Original Article

The association of tea consumption with bladder cancer risk: a meta-analysis

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The association between tea consumption and bladder cancer has been confirmed in several animal studies, but one epidemiological study in 2001 showed no association between them. In order to provide an accurate assessment of this, we conducted a meta-analysis on tea consumption and bladder cancer risk. Studies were identified by a literature search in PubMed from January 1980 to March 2012 and the reference lists of relevant studies. Random effect models were used to calculate summary relative risk estimates (RR) and their corresponding 95% confidence intervals (CI) based on high contrast to low intake values. Twenty-four publications (6 cohort studies and 18 case-control studies) based on consumption of overall tea, black tea, and green tea to bladder cancer risk were included in this analysis. For overall tea, the summary RR indicated no association between tea consumption and bladder cancer (RR= 1.09, 95%CI: 0.85-1.40). In subgroup analyses, we found a moderate increase of bladder cancer risk in smoking group (RR= 1.77, 95%CI: 1.04-3.01). In the black tea group, no statistically significant association was observed (RR= 0.84, 95%CI: 0.70-1.01). Interestingly, in the subgroup of sex, a protective effect was observed between tea consumption and bladder cancer risk in females (RR= 0.61, 95%CI: 0.38-0.98). For green tea group, there was no relationship associated with bladder cancer risk (RR= 1.03, 95%CI: 0.82-1.31). In conclusion, our data suggest that high overall tea intake in smokers increased the risk of bladder cancer, and high black tea intake in females may reduce the risk of bladder cancer.

Key Words: bladder cancer, overall tea, black tea, green tea, meta-analysis

INTRODUCTION

Bladder cancer is the second most common genitourinary tumor and a significant cause of morbidity and mortality for both males and females globally.1 At present, the majority of bladder cancers are superficial at the time of diagnosis and most of them (60-70%) have a propensity for recurrence after initial transurethral resection of bladder cancer. Some (15-25%) of patients are at high risk for progression to invasive bladder cancer.2 Adjuvant chemotherapy and immunotherapy have been used to treat invasive bladder cancer but have failed to show an apparently survival advantage.3,4

Bladder cancer has the highest lifetime treatment cost of any cancer.5 The direct exposure to carcinogens is implicated in bladder cancer development and many potentially protective compounds are concentrated in urine, making it an ideal target for preventive therapies.6 Over the past three decades, a number of epidemiological studies have been conducted to investigate determinants of bladder cancer.7-9 These studies suggested that bladder cancer is significantly influenced by environmental factors (e.g., cigarette smoking, fluid, chemicals and infections).

Tea is the most popular beverage in the world, second only to water, consumed by over two thirds of the world’s population.10 It is produced from the leaves of the plant Camellia sinensis, with differences in processing methods, of which green and black tea are the most consumed worldwide.11-13 Animal studies strongly have suggested that tea or the active ingredient of tea, polyphenols, have cancer preventative or inhibitory effects in various tissues.14-15 However, the effect of tea consumption on the risk of bladder cancer is poorly explored, only one meta-

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A meta-analysis of tea consumption and bladder cancer

An analysis article of association between tea consumption and bladder cancer risk has been published by Maurice PA Zeegers et al. in 2001.16

In order to clarify the role of different kind of tea in bladder cancer, we conducted a meta-analysis from cohort and case-control studies (until March 2012).

METHODS

Search strategy
We conducted a literature search in PubMed for all relevant papers published from January 1980 to March 2012 using the search terms “tea”, “green tea”, “black tea”, “catechin”, “theaflavin”, “thearubigin”, “water”, “beverage” or “fluid” combined with “bladder cancer”, “urothelial cancer”, “urinary tract cancer”, “bladder neoplasm” or “urothelial neoplasm”. Furthermore, we also reviewed the reference of those papers to make sure all relevant articles were collected.

Study selection
The following criteria were used to select relevant studies: 1) original cohort or case-control study design; 2) overall, green tea, and black tea consumption; 3) bladder cancer as the outcome (or bladder cancer accounting for the majority); 4) the risks estimate [relative risk (RR) or odds ratio (OR)] with their corresponding 95% confidence intervals (CI) were reported or these data could be calculated.

The process of study selection is showed in Figure 1.

![Figure 1. Process of study selection for tea consumption and risk of bladder cancer](image)

Twenty-four potentially relevant studies were identified by searching PubMed and references of retrieved articles or reviews. Four studies were excluded because of duplication, or if risk ratios or 95% CIs were not provided, or these data could not be calculated by sufficient information. Thus, a total of 24 studies were included in this meta-analysis.

