

The Economic Burden of Risk Factors in British Columbia, 2015

Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption



BC Centre for Disease Control

An agency of the Provincial Health Services Authority

Prepared for the BC Centre for Disease Control (BCCDC)

Noorjean Hassam, Chief Operating Officer, BCCDC

Authors:

Dr. Hans Krueger, President, H. Krueger & Associates Inc.

Dr. Drona Rasali, Director, Population Health Surveillance & Epidemiology, BCCDC (Project Lead)

Daniel Fong, Manager, Knowledge Translation and Communications, BCCDC

Acknowledgements:

The BC Observatory for Population and Public Health (BCOPPH) Operations Committee members and other stakeholders are thankfully acknowledged for their review of this report. Thanks are due to the following colleagues for their constructive feedback to this report:

Rahul Chhokar,
Manager, Population Health Observatory, Fraser Health

Sara Forsting,
Regional Director, Public Health Surveillance Unit, Vancouver Coastal Health

Gillian Frosst,
Epidemiologist, Population Health, Interior Health

Maritia Gully,
Manager, Population Health Epidemiology, Island Health

Kari Harder,
Public Health Epidemiologist, Northern Health

Dr. James Lu,
Medical Health Officer, Vancouver Coastal Health

Dr. Mark Lysyshyn,
Medical Health Officer, Vancouver Coastal Health

Dr. Julian Mallinson,
Population Health Specialist, Interior Health

Dr. Ashraf Mohammed,
Director, Surveillance, First Nations Health Authority

Dr. Emily Newhouse,
Medical Health Officer, Vancouver Coastal Health

Megan Oakey,
Interim Director, Healthy Living Programs & Injury Prevention, Population and Public Health, BCCDC

Kate Smolina,
Director, BC Observatory for Population and Public Health, BCCDC

Xibiao Ye,
Director/Provincial Epidemiologist, Office of the Provincial Health Officer, BC Ministry of Health

BCCDC contact:

For further information contact:
BC Centre for Disease Control
Population & Public Health
655 West 12th Avenue
Vancouver, B.C. V5Z 4R4
pph@phsa.ca



Table of Contents

Executive Summary	1
Background	3
Chronic Diseases in BC	3
Modifiable Risk Factors	3
Definitions	4
Purpose	6
Overview of Methods	7
Limitations	7
Key Findings	8
Provincial Results	8
Regional Results	13
Excess Weight	18
Tobacco Smoking	21
Alcohol Use	24
Physical Inactivity	27
Low Fruit and Vegetable Consumption	29
Conclusion and Recommendations	31
References	33



List of Tables and Figures

Table 1. Estimated Prevalence of Risk Factors and Total Economic Burden, BC, 2015 (adjusted for multiple risk factors in one individual)	9
Table 2. Estimated Prevalence of Risk Factors and Total Economic Burden, split by sex, BC, 2015 (adjusted for multiple risk factors in one individual).	10
Figure 1. Total Economic Burden by Health Authority, BC, 2015.	11
Figure 2. Total Economic Burden <i>per Capita</i> , by Health Authority and Health Service Delivery Area (HSDA), BC, 2015.	12
Figure 3. Total Economic Burden by Disease Category, BC, 2015	12
Figure 4. Per Capita Economic Burden, Interior Health Authority, 2015	13
Figure 5. Per Capita Economic Burden, Fraser Health Authority, 2015.	14
Figure 6. Per Capita Economic Burden, Vancouver Coastal Health Authority, 2015	15
Figure 7. Per Capita Economic Burden, Vancouver Island Health Authority, 2015	16
Figure 8. Per Capita Economic Burden, Northern Health Authority, 2015.	17
Figure 9. Prevalence of Excess Weight, BC, 2015	19
Figure 10. Per Capita Cost of Excess Weight, BC, 2015.	19
Figure 11. Economic Burden of Excess Weight by Disease Category, BC, 2015.	20
Figure 12. Prevalence of Tobacco Smoking, BC, 2015.	22
Figure 13. Per Capita Cost of Tobacco Smoking, BC, 2015	22
Figure 14. Economic Burden of Tobacco Smoking by Disease Category, BC, 2015	23
Figure 15. Prevalence of Alcohol Use, BC, 2015	25
Figure 16. Per Capita Cost of Alcohol Use, BC, 2015.	25
Figure 17. Economic Burden of Alcohol Use by Disease Category, BC, 2015.	26
Figure 18. Prevalence of Physical Inactivity, BC, 2015	27
Figure 19. Economic Burden of Physical Inactivity by Disease Category, BC, 2015	28
Figure 20. Prevalence of Low Fruit and Vegetable Consumption, BC, 2015.	29
Figure 21. Per Capita Cost of Low Fruit and Vegetable Consumption, BC, 2015	30
Figure 22. Economic Burden of Low Fruit and Vegetable Consumption by Disease Category, BC, 2015	30



Executive Summary

In Canada, excess weight, tobacco smoking, alcohol use, physical inactivity and a diet low in fruits and vegetables are among the top seven modifiable risk factors of chronic diseases in terms of their attributable disease burden in the population.¹ The cost of chronic diseases is estimated based on the burden of conditions such as cardiovascular, musculoskeletal, respiratory and digestive diseases as well as cancer, diabetes, injury, and mental and behavioural disorders associated with these risk factors. Reducing the prevalence of risk factors can reduce the rate of chronic diseases and economic burden. Approaches to address these risk factors must consider the determinants of health and are influenced by interactions between our behaviours, life styles and the social and physical environment. Understanding the expected cost attributed to these risk factors enables informed policy and program planning at the provincial, regional health authority and health service delivery area levels in British Columbia. This report provides comprehensive estimates of the 2015 economic burden in British Columbia due to five risk factors and is a follow up to our 2013 estimates on three risk factors.¹²

For 2015, the estimated annual economic burden from excess weight, tobacco smoking, alcohol use, physical inactivity and low fruit and vegetable consumption in British Columbia was \$7.8 billion. The ranking of these risk factors in order of their total economic burden is as follows:

1. Excess weight - \$2.7 billion (34% of the total economic burden)
2. Tobacco smoking - \$2.1 billion (27%)
3. Alcohol use - \$1.5 billion (19%)
4. Physical inactivity - \$983 million (12%)
5. Low fruit and vegetable consumption - \$604 million (8%)

Approximately one-third of the total economic burden associated with these five risk factors is due to direct healthcare costs (\$2.59 billion of \$7.83 billion). Of these direct costs, \$1.14 billion (44%) is for hospital care, \$427 million (17%) is for drugs, \$314 million (12%) for physician services and \$709 million (27%) for 'other' costs such as public health, administration and health research. The remaining two-thirds of the economic burden associated with these risk factors is due to loss of economic contribution due to short- and long-term disability and/or death. Over 40% of the total economic burden from the five risk factors is from premature mortality, disability, and direct health care costs associated with cardiovascular diseases.

Of the total annual economic burden in BC, \$4.7 billion (60%) is attributable to males and \$3.1 billion (40%) to females. This relationship is consistent throughout all regions of the province, but the magnitude varies by health service delivery area. The higher economic burden in males largely results from differences between sexes in the prevalence of tobacco smoking and alcohol use. In BC, a higher proportion of males smoke (16.1%) compared to females (10.7%) and similarly, a higher proportion of males engage in harmful levels of alcohol consumption than females (11.6% vs. 7.5%, respectively). As a result, the economic burden associated with these two risk factors in males (\$2.41 billion) is more than twice that of females (\$1.15 billion). The five risk factors in BC have an annual economic burden of \$1,671 per capita. Again this is lower in females (\$1,327 across BC), than males (\$2,021 across BC).



There are significant regional differences in all risk factors except low fruit and vegetable consumption. Rates of excess weight are 19% lower in Vancouver Coastal Health Authority than the provincial average. Similarly, Interior Health, Vancouver Island Health and Northern Health have smoking rates above the provincial average while all but one health service delivery area in Fraser and Vancouver Coastal Health Authorities have rates below the provincial average. Vancouver Coastal contains the health service delivery areas with both the highest and lowest prevalence of alcohol use, while Interior and Island Health Authorities have the most active populations.

A complete understanding of the magnitude of this economic burden can inform and drive public health prevention and health promotion policy. The aim is to encourage action and implement policy that will reduce the prevalence of the risk factors and ultimately prevent chronic disease. Other publications have noted differences in risk factor prevalence due to education and socio-economic status.¹⁵ While it is beyond the scope of this report to prescribe specific policies or programs, some general recommendations are offered to guide creation of prevention initiatives.

- Benchmark against health service delivery areas that have the lowest prevalence of risk factors and determine the key drivers behind the lower prevalence. If these drivers are in the form of unique programs, innovative education, community engagement or other systems within the influence of the health authorities, consider if it is beneficial to adapt them in other health authorities. If the drivers are social or cultural in nature, coordinated approaches by health and other sectors are necessary to promote healthy practices in others across the province while respecting the diversity of values in our communities.²⁷ Previous research indicated that if every health service delivery area in the province were to achieve the best prevalence rates for tobacco smoking, excess weight and physical inactivity, then \$1.4 billion in economic burden could be avoided annually.¹⁴
- Set targets for measuring progress across province on a bi-annual basis. The only way to improve the burden of risk factors is to measure and track it to keep focussing on the goal of reduction. Inform senior management with evidence to make necessary policy changes through on-going evaluation of programs across all communities, especially those with prevalence rates currently exceeding the provincial average.
- Learn from experiences in Canada concerning tobacco smoking. The steps taken to reduce smoking rates can serve as a roadmap for tackling other modifiable risk factors in the future. We cannot solely attribute the reduction in smoking rates to one or two interventions; rather, various economic and policy changes as well as community-based and clinical interventions acted synergistically to lower smoking rates to where they are now. In the early years of tobacco prevention, there was a tendency to attribute behavioural change to personal choices. Similar attitudes and beliefs are often applied to current obesity prevention approaches. However, as the experience with smoking made clear, supportive environments are necessary to trigger and then reinforce individual change. An environment that makes it easy to make positive lifestyle decisions is best created through far-reaching policy and program changes, complemented by community and individual interventions.
- There is no 'quick fix'. Instead, interventions require a prolonged approach that span beyond the immediate political cycle. In order to see a meaningful reduction in risk factor prevalence, a long-term approach is required. It has been nearly 75 years since medical literature began reporting an association between tobacco smoking and chronic disease. While the net reduction today is remarkable, smoking rates were relatively slow to respond to interventions, and much work still remains.

Background

In Canada, tobacco smoking, excess weight, physical inactivity, alcohol use, and a diet low in fruits and vegetables are among the top seven modifiable risk factors of chronic diseases in terms of their attributable disease burden in the population. The other two are high blood pressure and high fasting plasma glucose.¹ Chronic diseases represent the largest health burden in British Columbia, and the findings in this report should be understood along with the context of the burden from other preventable causes of morbidity and mortality such as that from injury, communicable diseases, and environmental health risks.² Recent past reports in BC estimated the cost of excess weight, tobacco use and physical activity at \$5.6 billion in 2013, and the cost of preventable injury (aged 45 and under) at \$3.7 billion in 2010.^{12, 22}

Chronic Diseases in BC

Over half of British Columbians have at least one chronic condition,² and chronic diseases are responsible for the majority of deaths in the province. The three leading causes (cancer, cardiovascular disease and cerebrovascular disease) collectively result in 55% of all deaths in BC.³ The burden of chronic disease on individuals and society extends beyond disability and premature mortality. Quality of life can be reduced considerably for those living with chronic conditions, most notably for those living with arthritis, chronic lung disease, and congestive heart failure.⁴ Chronic diseases also commonly impact the lives of other family members, affecting social and leisure activities, time commitments, stress levels and personal relationships.⁵ It is also important to consider the economic burden of health care costs resulting from these chronic conditions. In 2005/06, chronic health conditions consumed approximately 80% of British Columbia's Medical Services Plan, PharmaCare, and acute care budgets.⁶ However, the economic burden of chronic disease includes more than just direct health care costs. Most chronic diseases have an underappreciated indirect cost associated with a loss of earning potential stemming from short- and long-term disability, as well as premature mortality. In addition to this, and often much harder to quantify, is the intangible value that individuals attribute to good health,⁷ as well as costs of caregiver time and personal costs incurred with illness (e.g., transportation costs).⁸

Modifiable Risk Factors

A large number of the common risk factors for chronic diseases are considered 'modifiable', in that they can be influenced to change through intervention at various levels. By reducing the prevalence of risk factors in a population, the prevalence of, and thereby the overall burden of, many chronic diseases can be reduced as well. Targeted prevention efforts focussed on these risk factors can improve health behaviours, which in turn lead to improvement in health outcomes, quality of life, and the sustainability of health care.⁹ In addition to reducing disease incidence, many interventions and prevention activities have proven to be cost-effective, or even cost-saving.^{10,11} In other words, investing in prevention-oriented initiatives that combat chronic disease risk factors may be less costly than dealing with the future healthcare and societal burden incurred by chronic disease treatment.

These risk factors also need to be considered in the context of broader structural and social determinants that shape our health. Groups that often experience poorer health in BC include those

living in poverty, those with mental health or substance abuse issues, Indigenous people, immigrants, and refugees. Health inequities can also arise between populations across different geographic regions, genders, ages, and ethnicities. Groups that experience inequities may be at greater risk of adopting behavioural or lifestyle-related risk factors, which can lead to higher rates of chronic disease among these groups. While interventions that aim to modify individual behaviour or lifestyles can be effective, approaches that target the upstream causes of poor health are better able to promote health equity and foster opportunities for everyone to make healthy choices. Policy- and community-level changes can help create supportive environments that encourage healthy choices.

Definitions

Excess weight

Excess weight is considered to be a body mass index (BMI) greater than 25 kg/m², with a BMI between 25 kg/m² and 29.9 kg/m² considered overweight and a BMI greater than 30 kg/m² considered obese.

Tobacco smoking

The prevalence of tobacco smoking is calculated using only individuals who currently smoke occasionally or daily, and does not include former smokers. Smokers are classified into three categories of risk factor exposure: light (<10 cigarettes per day or occasional smoking), moderate (10-19 cigarettes per day) and heavy (≥20 cigarettes per day). It was assumed that no children under 12 smoked.

Alcohol use

Alcohol use is categorized as defined by Taylor and colleagues.¹⁹

■ Males were categorized as:

- category I – low (0.02 – 2.93 drinks/day),
- category II – hazardous (2.94 – 4.40 drinks/day), and
- category III – harmful (≥ 4.41 drinks/day).

■ Females were categorized as:

- category I – low (0.02 – 1.46 drinks/day),
- category II – hazardous (1.47 – 2.93 drinks/day), and
- category III – harmful (≥ 2.93 drinks/day).

Physical inactivity

The physical activity level of an individual can be quantified by the intensity level of the specific activities that they participate in. A standard way to accomplish this is using metabolic equivalents (METs), or multiples of resting oxygen uptake.

An energy expenditure (EE) can be calculated using the frequency and duration per session of the physical activity and the associated MET value, as follows:

$$\text{Average Daily EE for each activity} = \frac{N \times D \times \text{METvalue}}{365}$$

where N is the number of times a respondent engaged in an activity over a 12-month period, D is the average duration in hours of the activity and the MET value is the energy cost of the activity expressed as (kcal/kg/hour). Individuals were categorized as being “inactive” if they had an average daily energy expenditure of less than 1.5 kcal.

Low fruit and vegetable consumption

Prevalence of low fruits and vegetable consumption was estimated using a single derived variable “FVCDTOT” from CCHS 2013/14 data, in which the number of times fruits and vegetables consumed per day was used as a proxy for the number of servings of fruits and vegetables consumed.

