# The consumption of coffee and black tea and the risk of lung cancer

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## Abstract

### Purpose
Coffee and black tea are among the most consumed beverages worldwide. While their potential role in lung cancer occurrence has been investigated in several studies, results have been inconclusive. We investigated the associations between intake of coffee and black tea with lung cancer in a population-based case-control study in Montreal, Canada.

### Methods
These analyses included 1,130 cases and 1,483 controls. Adjusted odds ratios (OR) were estimated between four metrics of coffee and black tea consumption (frequency, average daily amount, duration, and cumulative amount) and lung cancer, using unconditional logistic regression.

### Results
The adjusted ORs (95% confidence intervals) for lung cancer comparing daily to never consumers were 0.73 (0.49-1.10) for coffee and 1.05 (0.85-1.31) for black tea. Analyses of other metrics did not reveal any clear patterns of increasing or decreasing risk with increasing amounts or duration of consumption. There was no strong evidence of OR modification by sex or smoking level. The OR estimates did not materially differ by histological subtype for either of the beverages.

### Conclusion
Our results do not provide strong support for associations between consumption of coffee and black tea and lung cancer.


**List of abbreviations:** OR (odds ratio), CI (confidence interval), CSI (comprehensive smoking indicator)

**Keywords:** Coffee, tea, lung neoplasms, epidemiology, case-control studies, risk factors

## Introduction

Coffee and tea, which are consumed worldwide by billions of individuals, may contribute to lung cancer risk. Both beverages are composed of hundreds of chemicals, some of which may reduce risk while others may increase it. For instance, catechins, found in tea, and chlorogenic acid, present in coffee, are antioxidants that could reduce lung cancer risk (1-4). Caffeine, present in both coffee and tea, could increase risk via activation of proteins involved in various regulatory signal transduction pathways (5).

In a systematic review of the literature published through 2006, the available evidence on the associations between consumption of coffee and tea and lung cancer was judged to be limited and inconclusive (6). In two subsequently published meta-analyses (7, 8), the evidence was consistent with no association between black tea consumption and lung cancer, though in one of these, statistically significant heterogeneity between studies was reported (7). In subsequently published meta-analyses (8-11) and individual studies (12, 13) of coffee intake, positive associations were reported in all but one individual study (11); statistically significant heterogeneity between studies was reported in two of the meta-analyses (9, 10).

Residual confounding by smoking may have affected the results in some studies of both coffee and black tea. For instance, in two of the meta-analyses that reported positive associations with coffee consumption, inverse associations were suggested among never smokers (9, 10). Also, only a few studies (14-17) have adjusted for occupational exposure to lung carcinogens, one of the most important lung cancer risk factors after smoking (18). Furthermore, lifetime duration of consumption of these beverages might be an important aspect in the association with lung cancer risk, but to our knowledge only one study has examined duration (16).

In the context of a large population-based case-control study of lung cancer carried out in Montreal, Canada, we examined the association between coffee and black tea consumption and

lung cancer risk overall, by sex and smoking level, as well as separately according to histological subtype.

## Material and methods

### Study population

The design of the study has been described previously (19). Briefly, participants were recruited from 1996 to 2001 and included Canadian citizens aged 35 to 75 years who resided in the greater Montreal area. Incident lung cancer cases were identified in the 18 major hospitals serving the study region, and controls were selected from the Quebec voter registration list and frequency matched to the cases by 5-year age group and sex. The response rate was 85% among cases and 69% among controls. The current analysis was limited to participants with complete information on their consumption of either coffee or tea, and on their smoking habits (n=1,111 cases and 1,469 controls in the analysis of tea, and 1,009 cases and 1,434 controls in the analysis of coffee). Written informed consent was obtained from participants, and the study was approved by the Institutional Review Boards of participating universities and hospitals.

### Data collection

Study participants or their proxies (for 389 cases and 103 controls) participated in a face-to-face interview that was divided into two parts. The first part was a structured section during which data on socio-demographic characteristics (including ethnic group and highest level of schooling) and lifestyle (including coffee and tea intake, alcohol intake, other dietary factors, smoking, and physical activities) were collected. In the second part, a detailed description of lifetime occupational history was collected (19). Participants' occupational histories were subsequently assessed by expert chemists and industrial hygienists to determine lifetime

occupational exposure to a list of nearly 300 agents (20-23). Family income was represented by the median family income level for the census tract the participant lived in at the time of interview.

For tea and coffee consumption, participants were first asked if they drank the beverage at least once a week and if yes, they were then asked if they drank it nearly every day. For participants who reported drinking the beverage nearly every day, further questions were asked that assessed the age at which they started and stopped consumption, as was the average daily amount consumed (in cups) during the time that they were consumers. The specific type of tea consumed was not assessed, however, in the birth cohort of our participants (most born around 1920-1950), lifetime tea consumption was predominantly black tea. Black tea has historically been the dominant type consumed in North America (24); in Canada, significant green tea importation began only in the late 1990s (reaching 17% of total tea imported in 2009 (25)). Similarly, our questionnaire did not differentiate between caffeinated and decaffeinated coffee; however, only around 8% of coffee consumed in Canada in 2010 was decaffeinated (26) and this proportion was likely much lower in the past. Thus, coffee consumption in our study population likely represents primarily caffeinated consumption.

