Smoking-attributable mortality and expected years of life lost in Canada 2002: Conclusions for prevention and policy

Dolly Baliunas, Jayadeep Patra, Jürgen Rehm, Svetlana Popova, Murray Kaiserman and Benjamin Taylor

Abstract

Cigarette smoking is one of the most important risk factors for burden of disease. Our objective was to estimate the smoking-attributable deaths and the years of life lost for Canada 2002. For Canada in 2002, 37,209 of all deaths aged 0 to 80+ years were attributable to smoking, 23,766 in men and 13,443 in women. This constituted 16.6% of all deaths in Canada, 21% for men and 12.2% for women. Main causes of smoking-attributable death were malignant neoplasms (17,427), cardiovascular diseases (CVD) (10,275) and respiratory diseases (8,282). Lung cancer (13,401) and chronic obstructive pulmonary disease (COPD) (7,533) were the single largest disease contributors to deaths caused by smoking. 515,608 years of life were lost prematurely in Canada in that year, 316,417 years in men and 199,191 years in women. Cigarette smoking is a major contributor to mortality in Canada and its impact on Canadian society continues to be an unacceptable burden.

Key words: *Canada, expected years of life lost (EYLL), mortality, relative risks (RR), smoking-attributable fractions (SAF)*

Introduction

Tobacco use is responsible for high levels of mortality and morbidity. Smoking causes substantially increased risk of mortality from lung cancer, upper aerodigestive (i.e., head, neck and oesophageal) and other cancers, heart disease, stroke, chronic respiratory disease and a number of other medical conditions.[1] In the developed world in the year 2000, smoking was reported to be the risk factor with the largest attributable mortality and attributable disability-adjusted life years (DALYS) by the World Health Organization,[2] overall, 12.2% of all DALYS were attributed to this risk factor.

The most recently published Canadian estimate of smoking-attributable mortality (SAM) was produced using 1998 mortality data, 1998/1999 smoking prevalence data[3] and relative risks (RR) from the American Cancer Society's Cancer Prevention Study II (CPS-II). The total SAM was estimated to be 47,581 (21% of all deaths, age ≥ 35). However, the CPS-II has been criticized for not being generalizable to the entire US population. When compared to the general population, participants in CPS-II tend to overrepresent the middle class and have more education. As well, a disproportionate number of them are white.[4,5] Thus, direct application of a large US survey to the Canadian population may not be appropriate.

In addition, more recent information may affect current SAM estimates. The prevalence proportion of current smoking has been steadily decreasing in Canada since the mid-1980s[6] and, in 2004, was at 20% for those aged 15 and older.[7] Self-reported consumption has also declined, with the average daily smoker consuming slightly less than 16 cigarettes per day.[7] In 2004, the Surgeon General (SG) added several diseases to the list of those for which evidence is sufficient to conclude a causal relationship between smoking and disease: stomach cancer, renal cell carcinoma, uterine cervical cancer, pancreatic cancer and pneumonia. Some of these had been included in recent SAM estimates, such as those produced by Illing & Kaiserman.[3]

Given the changes in smoking behaviour among Canadians since 1998, the availability of new and possibly more relevant relative risks, as well as continued interest in the issue, there was a need for an updated estimate of smoking-attributable mortality. This paper, using a sex-, age- and disease-specific approach to estimate the number of deaths and years of life lost for Canada in 2002, tries to meet that need.

Author References

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Method

The aim of the present study was to estimate the proportion of deaths caused by smoking and the number of premature deaths in Canada for the year 2002. Several elements necessary for this estimate are described below: the method for identification of diseases, the measurement of smoking prevalence, the determination of risk relationships and attributable fractions, and the mortality data source.

Identification of diseases and meta-analyses

To identify the malignant and non-malignant health conditions for inclusion in the SAM estimate, this analysis was guided by the *Health Consequences of Smoking: A Report of the Surgeon General*,[1] which considers the following criteria in judgments of causality: consistency, strength of association, specificity, temporality, coherence, dose-response and experimental evidence. The 2004 SG report implemented a standardized, hierarchical language to summarize conclusions about causality, the strongest of which is "evidence is sufficient to infer causality". Our analyses include only health outcomes for which this conclusion was reached.

Once identified, conditions were translated into corresponding codes from the tenth revision of the *International Classification of Diseases (ICD-10)*. Finally, a comprehensive search strategy of current meta-analyses was performed for each disease category and its risk relationship with smoking.

Meta-analyses were identified using the PubMed and OVID (1966 – January Week 3, 2005) databases. Search criteria were as follows: smoking or tobacco, meta-analysis, and each malignant and non-malignant disease category described in this paper.

