

## Cancer Incidence Attributable to Tobacco in Alberta, Canada in 2012

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**ABSTRACT**

**Background:** Strong and consistent epidemiologic evidence exists that tobacco smoking causes cancers at various sites. The purpose of this study was to quantify the proportion and total number of site-specific cancers in 2012 in Alberta attributable to tobacco exposure.

**Methods:** The proportion of incident cancer cases attributable to active and passive tobacco exposure in Alberta was estimated with population attributable risks. Data from the 2000- 2007 Canadian Community Health Surveys were used to estimate prevalence of active (current or former smoker) and passive (second-hand smoke) tobacco exposure in Alberta.

**Results:** Prevalence of current or former smokers ranged from 68% - 82% in men and 51% - 66% in women. Approximately 78% and 73% of lung cancer in men and women, respectively, could be attributed to current or former active tobacco smoking. Population attributable risk estimates for the other tobacco-related cancer sites ranged from approximately 4% for ovarian cancer to 74 % for laryngeal cancer. Approximately 5% of incident lung cancers in never smoking men and women could be attributed to passive tobacco exposure. Overall, 37% of tobacco-related cancers in Alberta were attributable to active tobacco smoking in 2012. This percentage equals 16% of all incident cancers in Alberta in 2012.

**Interpretation:** A notable proportion of cancers at sites associated with tobacco use can be attributed to active smoking in Alberta. Passive exposure remains an important risk factor for lung cancer. Strategies to reduce the prevalence of active tobacco smokers in Alberta could have a considerable impact on future cancer incidence.

## INTRODUCTION

There is sufficient evidence from multiple meta-analyses, cohort and case-control studies in humans to conclude that active tobacco smoking is associated with an increased risk of cancers of the lung, larynx, oral cavity and pharynx, paranasal sinuses, esophagus, stomach, pancreas, liver, kidney, ureter, bladder, uterine cervix, bone marrow (myeloid leukemia) ovary, colon and rectum, as determined by the International Agency for Research on Cancer.[1] In 2012, International Agency for Research on Cancer determined that there was sufficient human evidence to conclude that residential and occupational passive tobacco exposures are both lung cancer carcinogens. The monograph included results from a meta-analysis of 55 studies by Taylor et al.,[2] which reported a relative risk (RR) of 1.27 for lung cancer in never smoking women exposed to second-hand smoke from their spouse. In a more recent pooled analysis of 18 case-control studies, the RR of lung cancer in male and female never smokers exposed to second-hand smoke at home was 1.19.[3] Results were inconsistent for all other cancer sites considered.

Based on these consistent associations, the purpose of this study was to estimate the population attributable risk and subsequently the proportion of cancers attributable to each of active and passive tobacco exposure in Alberta, Canada.

## METHODS

Detailed methods on the data abstraction and population attributable risk calculations for the current study were previously published.[4] In determining the population attributable risks for tobacco exposure and cancer in Alberta, separate methods were used for active and passive tobacco exposures, as the risk of cancer and the associated cancer sites differ between these two types of tobacco exposure.

### Active Tobacco Exposure

*Latency Period*

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3 The effect of tobacco smoking on cancer risk is understood to be the result of past exposure.  
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5 Therefore, a biologically meaningful latency period was identified for both active and passive tobacco  
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7 exposures from the literature. As previously described in this series, the cycle of the Canadian  
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9 Community Health Survey used corresponded to the midpoint of the latency period suggested by cohort  
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11 studies for each cancer site of interest. Latency periods and corresponding Canadian Community Health  
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13 Survey cycles used for each cancer site of interest are presented in Table 1.  
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### 16 17 *Prevalence of Exposure* 18 19

20 Data from the Canadian Community Health Survey were obtained online through the Statistics  
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22 Canada data portal [5] for active tobacco prevalence estimates. The population-based cross-sectional  
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24 Canadian Community Health Survey is used to collect information on the health status, health care  
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26 utilization and health determinants of Canadians. In the 2000/2001 cycle, 130,000 respondents aged 12  
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28 years and older were interviewed after being selected using a multi-stage sample allocation strategy based  
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30 on both the population size and number of health regions in each province and territory. The survey  
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32 methods have been described previously. [6] Information on two types of active smoking was used for the  
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34 current study. In the Canadian Community Health Survey, current smokers are defined as those who  
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36 smoked cigarettes daily or occasionally at the time of the interview, while former smokers are those who  
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38 did not smoke at the time of the interview and had smoked more than 100 cigarettes in their lifetime.  
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40 Never smokers are defined as those who did not smoke at the time of the interview and had smoked less  
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42 than 100 cigarettes in their lifetime.  
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### 46 47 *Risk Estimates* 48 49

50 For current and former smokers, the RRs of developing cancer at various sites and the sources for  
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52 these estimates are shown in Table 2. The majority of risk estimates used in this study were taken from a  
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54 meta-analysis of 216 studies published by Gandini et al.[7] The RRs from large meta-analyses published  
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by Tsoi et al.[8] and the Collaborative Group on Epidemiological Studies of Ovarian Cancer [9] were used for colorectal and ovarian cancers, respectively.

