Estimates of Smoking-attributable Mortality and Hospitalization in BC, 2002-2007

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ABSTRACT

Objective: The objective of this paper was to estimate the number and rate of deaths and hospitalizations attributable to smoking in British Columbia (BC) from 2002 to 2007.

Methods: Using attributable fractions adjusted to BC smoking prevalence and mortality and hospital administrative data, estimates of smoking-attributable mortality (SAM) and smoking-attributable hospitalization (SAH) were calculated by year, disease category, sex, and geographic region.

Results: Among active smoking adults 15 years of age and older, there were an estimated 4,851 deaths and 25,314 hospitalizations attributed to smoking in BC in 2007. SAM and SAH rates in 2007 were estimated as 119 and 633 per 100,000, respectively. Rates increased from 2002 to 2005 but have declined in subsequent years. Lung cancer and chronic obstructive pulmonary disease were responsible for the largest proportion of SAM and SAH, respectively. There were regional differences, with the Northern Health authority having the highest rate of SAM and SAH and Vancouver Coastal Health authority having the lowest.

Conclusion: Smoking still presents a substantial human and economic burden in BC. Estimates of annual SAM and SAH provide researchers with the ability to detect emerging trends, target intervention and cessation programs, and evaluate current smoking reduction programs. The methodology can be adapted to other provinces to allow for cross-province comparisons.

Key words: Smoking; mortality; morbidity; attributable fraction; British Columbia

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

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Tobacco use is a growing worldwide epidemic; it is estimated that tobacco use will kill over 8 million people annually by 2030.^{1,2} Today, it is a risk factor of six of the eight leading causes of death worldwide and is estimated to cause 1 in 10 deaths.¹ In Canada, results from the Canadian Tobacco Use Monitoring Survey (CTUMS) have shown a decline in the prevalence of current smokers from 25% in 1999 to 18% in 2008.³ However, this decline varied by region, age group, and sex. It is unclear how this trend has affected the burden of smoking on mortality and morbidity.

A number of countries, including Canada, have used attributable fractions (AFs) to estimate the number of deaths caused by smoking, more often referred to as smoking-attributable mortality (SAM).⁴⁻⁹ AFs describe the fraction of deaths an exposure is responsible for or alternatively, the proportion of disease that would not occur if the exposure were removed. Some of these countries have extended this methodology to hospitalization data to estimate smoking-attributable hospitalization (SAH).^{4,8,10} The Cost of Substance Abuse in Canada report (CSAC) estimated that smoking was responsible for over 37 thousand deaths and 339 thousand hospitalizations in 2002 (estimates for British Columbia: SAM 4,616; SAH 34,501).⁴ In comparison, it was estimated that alcohol was responsible for over 4 thousand deaths and almost 200 thousand hospitalizations, and illicit drug use accounted for 1,700 deaths and over 60 thousand hospitalizations.

In British Columbia (BC), a comprehensive substance use monitoring project (www.aodmonitoring.ca) is being undertaken with

the goal of building a system to provide timely data on risky patterns of substance use and related harms as a means of supporting more effective policy-making, facilitating research on substance use and informing public debate.¹¹ One component of the project is tracking alcohol-, drug-, and smoking-attributable mortality and hospitalization. This component is currently using the AFs that were used in the CSAC report. This allows for estimates by health region, age, gender, and disease condition.

Given that the AFs used in the CSAC report were based on 2003 smoking prevalence estimates of the Canadian population⁴ (current smoker prevalence = 23%), the availability of annual BC smoking prevalence from the Canadian Tobacco Use Monitoring Survey (CTUMS) presents an opportunity to more accurately estimate SAM and SAH in BC. BC has the lowest prevalence of current smokers among all provinces in Canada, so use of the Canadian prevalence would likely overestimate SAM and SAH. In addition, using a static set of AFs to estimate SAM and SAH over time does not take into

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Table 1. Health Conditions and the Corresponding ICD-10 Codes Attributable to Smoking

