

## Cancer Incidence Attributable to Alcohol Consumption in Alberta, Canada in 2012

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Running Title: Cancer Incidence Attributable to Alcohol in Alberta

Abstract Word Count: 240  
Manuscript Body Word Count: 2,898  
Number of Tables: 8  
Number of Figures: 1

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3 ABSTRACT  
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5 Background: Alcohol consumption is associated with risk of oral cavity/pharyngeal, laryngeal,  
6 esophageal, liver, colorectal and breast cancers. The purpose of this study was to quantify the proportion  
7 and total number cancers in Alberta in 2012 attributable to alcohol consumption.  
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10 Methods: Cancers attributable to alcohol consumption in Alberta were estimated using population  
11 attributable risk calculations. Relative risks were obtained from recent meta-analyses and alcohol  
12 consumption in Alberta was quantified using data from the Canadian Community Health Survey. Age-  
13 site-specific cancer incidence data for 2012 were obtained from the Alberta Cancer Registry. The  
14 impact of potential underestimation of alcohol consumption in Canadian Community Health Survey data  
15 was evaluated using per capita alcohol sales data from Statistics Canada.  
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18 Results: Proportions of cancers attributable to alcohol consumption in Alberta varied across individual  
19 cancer sites. For both men and women, while the total number of attributable cancer cases was highest  
20 among common cancers (colorectal, female breast), at individual cancer sites population attributable risks  
21 were highest for upper aerodigestive tract cancers. Using estimates of alcohol consumption from the  
22 CCHS, we estimated that 4.8% of alcohol-associated cancers (1.6% of all cancers) in Alberta could be  
23 attributed to alcohol consumption. After adjusting for recorded alcohol consumption these estimates  
24 increased to 11.7% of alcohol-associated cancers and 3.5% of cancers in Alberta overall.  
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27 Interpretation: Since no level of alcohol consumption is considered safe with respect to cancer risk,  
28 strategies to reduce alcohol consumption have the potential to reduce Alberta's cancer burden.  
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48 INTRODUCTION  
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50 This manuscript is the second in a series of exposure-specific manuscripts concerning the  
51 proportion of cancer attributable to modifiable lifestyle and environmental risk factors in the general  
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4 population of Alberta. The methodologic framework for this series methods has been previously  
5 described.[1] [

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7 In 1988, alcohol consumption was classified as carcinogenic to humans by the International Agency for  
8 Research on Cancer, specifically citing ‘sufficient evidence’ for cancers of the oral cavity, pharynx,  
9 larynx, esophagus and liver.[2] In 2012, an updated International Agency for Research on Cancer review  
10 of evidence identified additional data sufficient to support a carcinogenic role for alcohol consumption in  
11 cancers of the colorectum and female breast in addition to the previously mentioned cancer sites.[3] These  
12 classifications are similar to those from the 2017 World Cancer Research Fund report, where a  
13 ‘convincing increased risk’ with alcohol consumption was described for cancers of the mouth, pharynx,  
14 larynx, esophagus, breast and colorectum in men and a ‘probable increased risk’ described for cancers of  
15 the liver and colorectum in women.[4]

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17 While the specific mechanism through which alcohol influences cancer risk remains unknown,  
18 hypothesized pathways include actions of the alcohol metabolite acetaldehyde and the potential for  
19 alcohol to work as a solvent for other carcinogens.[5] However, even in the absence of specific  
20 mechanistic understanding, given the established relationships between alcohol consumption and cancer  
21 risk, understanding the cancer burden associated with alcohol consumption is relevant to the planning of  
22 cancer prevention programs and interventions. While an estimate of this burden was recently completed  
23 for Ontario [6], to our knowledge no similar estimates exist for Alberta. Thus, the purpose of this  
24 investigation was to quantify the proportion and absolute number of cancers diagnosed in 2012 in Alberta  
25 that could be attributed to previous consumption of alcoholic beverages.

## 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 METHODS

### 50 51 Latency Period

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53 The effect of alcohol on cancer risk is understood to be the result of past exposure. Therefore, a  
54 biologically meaningful latency period was identified for each cancer site by examining published  
55 prospective cohort studies that had investigated the association between alcohol consumption at baseline  
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and followed up the study participants for cancer incidence. As has been previously described [1], we considered the theoretical latency period to be the time between initiation of exposure and cancer diagnosis and the measured latency period to be the time between exposure measurement and cancer diagnosis. For the alcohol-specific analyses described here, in order to select appropriate prevalence data related to alcohol consumption in Alberta, we attempted to quantify the measured latency period from existing high-quality cohort studies and subsequently refer to this simply as the latency period. Latency periods of 11 – 12 years for breast, colorectal, oral cavity and pharynx, and esophagus cancers and 8 – 9 years for larynx and liver cancers were identified as the appropriate time periods for cancers to occur within these high quality cohort studies.[7][1] As previously described [1] prevalence estimates corresponding to the midpoint of the latency period suggested by cohort studies were chosen as the appropriate time period between alcohol exposure and cancer diagnosis. To estimate the number of alcohol-attributable cancer cases in Alberta for 2012, Canadian Community Health Survey data from cycle 1.1 (2007/2008) were used for an 11 – 12 year latency period (breast, colorectal, oral cavity and pharynx, and esophagus cancers) and data from cycle 2.1 (2003) were used for the 8 – 9 year latency period (larynx and liver cancers).

**Prevalence of Exposure**

Estimates of the prevalence of alcohol consumption in Alberta were obtained using data from the Canadian Community Health Survey, applying the methods described by Cancer Care Ontario.[6] Based on responses to the following three specific alcohol-related questions, individuals were categorized into one of fifteen individual alcohol consumption categories (Table 1), primarily focused on frequency of consumption.[6]

1. Thinking back over the past week, did you have a drink of beer, wine, liquor or any other alcoholic beverage? If yes, how many drinks did you have on each day?
2. During the past 12 months, how often did you drink alcoholic beverages?