Date extraction
All data were extracted independently by two investigators (Zhang and Li) according to the pre-specified selection criteria. Discrepancies were resolved by discussion. We extracted the following data from each publication by using a standardized data form: study name (first author and publication year), study design (cohort or case-control studies), study location, sample size, study follow-up period, tea type, results of studies (adjusted RR or OR with their corresponding 95% CI) and the adjusted factors. We are considering that bladder cancer is a rare disease, so the RR was assumed to be approximately the same as the OR.17 The most recent and complete study (adjusted by more factors in main multivariable model) was included if data were duplicated in more than one studies.

Statistical analyses
All statistical analyses were based on comparisons of the highest intake category with the lowest intake category (contained persons who did not consume tea). Heteroge-
neity was measured by Q-test, and was considered statistical significance while \( p < 0.1 \). OR is the common measure instead of HR and RR in this study.\(^{18}\) Fixed or Random effects models were used to calculate summary OR, 95% CI and corresponding \( p \)-values for heterogeneity.\(^{19}\) Forest plots were applied to assess the relationship between tea consumption and bladder cancer. Subgroup analyses (study design, sex, geographic region, smoking status and publication year) were also carried out for establishing the effects of clinical heterogeneity between studies. Age, gender, BMI, smoking status, and energy intake were the most essential confounders to bladder cancer risk. To evaluate whether low-quality studies would affect the results, this analysis was stratified according to whether the effect sizes had been adjusted for at least 3 of these confounders.\(^{17}\) A sensitivity analysis was conducted to test the impact of each study on the pooled estimates by removing each study in turn from the meta-analysis.\(^{3}\) Egger’s and Begg’s tests were applied to assess the possible bias captured to investigate whether publication bias might affect the validity of the estimates. As the two tests above have limited ability to detect possible biases,\(^{17}\) especially when the number of studies is small,\(^{20}\) we set \( p = 0.1 \) as our statistical penalty in these two tests (\( p < 0.1 \) indicated possible publication bias). All statistical analyses were conducted with Stata (version 12.0, Stata Corp, College Station, TX, USA).

RESULTS
Twenty-four studies are presented in Table 1. Studies were classified into 3 groups: overall tea group, green tea group and black tea group. Fifteen studies based on overall tea; whereas 5 reported data on green tea and 6 on black tea individually (some studies contained green tea or black tea besides overall tea). Among these studies, 8 were in Asia, 10 in the Americas, 5 in Europe and 1 in Oceania (Table 1). The primary outcomes of some studies were defined as urinary tract cancer.\(^{21-25}\) Most cases in these studies were bladder cancer. Moreover, the other studies contained bladder cancer only.

A moderate risk increase in smoking subgroup, but no significant association between overall tea consumption and bladder cancer were found in 15 studies on overall tea intake.\(^{21-23,26-27}\) In random effects model, no significant association between overall tea consumption (high in contrast to low intake) and bladder cancer risk was observed (Table 2 and Figure 2a, \( RR = 1.09, 95\% \text{ CI: 0.85-1.40} \), \( p \) for heterogeneity: \(<0.01\)). To explore the source of heterogeneity, we pooled the RR and 95% CI from the subgroups of study design (cohort or case-control), sex (male or female), geographical region, smoking, adjustments and publication years (before or after 2000). No significant association was observed in the subgroups stratified by study design (cohort: \( RR = 0.64, 95\% \text{ CI: 0.40-1.04} \), case-control: \( RR = 1.22, 95\% \text{ CI: 0.95-1.57} \)). According to sex, both male (\( RR = 1.34, 95\% \text{ CI: 0.62-2.88} \)) and female (\( RR = 0.93, 95\% \text{ CI: 0.56-1.53} \)) showed no significant association between overall tea consumption and bladder cancer risk. When we stratified the studies by region, non-association was noted in the Americas (\( RR = 1.19, 95\% \text{ CI: 0.86-1.64} \)), Europe (\( RR = 0.91, 95\% \text{ CI: 0.75-1.11} \)) and other continents (China and Netherland) (\( RR = 1.26, 95\% \text{ CI: 0.21-7.49} \)). Interestingly, we found a moderate risk increase in the smoking group (\( RR = 1.77, 95\% \text{ CI: 1.04-3.01} \), but no significance in the non-smoking group (\( RR = 1.35, 95\% \text{ CI: 0.69-2.65} \)). Both were not significant in the adjustments (\( \leq 3 \) or \( >3 \)) and publication years (before or after 2000) (\( [RR = 1.01, 95\% \text{ CI: 0.80-1.29}] \) and (\( RR = 1.00, 95\% \text{ CI: 0.65-1.57}] \)), (\( RR = 1.22, 95\% \text{ CI: 0.80-1.88} \)) and (\( RR = 0.95, 95\% \text{ CI: 0.73-1.23} \)). The majority of them were not identified as a possible source of heterogeneity among all tea studies included (Table 2).

