RESEARCH ARTICLE

Tea Consumption, Alcohol Drinking and Physical Activity Associations with Breast Cancer Risk among Chinese Females: a Systematic Review and Meta-analysis

Ying Gao[1], Yu-Bei Huang[2], Xue-Ou Liu[2], Chuan Chen[2], Hong-Ji Dai[2], Feng-Ju Song[2], Jing Wang[1], Ke-Xin Chen[2]*, Yao-Gang Wang[1]*

Abstract

Objective: To evaluate associations between tea consumption, alcohol drinking and physical activity and breast cancer risk among Chinese females. Methods: Three English databases (PubMed, ScienceDirect and Wiley) and three Chinese databases (CNKI, WanFang and VIP) were independently searched by 2 reviewers up to December 2012, complemented by manual searches. The quality of included studies was assessed with the Newcastle-Ottawa Scale items. Random-effects models were used to estimate the pooled odds ratios (ORs) and 95% confidence intervals (CIs). Potential publication bias was estimated through Egger's and Begg's tests. Heterogeneity between studies was evaluated with I^2 statistics. Results: Thirty-nine studies involving 13,204 breast cancer cases and 87,248 controls were identified. Compared with non-drinkers, regular tea drinkers had decreased risk (OR=0.79, 95%CIs: 0.65-0.95; I^2=84.9%; N=16). An inverse association was also found between regular physical activity and breast cancer risk (OR=0.73, 95%CIs: 0.63-0.85; I^2=77.3%; N=15). However, there was no significant association between alcohol drinking and breast cancer risk (OR=0.85, 95%CIs: 0.72-1.02; I^2=63.8%; N=26). Most of the results from the subgroup analysis were consistent with the main results. Conclusion: Tea consumption and physical activity are significantly associated with a decreased risk of breast cancer in Chinese females. However, alcohol drinking may not be associated with any elevation of risk.

Keywords: Breast cancer - tea consumption - alcohol drinking - physical activity - system review - meta-analysis

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Introduction

Breast cancer is the most common cancer in women worldwide. In China, both the incidence and mortality of breast cancer have increased at a high speed during the past decades (Li et al., 2012) and would continue to climb in the following years (Zhang et al., 2008). Whereas the factors responsible for the increasing rate of breast cancer in China remain unknown. Hence, to explore effective preventive interventions is a main focus for the prevention and control of breast cancer. Smoking as an independent risk factor of breast cancer, we will independently expound the association between them in another systematic review. In addition, tea consumption, alcohol drinking and physical activity were the most closely modifiable risk factors for breast cancer except smoking, so this study focuses on the possible quantitative relationship between these three modifiable factors and breast cancer risk among Chinese female.

Historically, as part of traditional Chinese life, tea consumption can be traced to several thousand years ago. Compelling evidence suggested that tea is rich in polyphenols, including catechins and gallocatchins, which have been reported to have antioxidant property and potential anti-tumor effect, especially for epigallocatechin-3-gallate (EGCG) (Landis-Piwowar et al., 2007; Shimizu et al., 2008). However, epidemiologic studies focused on the association between tea consumption and breast cancer risk have reported inconsistent results (Ewertz et al., 1990; La et al., 1992; Tao et al., 2002; Wu et al., 2003; Zhang et al., 2007; Shrubsole et al., 2009). Some Western studies reported no benefit (Ewertz et al., 1990; La et al., 1992), but most of Chinese studies suggested an inverse association (Tao et al., 2002; Wu et al., 2003; Zhang et al., 2007; Shrubsole et al., 2009). With high consumption of tea and increasing incidence of breast cancer in China, it's very important to investigate the effect of tea on breast cancer.

In addition, alcohol drinking is also another traditional part of Chinese life. According to the national investigation, the prevalence rate of alcohol consumption in China has increased from 17.94% in 1991 (PRC, 1995) to 21.0%

*[1]Department of Social Medicine and Health Service Management, School of Public Health, [2]Department of Epidemiology and Biostatistics, Key Laboratory of Cancer Prevention and Therapy, Key Laboratory of Breast Cancer Prevention and Therapy, Tianjin Medical University, Ministry of Education, National Clinical Research Center for Cancer, Tianjin Medical University Cancer Institute and Hospital, Tianjin, China *For correspondence: chenkexin1963@yahoo.com, wyg@tijmu.edu.cn*

in 2002 (Ma et al., 2005). In parallel, there is a marked increase in the prevalence rate of alcohol dependence, which has moved from the ninth to the third most prevalent mental illness (Cochrane et al., 2003). Although alcohol drinking was considered as an important risk factor for breast cancer in Western countries (Key et al., 2006), this association was still unclear for Chinese female. A recent study reported that alcohol drinking was associated with an elevated risk of breast cancer (Odds Ratios = 1.86, 95% Confidence Intervals: 1.02-3.39) (Gao et al., 2013). However, one study showed an inverse association (OR = 0.63; 95%CI: 0.52-0.76) (Zhang et al., 2011), while another found no relationship between them (OR = 1.50; 95%CI: 0.74-1.02) (Wang et al., 2013). Hence, it is necessary to clarify the association between alcohol drinking and breast cancer risk among Chinese female.