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3. Have you ever had a drink? If yes, did you ever regularly drink more than 12 drinks in a week? (Respondents only asked this question if they reported not drinking during past 12 months)

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The number of drinks per day consumed in each category was then estimated as in the Technical Appendix to the Cancer Care Ontario report.[6] Briefly, for categories 1 – 5 (Table 1), the median number of drinks reported by respondents from each category was assigned to estimate consumption.

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Consumption levels for categories 6 – 12 were estimated by first estimating the number of drinks per week using data on consumption in the past 12 months from individuals who did report drinking in the past week. The following adjustments were then applied: for category 6 the median number of drinks per drinking occasion was divided by 6 to reflect drinking once every two months; for category 7 the median number of drinks was divided by 3 to reflect drinking once per month; for category 8 the median number of drinks per drinking occasion was multiplied by 2.5 and divided by 3 to reflect drinking two to three times per month; for category 9 the median number of drinks was divided by 7 to reflect drinking once per week; for category 10 the median number of drinks was multiplied by 2.5 and divided by 7 to reflect drinking two to three times per week; for category 11 the median number of drinks was multiplied by 5 and divided by 7 to reflect drinking five times per week; and for category 12 the median number of drinks was multiplied by 1 to reflect drinking every day. A total of 13 drinks per week (or 1.9 per day) were assigned to category 13 and category 14 was assigned the same quantity as category 6. Values for each category of drinks per day were then converted to grams per day based on the standard 13.6 g of ethanol/drink in Canada.[22] The proportion of the population in each alcohol consumption category is shown in Table 1 and the estimated number of grams per day of alcohol is shown in Table 2, stratified by age and sex.

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#### Risk Estimates

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The risk of cancers at individual sites associated with alcohol consumption was conceptualized as the increase in risk per gram of alcohol consumption as in Parkin.[23] Specific risks obtained from the

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Parkin publication [23] (themselves obtained from metaanalyses and pooling projects) are shown in Table 3.

PAR Estimation

Population attributable risks for cancer in Alberta associated with alcohol consumption were estimated using methods similar to those used by Parkin [23] and a more recent Cancer Care Ontario [6] analysis. Population attributable risks were estimated for oral cavity and pharynx, larynx, esophagus, liver, breast and colon cancers using Equation 1, incorporating the multiple levels of alcohol exposure.

$$\begin{aligned}
 & \text{Equation 1: } P_{ex} \times \text{ERR}_x \\
 & = \frac{P_{ex} \times \text{ERR}_x + P_{ex} \times \text{ERR}_x + \dots + P_{ex} \times \text{ERR}_x}{1 + P_{ex} \times \text{ERR}_x + P_{ex} \times \text{ERR}_x + \dots + P_{ex} \times \text{ERR}_x}
 \end{aligned}$$

$P_{ex}$  represents the proportion of the population in alcohol consumption category  $x$ , while  $\text{ERR}_x$  represents the excess relative risk ( $\text{RR}_x - 1$ ) in each of the fifteen alcohol consumption categories. ERRs for each category were calculated as in Parkin[23], using Equation 2:

$$\text{Equation 2: } \text{ERR}_x = \# \text{ } \times \$ - 1$$

$R_x$  represents the excess risk per gram of alcohol intake and  $G_x$  represents the intake of alcohol in grams for consumption category  $x$ , as detailed in Table 2.

To estimate 95% confidence intervals around population attributable risk estimates, Monte Carlo simulation methods were used wherein the relative risk estimates were drawn from a log normal distribution, prevalence estimates were drawn from a binomial distribution, and incidence estimates were drawn from a Poisson distribution. Parameters for the distributions were defined by reported point estimates and confidence intervals. 10,000 samples were drawn and the 2.5th and 97.5th percentiles of the resulting population attributable risk distribution used as the lower and upper limits of a 95 % confidence interval. Similar techniques were used by two previous studies that estimated population attributable risk.[16,17] Wherever possible and appropriate, these estimations were performed for individual sex and age groups.

## Cancer Incidence Data

To estimate the total number of cancers at each site overall, and by age group and sex attributable to alcohol consumption, population attributable risks were applied to cancer incidence data obtained from the Alberta Cancer Registry for 2012. A lag period of 10 years was applied to the age groups used for cancer incidence data, hence, for example, for individuals exposed to alcohol at ages 20–34, cancer incidence data in 2012 was used for ages 30–44. The 10-year period was chosen to allow for consistent age groups across cancer sites, since it was the midpoint of the two latency periods used in this analysis.

## Sensitivity Analysis

Previous work has demonstrated that alcohol consumption measures in population surveys can underestimate alcohol consumption as measured by per capita consumption levels by as much as 30–70%. [26] Further, an Ontario study found that unrecorded alcohol consumption not accounted for in per capita sales data was 19.5% of recorded consumption, such that total alcohol consumption was the combination of recorded and unrecorded consumption. [27] To examine the impact of potential underestimation of alcohol consumption in Alberta as measured by Canadian Community Health Survey data, two separate sensitivity analyses were performed. In the first, the coverage rate was estimated using the formula described by Cancer Care Ontario [6], where total per capita consumption was characterized as total recorded consumption in Alberta, since, to our knowledge, the proportion of unrecorded alcohol consumption in Alberta has not been estimated. Subsequently, a second sensitivity analysis applying the proportion of unrecorded alcohol consumption in Ontario to Alberta data was performed, again estimating the coverage rate using the formula described by Cancer Care Ontario. The estimated coverage rates were then used to adjust estimates of the prevalence of alcohol consumption used in the estimation of population attributable risks, as previously described. [6]

## RESULTS

### Prevalence of Alcohol Consumption

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While no level of alcohol consumption is safe from the perspective of cancer prevention, the World Cancer Research Fund recommends that consumption be limited to no more than two drinks per day for men and one per day for women.[4] The proportions of men and women exceeding cancer prevention guidelines were similar, with 8.0% of men exceeding the two drinks per day guideline and 7.8% of women exceeding one drink per day. These proportions generally decreased with age, where the highest proportion of men exceeding the two drink per day guideline was seen among 20–34 year olds (12.6%), while the proportion of women exceeding the one drink per day guideline was highest among 35–49 year olds (9.7%).