### *Population Attributable Risk Estimation*

To estimate the population attributable risk for active tobacco smoking, Equation 1, previously used by both Parkin [10] and Cancer Care Ontario [11] was used here.

$$\text{Equation 1: Population attributable risk} = \frac{(P_{e1} \times ERR_1) + (P_{e2} \times ERR_2)}{1 + ((P_{e1} \times ERR_1) + (P_{e2} \times ERR_2))}$$

Where  $P_{e1}$  is the prevalence of current active tobacco smokers,  $P_{e2}$  is the prevalence of former active tobacco smokers,  $ERR_1$  is the excess RR (RR-1) of cancer in current smokers versus never smokers and  $ERR_2$  is the ERR of cancer in former smokers versus never smokers.

### *Cancer Incidence Data*

The population attributable risk was then multiplied by the incidence for the year 2012 for each respective cancer type, acquired through the Alberta Cancer Registry, to determine the number of cancer cases attributable to active smoking in Alberta. A lag time of either 5 or 10 years, depending on the cancer site, was applied the age groups used in the cancer incidence data, to account for cancers caused in 2012 attributable to past exposure. The latency period was rounded to a lag time of either 5 or 10 years to reduce the variation in age groups used for this analysis.

## **Passive Tobacco Exposure**

### *Latency Period*

A biologically plausible latency period between passive tobacco exposure and lung cancer was determined from the literature. The Canadian Community Health Survey cycle 2.1 (2003) was used to correspond to the midpoint of latency periods suggested by previous cohort studies (Table 1).

### *Prevalence of Exposure*

Data on the prevalence of passive smoking in never smokers was also available from the Canadian Community Health Survey.[5] In the survey, passive smokers were defined as those who were regularly exposed to tobacco smoke in their home, a vehicle, or a public place.

### *Risk Estimates*

A pooled analysis of 18 case-control studies in the International Lung Cancer Consortium by Kim et al.[3] was used to obtain the risk estimate for the association between passive exposure to tobacco smoke and lung cancer (Table 2).

### *Population Attributable Risk Calculation*

Equation 2 was used to calculate the population attributable risk for lung cancer and passive tobacco smoke exposure in never smokers:

$$\text{Equation 2: Population attributable risk} = \frac{P_e (RR-1)}{1+[P_e (RR-1)]}$$

Where  $P_e$  is the prevalence of passive tobacco exposure and  $RR$  is the RR of lung cancer in those passively exposed to tobacco smoke versus those never exposed.

### *Cancer Incidence Data*

To estimate the number of cases of lung cancer attributable to passive tobacco exposure, an approximation of 10% of incident lung cancer cases in 2012 from the Alberta Cancer Registry was used to represent the proportion of lung cancer occurring in never smokers.[12] The population attributable risk was then multiplied by this number to determine the number of lung cancer cases attributable to passive tobacco smoke exposure in Alberta. A process similar to that described for active tobacco exposure was used to adjust the age groups for the cancer incidence data to account for cancers caused by past exposures to passive tobacco smoke.

## RESULTS

### Active Tobacco Exposure

#### *Prevalence of Active Tobacco Exposure*

Data from the Canadian Community Health Survey estimated that in 2000-2001, between 12.9% (95% confidence interval [CI] = 10.9, 14.9) and 35.4% (95% CI = 33.0, 37.7) of Albertans were current smokers and between 28.4% (95% CI = 36.4, 30.5) and 52.2% (95% CI = 49.4, 55.0) were former smokers (Table 3). For all age groups, the prevalence of current smokers was higher in men than women. This higher prevalence amongst men was also observed for the prevalence of former smokers, with the exception of the 20-34 year age group, where the prevalence was comparable between sexes. The prevalence of current smokers decreased with increasing age for both sexes. In contrast, the prevalence of former smokers increased with increasing age (Table 3).

#### *Population Attributable Risk Results*

Population attributable risk estimates and numbers of observed and excess attributable cancer cases for each age group by sex and combined sexes for active tobacco smoking are presented in Table 4. Measures of uncertainty (95% CIs) for the population attributable risk estimates can be found in Supplementary Table 1. In 2012, an estimated 2485 incident cancer cases could be attributable to active smoking. This number of cases was 37.0% of cancers known to be associated with active smoking and 15.7% of all incident cancers in 2012 (Table 5). Lung cancer accounted for over half of the excess cases, with 739 cases in men and 733 cases in women. The second greatest contributor to the number of excess cases was colorectal cancer, with 141 excess cases in men and 85 excess cases in women. Although the population attributable risk estimates for colorectal cancer were relatively low, the number of excess cases was high because of the large number of incident colorectal cancer cases in Alberta in 2012. With the exceptions of pancreatic cancer, the overall burden of attributable cancer cases was greater among men than women.

## Passive Tobacco Exposure

### *Prevalence of Passive Tobacco Exposure*

Between 11.3% (95% CI = 8.7, 13.9) and 32.3% (95% CI = 28.9, 35.8) of Albertan never smokers were regularly exposed to passive tobacco smoke in 2003 (Table 3). In those 65 years of age and older, prevalence estimates were comparable between sexes. For all other age groups, the prevalence of passive tobacco exposure was higher for men than women. Prevalence of passive tobacco exposure decreased with increasing age for both men and women (Table 3).

### *Population Attributable Risk Results*

The population attributable risks and the numbers of observed and excess attributable lung cancer cases for each age group by sex and combined sexes for passive tobacco exposure are presented in Table 6. Of the 139 incident cases of lung cancer in 2012 estimated to be among never smokers, three could be attributable to passive tobacco exposure (Table 5).