No publication bias was found among all studies either with Egger’s (\( p = 0.88 \)) or Begg’s test (\( p = 0.11 \)). We also performed sensitivity analysis by sequentially excluding each study in turn to examine the influence of individual studies on the overall estimate and found that none of the studies considerably affected the summary effects in this meta-analysis.

A risk decrease in females subgroup were found on black tea intake. The analysis of black tea and bladder cancer risk were based on 6 studies.\(^{24,25,38-41}\) The summary RR and 95% CI of bladder cancer risk were 0.84 and 0.70-1.01 (Table 2 and Figure 2c). To explore the source of the borderline significance, we pooled the summary RR by sex (male and female). As shown in Table 2, a positive relationship between black tea consumption and bladder cancer risk was observed in women (\( RR = 0.61, 95\% \text{ CI: 0.38-0.98} \)), but not in men (\( RR = 0.91, 95\% \text{ CI: 0.71-1.18} \)). And there were no evidence of heterogeneity among all studies and subgroup (sex) studies. No publication bias was detected (\( p = 1.00 \) by Egger’s test and \( p = 0.89 \) by Begg’s test).

Green tea intake was not associated with bladder cancer risk. A limited number of 5 studies of green tea were included in our meta-analysis.\(^{21,38,39,42,43}\) Green tea intake was not associated with bladder cancer risk (Table 2 and Figure 2b, \( RR = 1.03, 95\% \text{ CI: 0.82-1.31} \)). There was no evidence of heterogeneity and publication bias (\( p = 0.49 \) by Egger’s test and \( p = 0.81 \) by Begg’s test).

DISCUSSION
Many studies had demonstrated that tea has cancer preventative or inhibitory effects in various tissues. However, no association had been found between tea consumption and bladder cancer in previous analysis.\(^{16}\) Until now, 7 newly cohort or case-control studies on tea intake and bladder cancer have been published. Based on abundant literature, we completed this meta-analysis for more comprehensive results on the association between tea consumption and bladder cancer.