**Cancer site-specific Population Attributable Risk results**

Across all cancer sites, population attributable risks of cancer related to alcohol consumption were higher in men than in women (Table 4). In both men and women, the highest values were seen for cancers of the oral cavity and pharynx (15.8% to 27.5% in men, 4.6% to 10.3% in women), and overall population attributable risks were higher for upper aerodigestive tract (oral cavity and pharynx, larynx, esophagus) cancers. Despite relatively lower population attributable risks compared to other cancer sites, the largest numbers of cancers attributable to alcohol consumption were seen for colorectal cancer in men and breast cancer in women, since overall incidence of these cancers is higher.

**Overall Population Attributable Risk Results**

A total of 246 cancer cases in Alberta in 2012 could be attributable to alcohol consumption, which represents 4.8% of all alcohol-associated cancers and 1.6% of all cancers diagnosed. While the absolute number of attributable cases was higher in women than in men, these represented a greater overall proportion of cancers diagnosed in men (1.8%) than in women (1.3%) (Table 5). When alcohol consumption, was adjusted for survey undercoverage using Statistics Canada alcohol sales data for Alberta, the number of attributable cases increased substantially to 547. This number represented 10.7% of all alcohol-associated cancers and 3.5% of all cancers diagnosed in Alberta in 2012 (Supplementary Tables 1 and 2). These figures were further adjusted for unrecorded alcohol consumption, using the



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4 approximation based on Ontario data.[27] The number of attributable cases further increased to 67  
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6 (Supplementary Tables 3 and 4), representing 13.1% of all alcohol-associated cancers and 4.2% of all  
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8 cancers diagnosed in Alberta in 2012.

## 11 INTERPRETATION

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14 Overall we estimate that 1.6% of cancers in Alberta in 2012 were attributable to alcohol  
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16 consumption and this estimate increased to 4.2% after adjusting for underestimation of alcohol  
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18 consumption by Canadian Community Health Survey data using estimates of both recorded and  
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20 unrecorded consumption. These proportions were higher in men (1.8 to 5.1%) than in women (1.3 to  
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22 3.4%) and population attributable risks for individual cancer sites were highest for upper aerodigestive  
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24 tract cancers.

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27 These findings are consistent with the proportions of cancer attributable to alcohol consumption  
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29 in previous studies conducted in Ontario [6] and the United Kingdom.[23] In Ontario, 2 – 4% of cancers  
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31 could be attributed to alcohol consumption [6], where the upper end of this estimate represents the same  
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33 adjustment for underestimation of alcohol consumption as that used in our analysis. As in our analysis,  
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35 while the proportions of alcohol-attributable cancer were higher for upper aerodigestive tract cancers, in  
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37 Ontario the largest numbers of alcohol-attributable cancer cases were seen for colorectal and breast  
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39 cancers.[6] In the United Kingdom [23], approximately 4.1% of all cancers (4.6% in men and 3.3% in  
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41 women) were attributable to alcohol consumption, results that are comparable to those seen in Alberta.

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44 A separate analysis using data from the European Prospective Investigation into Cancer and  
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46 Nutrition cohort estimated that 1.1% of cancers in men and 3% of cancers in women in six European  
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48 countries (Denmark, Germany, Greece, Italy, Spain, United Kingdom) were attributable to alcohol  
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50 consumption.[18] These proportions are higher than those estimated for Alberta and some of these  
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52 differences may relate to the methods used to estimate the number of attributable cases, where relative  
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54 risks were derived directly from the EPIC cohort, a large prospective cohort study conducted across 10  
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56 European countries that included 8 years of follow up for this analysis. Further, alcohol consumption was  
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estimated using a triangulation algorithm that combined information on alcohol consumption from survey data as reported to the World Health Organization and per capita consumption data for men and women over age 15, which was then statistically modeled as a gamma function to create a continuous alcohol consumption variable that modeled the right-skewed nature of the data at the population level.[18] The estimated proportions of cancers attributable to alcohol in the United Kingdom were 8% in men and 3% in women, where methodological differences could impact differences in the observed proportion of alcohol-attributable cancer cases in the European study [18] and our analysis. These proportions were higher than the 4.6% in men but similar to the 3.3% in women observed in the Parkin analysis [23] where similar methods to ours were used. In addition, alcohol consumption levels were higher in these European countries [18] than in Alberta, which would also explain some of the observed differences in the proportions of alcohol-attributable cancers.