**Study variables**

Four metrics were used to summarize lifetime coffee and black tea consumption including: 1) frequency of consumption; 2) average daily amount; 3) duration of consumption and; 4) cumulative amount. For frequency of consumption, participants were categorized as 'never' consumers if they reported not drinking coffee/black tea at least once per week during their life; 'weekly, not daily' consumers if they reported drinking coffee/black tea at least once per week but not nearly every day; and 'daily' consumers if they reported drinking coffee/black

tea nearly every day. Among 'daily' consumers, categorical variables of average daily amount of consumption, duration of consumption, and cumulative consumption, which incorporated measures of both daily amount and duration of consumption, were defined. Duration of consumption was calculated by subtracting the age at which participants started consuming the beverage from the age at which they stopped. To minimize the risk of reverse-causality bias, consumption during the two years preceding the diagnosis date for cases or the interview date for controls were not included in the calculation of duration of consumption.

Data on consumption of wine was collected in a similar manner to that of coffee and black tea intake, and represented by a categorical variable. Lifetime history of cigarette smoking was represented by the comprehensive smoking index (CSI) (27), which is a continuous variable that incorporates information on smoking status, duration of smoking, time since the cessation of smoking, and average daily intensity of smoking. Exposure to seven known occupational lung carcinogens (asbestos, crystalline silica, chromium VI compound, nickel compounds, benzo(a)pyrene, cadmium compounds and diesel engine emissions) was represented by a categorical variable defining participants as never exposed, exposed to at least one of the seven carcinogens but only at non-substantial levels or exposed to at least one of the seven carcinogens at substantial levels. For a given occupational carcinogen, substantial exposure was defined as exposure to a medium or high level concentration for at least 5 years and for at least 2 hours per week, while non-substantial exposure was defined as exposure to a low concentration and/or shorter duration of exposure. Categorical variables were used to represent ethnic group and number of years of schooling. Family income was represented by tertiles.

**Statistical analysis**

The distribution of study variables was examined by case/control status. To assess the association between each metric of coffee or black tea consumption and lung cancer, odds ratios (OR) and 95% confidence intervals (CI) were estimated using unconditional logistic regression. Multivariable models included the frequency matching variables (age and sex) and covariates that were identified *a priori* based on their known association with lung cancer: ethnicity, family income (from median of census tract), years of education, smoking (CSI), and occupational exposure to lung carcinogens. Each model was also adjusted for respondent status (self/proxy). In addition, we considered potential confounding by exposure to other dietary variables (i.e. fruits and vegetables, wine, beer, and spirits), by entering each variable individually and retaining the variable if the OR changed by at least 10%. Only the variable for wine intake was retained and in 9 cases and 2 controls with missing values, the modal value among controls (never drinker) was used

Modification of the ORs for coffee or black tea consumption and lung cancer risk by sex or by smoking level was evaluated by including in the models product terms for the consumption metric and the potential effect modifier. The p-value for multiplicative interaction was based on the likelihood ratio test comparing the models with and without the product terms. Smoking level was categorized as never, light, and heavy, where light smoking and heavy smoking were defined based on dichotomizing at the median CSI value (1.928) among all ever-smokers in the study population. Because there were few cases in the never-smoking category (47 cases), never-smoking and light-smoking were combined into one category. Within each level of smoking, models were still adjusted for the continuous CSI variable.

We examined associations with histological subtype by conducting separate analyses based on the cases of a specified histological subtype and all controls. In sensitivity analyses,

analyses were restricted to self-respondents to assess the potential for information bias due to potentially poorer quality of recall by proxy respondents relative to self-respondents. We also conducted analyses where consumption of coffee or black tea during the 20 years prior to diagnosis or interview was not included in the exposure definition in order to examine associations with exposures restricted to the operational induction period of lung cancer.

**Results**

The majority of participants were male and over 65 years old (table I). Adenocarcinoma and squamous cell carcinoma were the most common histological subtypes of lung cancer. Compared to controls, cases were more likely to be represented by a proxy respondent during the interview, to be French Canadian, to have had fewer years of schooling, to have a lower family income, to be an ever-smoker, to have consumed less wine, and to have been exposed to the selected occupational carcinogens.

For black tea consumption, there was no strong pattern of association between frequency of consumption and lung cancer risk, nor for the quantitative metrics of daily consumption (table II). For daily coffee consumption an OR estimate of 0.73 was observed in the fully adjusted models, but the confidence limits did not exclude 1.0, while for weekly, but not daily coffee consumption, the OR was lower and statistically significant (table III). None of the quantitative metrics of daily coffee consumption indicated a monotonic dose-response pattern. However, compared to never drinking coffee, the lowest categories of amount of daily coffee consumption and lowest category of cumulative consumption indicated statistically significant lower risks of lung cancer, but OR estimates were virtually null for the highest intake categories for these variables. Differences observed between the age-/sex-adjusted versus fully-adjusted OR estimates were mainly due to confounding by smoking (results not shown). Similar results were observed

for all metrics of coffee and black tea consumption when excluding the last 20 years of consumption from the exposure definition, and by restricting the analyses to self-respondents (results not shown). When examining the joint effects of 'never' vs. 'ever' consumption of tea and coffee intake, the results were too imprecise to allow discrimination between the hypotheses of presence or absence of multiplicative interaction (results not shown).