## INTERPRETATION

Results of these analyses suggest that 15.7% (n = 2485) of all incident cases of cancer in Alberta in 2012 were attributable to active tobacco smoking. In addition, three cases of lung cancer in never smokers were attributable to passive tobacco exposure.

Recently, Cancer Care Ontario conducted a similar analysis for the province of Ontario, Canada[11] also using the Canadian Community Health Survey Cycle 1.1 (2000-2001) for prevalence estimates of tobacco use in Ontario. In the year 2000, 24.5% of the persons aged 12 and above in Ontario were current daily or occasional smokers, which was 3.1% lower than the prevalence in Alberta. These investigators found that an estimated 15% of new cancer cases (n = 9800) diagnosed in 2009 were attributable to active tobacco smoking, which is comparable to our estimate of 15.7%. Similar to the Alberta estimates, the largest population attributable risk estimates in the Ontario study were for cancers



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3 of the larynx (73%), lung and bronchus (71%), esophagus (41%) and lip, oral cavity and pharynx (39%).  
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5 For all cancer sites applicable to both sexes, population attributable risk estimates were greater for males  
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7 than females with the exception of pancreatic cancer, which was also observed in the Alberta  
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9 analysis.[11] No analyses were completed for passive smoke exposure in the Ontario study.  
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13 Using smoking prevalence data from the 2010 National Health Interview Survey, Jacobs et al.  
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15 (2015) [13] estimated that 31.7% (n = 568,191) of all cancer deaths in the United States in 2010 were  
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17 attributable to cigarette smoking, which is almost twice the proportion found in our analysis. However,  
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19 given that the outcome of death from cancer was examined for the American study whereas cancer  
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21 incidence was used in our work, these differences are expected since the cancers most associated with  
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23 active tobacco smoking are the major contributors to cancer-related death.  
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27 In 2010, Parkin determined that 86% (n = 34,599) of lung cancer cases in the United Kingdom  
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29 could be attributed to exposure to tobacco smoke, of which 97% was attributable to current or former  
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31 active smoking.[14] Furthermore, tobacco exposure accounted for 19% (n = 60,837) of all new cancer  
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33 cases in the UK. This overall estimate is higher than the 15.7% found in the current analysis, which could  
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35 be explained by both active and passive (at work and home) tobacco exposure being accounted for in the  
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37 overall analysis. In addition, prevalence estimates for the UK study were not available, so an  
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39 approximation based on data from the American Cancer Society's second Cancer Prevention Study was  
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41 used. Differences in prevalence estimates between the Alberta and UK populations could explain the  
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43 difference observed in population attributable risk.  
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## 46 47 **Limitations**

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49 A sensitivity analysis was completed using data from the population based Alberta Tomorrow  
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51 Project [15] to determine the prevalence of Albertans smoking tobacco products other than cigarettes. In  
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53 2008, approximately 0.1%, 0.09% and 0.42% of Albertans were daily smokers of cigars, pipes and  
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55 cigarillos, respectively. Therefore, for active smoking, population attributable risks were estimated only  
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3 for tobacco exposure through cigarettes. Information on occupational passive tobacco exposure was not  
4 available for the current study. Smoking in public places and workplaces in Alberta was legal until the  
5 Tobacco Reduction Act became law in 2008. Therefore, those passively exposed to tobacco in an  
6 occupational setting in 2003 were not captured. Parkin [14] also considered passive tobacco exposure in  
7 his analyses. Approximately 15% of lung cancer was shown to be attributable to passive tobacco smoking  
8 either at home from a spouse or at work. Since no prevalence data were available for occupational passive  
9 tobacco smoke exposure in Alberta, similar estimates related to occupational exposure could not be made.  
10 In 2012, Sisti and Boffetta conducted a study examining the proportion of lung cancer in never smokers  
11 attributable to several risk factors, including second-hand smoke exposure.[16] An estimated 6% of lung  
12 cancers in women and 8% in men in 2008 were attributed to second-hand smoke exposure in North  
13 America. When the source of exposure was examined separately, results showed highest population  
14 attributable risk estimates for exposure at the workplace compared with exposure at home, which could  
15 explain why our population attributable risk estimates for passive tobacco exposure are much smaller.  
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## 32 **Conclusion**

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35 To our knowledge, these are the first population attributable risk estimates for both active and  
36 passive tobacco exposure and the outcome of cancer in the province of Alberta, Canada. By examining a  
37 wide range of cancer sites, we were able to demonstrate which cancers are most influenced by tobacco  
38 exposure using prevalence estimates specific to Alberta. Although the Canadian Community Health  
39 Survey does not capture information on aboriginal Canadians living on reserves or those living on  
40 military facilities or crown land, the Canadian Community Health Survey sampling frame is  
41 representative of 96-98% of the adult Canadian population.  
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51 Despite compelling public health campaigns to reduce smoking in Alberta, in 2000-2001 27.6%  
52 of Albertans over the age of 12 were current smokers. However, data from the 2014 Canadian  
53 Community Health Survey suggest that this prevalence decreased to 19.0% in the last 14 years. Our  
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3 results estimate that approximately 15.7% of incident cancer cases, translating to 2485 cancer cases in  
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5 Alberta in 2012 were attributable to current or former active tobacco smoking. Reducing the prevalence  
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7 of smoking in through additional prevention strategies should be a top priority of public health agencies  
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9 in Alberta, since it could greatly decrease the number of incident cancers observed in Alberta each year.  
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**Table 1.** Predetermined latency periods by cancer site and cycle of prevalence data used for population attributable risk calculations