### Limitations

To our knowledge our study is the first to quantify the proportion of cancer in Alberta attributable to alcohol consumption. However, because data from population surveys such as the Canadian Community Health Survey tend to underestimate true alcohol consumption levels [26], population attributable risk estimates using these data are also likely underestimates of the true alcohol-attributable cancer burden. To address this limitation, we attempted to adjust for this under-coverage using alcohol sales data for Alberta from Statistics Canada to characterize recorded alcohol consumption. Following this adjustment, the proportion alcohol-attributable cancers in Alberta increased from 1.6% to 3.5%. In addition, a portion of consumption from sources such as home-brewing or illegal imports is unrecorded and needs to be accounted for when estimating population alcohol exposure levels.[6, 27] After adjusting for these other sources of alcohol intake, there was a further increase in the proportion of alcohol-attributable cancers to 4.2%. However, because data for unrecorded alcohol consumption do not exist in Alberta, Ontario estimates were used. This additional adjustment could represent either an under- or overestimate of the true proportion of cancers attributable to alcohol consumption, depending on whether

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4 actual unrecorded alcohol consumption levels are higher or lower in Alberta compared to Ontario and  
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6 error associated with this assumption represents a potential limitation of our work.

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8 A further limitation to our work was our assumption that the appropriate period between exposure  
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10 and cancer incidence (referred to as the latency period) was the midpoint of observed followup times  
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12 between exposure assessment and cancer incidence in large cohort studies. Since we did not have access  
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14 to data concerning alcohol consumption with the same level of detail as was included in our Canadian  
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16 Community Health Survey data for years prior to 2000, we were unable to conduct sensitivity analyses to  
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18 investigate whether or not choosing longer latency periods would have influenced our estimated  
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20 population attributable risks. Specifically, if the use of an alternate latency period suggested alcohol  
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22 consumption levels in Alberta were either higher or lower than those reported for our chosen latency  
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24 period, our estimates of population attributable risk would represent either under or over estimates  
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26 respectively.

#### 27 28 29 Conclusion

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31 No level of alcohol consumption is considered safe with respect to cancer risk [2, 3] and alcohol  
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33 represents a modifiable cancer risk factor. As such, with as much as 4.2% of cancers in Alberta  
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35 potentially attributable to alcohol consumption, strategies to reduce alcohol consumption have the  
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37 potential to reduce Alberta's cancer burden.  
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ACKNOWLEDGEMENTS

This project was funded by the Alberta Cancer Prevention Legacy Fund. Dr Christine Friedenreich is supported by an Alberta Innovates(Health Solutions Health Senior Scholar Award and the Alberta Cancer Foundation Weekend to End Women’s Cancers Breast Cancer Chair at the University of Calgary. Dr. Darren Brenner is supported by a Career Development Award in Prevention from the Canadian Cancer Society Research Institute. We gratefully acknowledge Dr. Laura McDougall from the Alberta Cancer Prevention Legacy Fund for her support and guidance. We also thank Bethany Kaposhi and Lorraine Shack from the Alberta Cancer Registry for providing cancer incidence data, the department of Data Integration, Measurement and Reporting at Alberta Health Services for access to CCHS data and Eileen Shaw for critical review of this manuscript.

Confidential

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Confidential



Table 1. Proportion of Alberta adults (%) in each alcohol consumption category by sex and age, 2012/2013 (Canadian Community Health Survey)

Consumption Category	Men by age (years) <sup>a</sup>				Women by age (years) <sup>a</sup>			
	20-34	35-49	50-64	≥ 65	20-34	35-49	50-64	≥ 65
1. Drank during past week: average ≤ 1 drink/day	34.4 (31.3,37.5)	37.8 (34.9,40.8)	34.6 (30.7,38.5)	32.4 (28.2,36.6)	30.6 (27.5,33.6)	33.9 (31.1,36.7)	32.0 (28.3,35.6)	21.5 (18.3,24.8)
2. Drank during past week: average 1-2 drinks/day	14.3 (12.0,16.6)	13.8 (11.4,16.1)	9.1 (6.9,11.3)	7.3 (4.8,9.8)	5.8 (4.3,7.4)	5.7 (4.3,7.1)	3.8 (2.1,5.4)	1.5 (0.6,2.3)
3. Drank during past week: average 2-3 drinks/day	5.3 (4.0,6.7)	3.4 (2.2,4.5)	4.3 (2.5,6.1)	1.7 (0.7,2.7)	1.2 (0.5,2.0)	1.1 (0.5,1.8)	0.9 (0.2,1.7)	0.0 (0.0,0.1)
4. Drank during past week: average 3-4 drinks/day	3.5 (2.3,4.7)	1.4 (0.7,2.2)	1.3 (0.6,2.0)	0.3 (0.0,0.8)	0.5 (0.1,0.9)	0.7 (0.2,1.2)	0.1 (0.0,0.3)	0.3 (0.0,0.8)
5. Drank during past week: average ≥ 4 drinks/day	3.5 (2.3,4.7)	1.9 (1.1,2.6)	0.7 (0.1,1.4)	1.0 (0.2,2.1)	0.4 (0.0,0.8)	0.4 (0.0,0.8)	0.2 (0.0,0.4)	0.0 (0.0,0.0)
6. No drinking past week but drank during past year ≤ 1 time/month	10.8 (8.5,13.0)	10.8 (8.8,12.8)	14.4 (11.3,17.5)	17.2 (13.4,21.0)	22.8 (19.8,25.8)	20.2 (17.7,22.6)	20.6 (17.2,24.0)	23.0 (19.7,26.4)
7. No drinking past week but drank during past year 1 time/month	5.3 (3.8,6.7)	5.8 (4.4,7.1)	4.6 (3.1,6.0)	3.8 (2.2,5.5)	8.5 (6.8,10.3)	6.2 (4.7,7.7)	4.9 (2.9,6.8)	3.5 (2.3,4.8)
8. No drinking past week but drank during past year 2-3 times/month	5.3 (4.0,6.6)	5.2 (3.9,6.5)	5.4 (3.5,7.4)	2.0 (0.8,3.3)	6.2 (4.7,7.8)	5.2 (3.8,6.5)	3.4 (2.1,4.6)	3.0 (1.6,4.5)
9. No drinking past week but drank during past year 1 time/week	3.5 (2.4,4.5)	3.0 (2.0,4.0)	2.3 (1.3,3.8)	2.2 (1.1,3.3)	3.1 (2.0,4.2)	2.7 (1.8,3.6)	2.0 (1.0,3.0)	1.3 (0.4,2.2)
10. No drinking past week but drank during past year 2-3 times/week	2.3 (1.2,3.3)	1.7 (1.0,4.0)	1.5 (0.6,2.4)	1.4 (0.2,2.6)	1.3 (0.7,2.0)	0.8 (0.3,1.2)	1.7 (0.5,2.9)	0.6 (0.1,1.2)
11. No drinking past week but drank during past year 4-6 times/week	0.0 (0.0,0.1)	0.1 (0.0,0.3)	0.1 (0.0,0.3)	0.6 (0.1,1.4)	0.0 (0.0,0.0)	0.0 (0.0,0.1)	0.0 (0.0,0.0)	0.2 (0.0,0.5)
12. No drinking past week but drank during past year everyday	0.2 (0.0,0.4)	0.2 (0.0,0.4)	0.4 (0.1,1.0)	0.6 (0.1,1.3)	0.1 (0.0,0.1)	0.1 (0.0,0.1)	0.8 (0.1,1.7)	0.1 (0.0,0.2)
13. Has had ≥ 1 drink in lifetime: used to regularly drink >12 drinks/week	1.4 (0.7,2.1)	4.4 (3.1,5.6)	6.5 (4.7,8.2)	6.5 (4.5,8.5)	0.8 (0.3,1.3)	1.7 (0.9,2.5)	1.8 (0.9,2.7)	1.6 (0.6,2.7)
14. Has had ≥ 1 drink in lifetime: did not regularly drink 12 drinks/week	3.2 (2.1,4.3)	4.0 (2.9,5.1)	6.6 (4.8,8.5)	14.0 (9.9,17.0)	7.8 (6.2,9.4)	12.3 (10.3,14.3)	15.9 (13.2,18.7)	28.2 (24.6,31.7)
15. Lifetime abstainers	4.3 (2.8,5.9)	3.8 (2.4,5.2)	4.8 (2.0,7.6)	5.8 (3.6,8.0)	9.0 (6.5,11.6)	7.6 (5.6,9.6)	10.2 (6.8,13.6)	13.5 (11.0,16.1)

