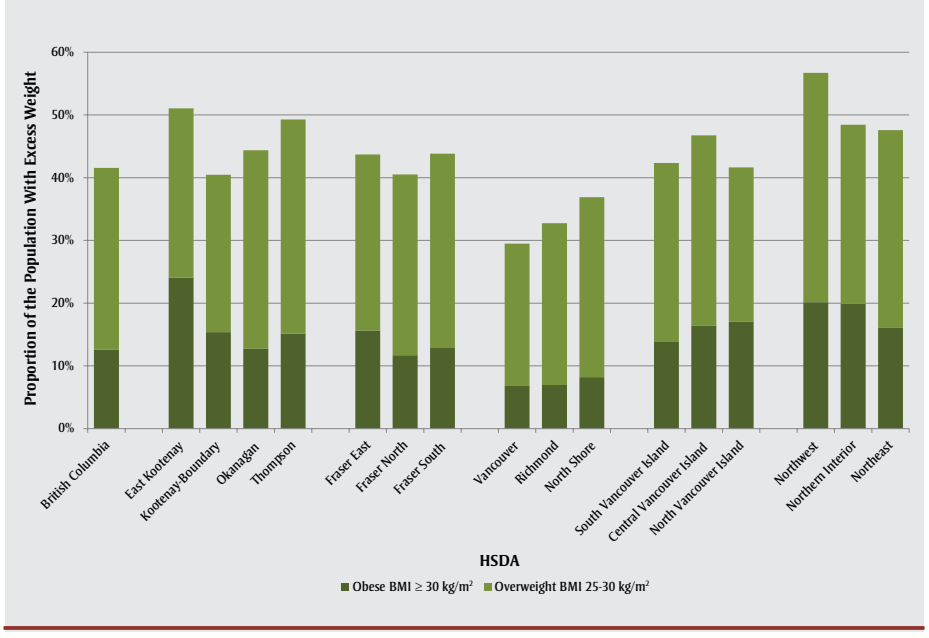
The annual risk factor-attributable economic burden per person is highest for all tobacco smokers ($3355), but ranges from $2146 for light smokers to $5397 for heavy smokers. The annual economic burden per person with excess weight is $1342 ($811 per overweight person and $2563 per obese person). While the annual economic burden per person with excess weight is substantially less than tobacco smoking, the high prevalence of excess weight (41.6%) compared to the prevalence of tobacco smoking (13.2%) in B.C. means that the total annual economic burden attributable to excess weight now exceeds that of tobacco smoking by 26%.

Among the HAs, the prevalence of smoking was higher than the provincial average in Interior Health, Northern Health and Vancouver Island Health, and the prevalence of excess weight was higher than the provincial average in all HAs except for Vancouver Coastal Health. Conversely, the prevalence of physical inactivity was lower than the provincial average in Interior Health and Vancouver Island Health. The prevalence of all three risk factors was above the provincial average in Northern Health (see Table 2). The total economic burden attributable to these three risk factors across HAs ranged from $453.0 million in Northern Health to $1997.1 million in Fraser Health.

The prevalence of excess weight varies by HSDA, from a low of 29.5% in the Vancouver HSDA to a high of 56.7% in the Northwest HSDA (B.C. average = 41.6%; see Figure 1). The prevalence of physical inactivity varies from a low of 27.1% in the Kootenay Boundary HSDA to a high of 43.8% in the Fraser North HSDA (B.C. average = 37.9%; see Figure 2). The prevalence of tobacco smoking varies from a low of 8.8% in the Richmond HSDA to a high of 21.3% in the Northeast HSDA (B.C. average = 13.2%; see Figure 3).