We evaluated the association between tea consumption and bladder cancer risk, and found no significant relationship between them. This result is similar to those found in 2001 by Maurice PA Zeegers et al.\(^{16}\) In order to examine the potential sources of heterogeneity, we conducted subgroup analysis by study design (cohort or case-control), sex (male or female), geographical region (the Americas, European, or other continents), smoking (ever or never), adjustments (at least 3 or not) and publication years (before or after 2000). However, the majority of them were not identified as a possible source of heterogeneity among all studies included. Interestingly, there was a moderate
<table>
<thead>
<tr>
<th>Study</th>
<th>First author and year</th>
<th>Study design</th>
<th>Tea types</th>
<th>Anatomical site of urinary tract</th>
<th>Study period</th>
<th>Cases/Subjects</th>
<th>Tea consumption levels (lowest vs highest)</th>
<th>Pooled RR (95% CI)</th>
<th>Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohno, E.</td>
<td>1985 40</td>
<td>case-control</td>
<td>black tea</td>
<td>Bladder</td>
<td>Japan</td>
<td>1976-1978</td>
<td>292/589</td>
<td>ever vs not (men) ever vs not (women)</td>
<td>0.95 (0.68, 1.32) (men) 0.55 (0.29, 1.03) (women)</td>
</tr>
<tr>
<td>Jensen, E.</td>
<td>1986 31</td>
<td>case-control</td>
<td>tea</td>
<td>Bladder</td>
<td>Denmark</td>
<td>1979-1981</td>
<td>371/771</td>
<td>0 ml/day vs (1000-1499) ml/day (men) 0 ml/day vs (1000-1499) ml/day (women)</td>
<td>1.50 (0.70, 3.20) (men) 1.0 (0.40, 2.50) (women)</td>
</tr>
<tr>
<td>Heilbrun, E.</td>
<td>1986 50</td>
<td>cohort</td>
<td>black tea</td>
<td>Bladder</td>
<td>Japan</td>
<td>1965-1985</td>
<td>577/833</td>
<td>never vs once/day</td>
<td>0.71 (0.24, 1.74)</td>
</tr>
<tr>
<td>Slattery, E.</td>
<td>1988 27</td>
<td>case-control</td>
<td>tea</td>
<td>Bladder</td>
<td>America</td>
<td>1977-1982</td>
<td>419/889</td>
<td>0 cup/day vs ≥4 cups/day (never smoker) 0 cup/day vs ≥4 cups/day (ever smoker)</td>
<td>2.25 (1.25, 3.91) (never smoker) 3.04 (1.92, 4.84) (ever smoker)</td>
</tr>
<tr>
<td>Abraham, E.</td>
<td>1991 25</td>
<td>case-control</td>
<td>black tea</td>
<td>urinary tract</td>
<td>America</td>
<td>1977-1986</td>
<td>259/520</td>
<td>0 cup-years vs &gt;10 cups-years* (men) 0 cup-years vs &gt;10 cups-years* (women)</td>
<td>0.70 (0.4, 1.20) (men) 0.7 (0.30, 1.70) (women)</td>
</tr>
<tr>
<td>Kunze, E.</td>
<td>1992 24</td>
<td>case-control</td>
<td>black tea</td>
<td>urinary tract</td>
<td>Germany</td>
<td>1977-1985</td>
<td>283/486</td>
<td>0 cup/day vs ≥5 cups/day (men) 0 cup/day vs &gt;5 cups/day (women)</td>
<td>1.40 (0.70, 3.10) (men) 0.70 (0.20, 2.50) (women)</td>
</tr>
<tr>
<td>La Vecchia, E.</td>
<td>1992 32</td>
<td>case-control</td>
<td>tea</td>
<td>Bladder</td>
<td>Italy</td>
<td>1983-1990</td>
<td>365/6147</td>
<td>never vs ≥1 cup/day</td>
<td>0.80 (0.50, 1.10)</td>
</tr>
<tr>
<td>D'Avanzo, E.</td>
<td>1992 33</td>
<td>case-control</td>
<td>tea</td>
<td>Bladder</td>
<td>Italy</td>
<td>1985-1990</td>
<td>555/855</td>
<td>never vs ever</td>
<td>0.90 (0.60, 1.20)</td>
</tr>
</tbody>
</table>

*: Cup-years indicate number of cups/day×years. For example: 10 cups-years could equal 10 cups/day for one year.
Table 1. Study characteristics of published cohort and case-control studies on tea intake and bladder cancer (cont.)

<table>
<thead>
<tr>
<th>First author and year</th>
<th>Study design</th>
<th>Tea types</th>
<th>Anatomical site of urinary tract</th>
<th>Study location</th>
<th>Study period</th>
<th>Cases/Subjects</th>
<th>Tea consumption levels (lowest vs highest)</th>
<th>Pooled RR (95% CI)</th>
<th>Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bates et al, 2007</td>
<td>case-control</td>
<td>mate</td>
<td>Bladder</td>
<td>Argentina</td>
<td>1996-2000</td>
<td>114/114</td>
<td>≤0.09 L/day vs &gt;0.9 L/day (Mate con bombilla)</td>
<td>1.16 (0.46, 2.93)</td>
<td>sex, age, county of residence, level of education, cigarettes smoked per day, and an indicator variable for whether or not the other type of mate was consumed at that time</td>
</tr>
<tr>
<td>De Stefani et al, 2007</td>
<td>case-control</td>
<td>tea</td>
<td>Bladder</td>
<td>Uruguay</td>
<td>1996-2000</td>
<td>221/462</td>
<td>Never vs ≥7 cups/week</td>
<td>1.50 (0.80, 2.80)</td>
<td>age, sex, residence, urban/rural status, education, family history of bladder cancer among first-degree relatives, body mass index, occupation, smoking status, years since quitting, number of cigarettes smoked per day, mate drinking, soft drink intake, milk intake</td>
</tr>
<tr>
<td>Demirel et al, 2008</td>
<td>case-control</td>
<td>black tea</td>
<td>Bladder</td>
<td>Japan</td>
<td>2001-2006</td>
<td>/</td>
<td>0 cup/day vs ≥5 cups/day</td>
<td>0.74 (0.38, 1.43)</td>
<td>/</td>
</tr>
<tr>
<td>Jiang et al, 2008</td>
<td>case-control</td>
<td>tea</td>
<td>Bladder</td>
<td>America</td>
<td>1987-1999</td>
<td>1586/1586</td>
<td>&lt;1 cup/day vs ≥5 cups/day (men)</td>
<td>0.88 (0.54, 1.45)</td>
<td>education, NSAIDs, intake of carotenoids, number of years as a hairdresser/barber, smoking</td>
</tr>
<tr>
<td>Kurahashi et al, 2009</td>
<td>cohort</td>
<td>green tea</td>
<td>Bladder</td>
<td>Japan</td>
<td>1990-2005</td>
<td>206/104440</td>
<td>&lt;3 cup/day vs ≥5 cups/day (women)</td>
<td>0.9 (0.56, 1.45)</td>
<td>age, area, smoking status, alcohol, coffee</td>
</tr>
<tr>
<td>Hemelt et al, 2010</td>
<td>case-control</td>
<td>green and black tea</td>
<td>Bladder</td>
<td>China</td>
<td>2005-2008</td>
<td>432/392</td>
<td>Never vs ≥4 cups/day (green tea)</td>
<td>0.83 (0.53, 1.28)</td>
<td>age, sex, smoking status, smoking frequency, smoking duration</td>
</tr>
<tr>
<td>Ros et al, 2011</td>
<td>cohort</td>
<td>tea</td>
<td>Bladder</td>
<td>European</td>
<td>not mentioned</td>
<td>513/233236</td>
<td>&lt;12 ml/day (men) or 16 ml/day (women) vs ≥200 ml/day (men) or 264 ml/day (women)</td>
<td>0.91 (0.64, 1.30)</td>
<td>age and sex and centre</td>
</tr>
</tbody>
</table>