a. Proportions are shown as the percentage of Albertans with the 95% confidence interval in brackets

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Table 2. Quantities of alcohol consumed (grams per day) calculated for alcohol consumption categories

Consumption Category	Men by age (years)				Women by age (years)			
	20-34	35-49	50-64	≥ 65	20-34	35-49	50-64	≥ 65
1. Drank during past week: average ≤ 1 drink/day	5.44	5.44	5.44	4.8	4.8	4.8	4.8	2.72
2. Drank during past week: average 1-2 drinks/day	19.4	19.4	19.4	20.4	17.68	17.68	17.68	25.84
3. Drank during past week: average 2-3 drinks/day	32.64	32.64	32.64	32.64	32.64	36.72	36.72	28.56
4. Drank during past week: average 3-4 drinks/day	46.24	44.88	47.6	46.24	42.16	43.52	47.6	53.4
5. Drank during past week: average ≥ 4 drinks/day	82.4	73.44	69.36	62.56	61.2	63.92		
6. No drinking past week but drank during past year ≤ 1 time/month	4.41	4.27	4.27	4.27	4.14	4.27	4.14	4.27
7. No drinking past week but drank during past year 1 time/month	1.22	1.68	1.41	1.27	1.82	1.41	1.27	1.41
8. No drinking past week but drank during past year 2-3 times/month	2.72	1.36	1.36	1.82	1.36	1.36	1.36	1.19
9. No drinking past week but drank during past year 1 time/week	4.8	4.8	2.72	1.36	4.8	1.36	2.72	1.36
10. No drinking past week but drank during past year 2-3 times/week	14.96	10.88	9.52	6.8	9.52	9.52	6.8	6.8
11. No drinking past week but drank during past year 4-6 times/week	40.8	28.56	19.4	9.52	27.2	17.68	12.24	9.52
12. No drinking past week but drank during past year everyday	34.4	31.28	25.84	19.4	14.96	17.68	17.68	13.6
13. Has had ≥ 1 drink in lifetime: used to regularly drink >12 drinks/week	25.84	25.84	25.84	25.84	25.84	25.84	25.84	25.84
14. Has had ≥ 1 drink in lifetime: did not regularly drink 12 drinks/week	4.41	4.27	4.27	4.27	4.27	4.27	4.14	4.27
15. Lifetime abstainers								

Table 3. Risk associated with 1g of alcohol consumption per day for individual cancer sites[23].

Cancer Type	Source (First author, year)	Sex	Increase in risk per gram alcohol per day (95% Confidence Interval)
Breast	CGHFBC, 2002 [28]	Women	0.071 (SE = 0.008)
Oral Cavity and Pharynx	Corrao, 2004 [29]	All	0.085 (0.0770-0.092)
Larynx	Corrao, 2004 [29]	All	0.036 (0.0240-0.048)
Esophagus	Corrao, 2004 [29]	All	0.029 (0.0210-0.036)
Liver	Corrao, 2004 [29]	All	0.059 (0.0410-0.079)
Colorectal Cancer	Ferrari, 2007 [30]	All	0.058 (0.0330-0.082)

Abbreviations: CGHFBC = Collaborative Group on Hormonal Factors in Breast Cancer, WCRF = World Cancer Research Fund, SE = Standard Error

Table 4. Observed cancer cases in Alberta (2012) and proportions attributable to alcohol consumption<sup>a</sup>