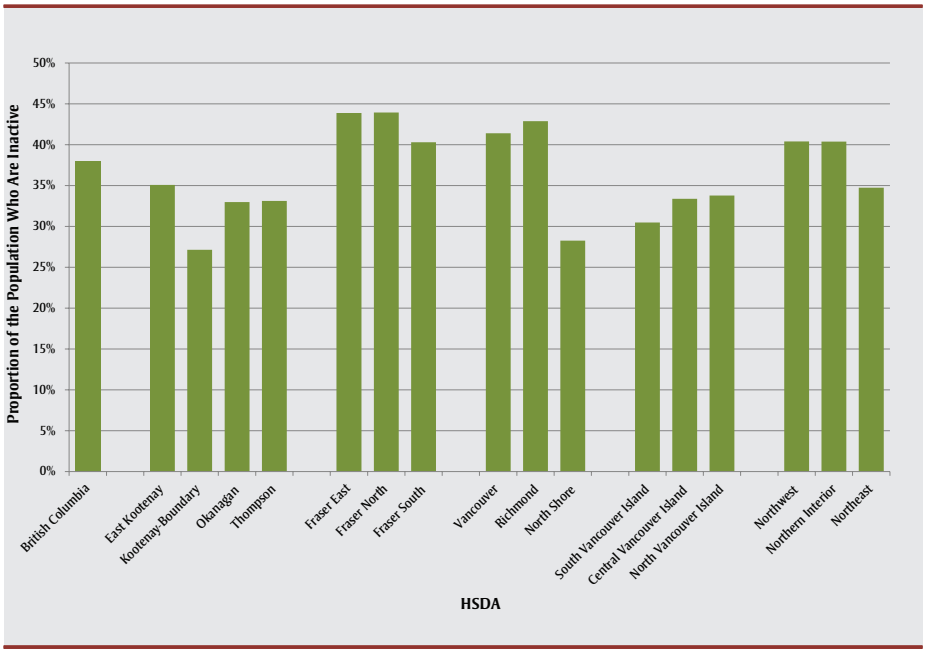
The variable prevalence rates of the three risk factors in each HSDA results in a varying economic burden per capita in each region (see Figure 4). The Richmond HSDA has the lowest per capita economic burden at $738, while the Northwest HSDA has the highest at $1766, more than double that of

FIGURE 1
Prevalence of excess weight in British Columbia, by excess weight category and HSDA, 2011/12



Abbreviations: BMI, body mass index; HSDA, health service delivery area.

FIGURE 2
Prevalence of physical inactivity in British Columbia, by HSDA, 2011/12



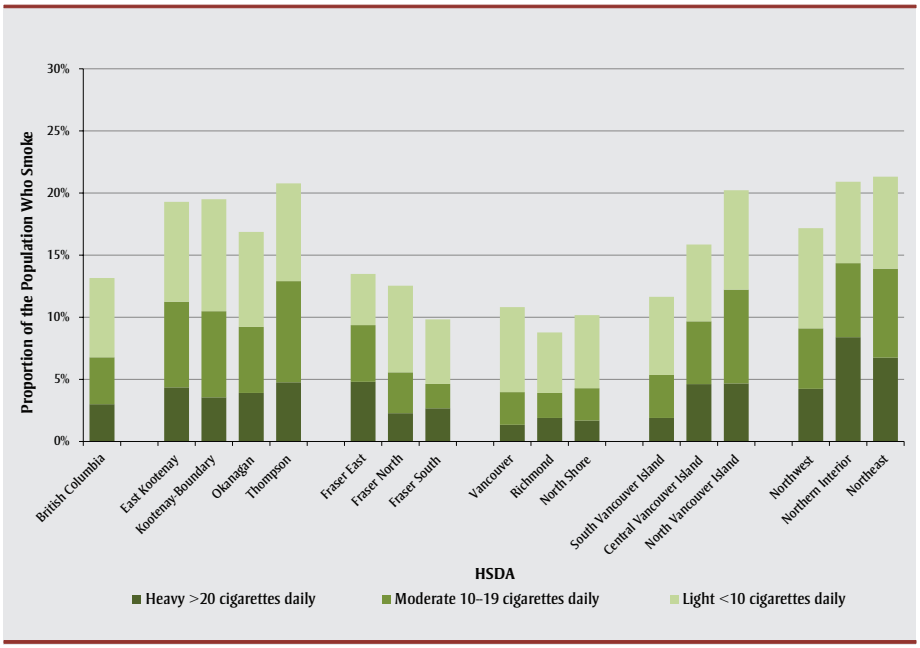
Abbreviation: HSDA, health service delivery area.

the Richmond HSDA. The provincial average per capita economic burden is $1222.

Applying the lowest sex- and age-specific prevalence rates for excess weight from the Vancouver HSDA, for tobacco smoking from the Richmond HSDA and for physical inactivity from the Kootenay Boundary HSDA to the population of each remaining HSDAs in the province would reduce the per capita annual economic burden by between $60 (in the Richmond HSDA) and $651 (in the Northwest HSDA) (see Figure 5).

The *total* annual reduction in economic burden would range between $12.1 million in the Richmond HSDA to $200.1 million in the Fraser South HSDA (see Figure 6). If all HSDAs were to achieve the best prevalence rates for the three risk factors, then $1362.2 million in economic burden could be avoided annually, comprising $449.8 million in direct costs and $912.4 million in indirect costs.