Meta-analyses that included measures of smoking dose were preferred over those that only used the "current", "former" or "never" categories. However, if relative risks (RR) for dose-responses were not found from the studies, we used the "current/former/never" or "ever/never" category where available. Similarly, analyses that included age- and sex-stratified estimates of relative risk were preferred over more crude estimates.

In cases where a more current meta-analysis did not exist, the analysis from English et al. was used.[8] When a meta-analysis was published later than 1995, there was usually only one that presented data on smoking dose, so it was used as the source of relative risk. If there was more than one, all were examined and the most comprehensive one was chosen, based on smoking dose and age categories.

Prevalence of smoking in Canada

Smoking prevalence for different levels of smoking consumption was obtained from the Canadian Community Health Survey (Cycle 2.1).[9] Categories included current, former and never smokers by sex and age group. Current smokers were those who reported occasional smoking or daily smoking (cigarettes per day dose-response: e.g., 1-14, 15-24, 25+ cigs/day; < 20 or ≥ 20 cigs/day, etc.). For each disease for which the identified meta-analysis included dose-response-specific RRs, prevalence estimates were calculated using the same categorizations of smoking consumption. The prevalence of non-smokers whose home is also inhabited by a person who smokes was available as well from the CCHS data set and it was used to calculate 2002 passive smoking deaths.

To ensure comparability between the CCHS sample and the Canadian population, the sample was weighted prior to calculating prevalence, based on sex and age groups. The age groups used were 15-29, 30-44, 45-59, 60-69, 70-79 and 80+.

Mortality data

Mortality data in Canada for the year 2002 were obtained from Statistics Canada coding according to ICD-10.[10] Table 1 shows the disease conditions that were used, by diagnosis, and the source of measure of association or smoking-attributable fraction (SAF).

Computing smoking-attributable fractions (SAF) of mortality

"Smoking-attributable fraction" (SAF) is defined as the fraction of the disease in the population that would not have occurred if the effects associated with smoking were absent.[24,25]

SAFs were assessed for specific causes of natural and unnatural deaths by two methods:

- Chronic disease smoking-attributable fractions were calculated by combining smoking prevalence from CCHS and relative risk estimates from meta-analyses.
- Fire injury was calculated using direct estimates of smoking involvement from the Council of Canadian Fire Marshals and Fire Commissioners.[23]

We used the most comprehensive meta-analysis for each condition, as indicated in Table 1. The age- and sex-specific relative risk (where available) for each condition was combined with different levels of smoking for each sex and age group and an attributable fraction was obtained using the following formula.[24,25]

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

i: smoking category with baseline category or never smoking $i = 0$.
RR (i): relative risk at smoking level i compared to never smoking
P (i): prevalence of the i th category of smoking

The SAFs were then applied to the mortality data to estimate the smoking-attributable mortality (SAM) by age and sex.

Passive-smoking-attributable mortality (PSAM), was derived by applying age- and sex-specific relative risk and rates of mortality from lung cancer and ischemic heart disease (IHD) to the population of Canadians who have never smoked but who are exposed to environmental tobacco smoke (ETS) from spouses and other sources. Relative risks estimates were obtained from the most comprehensive meta-analyses applicable to Canada. Our estimates for ETS mortality

TABLE 1
Smoking-related disease categories and sources of measure of association

Condition	ICD-10	Source from meta-analysis or SAF
Mental and behavioural disorders due to use of tobacco	F17	100% SAF per definition
Malignant neoplasms		
Oropharyngeal cancer	C00-C14, D00.0	English et al., 1995
Oesophageal cancer	C15, D001	English et al., 1995
Stomach cancer	C16, D002	Tredaniel et al., 1997
Pancreatic cancer	C25, D01.90	English et al., 1995
Laryngeal cancer	C32, D02.0	English et al., 1995
Trachea, bronchus and lung cancers	C32, D02.0	Simonato et al., 2001
Cervical cancer	C53, D06	Plummer et al., 2003
Uninary tract cancer	C64-C68	Zeegers et al., 2000
Renal cell carcinoma	C64	Hunt, 2005
Bladder cancer	C67, D09.0	Brennan et al., 2000; 2001
Acute myeloid leukaemia	C92.0	Brownson et al., 1993
Cardiovascular diseases		
Ischaemic heart disease	I20-I25	Law, 1997 and Law, 2003
Pulmonary circulatory disease	I26-I28	English et al., 1995
Cardiac arrhythmias	I47-I49	Follow IHD
Heart failure; complications and ill-defined descriptions of heart disease	I50-I51	Follow IHD
Cerebrovascular diseases	I60-I69	English et al., 1995
Atherosclerosis	I70-I79	English et al., 1995
Respiratory or intestinal diseases		
Pneumonia and Influenza	J10-J18	English et al., 1995
Chronic obstructive plumonary disease	J40-J44	Single et al., 1996 (cost study)
Ulcers	K25-K28	English et al., 1995
Conditions arising during the perinatal period (maternal use)		
Low birth weight and short gestation	P05-P07	English et al., 1995
Sudden infant death syndrome	R95	English et al., 1995
Unintentional injuries		
Fires	X00-X09	Council of Canadian Fire Marshals and Fire Commissioners. Annual Report 2000, 2003