Age at Exposure (years)	Age at Outcome (years)	Larynx			Colorectum			Liver		
		Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)
Men										
2-4	3-4	<5	19.4 (17.6-21.4)	□	37	7.9 (4.9-12.8)	3 (20)	<5	7.9 (5.9-11.3)	□
5-9	45-59	18	13.2 (12.1-14.5)	2 (20)	276	6.2 (3.9-9.8)	17 (11-27)	58	5.5 (4.0-7.7)	3 (20)
5-64	6-74	37	13 (11.8-14.2)	5 (40)	454	5.4 (3.4-8.6)	25 (15-39)	54	5.5 (4.0-7.7)	3 (20)
≥ 65	≥ 75	7	8.6 (7.8-9.4)	1 (10)	338	4.5 (2.8-7.2)	15 (9-24)	34	3.6 (2.6-5.0)	1 (10)
Total	Total	<67		8	1115		60	<151		8
Women										
2-4	3-4	0	0	0	35	3.0 (1.9-4.8)	1 (10)	<5	2.5 (1.8-3.5)	□
5-9	45-59	<5	5.3 (4.8-5.8)	□	193	2.9 (1.8-4.7)	6 (3-9)	17	2.2 (1.6-3.1)	□ (10)
5-64	6-74	6	5.2 (4.9-5.5)	□ (10)	292	2.3 (1.4-3.6)	7 (4-11)	32	2.2 (1.5-3.1)	1 (10)
≥ 65	≥ 75	5	3.3 (3.0-3.7)	□ (10)	326	1.3 (0.9-2.2)	4 (3-7)	18	1.4 (1.0-1.9)	□ (10)
Total	Total	<16		□	846		18	<72		1

<sup>a</sup> Alcohol consumption in Alberta by age/sex group assessed using data from the Canadian Community Health Survey.

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

<sup>c</sup> Population attributable risk of individual cancers related to alcohol consumption.

<sup>d</sup> Number of cancer cases at individual cancer sites that can be attributed to alcohol consumption.

<sup>e</sup> Represents all cancers with a known association with alcohol consumption, as listed in table.

<sup>f</sup> Represents all incident cancers in Alberta in 2012 in all age groups.

Table 4 ctd. Observed cancer cases in Alberta (2012) and proportions attributable to alcohol consumption<sup>a</sup>

Age at Exposure (years)	Age at Outcome (years)	Esophagus			Oral Cavity and Pharynx			Breast		
		Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)
Men		Men								
2-4	3-4	<5	18.4 (17.30 19.7)	<5	24	27.5 (25.70 29.5)	7 (608)			
5-9	4-9	41	14.2 (13.30 15.1)	6 (506)	119	22.9 (19.50 22.4)	25 (23027)			
5-64	6-74	69	12.4 (11.70 13.2)	9 (809)	96	18.3 (17.10 19.6)	18 (16019)			
≥ 65	≥ 75	37	11.5 (9.80 11.2)	4 (404)	34	15.8 (14.70 17.0)	5 (506)			
Total	Total	<152		<24	273		54			
Women		Women								
2-4	3-4	<5	6.9 (6.50 7.4)	0	12	3.7 (9.60 11.0)	1 (101)	257	3.7 (2.90 4.7)	9 (7012)
5-9	4-9	9	6.9 (6.40 7.3)	1 (101)	22	3.6 (9.60 11.1)	2 (202)	798	3.6 (2.90 4.5)	29 (23086)
5-64	6-74	15	5.2 (4.90 5.5)	1 (101)	34	7.6 (7.10 8.2)	3 (208)	84	2.8 (2.20 3.5)	23 (18029)
≥ 65	≥ 75	7	3.1 (2.90 3.3)	0 (00)	32	4.6 (4.30 4.9)	1 (102)	427	1.7 (1.30 2.1)	7 (609)
Total	Total	<36		2	100		8	2322		69

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Table 5 Summary of cases and proportions of cancer in Alberta adults in 2012 attributable to alcohol consumption<sup>a</sup>

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
Breast	2322	69	3				2322	69	3
Larynx	76	9	11.4	64	8	12.8	12	1	4.4
Colorectum	1951	77	4.0	1105	60	5.4	846	18	2.1
Liver	217	9	4.1	148	8	5.1	69	1	2
Esophagus	183	21	11.3	151	19	12.6	32	2	5.3
Oral Cavity/Pharynx	373	62	16.6	273	54	19.9	100	8	7.6
All Associated Cancers <sup>f</sup>	5122	246	4.8	1741	149	8.5	3381	98	2.9
All Cancers <sup>g</sup>	15836	246	1.6	8155	149	1.8	7681	98	1.3

<sup>a</sup> Alcohol consumption in Alberta by age&sex group assessed using data from the Canadian Community Health Survey.  
<sup>b</sup> Cancer incidence data obtained from the Alberta Cancer Registry. Data from 2012 was used for observed cancer cases for all cancer sites.  
<sup>c</sup> Number of observed cancer cases in Alberta in 2012 at individual cancer sites.  
<sup>d</sup> Number of cancer cases at individual cancer sites that can be attributed to alcohol consumption.  
<sup>e</sup> Proportion of cancers at individual cancer sites attributable to alcohol consumption. Calculated as excess attributable cases/observed cases.  
<sup>f</sup> Represents all cancers with a known association with alcohol consumption, as listed in table.  
<sup>g</sup> Represents all incident cancers in Alberta in 2012 in all age groups.