Associations between black tea and coffee consumption and lung cancer did not statistically significantly differ by sex or by smoking level (all p-values for multiplicative interaction were greater than 0.05) (appendix tables A.I and A.II). The results according to histological type were very imprecise (table IV), with four of the tested associations being statistically significant (i.e, for >50 years of black tea consumption and adenocarcinoma (OR=1.60), for >2 cups/day of black tea for ≤ 40 years and squamous cell carcinoma (OR=2.18), and for weekly but not daily consumption of coffee with both squamous cell carcinoma and small cell carcinoma (ORs=0.33 and 0.10, respectively).

**Discussion**

In this large population-based case-control study, we did not observe evidence for an association between black tea consumption, defined according to frequency, amount, duration, and cumulative consumption, and lung cancer overall, nor subgroups defined by sex or level of smoking. For coffee consumption, there was evidence of a lower risk of lung cancer among weekly but not daily consumers compared to never consumers. Similarly, there was some evidence that lower coffee intakes defined by average daily amounts and cumulative consumption may be associated with lower risks. The associations between coffee intake and lung cancer did not vary significantly by sex or smoking level. While some statistically significant associations with certain metrics of coffee or black tea intake were observed for

different histological types, in general the estimated ORs did not vary appreciably across histological subtypes of lung cancer.

In previous research, five cohort studies (13, 28-31) and 14 case-control studies (14, 15, 17, 32-42) have examined lung cancer risk in relation to black tea consumption (15, 30, 31, 40-42) or tea consumption in countries where black tea was the predominant type consumed (13, 14, 17, 28, 29, 32-39). Findings have been inconsistent with studies having reported positive (14, 17, 31, 37-39, 42), inverse (29, 31, 32, 34-36, 41, 42) and null (13, 15, 28, 30, 33, 40-42) associations for increasing intakes in populations of men only, women only and/or men and women together. Of those results that were statistically significant, three (37-39) suggested a positive association and six (29, 32, 35, 36, 41, 42) suggested an inverse association.

For coffee intake, eight cohort studies (12, 13, 31, 43-47) and 14 case-control studies (14-17, 33-39, 42, 48, 49) have previously reported associations with lung cancer. Out of 30 relative risks for increasing coffee intakes reported for men only, women only and/or both men and women across these 22 studies, 17 were in the positive direction (12-15, 31, 33, 34, 38, 39, 44-49), which was statistically significant in eight (12-15, 38, 45, 46, 48). Among the other results, the majority were near the null value, with only two having reported relative risk estimates of 0.5 or less (17, 48), which were not statistically significant.

Our results for black tea consumption do not provide strong evidence of an association with lung cancer risk. Tea has been hypothesized to reduce lung cancer risk because of its high concentration of catechins, an antioxidant (3). However, the principal catechins found in black tea are theaflavin and thearubigen, which are oxidized forms of catechins and less bioavailable (4). Thus, our findings, as well as that of others, may reflect the fact that the antioxidative properties of black tea are relatively weak. It is also possible that consumption habits such as beverage size, brewing time, quantity of black tea in a cup or the use of additives resulted in

antioxidant concentrations that were too small for an effect on lung cancer risk. We were unable to examine these factors, as they were not measured.

For coffee consumption and lung cancer, we observed a statistically significantly inverse association with weekly consumption, but not with daily consumption. Our findings for average daily amount of coffee consumed and cumulative consumption were consistent with this lower relative risk at lower intakes, which then shifts towards the null at higher intakes. Coffee is a complex substance composed of hundreds of chemicals including antioxidants (1, 2), which could prevent cancer, as well as caffeine which has been shown to promote lung cancer proliferation (5) and inhibit the effects of antioxidants (50). Our observation of inverse associations only with lower consumption (i.e., presumably lower caffeine intake compared to daily/higher consumption) may reflect the possibility that at higher amounts of coffee consumption, any positive effect of antioxidants may be counterbalanced by a carcinogenic effect of caffeine in coffee. In five previous studies that specifically assessed decaffeinated coffee (12, 13, 15, 33, 39), strong inverse associations with lung cancer were reported in three (15, 33, 39), supporting the notion that coffee contains potentially cancer preventive properties. Furthermore, in studies of caffeinated coffee where the reference category included low consumers (15, 45, 46, 48), rather than an 'unexposed' group of non-drinkers, the observed statistically significant positive associations support the notion that increasing caffeine intakes might increase risk, and thus possibly mask any protective effects of other components of coffee. Interestingly, one study (49) reported a similar pattern of association, with a statistically significant lower risk at the lowest level of consumption vs. non-drinkers but a non-significant higher risk at the highest consumption. On the other hand, the non-monotonic relation with coffee intake suggested in our study may reflect chance.

A fairly unique aspect of our study was our ability to examine risk as a function of duration of intake. Only one other study analyzed duration of coffee consumption and, similar to us, observed no statistically significant association with lung cancer (16). Our findings for different histological types were consistent with the relatively few studies of black tea (15, 36, 42) and coffee consumption (12, 15-17, 36, 42, 48) that reported no significant differences in the strength or direction of the associations for different histological subtypes of lung cancer.