Exposure	Cancer site	Latency period (range in years)	Source (first author, year)	Corresponding CCHS cycle (year)
<b>Active tobacco</b>	Lung	7-33	Boffetta, 2006[1]	1.1 (2000/2001)
			Kenfield, 2008[2]	
			Freedman, 2008[3]	
	Oral Cavity and pharynx	4-26	Yun, 2005[4]	1.1 (2000/2001)
			Boffetta, 2006[1]	
			Friborg, 2007[5]	
			Nordlund, 1997[6]	
			Jee, 2004[7]	
	Larynx	4-9	Freedman, 2007[3]	3.1 (2005)
			Yun, 2005[4]	
	Oesophagus	9-15	Tran, 2004[8]	1.1 (2000/2001)
			Jee, 2004[7]	
			Ishiguro, 2009[9]	
	Stomach	6-8	Jee, 2004[7]	3.1 (2005)
			Lindblad, 2005[10]	
Sung, 2007[11]				
Liver	5-26	Yang, 2002[12]	1.1 (2000/2001)	
		Nordlund, 1997[6]		
		Basa, 1977[13]		
Pancreas	6-23	Nordlund, 1997[6]	1.1 (2000/2001)	
		Friedman, 1993[14]		
Colon-rectum	9-13	Tsoi, 2009[15]	1.1 (2000/2001)	
		Jee, 2004[7]		
		Hannan, 2009[16]		
Ovary	13-23	Terry, 2003[17]	1.1 (2000/2001)	
		Tworoger, 2008[18]		
		Gram, 2008[19]		
		Kapeu, 2009[20]		
Cervix	2-10	McIntyre-Seltman, 2005[21]	4.1 (2007)	
		Schiffman, 1993[22]		
		Chow, 2000[23]		
Kidney	16-27	Engeland, 1996[24]	1.1 (2000/2001)	
		Nordlund, 1997[6]		
Myeloid Leukemia	19-26	Fernberg, 2007[25]	1.1 (2000/2001)	
		Nordlund, 1997[6]		
		Engeland, 1996[24]		
Bladder	3-26	Alberg, 2007[26]	1.1 (2000/2001)	
		Tulinius, 1997[27]		
		Nordlund, 1997[6]		
<b>Passive tobacco</b>	Lung	Yuan, 1996[28]	2.1 (2003)	
		Veglia et al., 2007[29]		
		Vineis et al., 2005[30]		
			Kurahashi et al., 2008[31]	

Abbreviations: CCHS = Canadian Community Health Survey

**Table 2.** Relative risks of cancers for current and former active tobacco and passive tobacco exposure

Cancer site	Period of exposure	Relative Risk (95% confidence interval)		
		Men	Women	All
<b>Active Tobacco</b>				
Lung <sup>a</sup>	Current	9.9 (6.8-14.2)	7.6 (5.4-10.7)	9.0 (6.70-12.1)
	Former	-	-	3.8 (2.8-5.3)
Oral Cavity and pharynx <sup>a</sup>	Current	-	-	3.6 (2.6-4.8)
	Former	-	-	1.2 (0.7-1.9)
Larynx <sup>a</sup>	Current	-	-	7.0 (3.1-15.5)
	Former	-	-	4.6 (3.4-6.4)
Oesophagus <sup>a</sup>	Current	2.52 (1.8-3.5)	2.3 (1.5-3.4)	2.5 (2.0-3.1)
	Former	-	-	2.0 (1.8-2.3)
Stomach <sup>a</sup>	Current	1.7 (1.5-2.1)	1.4 (1.2-1.8)	1.6 (1.4-2.0)
	Former	-	-	1.3 (1.2-1.5)
Liver <sup>a</sup>	Current	1.8 (1.2-2.8)	1.5 (1.1-2.0)	1.6 (1.3-1.9)
	Former	-	-	1.5 (1.1-2.1)
Pancreas <sup>a</sup>	Current	1.6 (1.3-2.0)	1.7 (1.3-2.3)	1.7 (1.5-1.9)
	Former	-	-	1.2 (1.0-1.3)
Colon-rectum <sup>b</sup>	Current	1.4 (1.2-1.6)	1.1 (1.0-1.1)	1.2 (1.1-1.3)
	Former	1.2 (1.1-1.4)	1.2 (1.1-1.3)	1.2 (1.1-1.2)
Ovary <sup>c</sup>	Current	-	1.1 (1.0-1.1)	-
	Former	-	1.1(1.0-1.1)	-
Cervix <sup>a</sup>	Current	-	2.2 (1.1-4.4)	-
	Former	-	1.3 (1.1-1.4)	-
Kidney <sup>a</sup>	Current	1.6 (1.3-1.9)	1.4 (1.0-1.7)	1.5 (1.3-1.7)
	Former	-	-	1.2 (1.1-1.4)
Myeloid Leukemia <sup>a</sup>	Current	-	-	1.1 (0.7-1.7)
	Former	-	-	1.3 (0.3-5.8)
Bladder <sup>a</sup>	Current	2.8 (2.0-3.9)	2.7 (1.8-4.1)	2.8 (2.2-3.5)
	Former	-	-	1.7 (1.5-2.0)
<b>Passive tobacco</b>				
Lung <sup>d</sup>	Ever exposed	-	-	1.34 (1.24-1.45)