ICD = *International Classification of Diseases, Version 10*

SAF = smoking-attributable fraction

used an RR estimate of 1.21[26] for lung cancer and RR estimate of 1.24[27,28] for IHD, which are consistent with other results. Zhong et al.[29] cited an RR estimate of 1.2 for lung cancer from a meta-analysis of 35 case-control and five cohort studies. Taylor (2001) estimated an RR estimate of 1.21 for Western industrialized countries. The incidence density ratio (relative risk) associated with exposure to environmental tobacco smoke for IHD was estimated from two recent meta-analyses. Thun et al.[30] noted relative risks of 1.24 for males and 1.23 for females exposed to passive smoking, while He et al.[31] estimated a relative risk of 1.25 for both sexes.

For reasons of comparability and conservatism, we used an RR estimate of 1.21 for lung cancer and an RR estimate of 1.24 for IHD. This method had been employed previously, for the year 1998.[3]

Total 2002 SAM was calculated by summing all chronic disease SAM, pediatric disease SAM and total PSAM for each sex and age group.

Two sensitivity analyses were conducted. For each disease, the lower limit of the confidence interval around relative risk and the lower limit around the confidence interval of the accompanying smoking prevalence estimates were used simultaneously to derive the SAF. As before, the SAF was multiplied by number of deaths to produce SAM estimates. This procedure was repeated with the upper limits of the confidence intervals.

Smoking-attributable expected years of life lost (EYLL)

Expected years of life lost (EYLL) is a measure of the impact of premature mortality on a population. Persons dying due to smoking consumption would have lived longer if they had not smoked. The average extra time such individuals would have lived is known as the residual life expectancy. For example, if a male dies of chronic obstructive pulmonary disease (COPD) at age 50, in Canada he would have a residual life expectancy of 28.4 years.[32] The sum of these extra years for all people dying from smoking in a population is known as EYLL due to smoking. EYLL for each age group category can be estimated from the observed mean age at death in the age interval and the life expectancies tables at the exact ages defining the age interval through interpolation. The life expectancies table for Canada mortality in 2000 is available from the WHO Web site (www.who.int/evidence). In calculating the mean ages within the intervals, the rules specified by the Global Burden of Diseases (GBD) study were followed.[33] EYLL due to smoking in Canada has been calculated for each age group (0-14, 15-29, 30-44, 45-59, 60-69, 70-79 and 80+) by multiplying the number of smoking-attributable deaths by the interpolated life expectancy for the observed mean age at death in the interval. Mean ages for 80+ age group for men (84 years) and women (85 years) were calculated from the life

table. EYLL was calculated per 100,000 population.

Results

Table 2 gives an overview of the estimated degree of smoking prevalence in Canada by sex and age group. As expected, more men than women were current smokers and the prevalence of current consumption decreased as age increased.

Table 3 provides the estimates of SAM by disease and PSAM for lung cancer and IHD. Overall results in Canada show that 37,209 smoking-attributable deaths were estimated, accounting for 23,766 deaths among men and 13,443 among women for the year 2002, including 58 boys and 34 girls under the age of one who died as a result of smoking-related causes. The 37,209 smoking-attributable deaths constituted 16.6% of all Canadian deaths (there were 223,603 deaths in Canada in 2002).

Most of the deaths attributable to smoking may be grouped into three broad categories. The three largest contributors were cancers (malignant neoplasms), cardiovascular diseases (CVD) and respiratory diseases (see Table 3). Cancer accounted for 46.8% of smoking-attributable deaths (17,427 deaths: m: 11,891; f: 5,566), CVD accounted for 27.6% (10,275 deaths: m: 6,373; f: 3,902), and respiratory disease accounted for 22.3% (8,282 deaths: m: 4,788; f: 3,494). Total deaths due to ETS (lung cancer and IHD) accounted for 2.2% (831 deaths: m: 507; f: 324). With respect to single disease categories within these broad categories, lung cancer (13,401 deaths: m: 9,028; f: 4,373), IHD (5,343 deaths: m: 3,837; f: 1,506) and COPD (7,533 deaths: m: 4,378; f: 3,155) constituted the largest smoking-attributable categories. Together, these three diseases account for more than two thirds (70.6%) of all smoking-attributable deaths in Canada in 2002. Almost two thirds (63.9%) of those who died from smoking-related causes in Canada were men.