The 2011 revision of Canada Food Guide (CFG) recommends the number of daily servings of fruits and vegetables based on the sex and age of the individual.²⁰ These age- and sex- specific recommendations were used to group individuals into the following five categories:

1. Meets or exceeds CFG recommendations for daily consumption of fruits and vegetables (reference category)
2. Consumes 1-2 servings below daily recommendations (Category I)
3. Consumes 3-4 servings below daily recommendations (Category II)
4. Consumes 5-6 servings below daily recommendations (Category III)
5. Consumes 7-8 servings below daily recommendations (Category IV)

Purpose

The aim of this report is to provide insight into the economic burden associated with excess weight, tobacco smoking, alcohol use, physical inactivity and low fruit and vegetable consumption across British Columbia, in each health authority and health service delivery area (HSDA) in BC. All estimates are based on 2015 data, an update from our previous report on three risk factors.¹² This economic burden is determined by using an economic model that estimates:

1. how much disease in BC arises because of one or more of these risk factors and
2. the economic burden of these risk factors.

A risk factor's economic burden is expressed as the sum of the direct costs and indirect costs incurred for each of the risk factors, based on disease-specific economic data. The model used adjusts for individuals with more than one (i.e. overlapping) risk factor to represent, as accurately as possible, the impact of each risk factor independent of the others. An explanation of the methods used have been previously published and outlined in the next section.^{13,14}

The goal of presenting the economic burden of excess weight, tobacco smoking, alcohol use, physical inactivity and low fruit and vegetable consumption is to indicate the degree of impact these risk factors have on current and future health care expenditures and associated indirect costs, and to prioritize prevention efforts accordingly. To facilitate this goal and aid in policy development, the results of this study are broken down and presented in several different ways (see following box).

Prevalence

- An indicator of how many people the risk factor applies to, with details by sex and health authority. A higher prevalence leads to an increased economic burden. Programs and policies should aim to reduce the prevalence of all five risk factors through education and intervention.

Total Economic Burden

- The direct and indirect cost of the risk factors in dollars, with details by sex, health authority and disease category. This shows which risk factors should be prioritized. Used to aid cost-benefit analyses of programs and policies to reduce risk factor prevalence.

Per Capita Cost

- A measure of the economic burden as a function of total population (not just those with the risk factor), with details by gender, health authority and health service delivery area. Used to highlight regions that are doing well and take programs, policies and lessons learned from those regions and apply them to other regions.

Overview of Methods

There were six key steps to develop the data for this report. Details of the model for analyses are presented elsewhere.^{13, 14} Modifications from the methods from previous studies are included below.

1. **Estimate the prevalence of the five risk factors in the regions of interest.** Prevalence rates for all five risk factors were based on self-reported data from the 2013/14 Canadian Community Health Survey, using Public Use Microdata File (PUMF) data.²³ The prevalence of alcohol use is notoriously under-reported so appropriate adjustments were made to align total consumption with alcohol sales.
2. **Estimate the causal relationship between the risk factors and comorbidities based on relative risk.** This step involved reviewing high quality literature that estimates the increased risk associated with a specific risk factor (such as smoking) and a specific comorbidity (such as lung cancer) by smoking intensity. For example, smoking less than 10 cigarettes a day increases the risk of lung cancer by 11 times while smoking more than 20 cigarettes increases the risk by 36 times, when compared with someone who has never smoked.
3. **Calculate the population attributable fraction (PAF).** Doing so involves combining data on prevalence (from step 1) with data on relative risk (from step 2) taking into account the multiple levels of exposure intensity to the risk factor (e.g. non-smoker, light, moderate and heavy smoker).
4. **Estimate the direct costs of treating the comorbidities associated with the risk factors.** This involves what we call a prevalence-based cost-of-illness approach. In this approach we assigned various types of health care expenditures, such as hospital care, physician care and medications spent in a year to the various diseases treated in that year. Data was extracted from the National Health Expenditure Database²⁴ and the Economic Burden of Illness in Canada 2005-2008 online tool.²⁵
5. **Adjust direct costs for overlapping risk factors in a given person.** This ensures our results address double counting.¹³
6. **Estimate indirect costs.** These costs consider short- and long-term disability and premature mortality. In estimating these costs we used a modified human capital approach which values all indirect costs equally based on the average annual earnings of individuals within the geographic region.²⁶

Limitations

This report is based on 2013/14 survey data that is (largely) self-reported and uses 2015 health expenditure data. Prevalence data are applied to the general population, with some justified modifications. Assumptions made while applying survey data to the general population will influence the final reported results. This report does not aim to prescribe the means and methods to achieve prevalence reduction in the risk factors presented.



Key Findings

Provincial Results

The overall results for British Columbia in 2015 are summarised below:

■ Prevalence of risk factors

- In 2015, 13.4% of the BC population smoked tobacco, 41.9% had excess weight, 35.3% were physically inactive, 77.4% consumed less than the recommended number of daily servings of fruits and vegetables and 54.4% consumed alcohol (with 9.5% consuming alcohol at levels considered to be hazardous or harmful) (Table 1).

■ Economic burden

- Total annual economic burden was \$7.8 billion (Table 1).
- The per capita cost in 2015 was \$570 for excess weight, \$448 for tobacco smoking, \$311 for alcohol use, \$209 for physical inactivity and \$129 for low consumption of fruits and vegetables.
- Ratio of economic burden due to indirect and direct costs was 2:1 (Table 1).
- Nearly two-thirds of total economic burden was attributable to excess weight and tobacco smoking (Table 1).
- Males accounted for 60% of total economic burden, due to higher prevalence of certain risk factors and behaviours (Table 2).
- Substantial regional differences in annual per capita economic burden existed, ranging from a low of \$1,007 to a high of \$2,256 (Figures 1 & 2).
- Each heavy smoker carried an annual economic burden of \$5,835 per individual.
- Each person eating one or two servings of fruits and vegetables less than the daily recommendation in the Canada Food Guide carried an annual economic burden of \$67 per individual.
- The largest impact of the five risk factors, by a substantial margin, was on cardiovascular diseases, followed by diseases of the muscles and bones, cancers and respiratory diseases (Figure 3).

Table 1. Estimated Prevalence of Risk Factors and Total Economic Burden, BC, 2015
(adjusted for multiple risk factors in one individual)

	% Population with RF	# Individuals with RF	Total Direct Cost of RF (million\$)	Total Indirect Cost of RF (million\$)	Total Cost of RF (million\$)
<i>Excess Weight</i>					
Overweight - BMI of 25.0 to 29.9	28.6%	1,339,306	\$304.4	\$795.8	\$1,100.2
Obesity - BMI ≥ 30	13.3%	621,851	\$500.5	\$1,076.5	\$1,577.0
Subtotal - Excess Weight	41.9%	1,961,157	\$804.9	\$1,872.3	\$2,677.2
<i>Tobacco Smoking</i>					
Light - Less than 10 Cigarettes / Day	7.0%	330,094	\$259.2	\$468.8	\$728.1
Moderate - 10-19 Cigarettes / Day	3.9%	180,496	\$250.1	\$450.3	\$700.4
Heavy - 20 or more Cigarettes / Day	2.5%	117,473	\$240.9	\$431.7	\$672.5
Subtotal - Tobacco Smoking	13.4%	628,063	\$750.2	\$1,350.8	\$2,101.0
<i>Alcohol Use *</i>					
Category I - Low	44.9%	2,102,594	\$130.0	\$319.1	\$449.0
Category II - Hazardous	5.7%	267,587	\$115.1	\$237.9	\$353.0
Category III - Harmful	3.8%	179,430	\$242.3	\$417.6	\$659.9
Subtotal - Alcohol Use	54.4%	2,549,611	\$487.4	\$974.6	\$1,462.0
<i>Physical Inactivity</i>	35.3%	1,652,276	\$335.6	\$647.0	\$982.7
<i>Low Fruit and Vegetable Intake</i>					
Category 1 - 1 to 2 Servings below CFG Rec	24.4%	1,141,478	\$27.0	\$51.4	\$78.4
Category 2 - 3 to 4 Servings below CFG Rec	32.0%	1,496,979	\$82.7	\$155.8	\$238.5
Category 3 - 5 to 6 Servings below CFG Rec	18.5%	866,096	\$82.2	\$152.9	\$235.1
Category 4 - 7 or more Servings below CFG Rec	2.6%	119,731	\$18.4	\$34.0	\$52.4
Subtotal - Low Fruit and Vegetable Intake	77.4%	3,624,284	\$210.4	\$394.1	\$604.5
Total			\$2,588.5	\$5,238.8	\$7,827.3

RF = Risk Factor; BMI = Body Mass Index; CFG Rec = Canada's Food Guide Recommendations

* The volume of alcohol consumption used to categorize alcohol use varies by sex. Please see alcohol use section for more detail.

**Table 2. Estimated Prevalence of Risk Factors and Total Economic Burden, split by sex, BC, 2015
(adjusted for multiple risk factors in one individual)**

	Males					Females				
	% Population with RF	# Individuals with RF	Total Direct Cost of RF (million\$)	Total Indirect Cost of RF (million\$)	Total Cost of RF (million\$)	% Population with RF	# Individuals with RF	Total Direct Cost of RF (million\$)	Total Indirect Cost of RF (million\$)	Total Cost of RF (million\$)
Excess Weight										
Overweight - BMI of 25.0 to 29.9	35.2%	819,009	\$156.8	\$432.7	\$589.5	22.1%	520,297	\$147.6	\$363.1	\$510.7
Obesity - BMI ≥ 30	15.5%	359,369	\$250.7	\$565.4	\$816.1	11.1%	262,482	\$249.8	\$511.1	\$760.9
Subtotal - Excess Weight	50.7%	1,178,379	\$407.5	\$998.1	\$1,405.6	33.2%	782,779	\$397.4	\$874.2	\$1,271.6
Tobacco Smoking										
Light - Less than 10 Cigarettes / Day	8.3%	193,918	\$163.1	\$300.1	\$463.1	5.8%	136,177	\$96.2	\$168.8	\$264.9
Moderate - 10-19 Cigarettes / Day	4.2%	97,672	\$150.5	\$274.6	\$425.2	3.5%	82,824	\$99.6	\$175.6	\$275.2
Heavy - 20 or more Cigarettes / Day	3.6%	83,106	\$169.6	\$306.9	\$476.5	1.5%	34,367	\$71.3	\$124.8	\$196.1
Subtotal - Tobacco Smoking	16.1%	374,695	\$483.2	\$881.6	\$1,364.8	10.7%	253,368	\$267.1	\$469.1	\$736.2
Alcohol Use *										
Category I - Low	48.4%	1,124,325	\$90.0	\$228.0	\$317.9	41.5%	978,269	\$40.0	\$91.1	\$131.1
Category II - Hazardous	6.1%	141,194	\$75.4	\$161.4	\$236.8	5.4%	126,393	\$39.7	\$76.5	\$116.2
Category III - Harmful	5.6%	129,475	\$179.6	\$313.7	\$493.3	2.1%	49,955	\$62.7	\$103.9	\$166.6
Subtotal - Alcohol Use	60.0%	1,394,994	\$344.9	\$703.1	\$1,048.0	48.9%	1,154,618	\$142.5	\$271.5	\$413.9
Physical Inactivity	33.2%	771,767	\$173.5	\$306.7	\$480.2	37.3%	880,509	\$162.1	\$340.4	\$502.5
Low Fruit and Vegetable Intake										
Category 1 - 1 to 2 Servings below CFG Rec	19.4%	450,328	\$13.0	\$24.8	\$37.8	29.3%	691,150	\$14.1	\$26.6	\$40.6
Category 2 - 3 to 4 Servings below CFG Rec	32.4%	753,068	\$48.3	\$91.3	\$139.6	31.5%	743,911	\$34.4	\$64.5	\$98.9
Category 3 - 5 to 6 Servings below CFG Rec	25.8%	599,250	\$60.6	\$113.1	\$173.7	11.3%	266,846	\$21.5	\$39.9	\$61.4
Category 4 - 7 or more Servings below CFG Rec	4.7%	108,667	\$17.0	\$31.4	\$48.5	0.5%	11,064	\$1.4	\$2.5	\$3.9
Subtotal - Low Fruit and Vegetable Intake	82.2%	1,911,312	\$138.9	\$260.7	\$399.6	72.6%	1,712,971	\$71.4	\$133.4	\$204.9
Total			\$1,548.0	\$3,150.2	\$4,698.2			\$1,040.5	\$2,088.6	\$3,129.1

RF = Risk Factor; BMI = Body Mass Index; CFG Rec = Canada's Food Guide Recommendations

* The volume of alcohol consumption used to categorize alcohol use varies by sex. Please see alcohol use section for more detail.

Figure 1. Total Economic Burden by Health Authority, BC, 2015

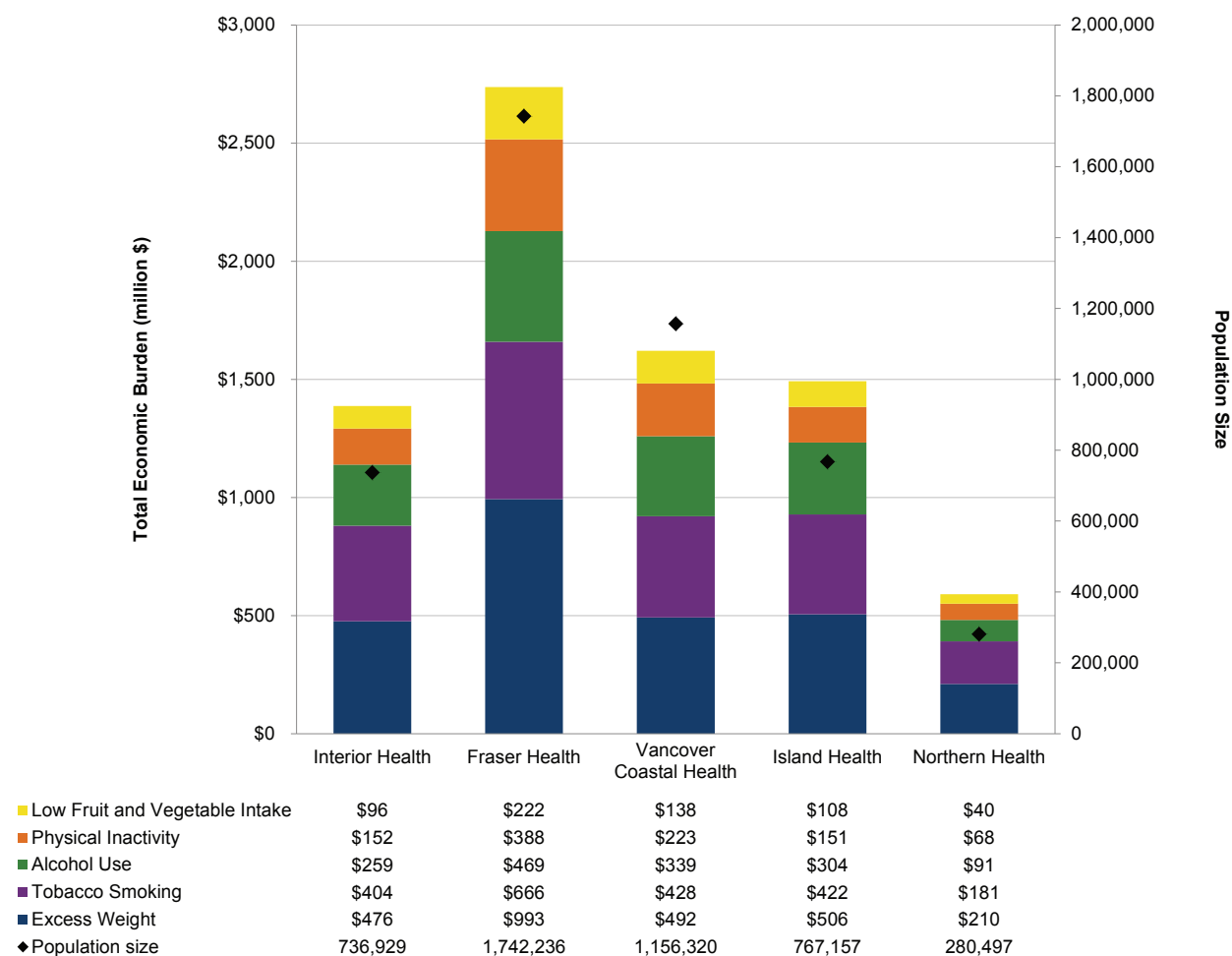


Figure 2. Total Economic Burden *per Capita*, by Health Authority and Health Service Delivery Area (HSDA), BC, 2015