Cases and controls were identified from the same study base, the identification of participants was independent of coffee or black tea, and the participation rates were quite high, thus minimizing the potential for selection bias. With 1,130 cases and 1,483 controls overall, we were able to explore differences by histological subtype and potential effect modification by sex and smoking. Nonetheless, these results were characterized by a high degree of statistical imprecision. Also, detailed information on frequency and duration of consumption was not collected for 'weekly, not daily' consumers thus limiting the number of participants included in analyses of metrics based on these variables.

A major strength of our study was the detailed assessment of smoking history, the most important potential confounder in our study. In particular, we adjusted for the CSI, a metric that was previously developed and validated by our team (27) and that incorporates, in an optimal manner, the key lung cancer-relevant aspects of cigarette-smoking history, including total duration of cigarette smoking, the average smoking intensity, and time since cessation. Furthermore, the detailed assessment of occupational history along with expert assessment of lung carcinogen exposure allowed for high quality control for potential confounding by the most important occupational lung carcinogens. Nonetheless, the weak inverse association we observed for weekly coffee intake may reflect confounding by unobserved confounding factors and/or residual confounding due to incomplete control for observed confounding factors. Prospective studies with

multiple assessments of exposures and covariates may reduce residual confounding due to error in measurement of observed confounders, while the effect of unobserved confounders can be addressed in instrumental variable-based designs (51, 52).

Our questionnaire assessed coffee and tea over the lifetime, in contrast to traditional food frequency questionnaires, which generally provides a measure of usual intake of various foods and beverages over a relatively recent period of time (such as past month or past year) (53). Thus, our assessment allowed us to have an estimate of lifetime intake which is particularly important in a study of cancer etiology as lifetime intake is more likely to better capture periods of etiologic relevance than current or very recent intake. Nonetheless, recall over a long period may contribute to misclassification of exposure, though studies have shown that intake of coffee and other dietary factors can be reliably and validly reported (54, 55), especially when interviewer-administered (56), as was the case in our study. Another potential source of non-differential misclassification of exposure is the absence of information on factors that may affect the concentration of relevant chemical components in the beverage (e.g. brewing time). The use of proxy respondents for some participants also may have resulted in exposure misclassification because of possible lower quality data, although our findings did not appreciably differ upon restricting the analysis to self-respondents.

In summary, our results do not provide strong support for an association between consumption of coffee or black tea and lung cancer. For coffee, our results are suggestive that low consumption may decrease the risk of lung cancer. Research that includes more detailed information on these beverages, including specific components of these beverages such as caffeine, may offer further insight.

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**Table I. Characteristics of the study participants**

| | | Cases, N=1,130 n (%) | Controls, N=1,483 n (%) |
|---|---|---|---|
| **Age** | | | |
| | <45 years | 37 (3.3) | 52 (3.5) |
| | 45 - <55 years | 164 (14.5) | 202 (13.6) |
| | 55 - <65 years | 381 (33.7) | 442 (29.8) |
| | 65 - <75 years | 511 (45.2) | 745 (50.3) |
| | ≥75 years | 37 (3.3) | 42 (2.8) |
| **Sex** | | | |
| | Male | 677 (59.9) | 878 (59.2) |
| | Female | 453 (40.1) | 605 (40.8) |
| **Respondent status** | | | |
| | Self | 741 (65.6) | 1380 (93.1) |
| | Proxy | 389 (34.4) | 103 (6.9) |
| **Ethnic group** | | | |
| | French Canadian | 876 (77.5) | 979 (66.0) |
| | English Canadian | 74 (6.6) | 82 (5.5) |
| | Other | 180 (15.9) | 422 (28.5) |
| **Years of schooling** | | | |
| | <7 | 285 (25.1) | 312 (21.0) |
| | 7 - <12 | 553 (48.9) | 563 (38.0) |
| | ≥12 | 292 (25.8) | 608 (41.0) |
| **Median census tract family income** | | | |
| | Low | 500 (44.3) | 491 (33.1) |
| | Middle | 369 (32.7) | 503 (33.9) |
| | High | 261 (23.1) | 489 (33.0) |
| **Cigarette smoking** | | | |
| | Never | 47 (4.2) | 460 (31.0) |
| | Ex-smoker | 644 (57.0) | 690 (46.5) |
| | Current smoker | 439 (38.8) | 333 (22.5) |
| | Average amount, cigarettes/year (median (IQR))[1] | 1175 (773) | 775 (838) |
| | Time since cessation, years (median (IQR))[2] | 1.2 (10.2) | 17.7 (16.6) |
| | Smoking duration, years (median (IQR))[1] | 43.0 (14.4) | 33.2 (21.1) |
| **Wine consumption** | | | |
| | Never | 739 (65.4) | 665 (44.8) |
| | Weekly, not daily | 225 (19.9) | 545 (36.8) |
| | Daily | 166 (14.7) | 273 (18.4) |
| **Exposures to occupational carcinogens[3]** | | | |
| | Never exposed | 652 (57.7) | 935 (63.0) |
| | Non-substantially exposed | 303 (26.8) | 372 (25.1) |
| | Substantially exposed | 175 (15.5) | 176 (11.9) |
| **Histological subtype** | | | |
| | Squamous cell carcinoma | 328 (29.0) | |
| | Adenocarcinoma | 443 (39.2) | |
| | Small cell carcinoma | 187 (16.6) | |