In addition, 2.2% of all smoking-attributable deaths (831 deaths: m: 507; f: 324) aged 15 years and over were a result of ETS exposure in 2002. Specifically, 252 Canadians (m: 157; f: 95) died from lung cancer PSAM, while 579 Canadians (m: 350; f: 228) died from IHD PSAM.

For some of the individual causes of death, smoking was responsible for more than 75% of deaths: lung cancer (78.0%), pulmonary circulatory disease (79.1%) and COPD (79.7%). In terms of absolute numbers, more males than females died of smoking-attributable causes. This probably is a reflection of the higher rates of current smoking among males.

Out of 198 fire deaths, smoking caused 28% of mortality (55 deaths).

Canadian residents lost an estimated 515,608 years of EYLL as a result of the premature mortality resulting from cigarette smoking (316,417 years of life lost among men and 199,191 years lost among women). The EYLL rate for deaths due to smoking was 2,151 per 100,000 for men and 1,302 per 100,000 for women aged 0 to 80+ (Table 4). That is, for every 100,000 population, there was an expected loss of 2,151 years of life among men and 1,302 years of life among women as a result of premature death due to smoking. A high EYLL rate for men was observed, indicating higher levels of premature mortality among men compared to women. Cancer was the leading cause of smoking-attributable EYLL in Canada in 2002, responsible for 262,268 years of expected life lost (162,612 male and 99,656 female). CVD caused a loss of 151,604 years (97,824 male and 53,780 female). Respiratory disease caused 79,330 years to be lost (42,007 male and 37,323 female).

Overall, smoking affected more men than women: In men, 21% of the deaths were smoking attributable, compared to 12.2% of the deaths among women.

The overall average age for smoking-attributable death was 71.2 years for men and 73.4 years for women. There were no such notable sex differences found between disease categories, except fire injury. For this category, the average age for a smoking-attributable death was 46.7 years for men and 58.0 years for women.

The sensitivity analyses produced a low estimate of 31,210 smoking-attributable deaths (20,594 among men and 10,617 among women). The upper estimate was 44,775 smoking-attributable deaths (27,747 among men and 17,028 among women).

TABLE 2
Estimated smoking prevalence proportions in Canada by sex and age group (years)

Smoking categories		15-29	30-44	45-59	60-69	70-79	80+	Overall (all ages)
Current	Female	0.263	0.247	0.230	0.151	0.103	0.059	0.218
	Male	0.310	0.307	0.260	0.172	0.098	0.075	0.263
Former	Female	0.262	0.383	0.435	0.452	0.427	0.389	0.378
	Male	0.258	0.389	0.530	0.642	0.704	0.735	0.446
Never	Female	0.475	0.369	0.334	0.398	0.471	0.552	0.404
	Male	0.431	0.304	0.211	0.187	0.197	0.190	0.291
Total per sex		**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**

Source: Canadian Community Health Survey, Cycle 2.1 (2003)

TABLE 3
Smoking-attributable fractions (SAF), mean age at death and number of deaths due to smoking by sex, age and disease category in Canada, 2002 (continued)