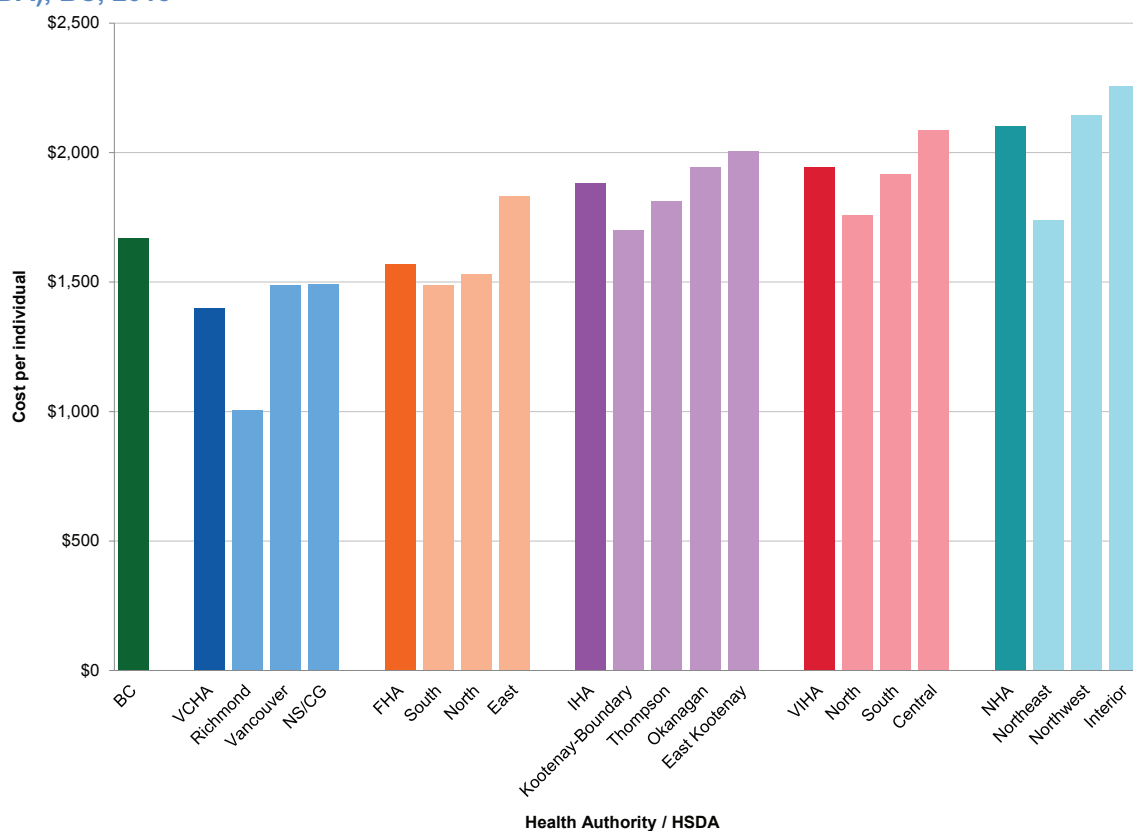
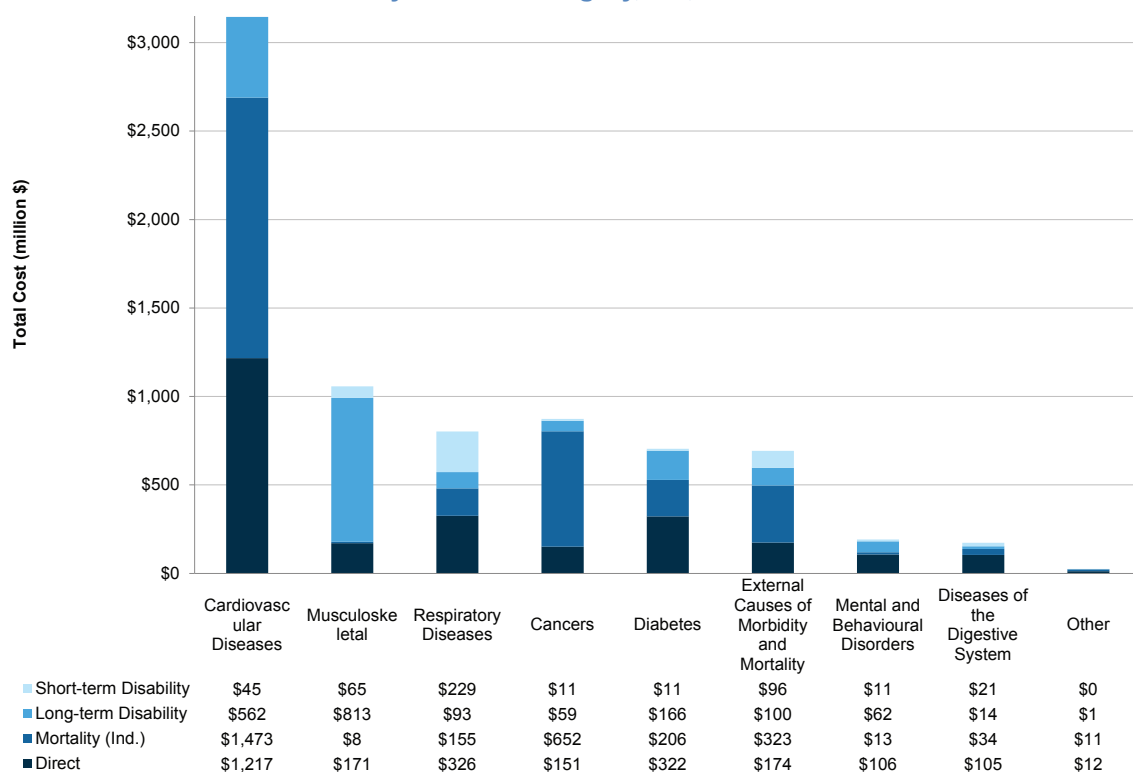


Figure 3. Total Economic Burden by Disease Category, BC, 2015

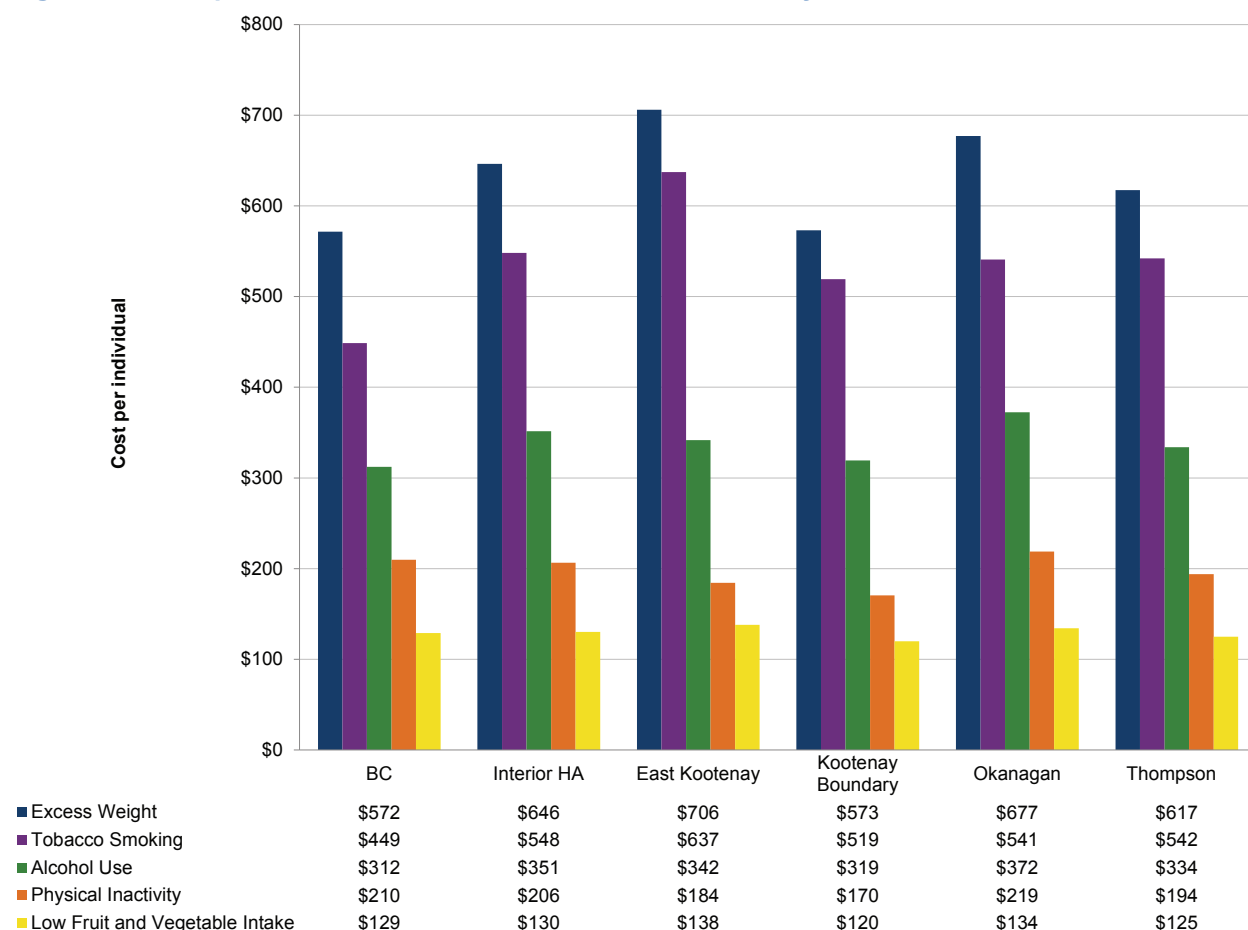


Regional Results

Interior Health

- In 2015, 17.4% of the Interior Health population smoked tobacco, 48.1% had excess weight, 33.4% were physically inactive, 76.1% consumed less than the recommended number of daily servings of fruits and vegetables and 60.7% consumed alcohol (with 11.6% consuming alcohol at levels considered to be hazardous or harmful).
- The prevalence of tobacco smoking was 30% **higher** than the provincial average, hazardous or harmful consumption of alcohol was 22% **higher** than the provincial average and excess weight was 15% **higher** than the provincial average.
- The annual economic burden was \$1.387 billion, or 18% of the total BC economic burden.
- The annual per capita burden of \$1,883 was 13% **higher** than the BC average (\$1,671), driven by the higher prevalence of tobacco smoking, hazardous or harmful consumption of alcohol and excess weight.
- The East Kootenay HSDA has the highest annual per capita burden (\$2,008) in Interior Health.

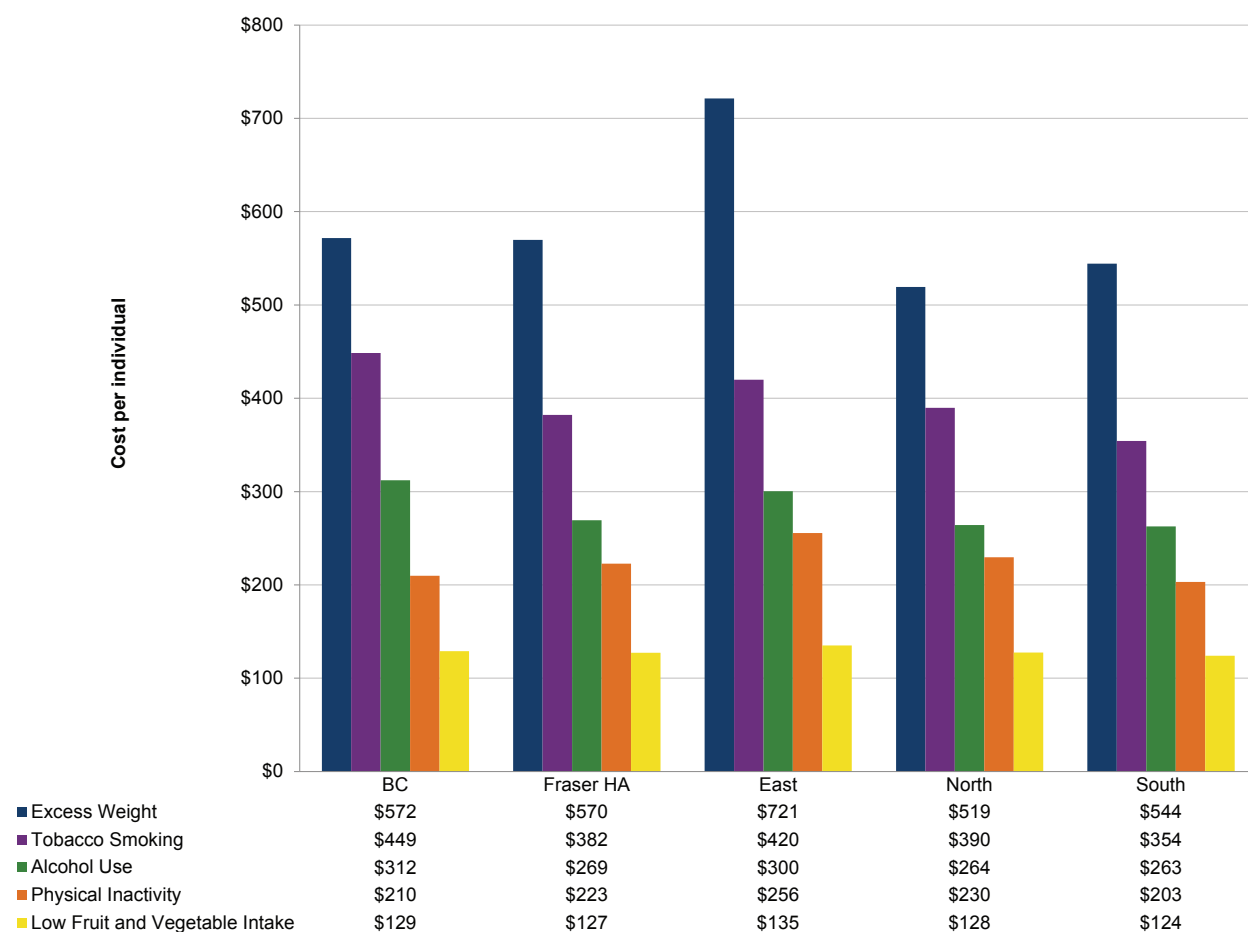
Figure 4. Per Capita Economic Burden, Interior Health Authority, 2015



Fraser Health

- In 2015, 10.5% of the Fraser Health population smoked tobacco, 42.7% had excess weight, 38.9% were physically inactive, 77.6% consumed less than the recommended number of daily servings of fruits and vegetables and 49.5% consumed alcohol (with 7.4% consuming alcohol at levels considered to be hazardous or harmful).
- The prevalence of tobacco smoking and hazardous or harmful consumption of alcohol were both 22% **lower** than the provincial average while physical inactivity was 10% **higher** than the provincial average.
- The annual economic burden was \$2.738 billion, or 35% of the total BC economic burden.
- The annual per capita burden of \$1,571 was 10% **lower** than the BC average (\$1,671), driven by the lower prevalence of tobacco smoking and hazardous or harmful consumption of alcohol.
- The Fraser East HSDA had the highest annual per capita burden (\$1,832) in Fraser Health.