<sup>a</sup> Estimates from Gandini et al.[32]

<sup>b</sup> Estimates from Tsoi et al.[15]

<sup>c</sup> Estimates from the Collaborative Group on Epidemiological Studies of Ovarian Cancer[33]

<sup>d</sup> Estimates from Kim et al., 2014 [34]

Age (years)	Prevalence (95% confidence interval)		
	Current Smokers <sup>a</sup>	Former Smokers <sup>a</sup>	Any Passive Tobacco Exposure <sup>b</sup>
Men			
20-34	39.5 (36.1,42.9)	28.3 (25.5,31.2)	39.0 (33.7,44.3)
35-44	34.4 (30.8,37.9)	38.3 (35.0,41.7)	25.3 (20.3,30.3)
45-64	28.9 (25.9,31.9)	49.1 (45.5,52.6)	20.9 (15.3,26.4)
≥ 65	13.5 (10.5,16.5)	68.5 (64.2,72.7)	11.1 (6.5,15.7)
Women			
20-34	31.0 (27.7,34.2)	28.5 (25.7,31.4)	26.0 (21.9,30.2)
35-44	29.7 (26.4,33.1)	35.1 (31.9,38.3)	20.8 (15.6,26.0)
45-64	26.0 (23.2,28.8)	40.1 (36.9,43.3)	14.4 (10.7,18.2)
≥ 65	12.4 (9.9,14.9)	38.7 (35.1,42.3)	11.4 (8.2,14.6)
Total			
20-34	35.4 (33.0,37.7)	28.4 (26.4,30.5)	32.3 (28.9,35.8)
35-44	32.1 (29.6,34.6)	36.7 (34.3,39.1)	23.0 (19.4,26.6)
45-64	27.5 (25.4,29.5)	44.6 (42.3,47.0)	17.0 (13.8,20.1)
≥ 65	12.9 (10.9,14.9)	52.2 (49.4,55.0)	11.3 (8.7,13.9)

<sup>a</sup>Data from cycle 1.1 of the Canadian Community Health Survey (2000-2001)

<sup>b</sup>Data from cycle 2.1 of the Canadian Community Health Survey (2003)

**Table 4.** Cancer cases and proportion attributable to active smoking in Alberta (2012)

Age at Exposure	Lung			Colorectum			Kidney			Pancreas			Oral Cavity and Pharynx			Bladder			Stomach									
	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC
<b>Men</b>																												
20-34	30-44	13	79.8	10	30-44	37	11.5	4	30-44	28	21.6	6	30-44	<5	24.7	<5	30-44	24	51.6	12	30-44	-	-	-	25-39	5	23.9	1
35-44	45-54	51	79.3	40	45-54	125	12.1	15	45-54	56	21.5	12	45-54	19	23.6	4	45-54	62	48.8	30	45-54	16	46.9	8	40-49	<5	24.2	<5
45-64	55-74	558	78.7	439	55-74	605	12.8	77	55-74	188	21.4	40	55-74	83	22.5	19	55-74	153	45.4	69	55-74	147	46.4	68	50-69	74	23.9	18
≥65	≥75	331	75.2	249	≥75	338	13.1	44	≥75	54	19.4	11	≥75	65	17.9	12	≥75	34	32.0	11	≥75	117	42.3	49	≥70	77	22	17
Total		953		739	Total	1105		141	Total	326		69	Total	<172		<40	Total	273		123	Total	280		125	Total	<161		<41
<b>Women</b>																												
20-34	30-44	8	76.6	6	30-44	35	10.2	4	30-44	14	18.9	3	30-44	<5	21.2	<5	30-44	12	45.9	6	30-44	-	-	-	25-39	5	19.7	1
35-44	45-54	76	77.1	59	45-54	108	10.9	12	45-54	28	19.5	5	45-54	26	21.3	6	45-54	14	45.2	6	45-54	<5	43.8	<5	40-49	13	21.9	3
45-64	55-74	574	76.3	438	55-74	377	11	42	55-74	81	19.1	15	55-74	96	20.3	19	55-74	42	42.5	18	55-74	32	42.8	14	50-69	29	21	6
≥65	≥75	341	67.6	231	≥75	326	8.6	28	≥75	33	13.9	5	≥75	85	13.5	11	≥75	32	28.0	9	≥75	39	33.2	13	≥70	50	16.8	8
Total	1	999		733	Total	846		85	Total	156		28	Total	<212		<41	Total	100		39	Total	<76		<32	Total	97		18
<b>Total</b>																												
20-34	30-44	21	78.4	16	30-44	72	10.9	8	30-44	42	20.3	9	30-44	5	23	1	30-44	36	49	18	30-44	-	-	-	25-39	10	21.9	2
35-44	45-54	127	78.3	99	45-54	233	11.5	27	45-54	84	20.6	17	45-54	45	22.5	10	45-54	76	47.1	36	45-54	<21	45.4	<13	40-49	<18	23.1	<8
45-64	55-74	1132	77.6	877	55-74	982	11.9	117	55-74	269	20.3	55	55-74	179	21.4	38	55-74	195	44.0	86	55-74	179	44.7	80	50-69	103	22.5	24
≥65	≥75	672	71.5	480	≥75	664	10.7	71	≥75	87	16.5	14	≥75	150	15.6	23	≥75	66	29.8	20	≥75	156	37.7	59	≥70	127	19.3	25
Total		1952		1472	Total	1951		223	Total	482		95	Total	379		72	Total	373		159	Total	<356		<157	Total	<258		<59