Disease condition*	SAF in % (all ages)		Mean age at death		Total		
	M	F	M	F	M	F	Overall
ACTIVE SMOKERS							
Malignant neoplasms							
Oropharyngeal cancer	57.0	47.2	64.7	68.4	430	156	586
Oesophageal cancer	48.4	38.0	67.6	72.9	523	149	672
Stomach cancer	16.1	11.7	70.0	70.6	184	90	273
Pancreatic cancer	17.1	12.7	68.6	70.2	266	209	475
Laryngeal cancer	67.0	59.1	69.9	68.6	271	52	323
Lung cancer	88.6	62.5	70.2	68.1	9,028	4,373	13,401
Cervical cancer	--	34.7	--	58.3	--	126	126
Urinary tract cancer	55.1	36.9	71.1	73.2	1,089	364	1,452
Renal cell carcinoma	26.5	6.8	67.9	69.0	221	35	256
Bladder cancer	67.9	51.3	75.9	77.0	740	223	964
Acute myeloid leukaemia	15.7	13.1	69.9	66.9	70	48	118
Total malignant neoplasms	60.9	43.2	69.9	68.5	11,861	5,566	17,427
Tobacco abuse							
Total tobacco abuse	100.0	100.0	64.2	73.4	37	20	57
Cardiovascular diseases							
Ischaemic heart disease							
Age < 45 yrs	51.9	45.1	36.5	36.4	208	47	254
45-59 yrs	42.2	37.3	52.0	52.0	1,128	232	1,360
60-69 yrs	29.1	23.4	64.5	64.5	1,055	290	1,345
70-79 yrs	10.0	7.3	74.5	74.5	664	300	965
80+ yrs	8.9	5.1	87.0	87.0	782	637	1,419
Pulmonary circulatory disease	83.3	76.5	70.2	72.9	305	446	751
Cardiac arrythmias							
Age < 45 yrs	50.9	43.8	33.9	32.7	20	6	26
45-59 yrs	42.2	37.3	52.0	52.0	38	12	50
60-69 yrs	29.1	10.5	64.5	64.5	29	10	39
70-79 yrs	10.0	7.3	74.5	74.5	26	13	39
80+ yrs	8.9	5.1	87.0	87.0	40	47	88
Heart failure							
Age < 45 yrs	50.8	44.2	33.7	33.8	19	8	26
45-59 yrs	42.2	37.3	52.0	52.0	38	19	57
60-69 yrs	29.1	23.4	64.5	64.5	60	26	86
70-79 yrs	10.0	7.3	74.5	74.5	54	36	89
80+ yrs	8.9	5.1	87.0	87.0	115	126	241
Cerebrovascular diseases							
Age < 65 yrs	39.2	35.2	53.1	52.0	292	207	499
≥ 65 yrs	14.3	9.6	80.7	82.6	803	814	1,617

* For condition definition from *International Classification of Diseases, Version 10*, see Table 1.

Note: These results were derived by multiplying SAFs with number of deaths for each category, thereby producing decimal numbers. As a result, there may be rounding errors due to collapsing numbers over different categories.

TABLE 3 (continued)
Smoking-attributable fractions (SAF), mean age at death and number of deaths due to smoking by sex, age and disease category in Canada, 2002

Disease condition*	SAF in % (all ages)		Mean age at death		Total		
	M	F	M	F	M	F	Overall
Atherosclerosis	31.6	31.3	75.4	79.7	697	628	1,325
Total cardiovascular diseases	18.7	11.3	68.5	75.3	6,373	3,902	10,275
Respiratory diseases							
Pneumonia/Influenza	19.9	12.9	79.8	82.1	410	340	750
Chronic obstructive pulmonary disease	83.1	75.4	79.1	79.0	4,378	3,155	7,533
Total respiratory diseases	65.4	51.2	79.1	79.3	4,788	3,494	8,282
Intestinal diseases							
Total ulcers	48.8	36.7	74.6	79.9	107	83	190
Conditions arising during perinatal period (maternal use)							
Low birthweight and short gestation	24.7	20.6	0.0	0.0	37	22	59
Sudden infant death syndrome	31.2	26.5	0.0	0.0	21	12	33
Total paediatric diseases < 1 year of age	26.7	22.4	0.0	0.0	58	33	92
Injury							
Total fire injury	28.0	28.0	46.7	58.0	35	20	55
TOTAL ACTIVE SMOKERS	37.8	24.0	71.2	73.3	23,259	13,119	36,378
PASSIVE SMOKERS							
Lung cancer	1.5	1.4	68.0	67.1	157	95	252
Ischaemic heart disease	1.6	1.2	71.2	79.3	350	228	579
TOTAL PASSIVE SMOKERS	1.6	1.3	70.2	75.7	507	324	831
All smoking-attributable deaths			71.2		23,766	13,443	37,209

* For condition definition from *International Classification of Diseases, Version 10*, see Table 1.
Note: These results were derived by multiplying SAFs with number of deaths for each category, thereby producing decimal numbers. As a result, there may be rounding errors due to collapsing numbers over different categories.

Discussion

Tobacco smoking is a major public health concern. It is responsible for significant mortality and years of life lost in Canada. Of the 223,603 deaths in Canada in 2002, almost forty thousand (16.6%) could be attributed to smoking. Among all smoking-attributable deaths, 46.8% were due to cancer, followed by CVD at 27.6% and respiratory diseases at 22.3%.