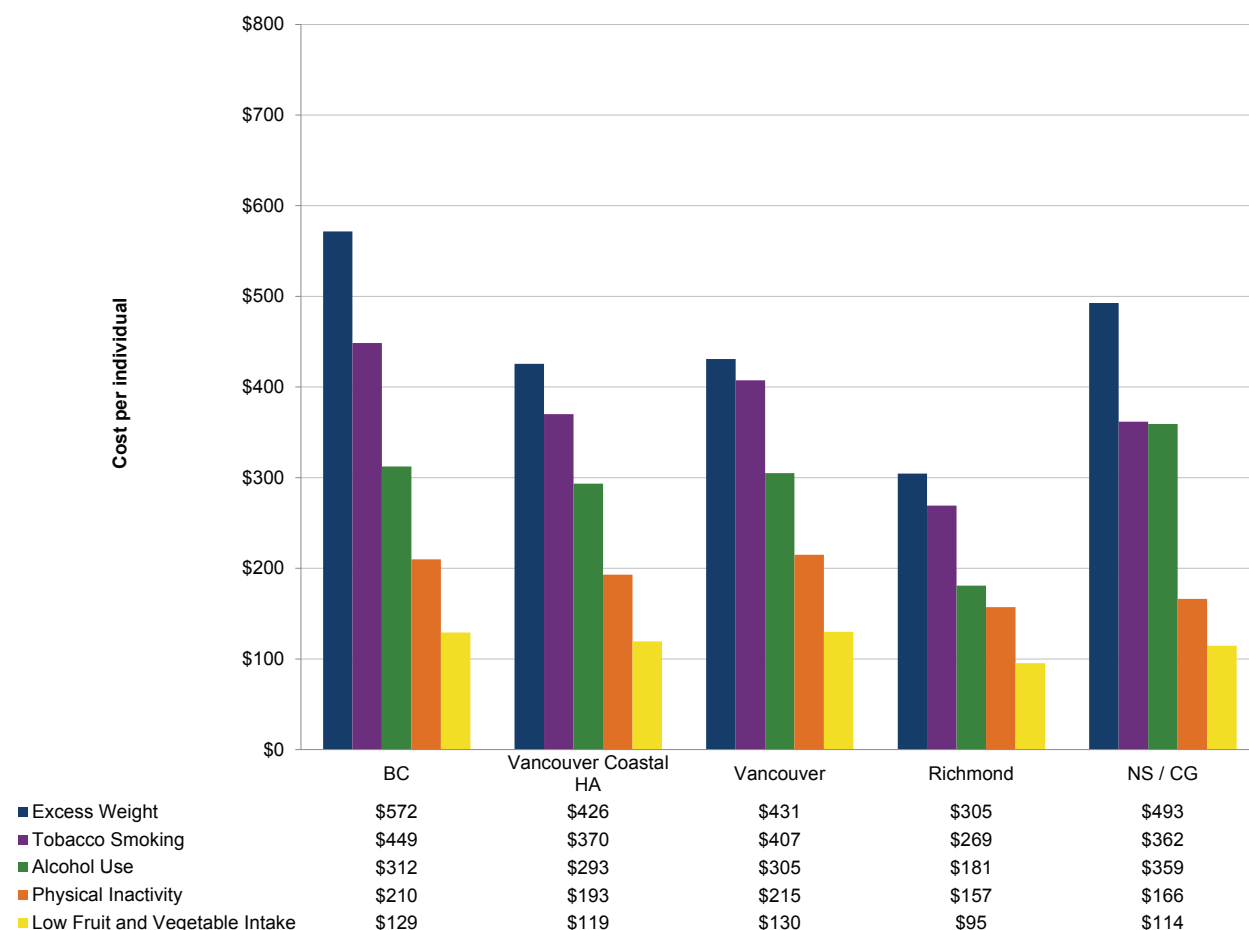
Figure 5. Per Capita Economic Burden, Fraser Health Authority, 2015



Vancouver Coastal Health

- In 2015, 12.8% of the Vancouver Coastal Health population smoked tobacco, 34.0% had excess weight, 35.5% were physically inactive, 78.4% consumed less than the recommended number of daily servings of fruits and vegetables and 54.3% consumed alcohol (with 9.9% consuming alcohol at levels considered to be hazardous or harmful).
- The prevalence of excess weight was 19% **lower** than the provincial average.
- The annual economic burden was \$1.621 billion, or 21% of the total BC economic burden.
- The annual per capita burden of \$1,401 was 16% **lower** than the BC average (\$1,671), driven by the lower prevalence of excess weight.
- The North Shore / Coast Garibaldi (NS/CG) HSDA had the highest annual per capita burden (\$1,494) in Vancouver Coastal Health. Tobacco smoking and alcohol costs were nearly equal in this HSDA whereas the cost of alcohol use is much less than tobacco smoking in all other HSDAs.

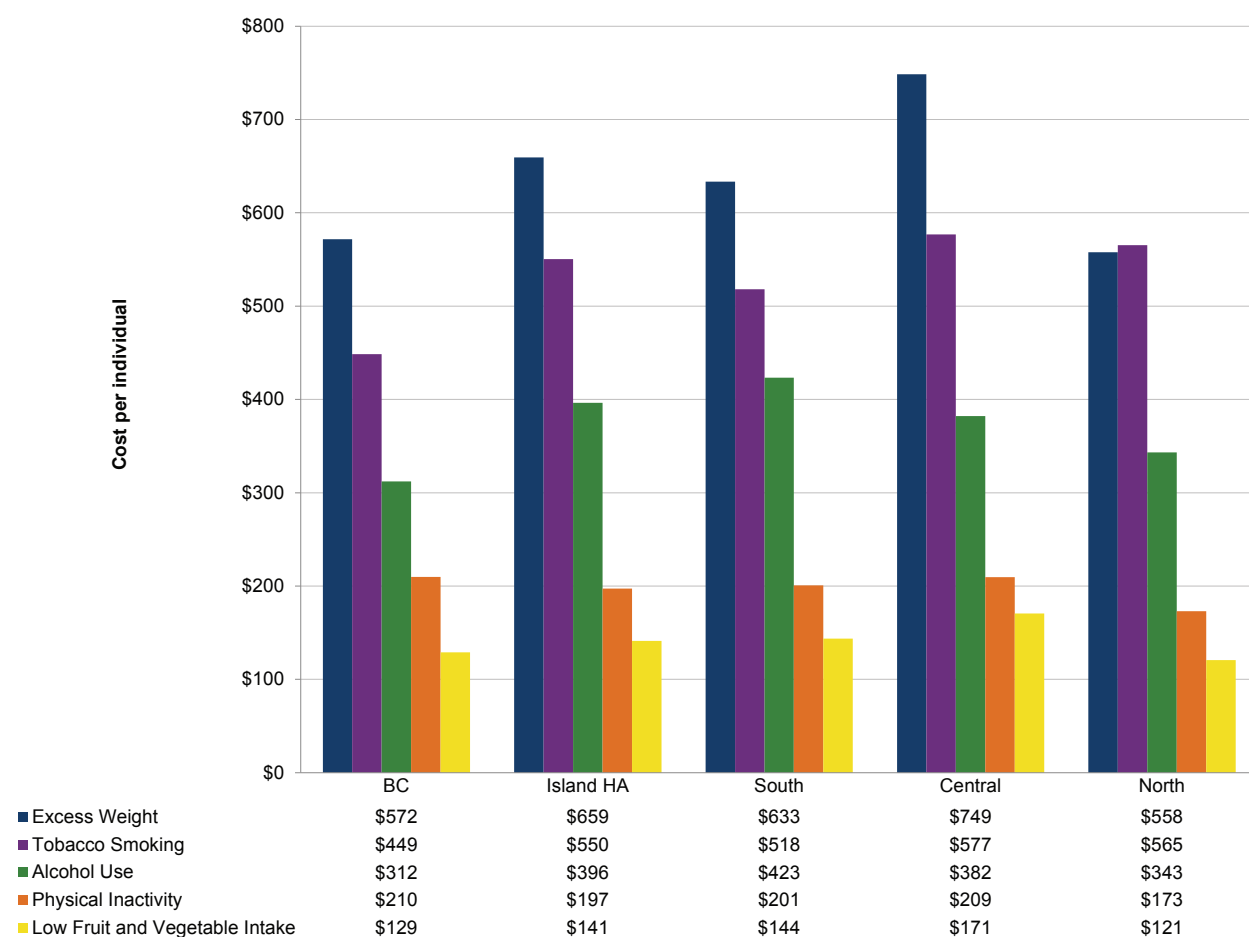
Figure 6. Per Capita Economic Burden, Vancouver Coastal Health Authority, 2015



Vancouver Island Health

- In 2015, 14.8% of the Vancouver Island Health population smoked tobacco, 42.8% had excess weight, 27.9% were physically inactive, 76.6% consumed less than the recommended number of daily servings of fruits and vegetables and 61.2% consumed alcohol (with 12.1% consuming alcohol at levels considered to be hazardous or harmful).
- The prevalence of tobacco smoking was 10% **higher** than the provincial average, hazardous or harmful consumption of alcohol is 27% **higher** than the provincial average, while physical inactivity was 21% **lower** than the provincial average.
- The annual economic burden was \$1.492 billion, or 19% of the total BC economic burden.
- The annual per capita burden of \$1,945 was 16% **higher** than the BC average (\$1,671), driven by the higher prevalence of tobacco smoking and hazardous or harmful consumption of alcohol.
- The Central Island HSDA had the highest annual per capita burden (\$2,087) in Vancouver Island Health.
- Tobacco smoking costs exceeded excess weight costs in the North Island HSDA whereas the cost of excess weight was higher in all other HSDAs.

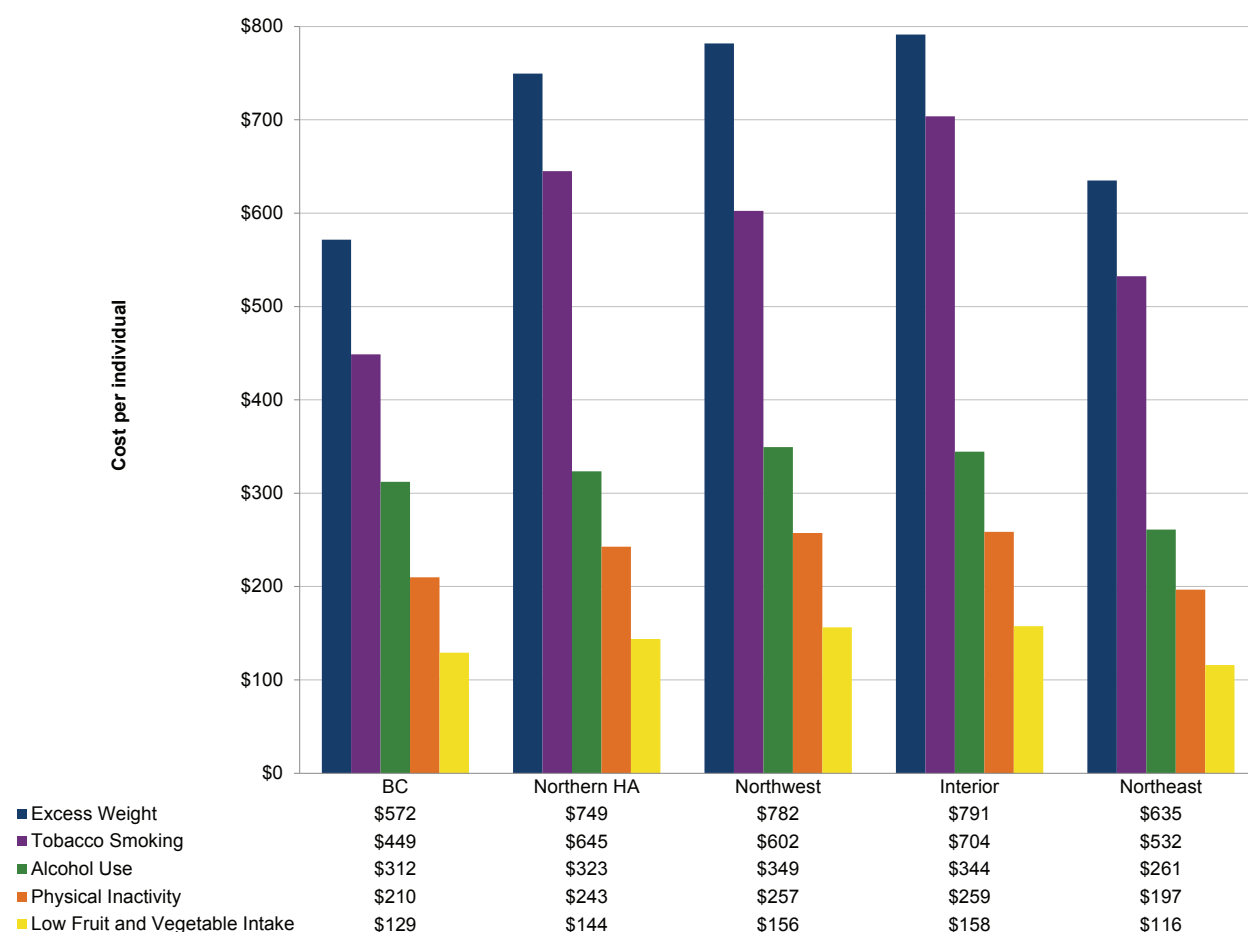
Figure 7. Per Capita Economic Burden, Vancouver Island Health Authority, 2015



Northern Health

- In 2015, 19.8% of the Northern Health population smoked tobacco, 50.3% had excess weight, 37.1% were physically inactive, 77.1% consumed less than the recommended number of daily servings of fruits and vegetables and 51.2% consumed alcohol (with 8.6% consuming alcohol at levels considered to be hazardous or harmful).
- The prevalence of tobacco smoking was 48% **higher** than the provincial average while excess weight was 20% **higher** than the provincial average.
- The annual economic burden was \$590 million, or 8% of the total BC economic burden.
- The annual per capita burden of \$2,104 was 26% **higher** than the BC average (\$1,671), driven by the higher prevalence of tobacco smoking and excess weight.
- The Northern Interior HSDA had the highest annual per capita burden (\$2,256) in Northern Health.

Figure 8. Per Capita Economic Burden, Northern Health Authority, 2015



Excess Weight

The key results from the analysis of excess weight as a risk factor in 2015 are summarized below:

- Excess weight contributed \$2.7 billion (34%) to the economic burden in BC, the most of any of the considered risk factors (Table 1).
- Rates of excess weight were **lowest** in Vancouver Coastal Health (34%), with Richmond HSDA the lowest in BC at 31% (Figure 9).
- Rates of excess weight were **highest** in Northern Health (50%), with Northeast HSDA the highest in BC at 54% (Figure 9).
- The economic burden of obesity (\$1.57 billion) alone was 20% of the total \$7.8 billion economic burden, more than that from alcohol use (\$1.05 billion), physical inactivity (\$983 million) or low fruit and vegetable consumption (\$605 million) (Table 1).
- Excess weight had an approximately equal effect on cardiovascular diseases and diseases of the muscles and bones (Figure 11). Note, however, that the distribution of these costs were quite different. The majority of the economic burden associated with diseases of the muscles and bones were due to long-term disability (77%) while the majority of the economic burden associated with cardiovascular diseases were due to premature mortality (45%). Diabetes was the third largest contributor of the economic burden associated with excess weight (Figure 11).