Abbreviations: EAC = Excess attributable cases due to exposure, Obs. = Total number of observed cases per age-sex group, PAR = Population attributable Risk

\*Cell counts of less than 5 for observed cases were suppressed to comply with confidentiality requirements

Table 4. Continued

Age at Exposure	Liver				Ovary				Esophagus				Myeloid Leukemia				Cervix			Larynx					
	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	Age at Outcome	Obs.	PAR	EAC	
<b>Men</b>																									
20-34	30-44	< 5	26.5	< 5					30-44	< 5	46.9	< 5	30-44	10	10.1	1				25-39	-	-	-		
35-44	45-54	20	27.6	6				45-54	21	47.7	10	45-54	15	11.8	2				40-49	6	76.4	5			
45-64	55-74	92	28.7	26				55-74	89	48.4	43	55-74	47	13.7	6				50-69	37	76.9	28			
≥65	≥75	34	29.1	10				≥75	37	47.6	18	≥75	27	16.5	4				≥70	21	75.8	16			
Total	Total	< 151		< 47				Total	< 152		< 76	Total	99		14				Total	64		49			
<b>Women</b>																									
20-34	30-44	< 5	23.9	< 5	30-44	15	3.4	1	30-44	< 5	43.1	< 5	30-44	9	9.5	1	25-39	49	25.3	12	25-39	-	-	-	
35-44	45-54	6	25.3	2	45-54	41	3.7	2	45-54	< 5	44.7	< 5	45-54	13	10.8	1	40-49	30	28.3	8	40-49	-	-	-	
45-64	55-74	43	25.5	11	55-74	85	3.8	3	55-74	20	44.5	9	55-74	27	11.6	3	50-69	38	27.7	11	50-69	5	73.7	4	
≥65	≥75	18	20.6	4	≥75	48	3	1	≥75	7	36.9	3	≥75	28	10.4	3	≥70	15	18.3	3	≥70	7	68.7	5	
Total	Total	< 72		< 22	Total	189		7	Total	32		14	Total	77		8	Total	132		34	Total	12		8	
<b>Total</b>																									
20-34	30-44	< 5	25.2	1	30-44	15	3.4	1	30-44	5	45.2	< 5	30-44	19	9.8	2	25-39	49	25.3	12	25-39	-	-	-	
35-44	45-54	26	26.4	8	45-54	41	3.7	2	45-54	< 26	46.2	< 15	45-54	28	11.3	3	40-49	30	28.3	8	40-49	6	75.4	5	
45-64	55-74	135	27.1	37	55-74	85	3.8	3	55-74	109	46.6	51	55-74	74	12.7	9	50-69	38	27.7	11	50-69	42	75.4	32	
≥65	≥75	52	24.7	14	≥75	48	3	1	≥75	44	42.2	19	≥75	55	13.2	7	≥70	15	18.3	3	≥70	28	72.4	20	
Total	Total	< 218		57	Total	189		7	Total	< 184		< 90	Total	176		22	Total	132		34	Total	76		56	

Abbreviations: EAC. = Excess attributable cases due to exposure, Obs. = Total number of observed cases per age-sex group, PAR = Population attributable Risk

\*Cell counts of less than 5 for observed cases were suppressed to comply with confidentiality requirements

**Table 5.** Summary of cases and proportions of cancer in Alberta in 2012 attributable to active and passive tobacco exposure<sup>a</sup>

Exposure	Cancer Site <sup>b</sup>	Total			Men			Women			
		Observed Cases <sup>c</sup>	Excess Attributable Cases <sup>d</sup>	% Attributable <sup>e</sup>	Observed Cases	Excess Attributable Cases	% Attributable	Observed Cases	Excess Attributable Cases	% Attributable	
Active Tobacco Smoking	Lung	1952	1475	75.6	953	739	77.5	999	733	73.4	
	Colorectum	1951	223	11.4	1105	141	12.7	846	85	10.1	
	Kidney	482	95	19.7	326	69	21.1	156	28	18	
	Pancreas	379	73	19.3	171	36	20.9	208	37	17.7	
	Oral Cavity and Pharynx	373	159	42.6	273	123	45	100	39	38.7	
	Bladder	354	147	41.6	280	125	44.7	74	28	37.8	
	Stomach	255	53	20.9	158	36	23	97	18	18.9	
	Liver	217	57	26.4	148	42	28.6	69	17	24.1	
	Ovary	189	7	3.6				189	7	3.6	
	Esophagus	183	83	45.4	151	73	48.1	32	14	42.8	
	Myeloid Leukemia	176	22	12.3	99	14	13.8	77	8	10.8	
	Cervix	132	34	25.9				132	34	25.9	
	Larynx	76	56	74.3	64	49	76.5	12	8	70.8	
		<b>All Associated Cancers</b>	6719	2485	37.0	3728	1446	38.8	2991	1056	35.3
	<b>All Cancers</b>	15836	2485	15.7	8155	1446	17.7	7681	1056	13.7	
Passive Tobacco Exposure	Lung	139	3	2.4	69	2	2.3	70	2	2.4	
		<b>All Associated Cancers<sup>f</sup></b>	139	3	2.4	69	2	2.3	70	2	2.4
		<b>All Cancers<sup>g</sup></b>	15836	3	-	8155	2	-	7681	2	-

<sup>34a</sup> Data on prevalence of tobacco exposure from the Canadian Community Health Survey.