This study found little change in smoking-attributable mortality from a previous analysis conducted using 1992 data.[21] In the 1992 study, smoking was estimated to account for 17% of all deaths in 1992, compared to our estimate of 16.6%. There is a wide gap between the two time periods, so a more appropriate comparison may be considered. The present study found lower smoking-attributable mortality than was reported in a recent study using 1998 data.[3] Although the top three causes of death due to smoking were the same between the two studies (lung cancer, ischemic heart disease and chronic obstructive pulmonary disease), their order was different. Among smoking-attributable deaths, this study reported lung cancer (36%) as the top killer, followed by COPD (20%) and IHD (14%). In the Illing article, lung cancer was number one, but the opposite order was reported for IHD (20%) and COPD (14%). It is unclear what the reason is for this difference, but a possible explanation could be the much greater numbers of IHD mortality in 1998 compared to 2002, whereas the numbers for COPD remained fairly similar between these years. This is consistent with an overall trend of increasing COPD and decreasing IHD deaths (IHD only for those under 65) reported for 1989-1998. The decrease in IHD deaths may be due to either a decrease in IHD incidence, improvement in survival, or both. Also of note is that higher percentages of smoking-attributable mortality due to lung cancer were reported in this study, despite the fact that lung cancer mortality rates in Canada have been slowly decreasing for men and are constant or slightly increasing for women.[34]

From 1989 to 1998, smoking-attributable mortality was shown to have increased in women, but remained fairly constant in men, resulting in the ratio of male-to-female smoking-attributable mortality decreasing from 2.6 to 1.8 over the same time period.[3] If we make a similar comparison between the 1998 ratio and this current analysis, we note that the ratio of male-to-female smoking-attributable mortality, at 1.77, is similar to that obtained for 1998.

There is one important methodological difference between this paper and the study by Illing and Kaiserman[3]: Our study

TABLE 4
Expected years of life lost (EYLL) attributable to smoking in Canada 2002 by age, sex and disease category

			Deaths				EYLL		
Sex	Age	Cancer	CVD*	RD**	Total	Cancer	CVD	RD	Total
Male	0-14	n/a	n/a	n/a	58	n/a	n/a	n/a	3,978
	15-29	5	25	2	40	272	1,383	109	2,151
	30-44	173	304	19	522	6,920	12,157	760	20,888
	45-59	1,975	1,462	149	3,708	51,646	38,226	3,896	96,954
	60-69	3,215	1,475	526	5,371	51,279	23,528	8,390	85,672
	70-79	4,144	1,344	1,567	7,260	39,575	12,832	14,965	69,335
	80+	2,349	1,763	2,525	6,807	12,920	9,698	13,888	37,438
						162,612	**97,824**	**42,007**	**316,417**
Rate per 100,000 persons = 2,151 years (men, all ages, all causes EYLL)									
Female	0-14	n/a	n/a	n/a	33	n/a	n/a	n/a	2,459
	15-29	9	16	2	29	536	951	119	1,750
	30-44	156	121	9	293	7,001	5,411	404	13,163
	45-59	1,171	450	115	1,782	35,903	13,798	3,526	54,633
	60-69	1,404	545	400	2,412	27,729	10,758	7,900	47,643
	70-79	1,772	850	1,064	3,807	21,636	10,376	12,991	46,486
	80+	1,054	1,921	1,905	5,085	6,851	12,487	12,383	33,056
						99,656	**53,780**	**37,323**	**199,191**
Rate per 100,000 persons = 1,302 years (females, all ages, all-causes EYLL)									

* Cardiovascular disease
**Respiratory disease

uses pooled relative risk estimates from existing meta-analyses, not relative risks from only one study. This potentially makes our estimates more generalizable to the Canadian population and more reliable through the use of multiple studies. The relative risks used in this current study tended to be lower, decreasing the smoking-attributable mortality estimates. It must be acknowledged that SAM estimates will vary based on the underlying assumptions implicit in population-attributable fraction methods, an issue that has engendered debate in Canadian estimates.[35] Our own sensitivity analysis resulted in a low estimate of 31,210 and a high estimate of 44,775.

Despite differences in risk estimation, tobacco smoking is responsible for a substantial number of Canadian deaths. The results of this paper indicate that the trend in smoking-attributable mortality may be stable or even declining. The change in trend may be the result of nearly forty years of tobacco control activities. Since 1965, when the first smoking rates were measured, fewer people have been smoking fewer cigarettes. Indeed, between 1985 and 2002, daily smokers reported smoking four cigarettes fewer per day. In addition, when compared to 1985 data, more smokers in 2002 were distributed in the "light" and "moderate" smoking categories.[36]

Policies and interventions aimed at cessation strategies will be helpful in reducing the short-term mortality burden in Canada. A number of cohort studies and clinical trials have shown that smoking cessation has been shown to reduce all-cause mortality[37,38] and prevent onset or development of cardiovascular[39,40] and respiratory diseases[41,42] in particular. Policies affecting adolescents, such as price, availability of cigarettes, smoking bans and the marketing of cigarettes are important to decreasing future smoking mortality. Immediate reductions to smoking-attributable fire deaths may be realized by the federal Cigarette Ignition Propensity Regulation that came into effect on October 1, 2005. This regulation requires that all Canadian-manufactured or imported cigarettes must burn their full length no more than 25% of the time when tested using a standard protocol.