Nearly half (41.9%) of British Columbians are overweight (28.7%) or obese (13.2%). Males have a significantly higher rate of self-reported excess weight than females (50.8% vs. 33.2%, respectively). On the other hand, annual cost per person with excess weight is higher for females (\$1,625) than for males (\$1,193). The rates of excess weight in BC are a significant concern given the known association between excess weight and many chronic diseases.

Rates of excess weight vary considerably across the province, from a high of 54% in the Northeast HSDA to a low of 31% in the Richmond HSDA. A previously published assessment of risk factors by the Provincial Health Services Authority (PHSA) showed very similar trends, with some variation in prevalence by HSDA. Overall the provincial prevalence of excess weight has hardly shifted since the previous report in 2015 (41.6% in previous report vs. 41.9% in this report).¹² The lowest rates of excess weight are found within Vancouver Coastal Health which had rates 19% lower than the provincial average. Social, economic and environmental factors may have influenced this geographic variation and other variation between or within groups. A 2016 report also confirmed regional variances in excess weight, as well as noting the impact education and economic status have on the risk factor.¹⁵ As a result, achieving rates of excess weight similar to Vancouver may be more challenging for some populations. However, prevention efforts should also recognize this variability in order to design interventions that consider these extrinsic factors and promote health equity.

There is at least one important caution when considering excess weight in BC. Like most people doing research in this area, we group individuals with a BMI between 25 kg/m² and 29.9 kg/m² as overweight. Some research has suggested, however, that negative health effects may occur for some ethnic groups at a BMI below 25 kg/m², particularly those of Asian descent.¹⁶ This is of relevance in BC as a high proportion of individuals identify as a visible ethnic minority (24.8%),¹⁷ with some regions much higher

than others. For example, in the Richmond HSDA, 44% of individuals identify as being of Chinese origin, 8.0% as South Asian, and 5.5% as Filipino. Using a cut-off of 25 kg/m² for this population may underestimate their excess weight-attributable economic burden.

Figure 9. Prevalence of Excess Weight, BC, 2015

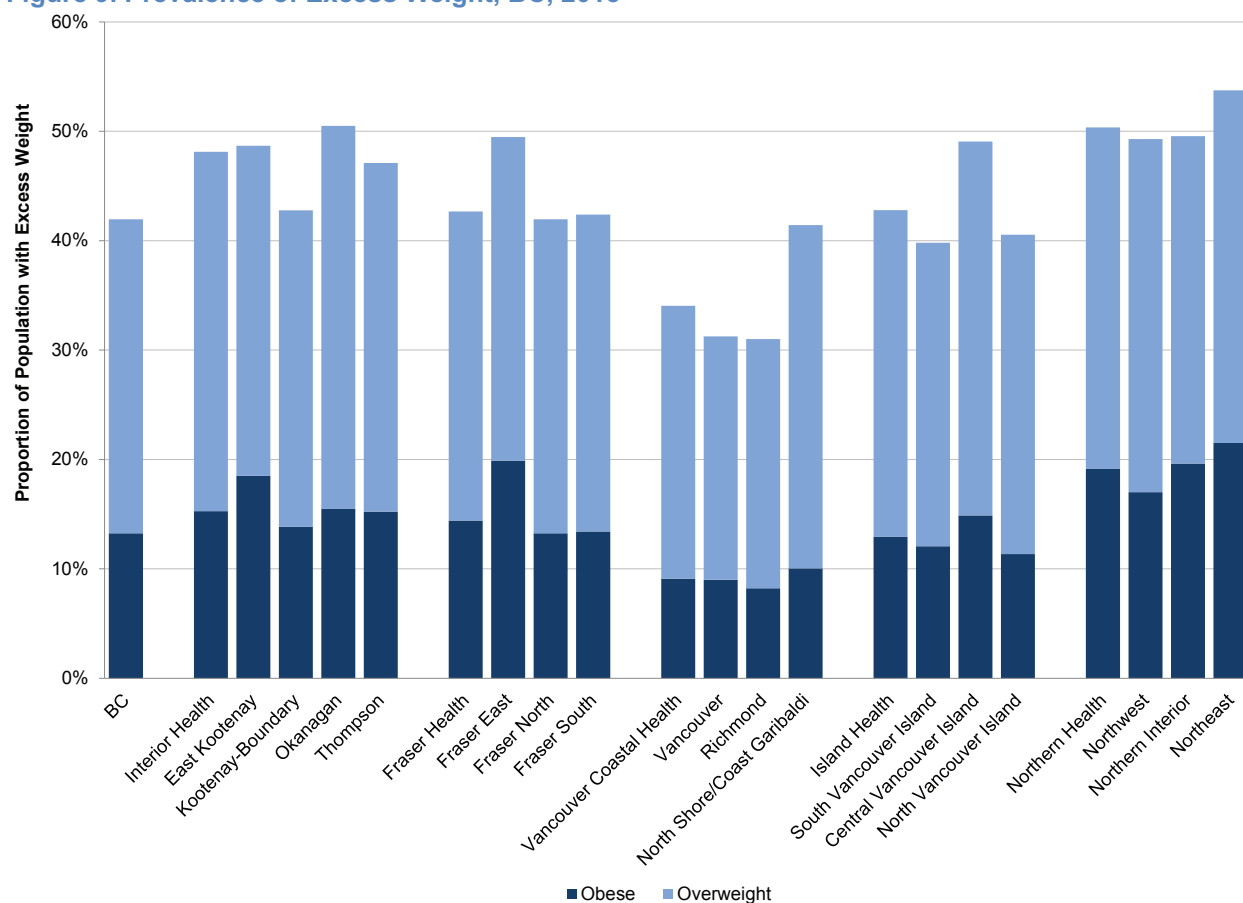


Figure 10. Per Capita Cost of Excess Weight, BC, 2015

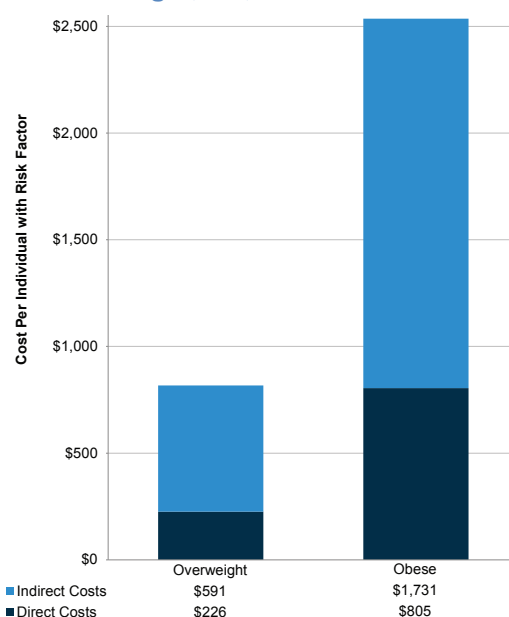
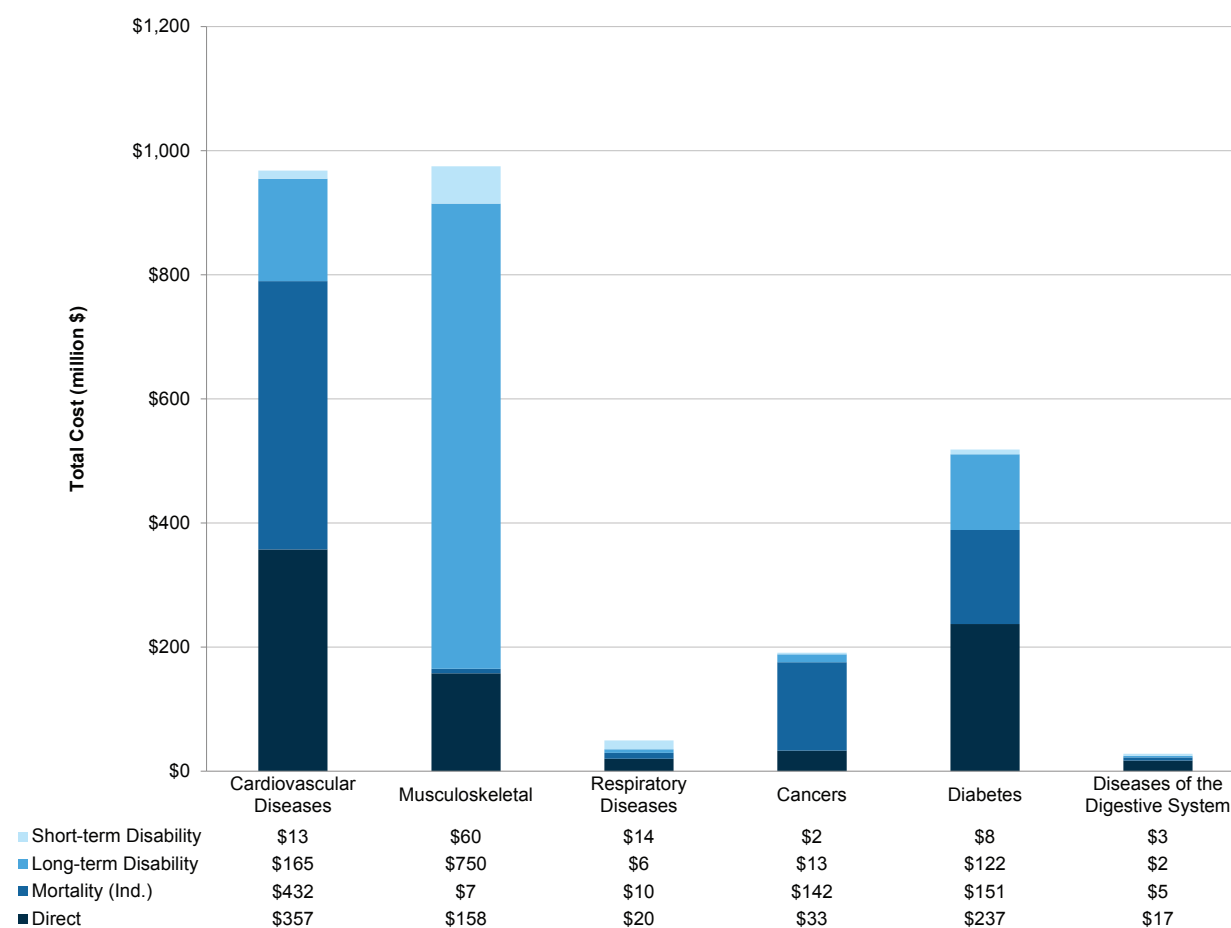


Figure 11. Economic Burden of Excess Weight by Disease Category, BC, 2015^a

^a Note: \$0 estimated for External Causes of Morbidity and Mortality, Mental and Behavioural Disorders, and Other

Tobacco Smoking

The key results from the analysis of tobacco smoking as a risk factor in 2015 are summarized below:

- Tobacco smoking contributed \$2.1 billion (27%) to the economic burden in BC, the second most of any of the considered risk factors (Table 1).
- Rates of tobacco smoking were **lowest** in Fraser Health (10.5%), with Fraser South HSDA the lowest in BC at 9.8% (Figure 12).
- Rates of tobacco smoking were **highest** in Northern Health (19.8%), but East Kootenay HSDA had the **highest** rate in BC at 21.8% (Figure 12).
- Not one HSDA in Interior, Island or Northern Health Authorities was below the provincial average for smoking prevalence of 13.4% (Figure 12).
- Tobacco smoking had the greatest regional disparity of any risk factor, ranging from 9.8% to 21.8% (Figure 12).
- Tobacco smoking was the most costly of the five risk factors, with an average annual cost of \$3,345 per smoker; \$2,206 for a light smoker and \$5,725 for a heavy smoker (Figure 13).
- Tobacco smoking had the largest effect on cardiovascular (heart) and respiratory (lung) diseases, with the effect on cancers being a distant third (Figure 14).

In total, 13.4% of British Columbians self-reported smoking tobacco: 7.0% of British Columbians smoke fewer than 10 cigarettes per day or consider themselves occasional smokers, 3.9% smoke between 10 and 20 cigarettes per day, and 2.5% smoke more than 20 cigarettes per day. Rates of heavy smoking are much higher in males (3.6%) than females (1.5%). While this suggests that a large number of British Columbians are still smoking cigarettes, BC currently has the lowest rate of smoking in all 10 Canadian provinces.¹⁸ Comparing to estimates for 2013, smoking prevalence overall has remained stable (13.2% vs. 13.4%), but rates of heavy smoking have declined (3.0% vs. 2.5%).¹²

Of particular concern is the wide variation in smoking rates across the province, and the noticeable geographic trends that arise. All HSDAs within Fraser Health and all but one within Vancouver Coastal Health have smoking rates below the provincial average. Similarly, all HSDAs within Interior Health, Vancouver Island Health and Northern Health smoking rates that are above the provincial average. This would suggest that only some HSDAs are contributing to the low provincial smoking rates, and others still demand significant attention. The 2016 PHSA health equity indicator report confirmed regional variances in smoking prevalence, and noted that increases in education and economic status are associated with decreased rates of smoking.¹⁵