FIGURE 3
Prevalence of smoking in British Columbia, by smoking intensity and HSDA, 2011/12



Abbreviation: HSDA, health service delivery area.

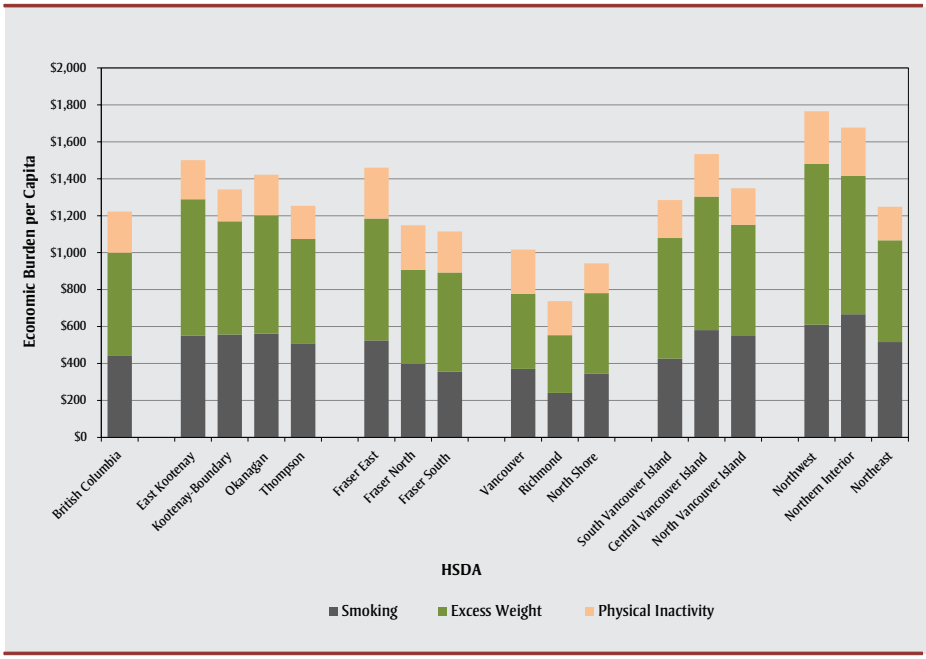
Discussion

We estimated the annual economic burden attributable to excess weight, tobacco smoking and physical inactivity in B.C. at $5.6 billion in 2013, with a higher proportion of this total attributable to excess weight ($2.6 billion) than to tobacco smoking ($2.0 billion). While B.C. has lower prevalence rates of the risk factors than any other Canadian province,[1] rates vary significantly within the province. If each HSDA in the province were to achieve the best prevalence rates for the three risk factors, then $1.36 billion in economic burden could be avoided annually. This suggests that a 24% reduction in the economic burden attributable to excess weight, tobacco smoking and physical inactivity in B.C. is possible if all regions achieved rates of these risk factors that are best in the province. It is important to note, however, that a reduction in economic burden is not equivalent to cost savings. Even for direct costs, the majority of resources freed up over time will likely be re-allocated (intentionally or unintentionally) elsewhere within health care.

A similar analysis using age- and sex-specific prevalence rates from B.C. applied to populations living in the other Canadian provinces indicated that the annual economic burden in Canada attributable to these three risk factors would be reduced by $5.3 billion, or 10.0% of the $52.8 billion total economic burden of the risk factors.[1] The intraprovincial variation in the prevalence of the risk factors thus seems to be substantially higher than the variation between provinces.

This study identified notable disparities in the prevalence of each risk factor across