*: Cup-years indicate number of cups/day×years. For example: 10 cups/years could equal 10 cups/day for one year
positive and higher association of tea consumption with risk of bladder cancer in smokers. We found that generally, smokers had higher tea consumption compared to non-smokers, and that the persons of no smoking and no drinking tea had a 2-fold increased risk compared to the persons of no smoking and drinking tea in a previous analysis, and smoking was a specific risk factor to bladder cancer. So in smokers, tea consumption may increase risk of bladder cancer, and the mechanism of this is unclear.

A completely novel finding of the present study compared with the previous meta-analysis was that high intake of black tea in females was associated with a statistically marginal reduced risk of bladder cancer, but the same association was not found with in green tea. Black tea (78%) is the most commonly consumed tea worldwide. Many in vitro and animals studies suggest that thearubigins and theaflavins that exist in black tea, specifically theaflavin-3,3′-digallate, have strong antioxidant activity and could reduce tumor formation, tumor size and cellular proliferation. In females, the androgen is much more lower than in male, and the androgen deprivation (androgen inhibitor) is a novel finding in bladder cancer treatment. In addition to these, less smoking and alcohol consumption could be found in females compared to males. So the anti-tumor effect on bladder cancer of black tea was reasonably better in females than in males. However, the total phenol content and antioxidant capacity of green tea have been shown to be much higher than that of black tea, but no association between green tea consumption and bladder cancer risk were found in this meta-analysis. Although this finding was very interesting and novel, it should be interpreted with caution because the subgroup analysis (black tea and green tea) included data from only 6 and 5 studies.

Five studies on urinary tract cancer were included in the present meta-analysis. Because the overwhelming majority of urinary tract tumors occurred in the bladder and, since the renal pelvis and urethra are covered by the same urothelium as the urinary bladder, no biologically plausible difference would be expected.

Our meta-analysis has several important limitations which should be taken into account when interpreting our results. Firstly, analytic comparisons varied a great deal across studies in this analysis. Different units (times/d, cups/d, cups/wk, ml/d, frequency/wk, cups/y) were found in each study with regard to tea consumption data. Secondly, only few studies were included in each subgroup (sex, smoking, geographical region). Thirdly, loss of follow-up in cohort study and recall bias in case-control study maybe exist. These differences may have contributed to the heterogeneity among studies (overall tea, green tea, black tea and some other subgroups). Lastly, we were prone to collect published studies, and the language of such publications was limited to English, so the publication bias maybe inevitable, even though no significant evidence of publication bias was observed.

In conclusion, our meta-analysis suggests that there was an absence of an association between tea intake and the risk of bladder cancer; however, high intake of overall tea in smokers and low intake of black tea in women may increased the risk of bladder cancer according to the results found in theses limited number studies. Further studies are needed to confirm these findings.