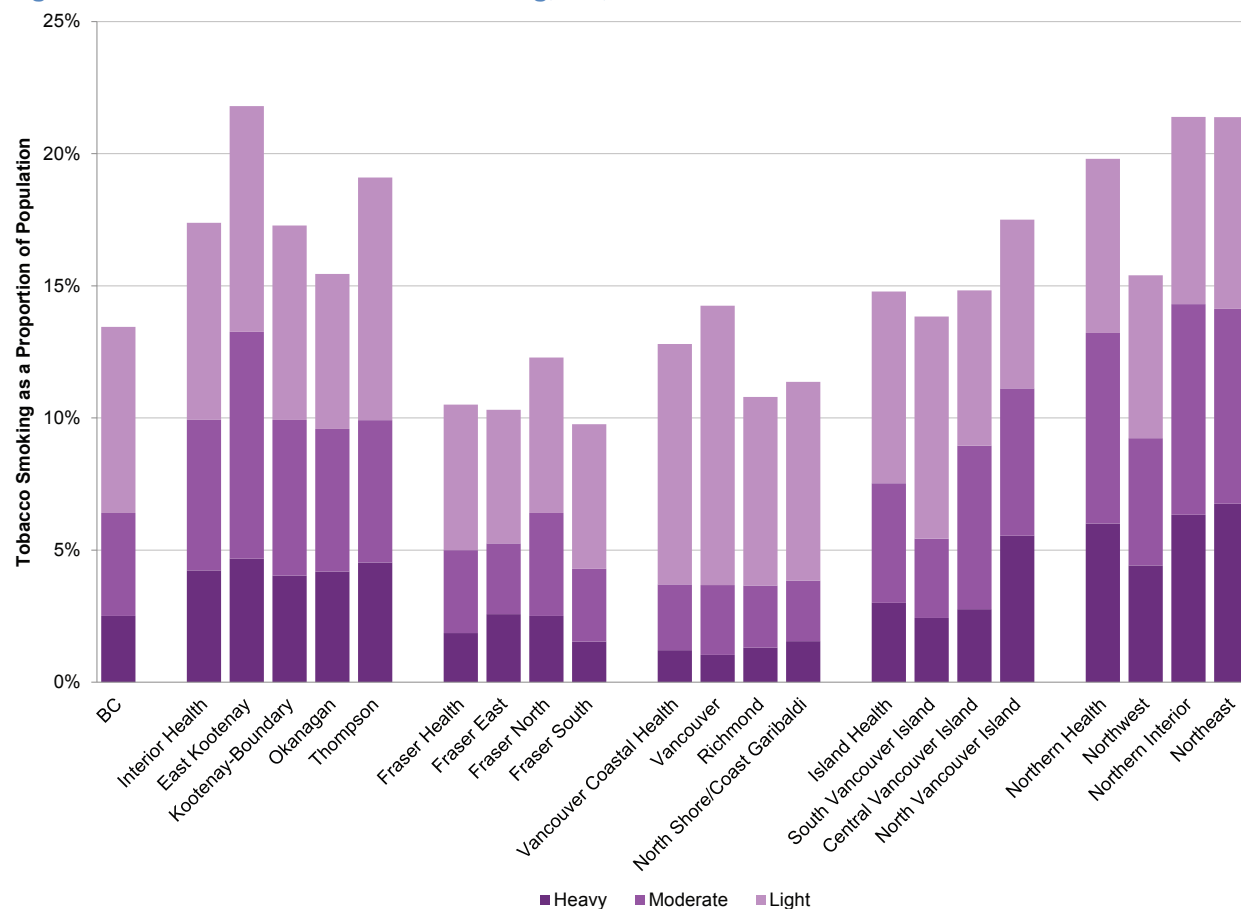
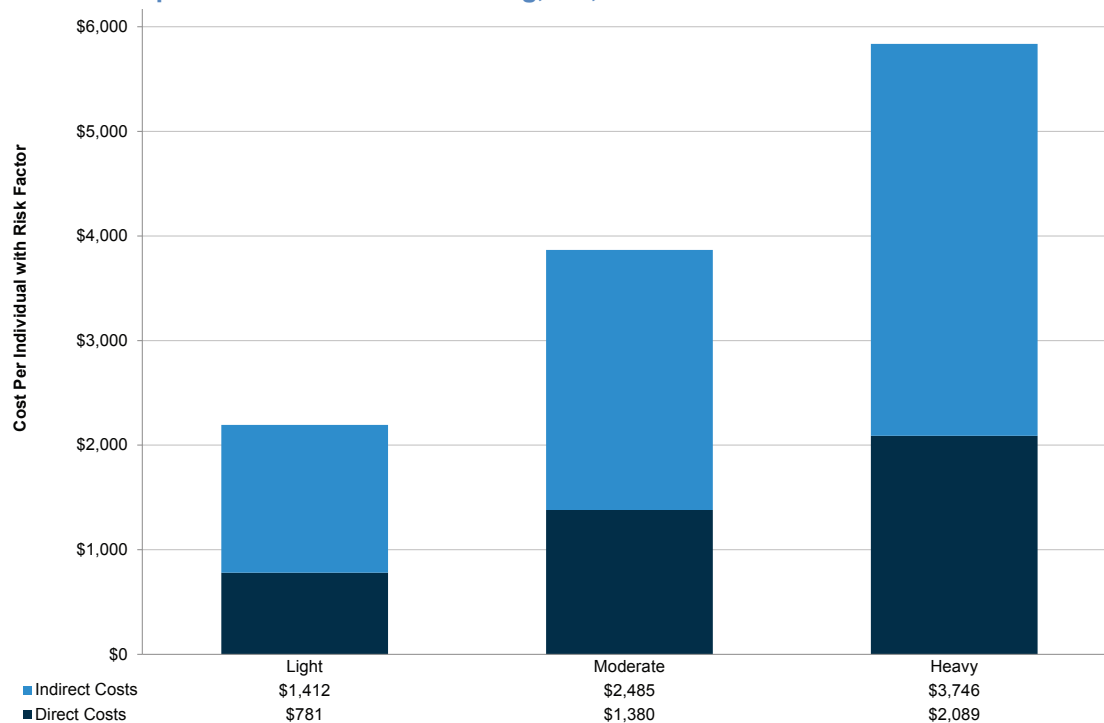
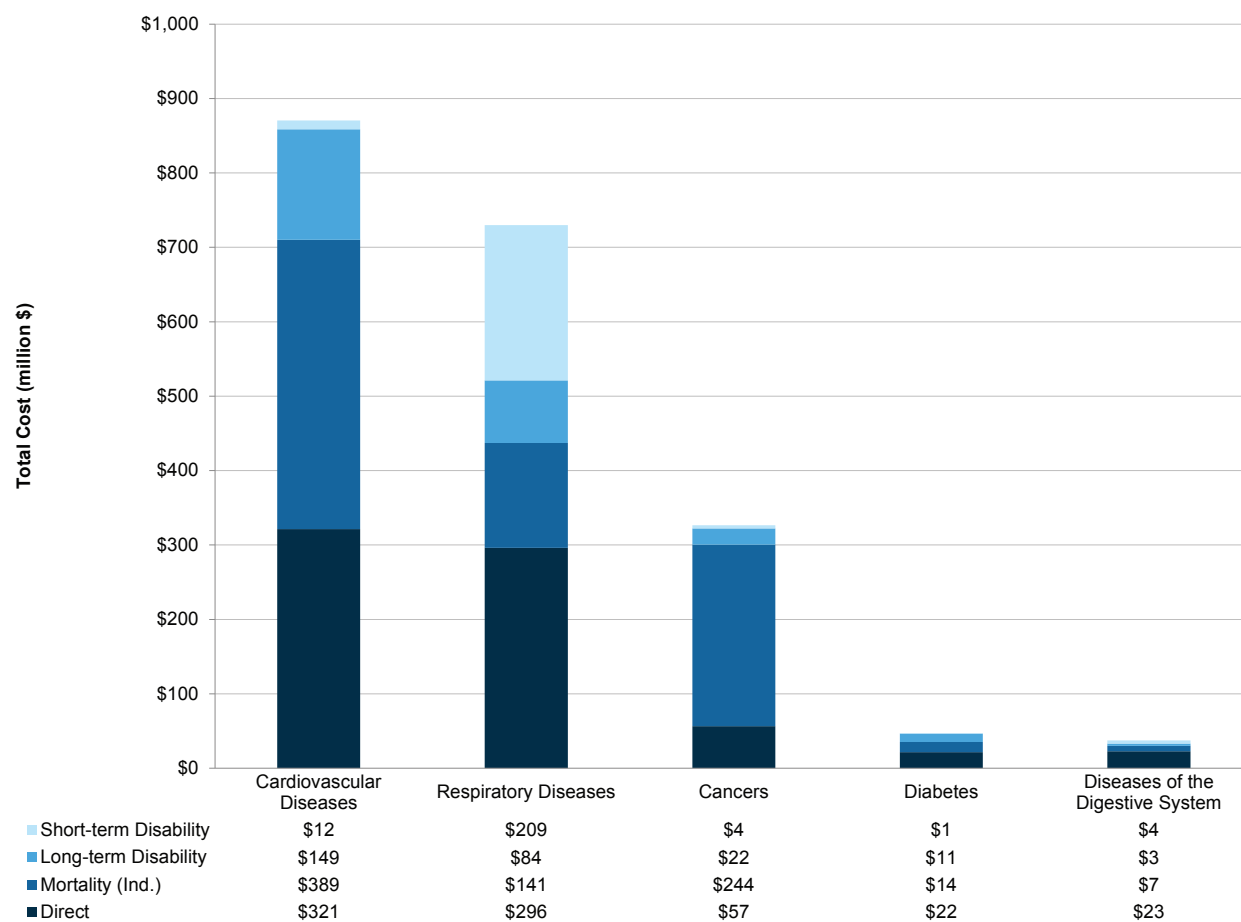
Figure 12. Prevalence of Tobacco Smoking, BC, 2015

Figure 13. Per Capita Cost of Tobacco Smoking, BC, 2015


Figure 14. Economic Burden of Tobacco Smoking by Disease Category, BC, 2015^b

^b Note: \$0 estimated for Musculoskeletal, External Causes of Morbidity and Mortality, Mental and Behavioural Disorder, and Other

Alcohol Use

The key results from the analysis of alcohol use as a risk factor in 2015 are summarized below:

- Alcohol use contributed \$1.5 billion (19%) to the economic burden in BC (Table 1).
- Vancouver Coastal had the **lowest** alcohol use prevalence, but had both the **lowest** and **highest** prevalence by HSDA (44% in Richmond and 64% in North Shore / Coast Garibaldi) (Figure 15).
- Rate of alcohol use was **highest** in Island Health at 61% (Figure 15).
- Not one HSDA in Interior or Vancouver Island HA was below the provincial average for prevalence of alcohol use (Figure 15).
- The annual cost per individual with harmful levels of alcohol consumption was almost as high (\$3,335) as that of a moderate smoker (\$3,880) (Table 1).
- Alcohol use had the largest effect on external causes of morbidity and mortality (48%) followed by cardiovascular diseases (16%) and mental and behavioural disorders (13%) (Figure 17).

Alcohol use is the only risk factor whose economic burden is dominated by external causes of morbidity and mortality. These external causes include falls, motor vehicle accidents and other unintentional injuries. Taken together external causes account for \$693 million (48%) of the risk factor total. Indirect costs due to external causes total \$519 million, or 75% of the disease category, which is substantially more than the provincial average.

Large disparities exist between geographies and even within individual health regions, most noticeable in the disparity in the proportion of hazardous and harmful drinkers in the Richmond and North Shore / Coast Garibaldi HSDA's in the Vancouver Coastal Health Authority. This disparity within a single health authority suggests that social, economic and environmental factors may influence the difference in risk factor prevalence between or within groups. The North Shore / Coast Garibaldi HSDA in particular comprises distinct urban and rural areas which might have different drivers that require further investigation for clarity behind these rates. Achieving rates of alcohol consumption equal to the “best-in-province” level will be more challenging for some populations. Prevention efforts should recognize this variability in order to design interventions that consider these extrinsic factors and promote health equity.