Condition	ICD-10	2007 Mortality Rates*	2007 Hospitalization Rates*
Active Smoking			
Malignant neoplasms		56.5	146.2
Oropharyngeal cancer	C00-C14, D00.0	2.1	6.8
Oesophageal cancer	C15, D00.1	2.8	5.7
Stomach cancer	C16, D00.2	0.7	2.2
Pancreatic cancer	C25, D01.9	1.8	2.2
Laryngeal cancer	C32, D02.0	0.7	3.4
Trachea, bronchus and lung cancers	C33, C34	42.3	52.8
Cervical cancer	C53, D06	0.4	7.5
Urinary tract cancer	C64-C68	0.3	2.0
Renal cell carcinoma	C64	0.7	2.2
Bladder cancer	C67, D09.0	4.2	60.2
Acute myeloid leukaemia	C92.0	0.5	1.3
Cardiovascular diseases		29.9	263.1
Ischaemic heart disease	I20-I25	12.8	125.7
Pulmonary circulatory disease	I26-I28	2.2	22.2
Cardiac arrhythmias	I47-I49	1.0	36.1
Heart failure; complications and ill-defined descriptions of heart disease	I50-I51	1.7	19.0
Cerebrovascular diseases	I60-I69	8.0	27.3
Atherosclerosis	I70-I79	4.3	32.8
Respiratory diseases		31.3	194.1
Pneumonia and influenza	J10-J18	5.1	27.1
Chronic obstructive pulmonary disease	J40-J44	26.2	167.0
Other diseases		0.9	29.3
Mental and behavioural disorders due to use of tobacco	F17	0.1	0
Toxic effects of tobacco	T65.2	0	0
Ulcers	K25-K28	0.6	28.4
Fires	X00-X09	0.2	0.9
Total		118.7	632.8

* Rates per 100,000 adults age 15+; numbers may not add up due to rounding.

Table 2. Smoking-attributable Mortality Rates (per 100,000), 2002-2007, and Smoking-attributable Mortality, 2007 for BC Population Age 15+

	Mortality Rate (per 100,000)						Smoking-attributable Mortality, 2007‡
	2002	2003	2004	2005	2006	2007	
Sex*							
Male	152	152	149	147	142	146	2948
Female	94	92	98	95	90	95	1903
Health Authority†							
Interior	129	134	140	130	120	128	1049
Fraser	116	121	123	122	115	119	1479
Vancouver Coastal	110	104	102	105	100	99	954
Vancouver Island	127	117	122	120	115	122	1052
Northern	164	149	151	135	155	163	317
British Columbia†	121	120	122	120	114	119	4851

* Rates are age-standardized.

† Rates are age- and sex-standardized.

‡ Calculated using relative risks found in the Cost of Substance Abuse in Canada, 2002 report.

account changes in prevalence over time. The prevalence of current smokers in BC has decreased from 20% in 2000 to 14% in 2007.³

Using current smoking data for BC, the objectives of this study are to:

- 1) adjust the AFs used in the CSAC report for each year of BC smoking prevalence data from 2002 to 2007;
- 2) apply the adjusted AFs to the respective annual BC mortality and hospitalization data to calculate the number of SAM and SAH;
- 3) and calculate standardized rates of SAM and SAH by gender, health region and disease category.

METHODS

Data sources

Mortality and Hospital Data

Mortality and hospital data by 5-year age group, sex, geographic health region, and ICD-10 code were obtained from BC Vital Statistics and the BC Ministry of Health, respectively, for 2002-2007.

Attributable Fractions and Calculation of SAM

Smoking AFs for chronic diseases were calculated using the formula:

$$AF = [\sum_{i=1}^k P_i(RR_i - 1)] / [\sum_{i=0}^k P_i(RR_i - 1) + 1]$$

Where:

k = total levels of exposure

i = exposure category with baseline exposure or no exposure i=0

RR(i) = relative risk at exposure level i compared to no consumption

P(i) = prevalence of the ith category of exposure.

AFs were calculated by age groups and sex. The age- and sex-specific AFs were then multiplied with the mortality and hospitalization data to estimate SAM and SAH.

The AF for fire injury was calculated using direct estimates of smoking involvement.¹² This number was used for all estimates.

Prevalence of Smoking

BC smoking prevalence was taken from Canadian Tobacco Use Monitoring Survey (CTUMS) by gender and age groups. In BC,

Table 3. Smoking-attributable Hospitalization Rate (per 100,000), 2002-2007, and Smoking-attributable Morbidity, 2007 for BC Population Age 15+

	Hospitalization Rate (per 100,000)						Smoking-attributable Hospitalization, 2007‡
	2002	2003	2004	2005	2006	2007	
Sex*							
Male	834	855	851	863	847	819	16,208
Female	464	459	463	480	457	462	9106
Health Authority†							
Interior	729	741	749	763	733	735	5735
Fraser	677	689	682	693	676	675	8450
Vancouver Coastal	499	500	513	531	519	483	4575
Vancouver Island	609	589	584	599	566	555	4439
Northern	872	911	901	935	922	909	1982
British Columbia†	640	646	648	663	643	632	25,314

* Rates are age-standardized.