<sup>35b</sup> Cancer incidence data for the year 2012 from the Alberta Cancer Registry.

<sup>36c</sup> Number of observed cancer cases in Alberta in 2012 at individual cancer sites.

<sup>38d</sup> Number of cancer cases at individual cancer sites that can be attributed to active/passive tobacco exposure.

<sup>39e</sup> Proportion of cancers at individual cancer sites attributable to active/passive tobacco exposure.

<sup>40f</sup> All associated cancers includes all cancers known to be associated with active or passive tobacco exposure (as listed in the current table).

<sup>42g</sup> All cancers includes all incident cancer cases in Alberta for all ages in 2012.

**Table 6.** Lung cancer cases and proportions due to passive tobacco exposure at home, in a car or in a public place

Age at Exposure	Age at Outcome	Obs.	PAR (95% CI)	EAC (95% CI)
<b>Men</b>				
20-34	30-44	< 5	11.7 (8.3,15.2)	-
35-49	45-59	14	7.9 (5.4,10.7)	1 (1,2)
50-64	60-74	47	6.6 (4.3,9.3)	3 (2,5)
≥ 65	≥ 75	33	3.6 (2.0,5.7)	1 (1,2)
Total	Total	< 99		5
<b>Women</b>				
20-34	30-44	< 5	8.1 (5.7,10.8)	-
35-49	45-59	17	6.6 (4.3,9.2)	1 (1,2)
50-64	60-74	48	4.7 (3.0,6.7)	2 (1,3)
≥ 65	≥ 75	34	3.7 (2.4,5.4)	1 (1,2)
Total	Total	< 104		4
<b>Total</b>				
20-34	30-44	< 5	9.9 (7.1,12.9)	-
35-49	45-59	31	7.3 (5.0,9.6)	2 (1,3)
50-64	60-74	95	5.5 (3.7,7.4)	5 (3,7)
≥ 65	≥ 75	67	3.7 (2.4,5.2)	2 (2,4)
Total	Total	< 198		9

Abbreviations: CI = confidence interval, EAC = Excess attributable cases due to exposure, Obs. = Total number of observed cases per age-sex group, PAR = Population attributable risk

\*Cell counts of less than 5 for observed cases were suppressed to comply with confidentiality requirements

Supplementary Table 1. Cancer cases observed in Alberta (2012) and proportions attributable to active smoking