Figure 15. Prevalence of Alcohol Use, BC, 2015

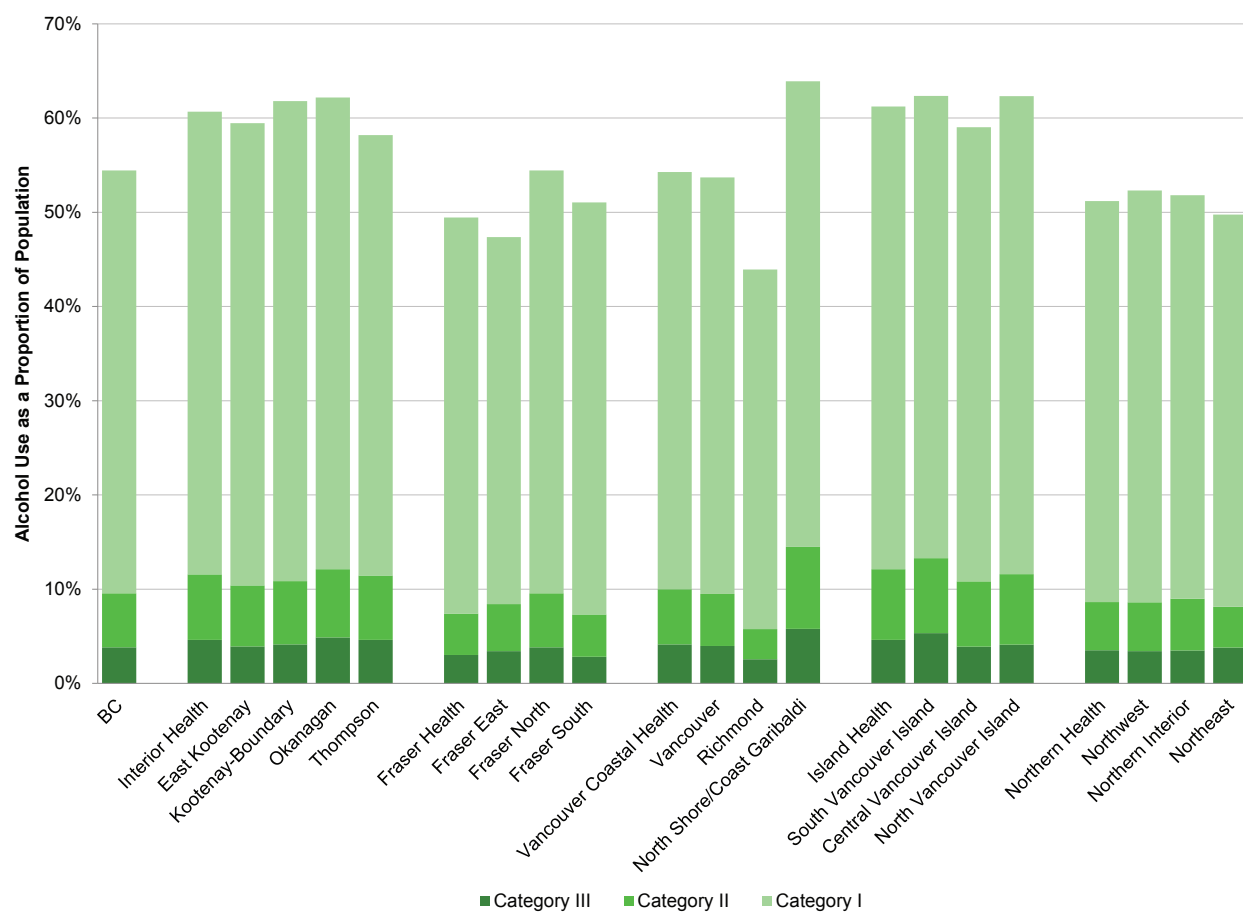


Figure 16. Per Capita Cost of Alcohol Use, BC, 2015

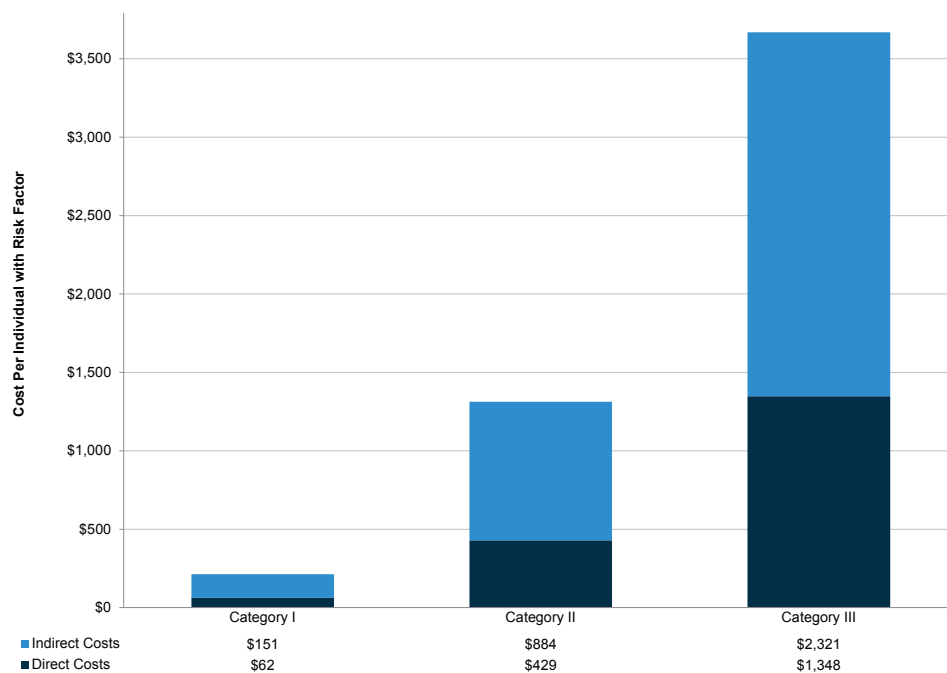
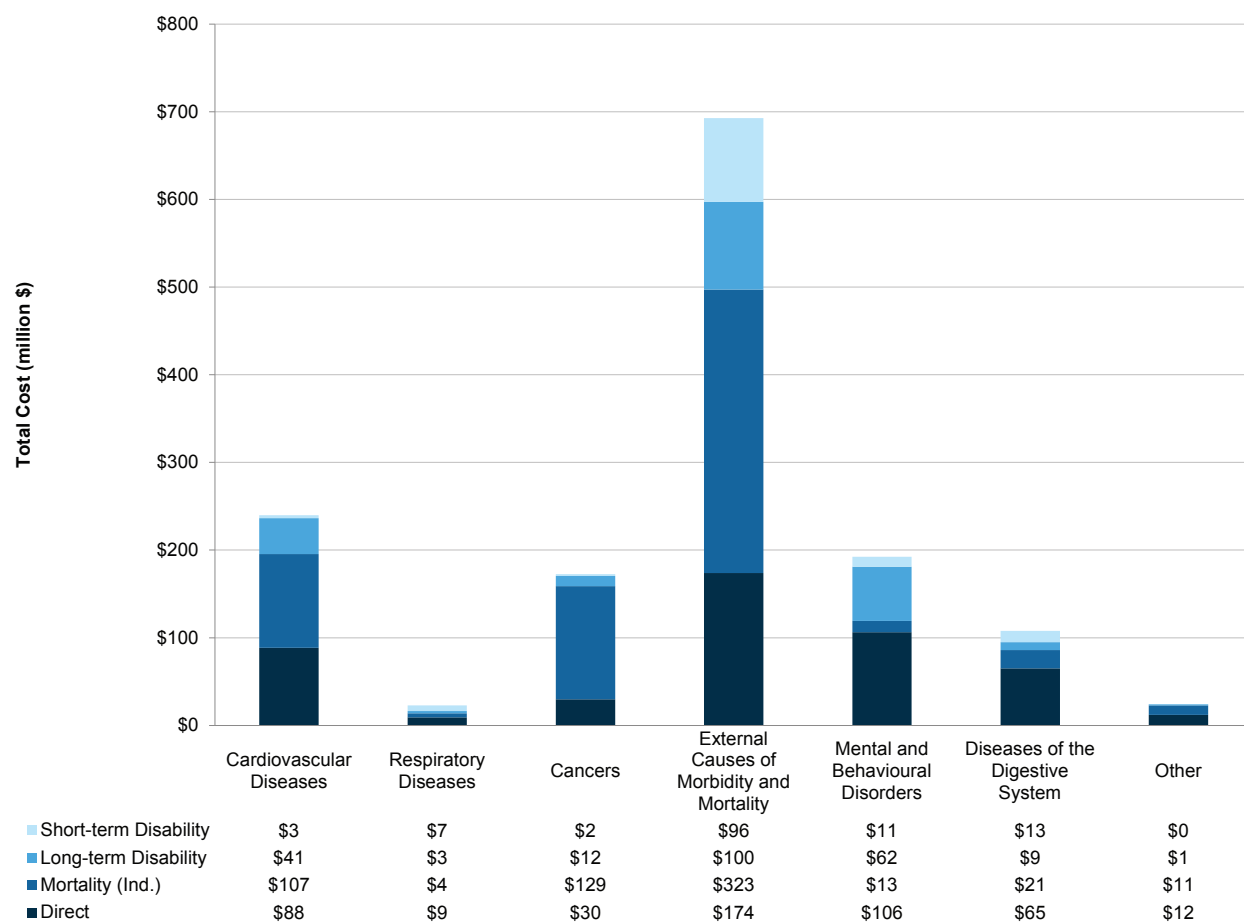


Figure 17. Economic Burden of Alcohol Use by Disease Category, BC, 2015^c

^c Note: \$0 estimated for Musculoskeletal and Diabetes

Physical Inactivity

The key results from the analysis of physical activity as a risk factor in 2015 are summarized below:

- Physical inactivity contributed \$983 million (13%) to the economic burden in BC (Table 1).
- Vancouver Island Health had the lowest rate of physical inactivity (28%), with all Island Health HSDA's below the provincial rate of 35% (Figure 18).
- Rates of physical inactivity were highest in Fraser Health (39%), with Fraser East HSDA the highest in BC at 42% (Figure 18).
- Physical inactivity had by far the largest effect on cardiovascular diseases (68%), followed by diabetes (14%) and cancers (12%) (Figure 19).

The annual economic burden per individual who is physically inactive is \$595. This relatively low cost, however, is offset by the high number of people in the province who are inactive, leading to an annual economic burden in BC approaching \$1.0 billion. Two-thirds of the economic burden attributable to physical inactivity is the result of cardiovascular diseases, while the remaining one-third is due to diabetes, cancers and musculoskeletal diseases combined.

Regional variances are significant for this risk factor, which was noted in the previous PHSA risk factor report.¹² In general, less urban PHSAs tend toward greater physical activity, most notably in the Island Health Authority and certain HSDAs in Interior Health. The 2016 PHSA health equity indicator report confirmed regional variances in physical activity levels, and noted that increases in education and economic status resulted in increased physical activity.¹⁵

Figure 18. Prevalence of Physical Inactivity, BC, 2015

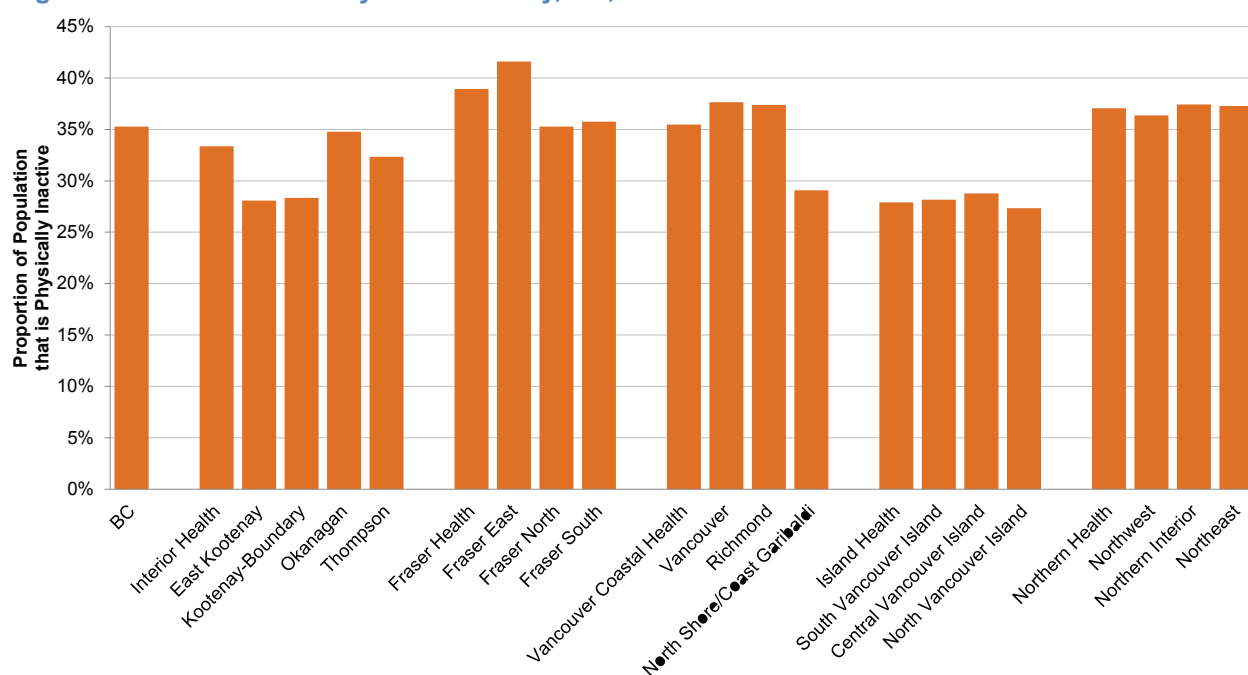
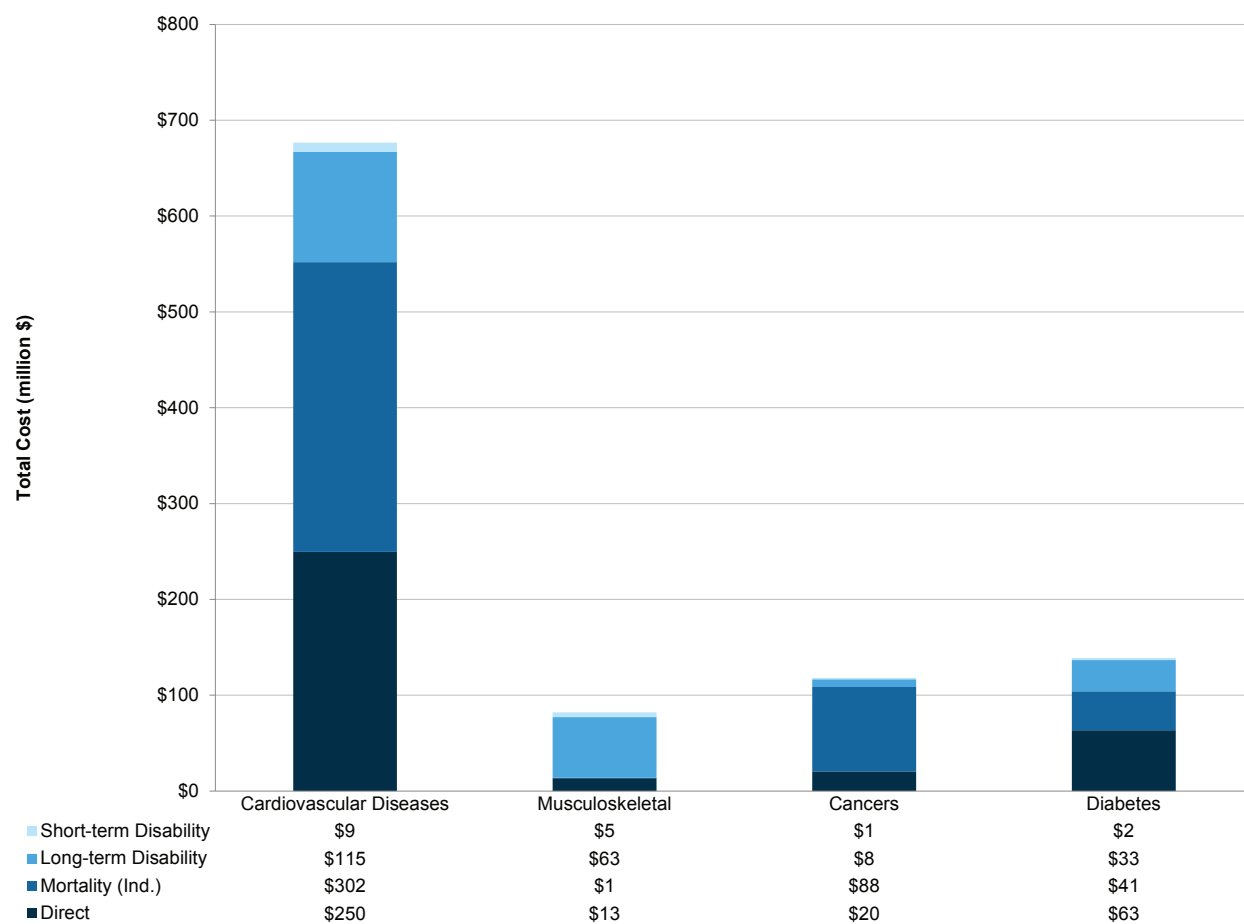


Figure 19. Economic Burden of Physical Inactivity by Disease Category, BC, 2015^d

^d Note: \$0 estimated for Respiratory Diseases, External Causes of Morbidity and Mortality, Mental and Behavioural Disorders, Diseases of the Digestive System, and Other

Low Fruit and Vegetable Consumption

The key results from the analysis of low fruit and vegetable consumption as a risk factor in 2015 are summarized below:

- Low fruit and vegetable consumption contributed \$605 million (8%) to the economic burden in BC, the least of any of the considered risk factors (Table 1).
- Females tend to consume more fruits and vegetables than males. For example, 57% of females either consumed the recommended number of servings or were just 1 to 2 servings below recommended guidelines, compared with 37% of males.
- The Central Vancouver Island HSDA had the highest proportion of the population (27%) whose fruit and vegetable consumption was at least five servings below daily recommendations (Figure 20).
- The cardiovascular disease category dominated economic burden (90%), with cancers a distant second (10%) (Figure 22). Indeed, there is some controversy as to whether fruit and vegetable consumption has any protective effect against cancers.²¹

The prevalence of low fruit and vegetable consumption is the highest of any of the risk categories averaging 77% of the population, while the overall economic burden was the lowest (\$605 million). This category may also be easiest to influence, since it is a matter of encouraging people to do a little more of an activity they already participate in, as opposed to taking up a new habit or completely discarding old ones. Also of interest is that until the age of 10, more than half of children in Canada get the recommended number of fruit and vegetable servings. This number drops below 20% by age 15 and never exceeds 20% again.²¹