### Table 2. Summary of pooled risk ratios of bladder cancer for the highest versus lowest category of tea intake by study design, sex, geographic region, smoking, publication years

<table>
<thead>
<tr>
<th>Analysis specifications</th>
<th>Number of studies</th>
<th>Pooled RR (95% CI)</th>
<th>p-values for interaction or moderation effect between the stratified factor and tea consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall tea</td>
<td>15</td>
<td>1.09 (0.85-1.40)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Study design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cohort</td>
<td>3</td>
<td>0.64 (0.40-1.04)</td>
<td>0.05</td>
</tr>
<tr>
<td>Case-control</td>
<td>12</td>
<td>1.22 (0.95-1.57)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>3</td>
<td>1.34 (0.62-2.88)</td>
<td>0.03</td>
</tr>
<tr>
<td>Women</td>
<td>3</td>
<td>0.93 (0.56-1.53)</td>
<td>0.98</td>
</tr>
<tr>
<td>Geographical region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Americas</td>
<td>9</td>
<td>1.19 (0.86-1.64)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>European</td>
<td>4</td>
<td>0.91 (0.75-1.11)</td>
<td>0.64</td>
</tr>
<tr>
<td>Other continents</td>
<td>2</td>
<td>1.26 (0.21-7.49)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever</td>
<td>3</td>
<td>1.77 (1.04-3.01)</td>
<td>0.02</td>
</tr>
<tr>
<td>Never</td>
<td>3</td>
<td>1.35 (0.69-2.65)</td>
<td>0.08</td>
</tr>
<tr>
<td>Adjustments*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥3</td>
<td>7</td>
<td>1.01 (0.80-1.29)</td>
<td>0.06</td>
</tr>
<tr>
<td>&lt;3</td>
<td>8</td>
<td>1.00 (0.65-1.57)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Publication years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before 2000</td>
<td>8</td>
<td>1.22 (0.80-1.88)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>After 2000</td>
<td>7</td>
<td>0.95 (0.73-1.23)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Black tea</td>
<td>6</td>
<td>0.84 (0.70-1.01)</td>
<td>0.88</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4</td>
<td>0.91 (0.71-1.18)</td>
<td>0.48</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>0.61 (0.38-0.98)</td>
<td>0.88</td>
</tr>
<tr>
<td>Green tea</td>
<td>5</td>
<td>1.03 (0.82-1.31)</td>
<td>0.83</td>
</tr>
</tbody>
</table>

*: adjusted for at least three of the following factors: age, gender, BMI, smoking, and energy intake.
Figure 2. Pooled relative risks (highest in contrast to lowest category) for 15 studies of overall tea intake (a), 5 studies of green tea intake (b), 6 studies of black tea intake (c) and bladder cancer risk.
AUTHOR DISCLOSURES
The authors have declared that no competing interests exist.

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Original Article

The association of tea consumption with bladder cancer risk: a meta-analysis

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喝茶与膀胱癌发生的整合分析

目前有关喝茶与膀胱癌的关系在动物实验中已经得以证实，但在 2001 年一篇研究却表明，喝茶与人类膀胱癌的发生无相关性。时至今日，为了能更精确的证明二者的关系，我们对此进行整合分析。通过 Pubmed 检索工具收集 1980 年 1 月至 2012 年 3 月的所有关于喝茶与人类膀胱癌发生的前瞻性及回顾性研究，并且基于喝茶量的极值（最大值和最小值），利用随机效应模型计算 RR 和 CI。最终纳入 24 篇相关文献（6 篇为队列研究，18 篇为病例-对照研究）进行整合分析。研究结果表明，对于未分类的茶而言，喝茶与膀胱癌发生无相关性（RR= 1.09, 95%CI: 0.85-1.40）。但在亚组分析中，却发现抽烟人群喝茶反而轻度增加膀胱癌的发生率（RR= 1.77, 95%CI: 1.04-3.01）。喝红茶与膀胱癌的发生无相关性（RR= 0.84, CI: 0.70-1.01）；但女性喝红茶可略减低膀胱癌发生的风险（RR= 0.61, 95%CI: 0.38-0.98）；喝绿茶与膀胱癌的发生无相关性（RR= 1.03, 95% CI: 0.82-1.31）。因此，由整合分析的结论为，抽烟人群喝茶可增加膀胱癌的发生，女性喝红茶则可降低膀胱癌的发生。

关键词：膀胱癌、未分类茶、红茶、绿茶、整合分析