1. Includes ex-smokers and current smokers only
2. Includes ex-smokers only
3. Exposure to asbestos, crystalline silica, chromium VI compound, nickel compounds, benzo(a)pyrene, cadmium compounds or diesel engine emissions

**Table II. Odds ratio estimates for the association between black tea consumption and lung cancer risk[1]**

| Consumption metric | Cases (N=1,111) | Controls (N=1,469) | Age and sex adjusted OR (95% CI) | Fully adjusted OR (95% CI)[2] |
|---|---|---|---|---|
| Frequency of consumption | | | | |
| Never[3] | 551 | 604 | 1.00 (ref) | 1.00 (ref) |
| Weekly, not daily[4] | 127 | 281 | 0.49 (0.39 - 0.62) | 0.78 (0.58 – 1.05) |
| Daily | 433 | 584 | 0.83 (0.70 - 0.98) | 1.05 (0.85 – 1.31) |
| Average daily amount of consumption[5] | | | | |
| Never[3] | 551 | 604 | 1.00 (ref) | 1.00 (ref) |
| ≤ 1 cup/day | 128 | 238 | 0.60 (0.47-0.76) | 0.95 (0.70-1.28) |
| >1 to 2 cups/day | 162 | 219 | 0.84 (0.66-1.06) | 1.06 (0.79-1.42) |
| >2 cups/day | 143 | 127 | 1.27 (0.97-0.99) | 1.25 (0.90-1.75) |
| Duration of consumption[5] | | | | |
| Never[3] | 551 | 604 | 1.00 (ref) | 1.00 (ref) |
| < 20 years | 52 | 61 | 0.89 (0.60 - 1.32) | 1.41 (0.87 – 2.29) |
| ≥ 20 to < 30 years | 39 | 55 | 0.67 (0.43 - 1.04) | 0.97 (0.57 – 1.64) |
| ≥ 30 to < 40 years | 80 | 106 | 0.76 (0.56 - 1.05) | 0.98 (0.66 – 1.45) |
| ≥ 40 to < 50 years | 141 | 203 | 0.81 (0.63 - 1.04) | 0.94 (0.69 – 1.28) |
| ≥ 50 years | 121 | 159 | 0.99 (0.74 - 1.31) | 1.24 (0.87 – 1.78) |
| Cumulative consumption[5] | | | | |
| Never[3] | 551 | 604 | 1.00 (ref) | 1.00 (ref) |
| ≤ 40 years, ≤ 2 cups/day | 118 | 187 | 0.63 (0.49-0.83) | 0.97 (0.70-1.34) |
| ≤ 40 years, > 2 cups/day | 53 | 39 | 1.37 (0.89-2.12) | 1.49 (0.88-2.52) |
| > 40 years, ≤ 2 cups/day | 172 | 270 | 0.77 (0.61-0.98) | 1.03 (0.77-1.38) |
| > 40 years, > 2 cups/day | 90 | 88 | 1.23 (0.89-1.27) | 1.14 (0.76-1.71) |

1. Only includes participants with complete information on their black tea consumption
2. Adjusted for age, sex, respondent status, smoking (CSI), wine intake (never; weekly, not daily; daily), ethnicity (French Canadian; English Canadian; other), median census tract income (low; medium; high), years of education (<7; 7-<12; ≥12) and occupational exposure to carcinogens (Never; non-substantial; substantial)
3. Participants were categorized as never consumers if they reported never consuming black tea at least once per week
4: Participants were categorized as "weekly, not daily" consumers if they reported consuming black tea at least once per week but not nearly every day
5. "Weekly, not daily" consumers not included

**Table III. Odds ratio estimates for the association between coffee consumption and lung cancer risk[1]**

| Consumption metric | Cases (N=1,009) | Controls (N=1,434) | Age and sex adjusted OR (95% CI) | Fully adjusted OR (95% CI)[2] |
|---|---|---|---|---|
| Frequency of consumption | | | | |
| Never[3] | 89 | 88 | 1.00 (ref) | 1.00 (ref) |
| Weekly, not daily[4] | 32 | 108 | 0.29 (0.18 - 0.48) | 0.29 (0.16 – 0.55) |
| Daily | 888 | 1238 | 0.71 (0.52 - 0.97) | 0.74 (0.49 – 1.10) |
| Average daily amount of consumption[5] | | | | |
| Never[3] | 89 | 88 | 1.00 (ref) | 1.00 (ref) |
| ≤ 1 cup/day | 203 | 420 | 0.48 (0.34-0.68) | 0.69 (0.45-1.07) |
| >1 to 2 cups/day | 224 | 412 | 0.54 (0.39-0.76) | 0.60 (0.39-0.93) |
| >3 to 4 cups/day | 280 | 295 | 0.94 (0.67-1.31) | 0.86 (0.55-1.33) |
| >4 cups/day | 181 | 110 | 1.61 (1.10-2.35) | 1.06 (0.65-1.72) |
| Duration of consumption[5] | | | | |
| Never[3] | 89 | 88 | 1.00 (ref) | 1.00 (ref) |
| < 20 years | 44 | 68 | 0.53 (0.32 - 0.87) | 0.71 (0.38-1.30) |
| ≥ 20 to < 30 years | 99 | 134 | 0.57 (0.38 - 0.87) | 0.88 (0.51-1.50) |
| ≥ 30 to < 40 years | 223 | 310 | 0.64 (0.45 - 0.91) | 0.68 (0.43-1.07) |
| ≥ 40 to < 50 years | 347 | 455 | 0.82 (0.59 - 1.14) | 0.76 (0.49-1.17) |
| ≥ 50 years | 175 | 271 | 0.78 (0.54 - 1.13) | 0.73 (0.45-1.18) |
| Cumulative consumption[5] | | | | |
| Never[3] | 89 | 88 | 1.00 (ref) | 1.00 (ref) |
| ≤ 40 years, ≤ 2 cups/day | 150 | 318 | 0.42 (0.29-0.60) | 0.60 (0.38-0.94) |
| ≤ 40 years, > 2 cups/day | 217 | 197 | 0.95 (0.66-1.38 | 0.87 (0.54-1.38) |
| > 40 years, ≤ 2 cups/day | 277 | 515 | 0.59 (0.42-0.82) | 0.68 (0.44-1.05) |
| > 40 years, > 2 cups/day | 244 | 208 | 1.27 (0.89-1.81) | 0.97 (0.61-1.53) |