† Rates are age- and sex-standardized.

‡ Calculated using relative risks found in the Cost of Substance Abuse in Canada, 2002 report.

Figure 1. Rates of tobacco-attributable mortality and hospitalizations by health services delivery areas (HSDA) for BC population age 15+, 2007

about 2,000 adults 15 years of age and older were sampled per year from 1999 onwards. The sample was weighted prior to calculating prevalence. Because of the low number of survey participants in the higher age groups, a 3-year moving average was calculated for 2002 to 2007 (e.g., to calculate the smoking prevalence in 2002, the weighted average of the 2001, 2002, and 2003 smoking prevalence was used). Categories of smoking prevalence included current, former and never-smokers. Current smoker was further broken down into occasional smoking or daily smoking categories. Detailed smoking definitions can be found in the CSAC report.

Relative Risks

Relative risks were taken from the CSAC report. Briefly, a list of causal health conditions attributable to smoking was compiled (Table 1). A comprehensive search of meta-analyses was performed for each disease category and its risk relationship with smoking. Where possible, the most detailed dose-response relative risks were used.

Rate Calculation

Rates were age- and sex-standardized using the direct method and the 2001 age 15 and over BC population as the standard.

RESULTS

Among active smoking adults 15 years of age and older, there were an estimated 4,851 deaths and 25,314 hospitalizations attributed to smoking in BC in 2007 (Tables 2 and 3). Males accounted for over 60% of those deaths and hospitalizations. In 2007, 15.6% of all deaths and 3.4% of all hospitalizations in BC were attributed to smoking.

The mortality rates attributable to smoking have hovered around 120 deaths per 100,000 adults over the six-year period from 2002-2007. In the most recent two years of that period, the rates have dropped below that benchmark. From 2002 to 2005, hospitalization rates attributable to smoking increased from 640 to 663 hospitalizations per 100,000, respectively; but like mortality, SAH declined in the subsequent two years to 632 per 100,000 in 2007.

Geographically, the Northern health authority (HA) has consistently held the highest rates of SAM and SAH over the course of the study period, while Vancouver Coastal HA had the lowest. With the largest population, Fraser HA has the largest number of SAM and SAH, with about 5 times more deaths and 4 times more hospitalizations than the Northern HA. Figure 1 displays the SAM and SAH rates by BC health services delivery area (HSDA) in 2006. The areas of high SAM rates generally correspond with areas of high SAH rates. The metro areas of Vancouver and Victoria have among the lowest rates of SAM and SAH.

Almost half of the deaths in 2007 were from cancer (47.8%), with lung cancer accounting for 75% of all smoking-related cancer deaths. Mortality rates by condition can be found in Table 1. Respiratory diseases accounted for 26.6% and cardiovascular disease accounted for 24.8% of smoking-related deaths. The top causes of SAM in 2007 were lung cancer (1,727 deaths), chronic obstructive pulmonary disease (COPD) (1,079), ischemic heart disease (526), and cerebrovascular disease (312). Together, these conditions accounted for 75% of all SAM.

In 2007, smoking caused 263 cardiovascular, 194 respiratory, and 146 cancer hospitalizations per 100,000 adults (Table 1). COPD, ischemic heart disease, bladder cancer, lung cancer and cardiac arrhythmia were the top five causes of SAH, accounting for 70% of all SAH.

DISCUSSION

Despite the decrease of current smokers from 2002 to 2007 in BC, the harms associated with tobacco smoking have not shown the same dramatic decrease. In fact, only since 2006 have there been signs that the rates of SAM and SAH have started to decrease. This is likely due to the latency between smoking and health outcome.¹³ In Canada, smoking prevalence has declined since the late 1960s; however, lung cancer rates did not start declining until about 1990.¹⁴ The timeframe of this study is too short to determine which stage of the epidemic curve BC is currently at; however, with continuous monitoring, this will become clear over several years. Another contributing factor to the discrepancy was the increase in the number of 'experimental' users, those who tried a few cigarettes and then for whatever reason stopped. These users moved from being never-smokers to former smokers, artificially increasing their risk of smoking-related harms. A study found that redefining former smokers as having smoked at least 100 cigarettes in a lifetime could decrease SAM estimates by 5%.¹⁵ It has not been determined which definition would produce the most accurate measurement.