Supplementary Table 1. Observed cancer cases in Alberta (2012) and proportions attributable to alcohol consumption, adjusted for recorded consumption

Age at Exposure (years)	Age at Outcome (years)	Larynx			Colorectum			Liver		
		Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)
<b>Men</b>										
20-34	30-44	<5	44.4 (40.1-49.1)	<5	37	17.2 (10.6-28.7)	6 (4-11)	<5	17.3 (12.2-24.8)	0
35-49	45-59	18	29.5 (26.7-32.6)	5 (5-6)	276	13.2 (8.2-21.5)	36 (23-59)	58	11.9 (8.5-16.9)	7 (5-10)
50-64	60-74	37	28.1 (25.5-30.9)	10 (9-11)	454	11.6 (7.2-19.0)	53 (33-86)	54	11.7 (8.3-16.4)	6 (7-9)
≥ 65	≥ 75	7	19.2 (17.4-21.2)	1 (1-1.5)	338	9.8 (6.0-16.3)	33 (20-55)	34	7.7 (5.4-10.8)	3 (2-4)
Total	Total	<67		<21	1105		128	<151		16
<b>Women</b>										
20-34	30-44	0	0	0	35	6.4 (3.9-10.7)	2 (1-4)	<5	5.3 (3.8-7.4)	0
35-49	45-59	<5	12 (10.8-13.4)	0	193	6.4 (3.9-10.7)	12 (8-21)	17	4.8 (3.4-6.8)	1 (1-1)
50-64	60-74	6	11.6 (10.5-12.9)	1 (1-1)	292	4.8 (3.0-7.9)	14 (9-23)	32	4.7 (3.3-6.7)	1 (1-2)
≥ 65	≥ 75	5	7.6 (6.9-8.5)	0 (0-0)	326	2.9 (1.8-4.7)	9 (6-15)	18	3 (2.1-4.3)	1 (0-1)
Total	Total	<16		1	846		37	<72		3

a. Alcohol consumption in Alberta by age-sex group assessed using data from the Canadian Community Health Survey, adjusted for survey under-coverage using Statistics Canada alcohol sales data.

b. Number of observed cancer cases in Alberta in 2012 at individual cancer sites.

c. Population attributable risk of individual cancers related to alcohol consumption.

d. Number of cancer cases at individual cancer sites that can be attributed to alcohol consumption.

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Supplementary Table 1 ctd. Observed cancer cases in Alberta (2012) and proportions attributable to alcohol consumption, adjusted for recorded consumption

Age at Exposure (years)	Age at Outcome (years)	Esophagus			Oral Cavity and Pharynx			Breast		
		Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)
<b>Men</b>										
20-34	30-44	<5	42.1 (39.3-45.0)	<5	24	62.8 (58.9-66.9)	15 (14-16)			
35-49	45-59	41	31.7 (29.7-33.9)	13 (12-14)	119	48.2 (44.9-51.8)	57 (53-62)			
50-64	60-74	69	27.8 (26.0-29.8)	19 (18-21)	96	42.8 (39.6-46.2)	41 (38-44)			
≥ 65	≥ 75	37	24.9 (23.1-26.8)	9 (9-10)	34	40.4 (37.0-44.1)	14 (13-15)			
Total	Total	<152		<46	273		127			
<b>Women</b>										
20-34	30-44	<5	15.8 (14.8-17.0)	0	12	25.1 (23.1-27.4)	3 (3-3)	257	8 (6.3-10.2)	21 (16-28)
35-49	45-59	9	16.3 (15.1-17.6)	1 (1-2)	22	27.2 (24.8-30.0)	6 (5-7)	798	8 (6.2-10.3)	64 (49-82)
50-64	60-74	15	11.5 (10.8-12.3)	2 (2-2)	34	17.6 (16.4-19.0)	6 (6-6)	840	6 (4.8-7.6)	50 (40-64)
≥ 65	≥ 75	7	6.9 (6.4-7.4)	0 (0-1)	32	10.5 (9.7-11.4)	3 (3-4)	427	3.6 (2.8-4.5)	15 (12-19)
Total	Total	<36		4	100		18	2322		150

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Supplementary Table 2. Summary of cases and proportions of cancer in Alberta adults in 2012 attributable to recorded alcohol consumption<sup>a</sup>

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
Breast	2322	150	6.5				2322	150	6.5
Larynx	76	19	25.2	64	18	28	12	1	10
Colorectum	1951	167	8.5	1105	128	16.5	846	38	4.5
Liver	217	19	8.8	148	16	10.9	69	3	4.3
Esophagus	183	47	25.6	151	43	28.5	32	4	12
Oral Cavity/Pharynx	373	146	39	273	127	46.6	100	18	18.4
All Associated Cancers <sup>f</sup>	5122	547	10.7	1741	333	22.2	3381	214	6.3
All Cancers <sup>g</sup>	15836	547	3.5	8155	333	4.7	7681	214	2.8

<sup>a</sup> Alcohol consumption in Alberta by age-sex group assessed using data from the Canadian Community Health Survey, adjusted for survey under-coverage using Statistics Canada alcohol sales data.

<sup>b</sup> Cancer incidence data obtained from the Alberta Cancer Registry. Data from 2012 was used for observed cancer cases for all cancer sites.

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

<sup>d</sup> Number of cancer cases at individual cancer sites that can be attributed to alcohol consumption.

<sup>e</sup> Proportion of cancers at individual cancer sites attributable to alcohol consumption. Calculated as excess attributable cases/observed cases.

<sup>f</sup> Represents all cancers with a known association with alcohol consumption, as listed in table.

<sup>g</sup> Represents all incident cancers in Alberta in 2012 in all age groups.