While smoking rates and cigarette consumption in Canada decline, smoking-attributable mortality has not yet kept pace due to the latent period between smoking and chronic disease outcomes—it thus remains unacceptably high. There is optimism for the future, however. In Canada, in 2004, there were more former than current smokers and the number of former smokers continues to increase. In fact, between 1999 and 2004, the number of current smokers in Canada declined by nearly one million and those who

continue to smoke are smoking much less than in the past. The benefit of this reduction in smoking prevalence will take some time to be reflected in estimates of smoking-attributable mortality. However, all of this activity, if continued (including government policies and cessation and prevention programs), will result in decreases in smoking-attributable deaths in the near future.

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References

1. U.S.Department of Health and Human Services. The health consequences of smoking: a report of the Surgeon General. 2004. Atlanta, GA., Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office of Smoking and Health.

2. World Health Organization. World Health Report 2002: Reducing risks, promoting health life. 2002. Geneva, World Health Organization.

3. Makomaski Illing EM, Kaiserman MJ. Mortality attributable to tobacco use in Canada and its regions, 1998. Canadian Journal of Public Health 2004; 95:38-44.

4. Sterling TD, Rosenbaum WL, Weindam JJ. Risk attribution and tobacco-related deaths. American Journal of Epidemiology 1993; 138:128-139.

5. Malarcher AM, Schulman J, Epstein LA, Thun MJ, Mowery P, Pierce B et al. Methodological issues in estimating smoking-attributable mortality in the United States. American Journal of Epidemiology 2000; 152:573-584.

6. Gilmore J. Report of smoking in Canada, 1985 to 2001. Catalogue 82F0077XIE. 2002. Ottawa, Statistics Canada.

7. Health Canada. Smoking rates: Canadian Tobacco Use Monitoring Survey. Available at: www.hc-sc.gc.ca/hl-vs/tobac-tabac/res/news-nouvelles/fs-if/ctums-esutc_e.html. 2005.

8. English DR, Holman CDJ, Milne E, Winter MJ, Hulse GK, Codde G et al. The quantification of drug caused morbidity and mortality in Australia 1995. 1995. Canberra, Australia, Commonwealth Department of Human Services and Health.

9. Statistics Canada. Canadian Community Health Survey, Cycle 2.1. Ottawa, 2003. Catalogue 82M0013XCB

10. Statistics Canada. Causes of death. Ottawa, 2004. Catalogue 84208XIE

11. Tredaniel J, Boffetta P, Buiatti E, Saracci R, Hirsch A. Tobacco smoking and gastric cancer: review and meta-analysis. International Journal of Cancer 1997; 72(565):573.

12. Simonato L, Agudo A, Ahrens W, Benhamou E, Benhamou S, Boffetta P et al. Lung cancer and cigarette smoking in Europe: an update of risk estimates and an assessment of inter-country heterogeneity. International Journal of Cancer 2001; 91:876-887.

13. Plummer M, Herrero R, Franceschi S, Meijer CJ, Snijders P, Bosch FX et al. Smoking and cervical cancer: pooled analysis of the IARC multi-centric case-control study. Cancer Causes & Control 2003; 14:805-814.

14. Zeegers MP, Tan FE, Dorant E, van Den Brandt PA. The impact of characteristics of cigarette smoking on urinary tract cancer risk: a meta-analysis of epidemiologic studies. [Review] [87 refs]. Cancer 2000; 89(3):630-639.

15. Hunt JD, van der Hel OL, McMillan GP, Boffetta P, Brennan P. Renal cell carcinoma in relation to cigarette smoking: meta-analysis of 24 studies. International Journal of Cancer 2005; 114:101-108.

16. Brennan P, Bogillot O, Greiser E, Chang-Claude J, Wahrendorf J, Cordier S et al. The contribution of cigarette smoking to bladder cancer in women (pooled European data). Cancer Causes & Control 2001; 12:411-417.

17. Brennan P, Bogillot O, Cordier S, Greiser E, Schill W, Vineis P et al. Cigarette smoking and bladder cancer in men: a pooled analysis of 11 case-control studies. International Journal of Cancer 2000; 86:289-294.

18. Brownson RC, Novotny TE, Perry MC. Cigarette smoking and adult leukemia: a meta-analysis. Archives of Internal Medicine 1993; 153:469-475.

19. Law MR, Morris JK, Wald NJ. Environmental tobacco smoke exposure and ischaemic heart disease: an evaluation of the evidence. British Medical Journal 1997; 315(7114):973-980.

20. Law MR, Wald NJ. Environmental tobacco smoke and ischemic heart disease. Progress in Cardiovascular Diseases 2003; 46:31-38.