Figure 20. Prevalence of Low Fruit and Vegetable Consumption, BC, 2015

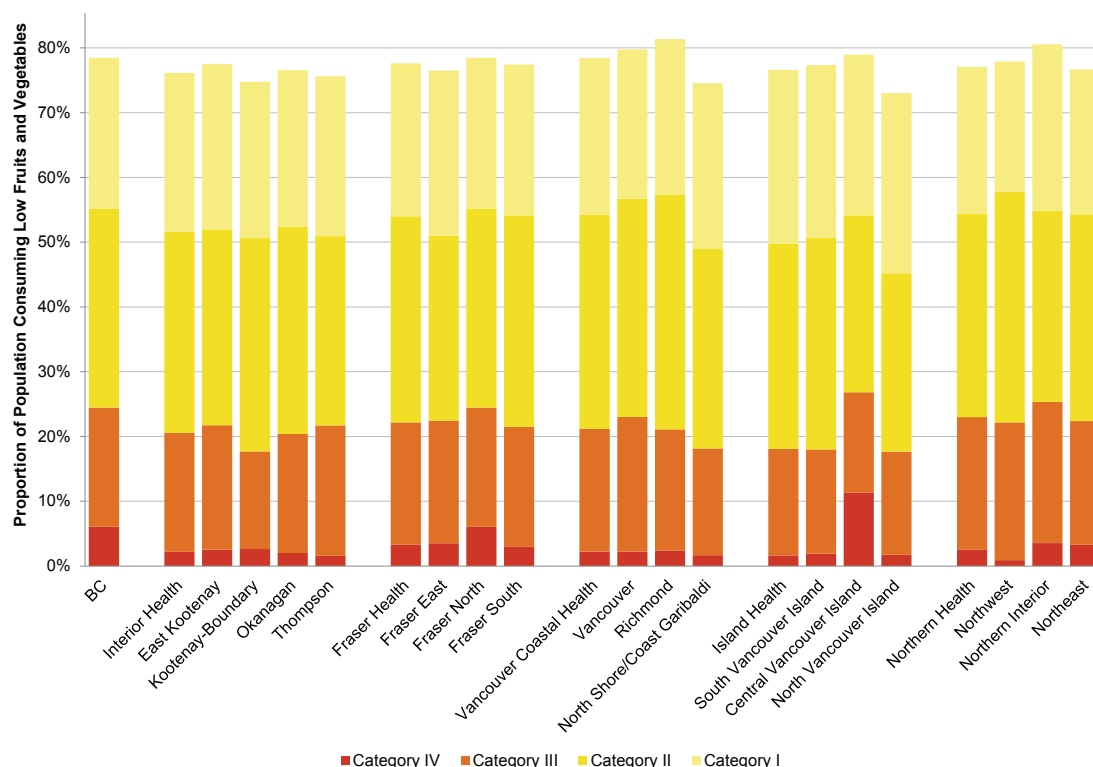
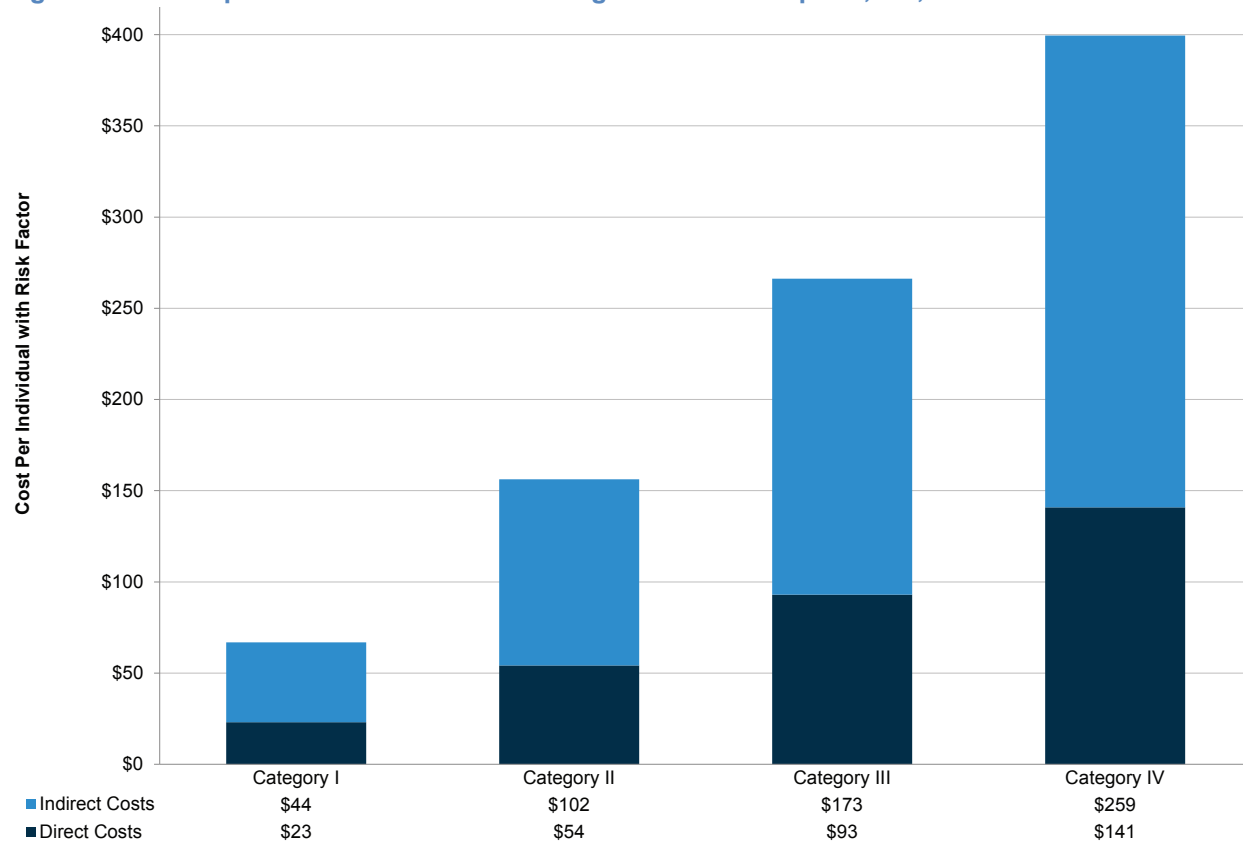
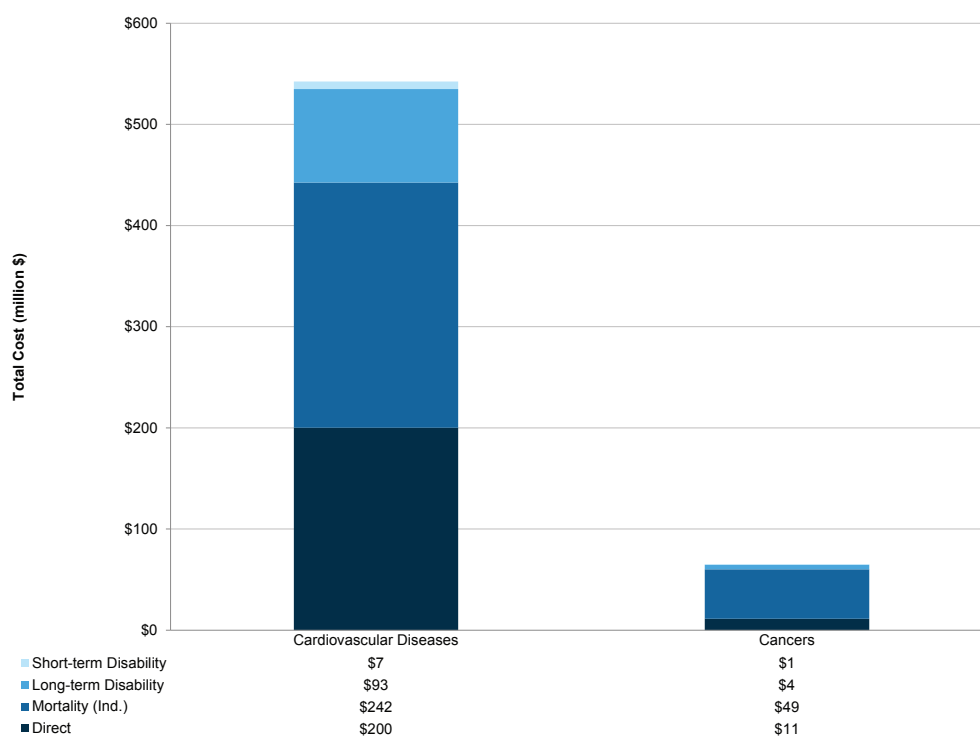


Figure 21. Per Capita Cost of Low Fruit and Vegetable Consumption, BC, 2015**Figure 22. Economic Burden of Low Fruit and Vegetable Consumption by Disease Category, BC, 2015^e**

^e Note: \$0 estimated for Musculoskeletal, Respiratory Diseases, Diabetes, External Causes of Morbidity and Mortality, Mental and Behavioural Disorders, Diseases of the Digestive System, and Other

Conclusion and Recommendations

The modifiable risk factors of excess weight, tobacco smoking, alcohol use, physical inactivity, and low fruit and vegetable consumption are associated with an annual economic burden of \$7.8 billion in British Columbia. The prevalence of these risk factors is noticeably variable by sex and across regions. Other PHSA publications have additionally noted differences in risk factor prevalence due to education and socio-economic status.¹⁵ Differences between the 2015 and 2013 estimates for excess weight, tobacco smoking, and physical inactivity use be due to real changes as well as methodological improvements.¹²

The economic burden of these risk factors is substantial, and over 40% of their total economic burden is from premature mortality, disability, and direct health care costs associated with cardiovascular diseases. Equally weighty is the question of how best to change behaviours to reduce these risk factors so that British Columbians live healthier lives and the economic burden associated with these risk factors are reduced. While it is beyond the scope of this report to prescribe specific policies or programs, some general recommendations are offered to guide creation of such policies and programs.

A complete understanding of the magnitude of this economic burden can inform and drive public health prevention and health promotion policy. The aim is to encourage action and implement policy that will reduce the prevalence of the risk factors and ultimately prevent chronic disease. Other publications have noted differences in risk factor prevalence due to education and socio-economic status.¹⁵ While it is beyond the scope of this report to prescribe specific policies or programs, some general recommendations are offered to guide creation of such policies and programs.

1. **Benchmark against health service delivery areas that have the lowest prevalence of risk factors and determine the key drivers behind the lower prevalence.** If these drivers are in the form of unique programs, innovative education, community engagement or other systems within the influence of the health authorities, consider if it is beneficial to adapt them in other health authorities. If the drivers are social or cultural in nature, coordinated approaches by health and other sectors are necessary to promote healthy practices in others across the province while respecting the diversity of values in our communities.²⁷ Previous research indicated that if every health service delivery area in the province were to achieve the best prevalence rates for tobacco smoking, excess weight and physical inactivity, then \$1.4 billion in economic burden could be avoided annually.¹⁴
2. **Set targets for measuring progress across province on a bi-annual basis.** The only way to improve the burden of risk factors is to measure and track it to keep focussing on the goal of reduction. Inform senior management with evidence to make necessary policy changes through on-going evaluation of programs across all communities, especially those with prevalence rates currently exceeding the provincial average.
3. **Learn from experiences in Canada concerning tobacco smoking.** Experiences in Canada concerning tobacco smoking serve as an excellent reminder of both the progress that is possible

through intensive efforts at reducing the prevalence of a risk factor, as well as the reduction in disease that accompanies it. The reduction in smoking during the last 50 years has had demonstrable effects, for example, on the incidence of lung cancer. The progress that we have made in reducing smoking rates should reinforce that similar successes are possible for other modifiable risk factors. Furthermore, the steps taken to achieve progress in reducing smoking rates can serve as a roadmap for tackling other modifiable risk factors in the future, including excess weight and physical inactivity. We cannot solely attribute the reduction in smoking rates to one or two interventions; rather, various economic and policy changes as well as community-based and clinical interventions acted synergistically to lower smoking rates to where they are now. In the early years of tobacco prevention, there was a tendency to attribute behavioural change to personal choices. Similar attitudes and beliefs are often applied to current obesity prevention approaches. However, as the experience with smoking made clear, supportive environments are necessary to trigger and then reinforce individual change. An environment that makes it easy to make positive lifestyle decisions is best created through far-reaching policy and program changes, complemented by effective community and individual interventions.

4. **There is no 'quick fix'.** Instead, interventions require a prolonged approach that span beyond the immediate political cycle. We have learned that in order to see a meaningful reduction in risk factor prevalence, a long-term approach is required. It has been nearly 75 years since medical literature began reporting an association between tobacco smoking and chronic disease. While the net reduction today is remarkable, smoking rates were relatively slow to respond to interventions, and much work still remains.

References

- 1 Lim SS, Vos T, Flaxman AD et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012; 380(9859): 2224-60.
- 2 Provincial Health Officer. Investing in prevention: Improving health and creating sustainability. The Provincial Health Officer's special report. Victoria, B.C.: Ministry of Healthy Living and Sport. September 2010. Available at https://www.health.gov.bc.ca/library/publications/year/2010/Investing_in_prevention_improving_health_and_creating_sustainability.pdf. Accessed March 2018.
- 3 British Columbia Vital Statistics Agency. Selected Vital Statistics and Health Status Indicators: One Hundred Fortieth Annual Report 2011. 2011. Available at <https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/statistics-reports/annual-reports/2011/pdf/ann2011.pdf>. Accessed March 2018.
- 4 Alonso J, Ferrer M, Gandek B et al. Health-related quality of life associated with chronic conditions in eight countries: results from the International Quality of Life Assessment (IQOLA) Project. *Quality of Life Research*. 2004; 13(2): 283- 98.
- 5 Golics C, Basra M, Finlay A, Salek S. The impact of disease on family members: a critical aspect of medical care. *Journal of the Royal Society of Medicine*. 2013. 136(10), 399-407.
- 6 BC Ministry of Health. Primary Health Care Charter: A Collaborative Approach. 2007. Available at https://www.health.gov.bc.ca/library/publications/year/2007/phc_charter.pdf. Accessed March 2018.
- 7 Suhrcke M, Sauto Arce R, McKee M et al. The Economic Costs of Ill Health in the European Region. 2008. World Health Organization Available at http://www.euro.who.int/__data/assets/pdf_file/0004/83443/E93695.pdf. Accessed March 2018.
- 8 Public Health Agency of Canada. Investing in Prevention: The Economic Perspective. 2009. Available at <https://www.canada.ca/en/public-health/services/health-promotion/population-health/investing-prevention-economic-perspective.html>. Accessed March 2018.
- 9 BC Ministry of Health. Promote, Protect, Prevent: Our Health Begins Here: BC's Guiding Framework for Public Health. 2013. Available at <https://www.health.gov.bc.ca/library/publications/year/2013/BC-guiding-framework-for-public-health.pdf>. Accessed March 2018.
10. Kendall P. Investing in Prevention: Improving Health and Creating Sustainability. The Provincial Health Officer's Special Report. 2010. Office of the Provincial Health Officer. Available at https://www.health.gov.bc.ca/library/publications/year/2010/Investing_in_prevention_improving_health_and_creating_sustainability.pdf. Accessed March 2018.
11. Public Health Agency of Canada. Investing in Prevention: The Economic Perspective. 2009. Available at <https://www.canada.ca/en/public-health/services/health-promotion/population-health/investing-prevention-economic-perspective.html>. Accessed March 2018.
12. Provincial Health Services Authority. The economic benefits of risk factor reduction in British Columbia: Excess weight, physical inactivity, and tobacco smoking. 2015. Available at http://www.bccdc.ca/pop-public-health/Documents/EconomicBenefitsofRiskFactorReductioninBC_full%20report.pdf. Accessed March 2018.
13. Krueger H, Williams D, Ready A et al. Improved estimation of the health and economic burden of chronic disease risk factors in Manitoba. *Chronic Diseases and Injuries in Canada*. 2013; 33(4): 236-46.

14. Krueger H, Koot J, Rasali D et al. Regional variation in the economic burden attributable to excess weight, physical inactivity and tobacco smoking across British Columbia. *Health Promotion and Chronic Disease Prevention in Canada*. 2016; 36(4): 76-86.
15. Provincial Health Services Authority. Priority health equity indicators for British Columbia: Selected indicators report. 2016. Available at http://www.phsa.ca/population-public-health-site/Documents/Priority%20health%20equity%20indicators%20for%20BC_selected%20indicators%20report_2016.pdf. Accessed March 2018.
16. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004; 363(9403):157-63.
17. BC Stats. BC Stats socio-economic profiles. Available online at <https://www2.gov.bc.ca/gov/content/data/statistics/people-population-community/socio-economic-profiles-indices/socio-economic-profiles>. Accessed March 2018.
18. Krueger H, Krueger J, Koot J. Variation across Canada in the economic burden attributable to excess weight, tobacco smoking and physical inactivity. *Canadian Journal of Public Health*. 2015; 106(4): e171-7.
19. Taylor B, Rehm J, Patra J et al. Alcohol-attributable morbidity and resulting health care costs in Canada in 2002: recommendations for policy and prevention. *Journal of Studies on Alcohol and Drugs*. 2007; 68(1): 36-47.
20. Health Canada. Eating Well with Canada's Food Guide. 2011. Available at http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/view_eatwell_vue_bienmang-eng.pdf. Accessed February 2018.
21. Krueger H, Koot J, Andres E. The economic benefits of fruit and vegetable consumption in Canada. *Canadian Journal of Public Health*. 2017; 108(2): e1-e10.
22. Rajabali F, Ibrahimova A, Barnett B, Pike I. Economic Burden of Injury in British Columbia. BC Injury Research and Prevention Unit: Vancouver, BC. 2015. Available at <http://www.injuryresearch.bc.ca/wp-content/uploads/2015/08/BCIRPU-EB-2015.pdf>. Accessed March 2018.
23. Statistics Canada. Canadian Community Health Survey 2013/14 Public Use Microdata File. All computations, use and interpretation of these data are entirely that of H. Krueger & Associates Inc.
24. Canadian Institute for Health Information. National Health Expenditure Trends, 1975 – 2015. Available at <https://www.cihi.ca/en/national-health-expenditure-trends>. Accessed March 2018.
25. Public Health Agency of Canada. Economic Burden of Illness in Canada 2005-2008 online tool. Available at <http://cost-illness.canada.ca/index.php>. Accessed March 2018.
26. Public Health Agency of Canada. Economic Burden of Illness in Canada 1998. Available at <http://www.publications.gc.ca/site/eng/448753/publication.html>. Accessed March 2018.
27. BC Ministry of Health. Healthy Families BC Policy Framework: A Focused Approach to Chronic Disease and Injury Prevention. 2014. Available at <https://www.health.gov.bc.ca/library/publications/year/2014/healthy-families-bc-policy-framework.pdf>. Accessed April 2018.