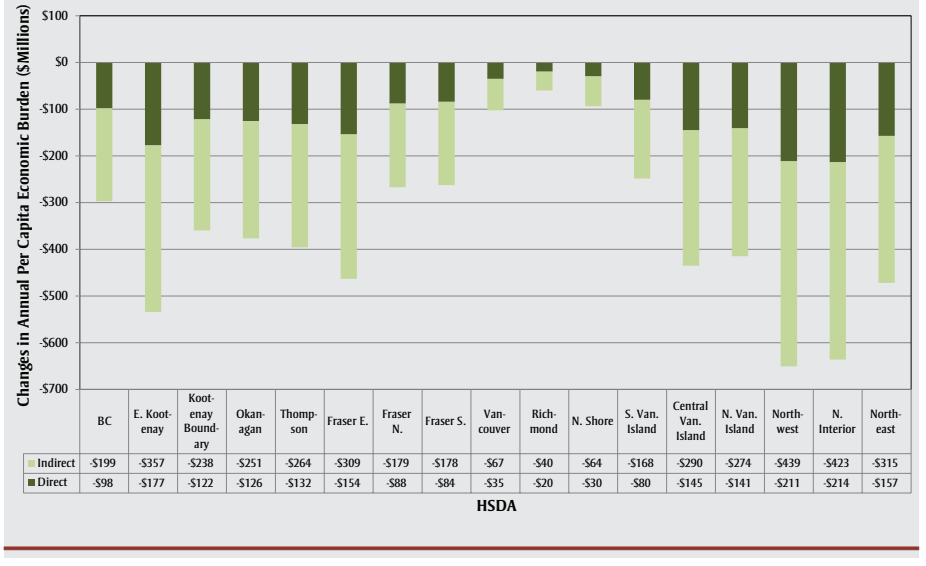
FIGURE 4
Economic burden per capita in British Columbia: smoking, excess weight and physical inactivity, by HSDA, 2013



Abbreviation: HSDA, health service delivery area.

health regions, which were mirrored in each region's attributable economic burden. Rates of excess weight were much lower in Vancouver Coastal Health than all other health authorities. Physical inactivity levels were typically much higher in regions with a higher population density (particularly in the Fraser North, Fraser East, Vancouver and Richmond HSDAs) compared to more rural populations. Conversely, smoking rates were much lower in urban areas than rural areas. Risk factor rates were almost always above the provincial average in the north of the province (Northwest, Northern Interior and Northeast HSDAs).

FIGURE 5
Changes in annual per capita economic burden in British Columbia based on best risk factor rates, by HSDA and direct/indirect costs ($Millions), 2013



	BC	E. Kootenay	Kootenay Boundary	Okanagan	Thompson	Fraser E.	Fraser N.	Fraser S.	Vancouver	Richmond	N. Shore	S. Van. Island	Central Van. Island	N. Van. Island	Northwest	N. Interior	Northeast
Indirect	-$199	-$357	-$238	-$251	-$264	-$309	-$179	-$178	-$67	-$40	-$64	-$168	-$290	-$274	-$439	-$423	-$315
Direct	-$98	-$177	-$122	-$126	-$132	-$154	-$88	-$84	-$35	-$20	-$30	-$80	-$145	-$141	-$211	-$214	-$157

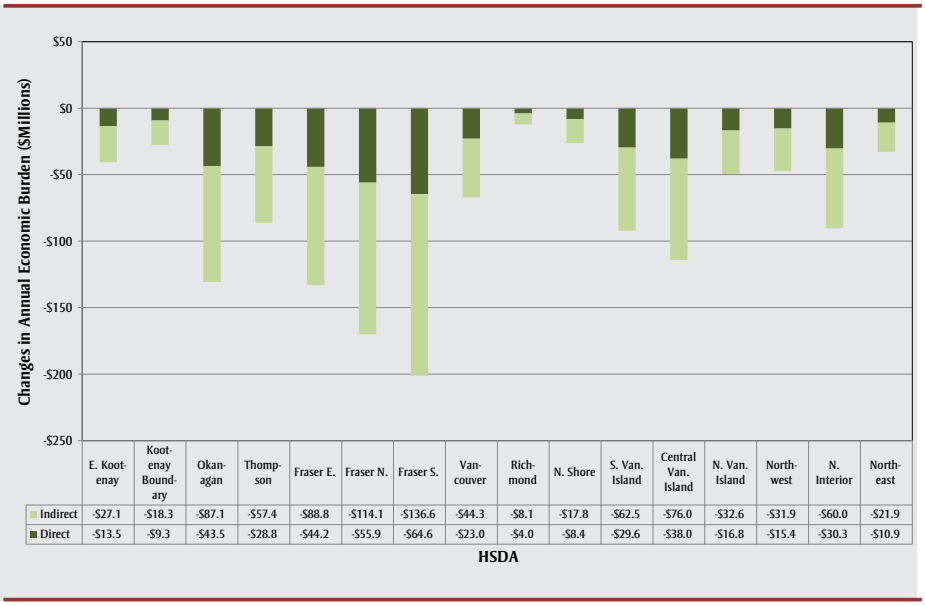
Abbreviations: BC, British Columbia; HSDA, health service delivery area.
Note: Sensitivity analysis suggests that these costs may vary by +/-17%.