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Supplementary Table 3 Observed cancer cases in Alberta (2012) and proportions attributable to alcohol consumption, adjusted for recorded and unrecorded consumption

Age at Exposure (years)	Age at Outcome (years)	Larynx			Colorectum			Liver		
		Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)
Men										
20-34	30-44	<5	54.2 (49.1-59.5)	<5	37	20.8 (12.8-34.6)	8 (5-13)	<5	21.1 (14.7-30.5)	0
35-49	45-59	18	36.1 (32.6-40.0)	6 (6-7)	276	16.0 (9.9-26.1)	44 (27-72)	58	14.3 (10.1-20.4)	8 (6-12)
50-64	60-74	37	34.0 (30.9-37.3)	13 (11-14)	454	14.0 (8.7-23.1)	64 (39-105)	54	14.1 (10.0-19.8)	8 (5-11)
≥ 65	≥ 75	7	23.5 (21.3-26.1)	2 (1-2)	338	11.9 (7.2-20.3)	40 (24-69)	34	9.3 (6.5-13.4)	3 (2-5)
Total	Total	<67		<27	1105		156	<151		19
Women										
20-34	30-44	□	□	□	35	7.8 (4.8-13.0)	3 (2-5)	<5	6.4 (4.5-9.1)	0
35-49	45-59	<5	14.9 (13.4-16.6)	0	193	7.8 (4.8-13.2)	15 (9-25)	17	5.8 (4.1-8.3)	1 (1-1)
50-64	60-74	6	14.3 (12.9-15.9)	1 (1-1)	292	5.8 (3.6-9.5)	17 (11-28)	32	5.6 (4.0-8.0)	2 (1-3)
≥ 65	≥ 75	5	9.5 (8.5-10.7)	0 (0-1)	326	3.5 (2.2-5.8)	11 (7-19)	18	3.6 (2.5-5.2)	1 (0-1)
Total	Total	<16		1	846		46	<72		4

<sup>a</sup> Alcohol consumption in Alberta by age-sex group assessed using data from the Canadian Community Health Survey, adjusted for survey under-coverage using Statistics Canada alcohol sales data and unrecorded alcohol consumption as an additional 19.5% of recorded consumption, as estimated in Ontario by Macdonald et al. [27].

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

<sup>c</sup> Population attributable risk of individual cancers related to alcohol consumption.

<sup>d</sup> Number of cancer cases at individual cancer sites that can be attributed to alcohol consumption.

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1 Supplementary Table 3 ctd. Observed cancer cases in Alberta (2012) and proportions attributable to alcohol consumption, adjusted for recorded and  
 2 unrecorded consumption  
 3

Age at Exposure (years)	Age at Outcome (years)	Esophagus			Oral Cavity and Pharynx			Breast		
		Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)	Total Obs. Cases <sup>b</sup>	PAR % <sup>c</sup> (95%CI)	EAC <sup>d</sup> (95%CI)
<b>Men</b>										
20-34	30-44	<5	51.5 (48.2-55.0)	<5	24	74.5 (70.5-78.4)	18	(17-19)		
35-49	45-59	41	39.0 (36.4-41.7)	16	(15-17)	119	59.2 (55.3-63.4)	70	(66-75)	
50-64	60-74	69	34.3 (32.0-36.8)	24	(22-25)	96	53.3 (49.4-57.6)	51	(47-55)	
≥ 65	≥ 75	37	31.4 (29.0-34.1)	12	(11-13)	34	52.0 (47.6-56.7)	18	(16-19)	
Total	Total	<152		<57	273		157			
<b>Women</b>										
20-34	30-44	<5	19.8 (18.3-21.3)	0		12	32.4 (29.6-35.5)	4	(4-4)	257 (7.6-12.5)
35-49	45-59	9	20.8 (19.1-22.6)	2	(2-2)	22	36.3 (32.8-40.2)	8	(7-9)	798 (7.6-12.8)
50-64	60-74	15	14.2 (13.2-15.2)	2	(2-2)	34	22.0 (20.4-23.9)	7	(7-8)	840 (5.7-9.2)
≥ 65	≥ 75	7	8.5 (7.9-9.1)	1	(1-1)	32	13.1 (12.1-14.2)	4	(4-5)	427 (3.4-5.5)
Total	Total	<36		5		100		24		2322 (15-23)

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Supplementary Table 4. Summary of cases and proportions of cancer in Alberta adults in 2012 attributable to recorded and unrecorded alcohol consumption<sup>a</sup>

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
Breast	2322	183	7.9				2322	183	7.9
Larynx	76	23	30.6	64	22	34.1	12	1	12.4
Colorectum	1951	202	10.3	1105	156	14.1	846	46	5.5
Liver	217	23	10.6	148	19	13.2	69	4	5.2
Esophagus	183	58	31.8	151	53	35.3	32	5	15
Oral Cavity/Pharynx	373	181	48.5	273	157	57.6	100	24	23.6
All Associated Cancers <sup>f</sup>	5122	670	13.1	1741	407	23.4	3381	262	7.8
All Cancers <sup>g</sup>	15836	670	4.2	8155	407	5.0	7681	262	3.4

<sup>a</sup> Alcohol consumption in Alberta by age/sex group assessed using data from the Canadian Community Health Survey, adjusted for survey under-coverage using Statistics Canada alcohol sales data and unrecorded alcohol consumption as an additional 19.5% of recorded consumption, as estimated in Ontario by Macdonald *et. al.*, 1999 [27].

<sup>b</sup> Cancer incidence data obtained from the Alberta Cancer Registry. Data from 2012 was used for observed cancer cases for all cancer sites.

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

<sup>d</sup> Number of cancer cases at individual cancer sites that can be attributed to alcohol consumption.

<sup>e</sup> Proportion of cancers at individual cancer sites attributable to alcohol consumption. Calculated as excess attributable cases/observed cases.

<sup>f</sup> Represents all cancers with a known association with alcohol consumption, as listed in table.

<sup>g</sup> Represents all incident cancers in Alberta in 2012 in all age groups.