1. Only includes participants with complete information on their coffee consumption
2. Adjusted for age, sex, respondent status, smoking (CSI), wine intake (never; weekly, not daily; daily), ethnicity (French Canadian; English Canadian; other), median census tract income (low; medium; high), years of education (<7; 7-<12; ≥12) and occupational exposure to carcinogens (Never; non-substantial; substantial)
3. Participants were categorized as never consumers if they reported never consuming coffee at least once per week
4: Participants were categorized as "weekly, not daily" consumers if they reported consuming coffee at least once per week but not nearly every day
5. "Weekly, not daily" consumers not included

**Table IV. Odds ratio estimates of the association between black tea and coffee consumption and lung cancer risk by histological subtype[1]**

| Black tea consumption metric[3] | OR (95%CI)[2] | | | Coffee consumption metric[4] | OR (95%CI)[2] | | |
|---|---|---|---|---|---|---|---|
| | Squamous cell carcinoma | Adenocarcinoma | Small cell carcinoma | | Squamous cell carcinoma | Adenocarcinoma | Small cell carcinoma |
| Frequency of consumption | | | | Frequency of consumption | | | |
| Never[5] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | Never[5] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| Weekly, not daily[6] | 0.81 (0.51–1.29) | 0.84 (0.57–1.25) | 0.78 (0.42–1.43) | Weekly, not daily[6] | 0.32 (0.13–0.83) | 0.50 (0.22 – 1.10) | 0.10 (0.02–0.50) |
| Daily | 1.07 (0.78–1.48) | 1.13 (0.85–1.51) | 0.85 (0.55–1.30) | Daily | 0.83 (0.46–1.49) | 0.93 (0.54 – 1.59) | 0.65 (0.32–1.33) |
| Average daily amount of consumption[7] | | | | Average daily amount of consumption[7] | | | |
| Never[5] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | Never[5] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| ≤ 1 cup/day | 0.78 (0.49-1.23) | 0.99 (0.67-1.48) | 0.82 (0.46-1.49) | ≤ 1 cup/day | 0.72 (0.38-1.38) | 0.82 (0.46-1.48) | 0.64 (0.29-1.42) |
| >1 to 2 cups/day | 1.15 (0.75-1.76) | 1.15 (0.78-1.68) | 0.60 (0.32-1.12) | >1 to 2 cups/day | 0.70 (0.37-1.33) | 0.75 (0.42-1.35) | 0.46 (0.21-1.04) |
| >2 cups/day | 1.48 (0.93-2.34) | 1.39 (0.90-2.15) | 1.32 (0.70-2.48) | >2 to 4 cups/day | 0.95 (0.50-1.80) | 1.24 (0.69-2.21) | 0.68 (0.31-1.49) |
| | | | | >4 cups/day | 1.25 (0.62-2.52) | 1.15 (0.60-2.18) | 1.05 (0.45-2.45) |
| Duration of consumption[7] | | | | Duration of consumption[7] | | | |
| Never[5] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | Never[5] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| < 30 years | 1.27 (0.73–2.21) | 1.15 (0.71–1.85) | 1.13 (0.55–2.30) | < 30 years | 0.80 (0.37-1.71) | 1.14 (0.60-2.19) | 0.50 (0.19-1.30) |
| ≥ 30 to < 40 years | 1.22 (0.69–2.14) | 1.12 (0.68–1.85) | 0.74 (0.33–1.68) | ≥ 30 to < 40 years | 0.91 (0.46-1.77) | 0.90 (0.50-1.64) | 0.59 (0.26-1.34) |
| ≥ 40 to < 50 years | 0.98 (0.64–1.52) | 0.89 (0.58–1.36) | 0.70 (0.38–1.29) | ≥ 40 to < 50 years | 0.88 (0.47-1.65) | 0.88 (0.49-1.58) | 0.71 (0.33-1.54) |
| ≥ 50 years | 1.01 (0.60–1.68) | 1.60 (1.01–2.52) | 0.92 (0.45-1.91) | ≥ 50 years | 0.68 (0.34-1.36) | 0.91 (0.48-1.75) | 0.73 (0.30-1.80) |
| Cumulative consumption[7] | | | | Cumulative consumption[7] | | | |
| Never[5] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | Never[5] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| ≤ 40 years, ≤ 2 cups/day | 0.99 (0.61-1.60) | 1.01 (0.67-1.54) | 0.80 (0.42-1.52) | ≤ 40 years, ≤ 2 cups/day | 0.74 (0.37-1.48) | 0.73 (0.39-1.35) | 0.51 (0.21-1.21) |
| ≤ 40 years, > 2 cups/day | 2.18 (1.07-4.46) | 1.61 (0.83-3.15) | 1.55 (0.55-4.38) | ≤ 40 years, > 2 cups/day | 0.97 (0.48-1.94) | 1.34 (0.72-2.49) | 0.62 (0.27-1.44) |
| > 40 years, ≤ 2 cups/day | 0.93 (0.61-1.43) | 1.11 (0.76-1.64) | 0.64 (0.35-1.17) | > 40 years, ≤ 2 cups/day | 0.69 (0.37-1.30) | 0.84 (0.47-1.53) | 0.57 (0.26-1.27) |
| > 40 years, > 2 cups/day | 1.20 (0.70-2.08) | 1.28 (0.75-2.17) | 1.22 (0.59-2.56) | > 40 years, > 2 cups/day | 1.09 (0.56-2.11) | 1.15 (0.62-2.15) | 0.99 (0.44-2.23) |