The obesity epidemic has been labelled by some as the "new tobacco" based on both its rapidly increasing prevalence worldwide and the tide of associated health consequences. Rates of tobacco smoking have decreased dramatically in recent decades, and this progress should reinforce that similar successes are also possible for other modifiable risk factors.[14,15] We have learned from our experiences with smoking that a comprehensive, multipronged approach is required to achieve substantial reductions.[16] The reduction in smoking rates could not be solely attributed to one or two interventions; rather it was the culmination of economic and policy interventions, community-based interventions and clinical interventions that acted synergistically to lower smoking rates to where they are now. We have also learned that to see a meaningful reduction in the prevalence of risk factors, a long-term approach is required. The problem of tobacco smoking was not solved by a quick fix, and it is unlikely that other modifiable risk factors will be either. Instead, interventions require multigenerational approaches that span beyond the immediate political cycle.

For the purpose of this study, we focussed on the costs associated with individual-level risk factors, but also acknowledged that excess weight, physical inactivity and tobacco smoking are strongly influenced by a variety of social, environmental and economic factors. These determinants are likely to drive some of the geographical variation that we observed in this study, and these underlying factors should also be considered in an effort to promote health equity. Not everyone has an equal opportunity to make healthy choices, and any population-level interventions should address chronic disease risk factors while acknowledging the social determinants of health.

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.[17-20] In 1998, EBIC used a modified human-capital approach[†], changing to the friction cost

FIGURE 6
Changes in annual economic burden in british Columbia based on best risk factor rates, by HSDA and direct/indirect costs ($Millions), 2013



Abbreviation: HSDA, health service delivery area.
Note: Sensitivity analysis suggests that these costs may vary by +/-17%.

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 B.C. would be reduced from $3756 million to $238 million. 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,''[2,p.452] 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 to 12 years,[22] the friction cost method only applies a value on the time period that it takes to replace this person 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.

Strengths and limitations

Despite all efforts to optimize the accuracy of the analysis, some limitations remain. Most studies, including this one, categorize people with a BMI between 25 kg/m^2 and 29.9 kg/m^2 as overweight. This range, especially the lower end, has been historically dynamic, however.[16] Recent research has suggested that a more appropriate lower boundary with respect to negative health effects might be 27 kg/m^2,[23] or even below 25 kg/m^2 for certain people, particularly those of Asian descent.[24] This is relevant to the current study as a high proportion of people in B.C. identify as a visible ethnic minority (24.8%),[25] with some regions much higher than others. For example, in the Richmond HSDA, 44% of people identify as being of Chinese origin, 8.0% as South Asian, and 5.5% as Filipino. Using a cut-off of 25 kg/m^2 for this population may underestimate their excess weight-attributable economic burden.

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 relative risks associated with smoking[7] and physical inactivity[9] adjust for known confounding factors in generating disease-specific relative risks. The meta-analyses for the relative risks associated with overweight and obesity, however, did not include physical

TABLE 3
Economic burden of illness in Canada by diagnostic category, indirect costs as a percentage of direct costs

	EBIC 1998 (Human capital)			EBIC 2008 (Friction)		
Diagnostic Category	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

Abbreviation: EBIC, economic burden of illness in Canada.

[†]In the human-capital approach, sex- 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.

[‡]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.

inactivity as a potentially confounding risk factor,[8] which may lead to an overestimate of the economic burden attributable to excess weight. On the other hand, relative risks calculated in this meta-analysis are based on a combination of studies including both self-reported and objective measures of BMI while our model uses the prevalence of excess weight based on self-reported height and weight, which may lead to an underestimate of the economic burden attributable to excess weight. Previous sensitivity analysis also suggests that the true economic burden may vary by +/− 17% of our best estimate.[2] Finally, the allocation of non-hospital costs to HAs and HSDAs in proportion to the allocation of hospital-related costs may over- or underestimate these costs in a given region of the province.

Conclusion

Our findings suggest that the economic burden of excess weight, physical inactivity and tobacco smoking are substantial and vary considerably between health regions in B.C. However, by reducing the prevalence of each of the three risk factors across the province to that of the region with the lowest prevalence, the associated direct and indirect costs could be reduced by about one quarter. Knowing this, prioritizing prevention initiatives should be at the forefront of system- and community-level changes. The economic evidence we present also suggests that various regions within B.C. demand specific attention. In particular, the geographical variations between health authorities and HSDAs may act as a guideline for where region-specific prevention efforts may be most valuable. A variety of social, environmental and economic factors likely drive some of this geographical variation and these underlying factors should be considered when developing prevention programs in an effort to promote health equity.

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