In comparison with the SAM estimates produced by BC Vital Statistics in their annual reports,¹⁶ our SAM estimates were 21-26% lower each year over the six-year period for the same age range. The relative risks used by BC Vital Statistics were taken from the American Cancer Society's Cancer Prevention Study II (CPS II). The CPS II has been criticized for not having a nationally representative sample and for not adjusting for potential confounding factors.^{17,18} Studies that estimated SAM using relative risks derived from a more representative US sample found that their estimates were between 16% and 40% lower than those derived from using the CPS II.¹⁷ Our estimates are also based on more detailed exposure and relative risk categorization.

There were considerable differences in SAM and SAH rates between health regions in BC, with the Northern HA having over 40% more deaths and 70% more hospitalizations than Vancouver Coastal HA. Northern HA has the highest prevalence of current

smokers compared with the other HAs.¹⁹ The high rates in Northern HA are not confined to one HSDA, nor are the low rates in Vancouver Coastal HA. Thompson Cariboo Shuswap HSDA of Interior HA and Fraser East of Fraser HA both have noticeably higher SAM and SAH rates than the other HSDA areas in their respective region.

Limitations

Although AFs can be used to theoretically determine the number of deaths and hospitalizations caused by smoking, there is currently no way to determine whether these estimates hold in real life. We cannot directly link smoking as a causal factor solely on the basis of diagnostic codes. There are other methodological issues that can impact SAM and SAH estimates, such as changes in exposure measurement, exposure and relative risk categorization, or relative risk estimates.¹⁵ However, our methodology is consistent with past Canadian studies of the same nature. The study does not include the harms related to second-hand smoke (passive smokers) or to maternal smoking. Both make up a relatively small fraction of SAM and SAH. Although AFs were adjusted using BC smoking prevalence, there are regional variations of smoking prevalence within BC. The SAM and SAH estimates would be an overestimate in low smoking prevalence regions and an underestimate in high smoking prevalence regions.

Despite potential issues with the methodology, these estimates play an important role in public health. They inform the public of the harms associated with smoking, help researchers identify high-risk areas and evaluate smoking reduction programs, and provide policy-makers with evidence of the effectiveness of policies. The methods are adaptable to other provinces and only require administrative data. Using attributable fractions adjusted for annual smoking prevalence to estimate SAM has been shown to be comparable to estimates derived from physician reports of tobacco-contributing deaths.²⁰

CONCLUSION

Smoking still presents a substantial human and economic burden in BC and in Canada. There is some indication that the recent trend is downwards, but with the long latency period between smoking and health outcome, long-term and ongoing follow-up is needed to see if this trend is sustained. The presence of the BC Alcohol and Other Drug Monitoring Project will allow for continued surveillance of emerging trends. Areas in BC with higher rates should be targeted for appropriate tobacco prevention and cessation programs. This methodology can be used by other provinces to allow comparisons between provinces and to observe trends over time by demographic and geographic characteristics.

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RÉSUMÉ

Objectif : Estimer le nombre et le taux des décès et des hospitalisations attribuables au tabagisme en Colombie-Britannique (C.-B.) de 2002 à 2007.

Méthode : À l'aide de fractions étiologiques du risque ajustées selon la prévalence du tabagisme en C.-B. et les données administratives provinciales sur les décès et les hospitalisations, nous avons calculé des estimations de la mortalité attribuable au tabagisme (MAT) et des hospitalisations attribuables au tabagisme (HAT) par année, par catégorie de maladie, par sexe et par région géographique.

Résultats : Chez les fumeurs actifs de 15 ans et plus, on estime à 4 851 le nombre de décès et à 25 314 le nombre d'hospitalisations attribuables au tabagisme en C.-B. en 2007. Les taux de MAT et de HAT en 2007 sont estimés à 119 et à 633 p. 100 000, respectivement. Les taux ont augmenté de 2002 à 2005, mais diminué les années suivantes. Le cancer du poumon et la maladie pulmonaire obstructive chronique étaient les causes de la plus grande proportion de la MAT et des HAT, respectivement. On observe des disparités régionales : les taux les plus élevés de MAT et de HAT étaient déclarés par le bureau sanitaire du Nord de la province, et les taux les plus faibles, par le bureau sanitaire de la zone côtière de Vancouver.

Conclusion : Le tabagisme constitue encore un fardeau humain et économique considérable en C.-B. Les estimations annuelles de la MAT et des HAT permettent aux chercheurs de déceler les tendances émergentes, de cibler les interventions et les programmes d'arrêt du tabac et d'évaluer les programmes de réduction du tabagisme en vigueur. La méthode peut être adaptée à d'autres provinces, ce qui permettrait des comparaisons interprovinciales.

Mots clés : tabagisme; mortalité; morbidité; fraction étiologique du risque; Colombie-Britannique

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