21. Single E, Robson L, Xie X, Rehm J. The costs of substance abuse in Canada. 1996. Ottawa, Canadian Centre on Substance Abuse.

22. Castles A, Adams EK, Melvin CL, Kelsch C, Boulton ML. Effects of smoking during pregnancy. Five meta-analyses. American Journal of Preventive Medicine 1999; 16(3):208-215.

23. Council of Canadian Fire Marshalls and Fire Commissioners. Fire Losses in Canada Annual Report, 2000. 2003. Council of Canadian Fire Marshals and Fire Commissioners.

24. Walter SD. The estimation of interpretation of attributable risk in health research. Biometrics 1976; 32:829-849.

25. Walter SD. Prevention of multifactorial disease. American Journal of Epidemiology 1980; 112:409-416.

26. Taylor R, Cumming R, Woodward A, Black M. Passive smoking and lung cancer: a cumulative meta-analysis. Australian & New Zealand Journal of Public Health 2001; 25:203-211.

27. de Groh M, Morrison HL. Environmental tobacco smoke and deaths from coronary heart disease in Canada. Chronic Diseases in Canada 2002; 23:13-16.

28. Heloma A, Jaakkola MS. Four-year follow-up of smoke exposure, attitudes and smoking behaviour following enactment of Finland's national smoke-free work-place law. Addiction 2003; 98:1111-1117.

29. Zhong L, Goldberg MS, Parent ME, Hanley JA. Exposure to environmental tobacco smoke and the risk of lung cancer: a meta-analysis. Lung Cancer 2000; 27(1):3-18.

30. Thun MJ, Henley J, Apicella L. Epidemiologic studies of fatal and nonfatal cardiovascular disease and ETS exposure from spousal smoking. Environmental Health Perspectives 1999; 107:841-846.

31. He J, Vupputuri S, Allen K, Prerost MR, Hughes J, Whelton PK. Passive smoking and the risk of coronary heart disease--a meta-analysis of epidemiologic studies. New England Journal of Medicine 1999; 340(12):920-926.

32. WHO Statistical Information System. Discussion paper No.40: Life tables for 191 countries for 2000: data, methods, results. 2000. Geneva, World Health Organization.

33. Mathers CD, Vos A, Lopez AD, Salomon J, Ezzati M. National burden of disease studies: A practical guide. 2nd ed. Geneva: Global Program on Evidence for Health Policy, World Health Organization, 2001.

34. Public Health Agency of Canada. Cancer surveillance on-line. Available at: http://dsol-smed.phac-aspc.gc.ca/dsol-smed/cancer/d_time_e.html. 2005.

35. Tanuseputro P, Schult S, Manuel D. Estimating smoking attributable mortality. Canadian Journal of Public Health 2004; 95(2):132.

36. Health Canada. Canadian Tobacco Use Monitoring Survey (CTUMS): Summary of results for 2003. Available at: www.hc-sc.gc.ca/hl-vs/tobac-tabac/research-recherche/stat/ctums-esutc/2003/index_e.html. 2005.

37. Godtfredsen NS, Holst C, Prescott E, Vestbo J, Osler M. Smoking reduction, smoking cessation, and mortality: a 16-year follow-up of 19,732 men and women from The Copenhagen Centre for Prospective Population Studies. American Journal of Epidemiology 2002; 156:994-1001.

38. Russell LB, Carson JL, Taylor WC, Milan E, Dey A, Jagannathan R. Modelling all-cause mortality: projections of the impact of smoking cessation based on the NHEFS NHANES I Epidemiologic Follow-up Study. American Journal of Public Health 1998; 88:630-636.

39. Critchley J, Capewell S. Smoking cessation for the secondary prevention of coronary heart disease. The Cochrane Library 2005; Vol 1.

40. Iso H, Date C, Yamamoto A, Toyoshima H, Watanabe Y, Kikuchi S et al. Smoking cessation and mortality from cardiovascular disease among Japanese men and women: the JACC Study. American Journal of Epidemiology 2005; 161(2):170-179.

41. Scanlon PD, Connett JE, Waller LA, Altose MD, Bailey WC, Buist AS. Smoking cessation and lung fuction in mild-to-moderate chronic obstructive pulmonary disease. The Lung Health Study. American Journal of Respiratory & Critical Care Medicine 2000; 161:381-390.

42. Kanner RE, Connett JE, Williams DE, Buist AS. Effects of randomized assignment to a smoking cessation intervention and changes in smoking habits on respiratory symptoms in smokers with early chronic obstructive pulmonary disease: the Lung Health Study. American Journal of Medicine 1999; 106:410-416.