1. n=322 cases of squamous cell carcinoma, 438 cases of adenocarcinoma and 183 cases of small cell carcinoma
2. Adjusted for age, sex, respondent status, smoking (CSI), wine intake (never; weekly, not daily; daily), ethnicity (French Canadian; English Canadian; other), median census tract income (low; medium; high), years of education (<7; 7-<12; ≥12) and occupational exposure to carcinogens (Never; non-substantial; substantial)
/drug effects/physiology</keyword><keyword>Signal Transduction/*drug effects/physiology4. Only includes participants with complete information on their coffee consumption
4. Only includes participants with complete information on their coffee consumption
5. Participants were categorized as never consumers if they reported never consuming black tea/coffee at least once per week
6: Participants were categorized as "weekly, not daily" consumers if they reported consuming black tea/coffee at least once per week but not nearly every day
7. "Weekly, not daily" consumers not included

**Appendix table A.I. Odds ratio estimates for the association between black tea consumption and lung cancer risk, by sex and by smoking level[1]**

| Consumption metric | OR (95% CI) by sex[2] | | OR (95% CI) by smoking level[3] | |
|---|---|---|---|---|
| | Males | Females | Never/light smokers | Heavy smokers |
| Frequency of consumption | | | | |
| Never[4] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| Weekly, not daily[5] | 0.88 (0.60–1.31) | 0.66 (0.40–1.09) | 0.79 (0.53–1.19) | 0.82 (0.51–1.32) |
| Daily | 1.10 (0.84–1.45) | 0.98 (0.67–1.44) | 1.08 (0.80–1.46) | 1.02 (0.74–1.41) |
| $p_{interaction}$[6] | 0.41 | | 0.84 | |
| Average daily amount[7] | | | | |
| Never[4] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| ≤ 1 cup/day | 0.84 (0.57-1.24) | 1.21 (0.72-2.01) | 1.12 (0.75-1.68) | 0.76 (0.48-1.20) |
| >1 to 2 cups/day | 1.26 (0.87-1.83) | 0.78 (0.47-1.30) | 0.97 (0.64-1.45) | 1.14 (0.73-1.79) |
| >2 cups/day | 1.37 (0.90-2.09) | 1.09 (0.61-1.94) | 1.34 (0.83-2.14) | 1.20 (0.74-1.94) |
| $p_{interaction}$[6] | 0.29 | | 0.47 | |
| Duration of consumption[7] | | | | |
| Never[4] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| < 30 years | 1.25 (0.74–2.12) | 1.27 (0.71–2.25) | 1.18 (0.73–1.93) | 1.26 (0.68–2.33) |
| ≥ 30 to < 40 years | 1.31 (0.77–2.20) | 0.67 (0.36–1.23) | 0.70 (0.39–1.27) | 1.27 (0.70–2.31) |
| ≥ 40 to < 50 years | 0.92 (0.63–1.34) | 0.93 (0.52–1.65) | 1.12 (0.73–1.72) | 0.75 (0.48–1.18) |
| ≥ 50 years | 1.24 (0.80–1.91) | 1.26 (0.65–2.44) | 1.41 (0.87–2.27) | 1.08 (0.63–1.86) |
| $p_{interaction}$[6] | 0.47 | | 0.13 | |
| Cumulative consumption[7] | | | | |
| Never[4] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| ≤ 40 years, ≤ 2 cups/day | 1.05 (0.67-1.64) | 0.91 (0.55-1.50) | 0.87 (0.56-1.37) | 1.07 (0.65-1.77) |
| ≤ 40 years, > 2 cups/day | 1.98 (0.98-3.98) | 1.12 (0.49-2.54) | 1.14 (0.56-2.33) | 2.32 (0.92-5.89) |
| > 40 years, ≤ 2 cups/day | 1.03 (0.72-1.46) | 1.05 (0.61-1.82) | 1.20 (0.80-1.78) | 0.85 (0.55-1.31) |
| > 40 years, > 2 cups/day | 1.14 (0.69-1.88) | 1.10 (0.53-2.26) | 1.51 (0.85-2.68) | 0.91 (0.52-1.58) |
| $p_{interaction}$[6] | 0.69 | | 0.11 | |