	Age at Exposure	Age at Outcome	Cancer Site	Total Obs. Cases	Total PAR (95% CI)	Men Obs. Cases	Men PAR (95% CI)	Women Obs. Cases	Women PAR (95% CI)
5		30-44	Lung	21	78.4 (73.3,82.8)	13	79.8 (74.8,84.1)	8	76.6 (71.2,81.3)
6		30-44	Colorectum	72	10.9 (7.7,14.1)	37	11.5 (8.1,15.0)	35	10.2 (7.3,13.2)
8		30-44	Kidney	42	20.3 (15.2,25.5)	28	21.6 (16.3,27.1)	14	18.9 (14.0,23.8)
9		25-39	Pancreas	5	23.0 (18.0,27.9)	< 5	24.7 (19.4,29.8)	< 5	21.2 (16.3,25.8)
10		30-44	Oral cavity and pharynx	36	49.0 (37.5,59.4)	24	51.6 (39.7,61.9)	12	45.9 (34.5,56.7)
11		30-44	Bladder	0	45.4 (37.6,52.9)	0	47.4 (39.4,55.2)	0	43.0 (35.3,50.5)
13	<b>20-34</b>	30-44	Stomach	10	21.9 (16.1,27.7)	5	23.9 (17.3,30.3)	5	19.7 (14.5,25.0)
14		25-39	Liver	< 5	25.2 (15.1,35.1)	< 5	26.5 (16.1,36.4)	< 5	23.9 (14.1,34.1)
15		25-39	Ovary	15	3.4 (1.0,5.9)			15	3.4 (1.0,5.9)
17		30-44	Esophagus	5	45.2 (38.5,51.5)	< 5	46.9 (40.1,53.7)	< 5	43.1 (36.7,49.5)
18		30-44	Myeloid Leukemia	19	9.8 (-28.1,59.1)	10	10.1 (0.0,59.5)	9	9.5 (0.0,57.7)
19		30-44	Cervix	49	25.3 (9.3,44.4)			49	25.3 (9.3,44.4)
20		30-44	Larynx	-	-	-	-	-	-
24		45-54	Lung	127	78.3 (73.4,82.6)	51	79.3 (74.4,83.5)	76	77.1 (71.7,81.6)
25		45-54	Colorectum	233	11.5 (8.3,14.6)	125	12.1 (8.7,15.4)	108	10.9 (7.9,14.0)
26		45-54	Kidney	84	20.6 (15.5,25.5)	56	21.5 (16.3,26.7)	28	19.5 (14.7,24.3)
28		40-49	Pancreas	45	22.5 (17.4,27.6)	19	23.6 (18.3,28.9)	26	21.3 (16.3,26.3)
29		45-54	Oral cavity and pharynx	76	47.1 (35.1,58.1)	62	48.8 (36.0,59.8)	14	45.2 (33.1,56.3)
30		45-54	Bladder	< 21	45.4 (37.9,52.6)	16	46.9 (39.2,54.2)	< 5	43.8 (36.3,50.9)
31	<b>35-44</b>	45-54	Stomach	< 18	23.1 (17.1,29.2)	< 5	24.2 (17.8,30.8)	13	21.9 (16.0,27.8)
32		40-49	Liver	26	26.4 (15.2,37.9)	20	27.6 (16.0,39.0)	6	25.3 (14.3,36.5)
33		40-49	Ovary	41	3.7 (1.1,6.5)			41	3.7 (1.1,6.5)
36		45-54	Esophagus	< 26	46.2 (39.9,52.2)	21	47.7 (41.5,53.8)	< 5	44.7 (38.4,50.9)
37		45-54	Myeloid Leukemia	28	11.3 (0.0,63.5)	15	11.8 (0.0,64.7)	13	10.8 (0.0,63.2)
38		45-54	Cervix	30	28.3 (10.1,48.6)			30	28.3 (10.1,48.6)
39		45-54	Larynx	6	75.4 (64.5,85.0)	6	76.4 (64.6,85.9)	-	-
42		55-74	Lung	1132	77.6 (72.6,81.9)	558	78.7 (73.8,83.0)	574	76.3 (71.0,80.9)
43		55-74	Colorectum	982	11.9 (8.7,15.1)	605	12.8 (9.4,16.2)	377	11.0 (8.1,14.1)
44		55-74	Kidney	269	20.3 (15.3,25.2)	188	21.4 (16.2,26.5)	81	19.1 (14.5,23.8)
45		50-69	Pancreas	179	21.4 (16.0,26.8)	83	22.5 (16.7,28.1)	96	20.3 (15.1,25.4)
46		55-74	Oral cavity and pharynx	195	44.0 (31.1,56.0)	153	45.4 (32.1,57.6)	42	42.5 (29.7,54.3)
47		55-74	Bladder	179	44.7 (37.6,51.4)	147	46.4 (38.9,53.3)	32	42.8 (35.5,49.7)
48	<b>45-64</b>	55-74	Stomach	103	22.5 (16.7,28.3)	74	23.9 (17.7,30.0)	29	21.0 (15.4,26.5)
49		50-69	Liver	135	27.1 (14.2,39.8)	92	28.7 (15.2,41.8)	43	25.5 (13.4,37.9)
50		50-69	Ovary	85	3.8 (1.1,6.6)			85	3.8 (1.1,6.6)
51		55-74	Esophagus	109	46.6 (40.7,52.2)	89	48.4 (42.4,54.2)	20	44.5 (38.4,50.3)
52		55-74	Myeloid Leukemia	74	12.7 (0.0,68.8)	47	13.7 (0.0,70.9)	27	11.6 (0.0,66.9)
53		55-74	Cervix	38	27.7 (11.6,47.2)			38	27.7 (11.6,47.2)
54		55-74	Larynx	42	75.4 (66.2,83.8)	37	76.9 (67.7,84.9)	5	73.7 (63.9,82.7)



Supplementary Table 1. Continued

Age at Exposure	Age at Outcome	Cancer Site	Total Cases	Total PAR (95% CI)	Men Obs. Cases	Men PAR (95% CI)	Women Obs. Cases	Women PAR (95% CI)
≥65	≥ 75	Lung	672	71.5 (64.8,77.3)	331	75.2 (68.5,80.8)	341	67.6 (60.4,73.9)
	≥ 75	Colorectum	664	10.7 (7.7,13.7)	338	13.1 (9.5,16.7)	326	8.6 (6.2,11.2)
	≥ 75	Kidney	87	16.5 (11.7,21.1)	54	19.4 (13.7,25.0)	33	13.9 (9.9,17.9)
	≥ 75	Pancreas	150	15.6 (9.6,21.3)	65	17.9 (10.8,24.9)	85	13.5 (8.8,18.6)
	≥ 75	Oral cavity and pharynx	66	29.8 (13.6,45.6)	34	32.0 (10.9,50.2)	32	28.0 (14.1,41.8)
	≥ 75	Bladder	156	37.7 (30.5,44.6)	117	42.3 (34.6,49.4)	39	33.2 (26.6,40.0)
	≥ 75	Stomach	127	19.3 (13.7,24.7)	77	22.0 (15.6,28.4)	50	16.8 (11.7,22.0)
	≥ 75	Liver	52	24.7 (9.2,39.3)	34	29.1 (10.1,45.8)	18	20.6 (8.3,33.5)
	≥ 75	Ovary	48	3.0 (0.7,5.4)			48	3.0 (0.7,5.4)
	≥ 75	Esophagus	44	42.2 (36.4,47.8)	37	47.6 (41.3,53.5)	7	36.9 (31.0,42.6)
	≥ 75	Myeloid Leukemia	55	13.2 (0.0,71.6)	27	16.5 (0.0,76.9)	28	10.4 (0.0,64.7)
	≥ 75	Cervix	15	18.3 (9.5,30.4)			15	18.3 (9.5,30.4)
	≥ 75	Larynx	28	72.4 (63.8,80.0)	21	75.8 (68.0,82.7)	7	68.7 (59.2,77.7)

Abbreviations: CI = confidence interval, Obs. = Total number of observed cases per age-sex group, PAR = Population attributable Risk

\*Cell counts of less than 5 for observed cases were suppressed to comply with confidentiality requirements