1. Only includes participants with complete information on their black tea consumption
2. Adjusted for age, respondent status, smoking (CSI), wine intake (never; weekly, not daily; daily), ethnicity (French Canadian; English Canadian; other), median census tract income (low; medium; high), years of education (<7; 7-<12; ≥12) and occupational exposure to carcinogens (Never; non-substantial; substantial)
3. Adjusted for same covariates as above, plus sex
4. Participants were categorized as never consumers if they reported never consuming black tea at least once per week
5: Participants were categorized as "weekly, not daily" consumers if they reported consuming black tea at least once per week but not nearly every day
6. $p_{interaction}$ is the p-value for the test of for interaction between the consumption metric and either sex or smoking level
7. "Weekly, not daily" consumers not included

**Appendix table A.II. Odds ratio estimates for the association between coffee consumption and lung cancer risk, by sex and by smoking level[1]**

| Consumption metric | OR (95% CI) by sex[2] | | OR (95% CI) by smoking level[3] | |
|---|---|---|---|---|
| | Males | Females | Never/light smokers | Heavy smokers |
| Frequency of consumption | | | | |
| Never[4] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| Weekly, not daily[5] | 0.22 (0.10–0.47) | 0.58 (0.20–1.70) | 0.24 (0.10–0.58) | 0.32 (0.12–0.85) |
| Daily | 0.68 (0.41 – 1.12) | 0.87 (0.44–1.73) | 0.63 (0.38–1.04) | 0.80 (0.41–1.57) |
| $p_{interaction}$[6] | 0.27 | | 0.80 | |
| Average daily amount[7] | | | | |
| Never[4] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| ≤ 1 cup/day | 0.68 (0.40-1.16) | 0.75 (0.36-1.58) | 0.55 (0.32-0.96) | 0.86 (0.41-1.79) |
| >1 to 2 cups/day | 0.56 (0.33-0.96) | 0.70 (0.34-1.47) | 0.51 (0.29-0.88) | 0.66 (0.32-1.35) |
| >2 to 4 cups/day | 0.74 (0.43-1.27) | 1.23 (0.58-2.58) | 0.76 (0.43-1.33) | 0.91 (0.45-1.85) |
| >4 cups/day | 0.92 (0.50-1.68) | 1.33 (0.58-3.05) | 1.19 (0.63-2.27) | 0.86 (0.40-1.84) |
| $p_{interaction}$[6] | 0.73 | | 0.45 | |
| Duration of consumption[7] | | | | |
| Never[4] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| < 30 years | 0.60 (0.31-1.17) | 1.37 (0.61-3.08) | 0.75 (0.41-1.38) | 0.83 (0.35-1.99) |
| ≥ 30 to < 40 years | 0.57 (0.32-1.00) | 0.95 (0.45-2.04) | 0.53 (0.29-0.95) | 0.72 (0.34-1.50) |
| ≥ 40 to < 50 years | 0.74 (0.44-1.26) | 0.77 (0.36-1.63) | 0.60 (0.35-1.04) | 0.90 (0.44-1.81) |
| ≥ 50 years | 0.76 (0.42-1.36) | 0.64 (0.27-1.50) | 0.67 (0.36-1.24) | 0.79 (0.37-1.70) |
| $p_{interaction}$[6] | 0.99 | | 0.35 | |
| Cumulative consumption[7] | | | | |
| Never[4] | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) | 1.00 (ref) |
| ≤ 40 years, ≤ 2 cups/day | 0.51 (0.28-0.92) | 0.84 (0.40-1.80) | 0.47 (0.27-0.85) | 0.74 (0.34-1.60) |
| ≤ 40 years, > 2 cups/day | 0.66 (0.36-1.19) | 1.45 (0.66-3.18) | 0.83 (0.45-1.53) | 0.74 (0.34-1.59) |
| > 40 years, ≤ 2 cups/day | 0.69 (0.41-1.17) | 0.61 (0.29-1.32) | 0.57 (0.33-1.00) | 0.76 (0.37-1.55) |
| > 40 years, > 2 cups/day | 0.91 (0.52-1.59) | 1.10 (0.49-2.44) | 0.90 (0.49-1.64) | 1.01 (0.49-2.10) |
| $p_{interaction}$[6] | 0.78 | | 0.34 | |

1. Only includes participants with complete information on their coffee consumption
2. Adjusted for age, respondent status, smoking (CSI), wine intake (never; weekly, not daily; daily), ethnicity (French Canadian; English Canadian; other), median census tract income (low; medium; high), years of education (<7; 7-<12; ≥12) and occupational exposure to carcinogens (Never; non-substantial; substantial)
3. Adjusted for same covariates as above, plus sex
4. Participants were categorized as never consumers if they reported never consuming coffee at least once per week
5: Participants were categorized as "weekly, not daily" consumers if they reported consuming coffee at least once per week but not nearly every day
6. $p_{interaction}$ is the p-value for the test of for interaction between the consumption metric and either sex or smoking level
7. "Weekly, not daily" consumers not included