Since the first epidemiologic study on physical activity and breast cancer risk was published in 1985 (Frisch et al., 1985), more than 80 studies have been conducted to assess this association worldwide during the past 20 years (Friedenreich et al., 2008). The meta-analysis found that the risk of breast cancer had decreased approximately 50% among Asian women exercisers (Friedenreich et al., 2008). Another meta-analysis reported that this inverse association was only statistically significant among women in Western countries, but not in Asian countries (OR: 0.82; 95%CI: 0.62-1.08) (Wu et al., 2013). As another modifiable risk factor, numerous epidemiologic studies suggested physical activity has a protective role in breast cancer development in Western female, but it is unclear whether the empirical findings in Western countries will hold in Asian countries, especially in China. In order to increase statistical power and clarify these conflicting results, a large-scale population-based systematic review was conducted to determine the effects of these modifiable behavioral factors on breast cancer risk among Chinese female.

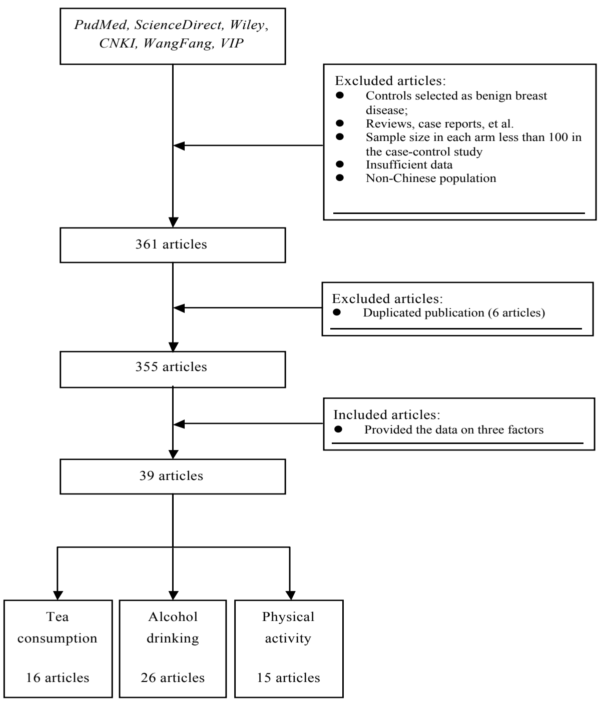

Figure 1. Flowchart of the Included Studies

Materials and Methods

This systematic review was conducted according to the MOOSE guidelines (Stroup et al., 2000).

Search strategy

Three English databases (ScienceDirect and Wiley) and three Chinese databases (WanFang and VIP) were independently searched by two reviewers up to December 2012, complemented by manual searching of reference. We used the following three groups of key words in the searching strategies: (1) case-control study, cohort study, prospective study, and randomized controlled trial; (2) breast cancer, breast carcinoma, breast tumor, breast neoplasm, mammary cancer, mammary carcinoma, mammary tumor, and mammary neoplasm; (3) risk factors, behavior factor, tea, drinking, alcohol drinking, physical activity, and exercise. Paper in English or Chinese was reviewed, and only studies on Chinese female were included.

Selection of Studies

Two reviewers independently determined the selection of studies. All included articles must provide a complete cross-table data of exposure with outcomes. Systematic reviews, meta-analysis, case-report, and studies with control selected from subjects with benign breast disease were excluded. For the different articles from the same study, only studies which had the largest sample size or most update data were included in the analysis.

Data Extraction and Quality Assessment

The data extraction and study quality assessment were independently performed by two reviewers. The following information was collected with standardized data extraction forms: the first author, publication year, region of China, type of study, original sample size, and sources of population. All data entry was double-checked. The Newcastle-Ottawa Scale (NOS) item (Wells et al., 2012) was used to assess the quality of included studies based on three broad perspectives: the selection of the study groups; the comparability of the groups; and the ascertainment of either the exposure or outcome of interest for case-control or cohort studies, respectively. Studies were classified into three levels: high quality with scores greater than 7, moderate quality with scores between 5-7, and low quality with scores less than 5.

Any disagreement on selection of studies, data collection, and quality assessment was adjudicated by a third reviewer.

Statistical Analysis

Pooled odds ratios (ORs) and 95% confidence intervals (95%CIs) were calculated with random effects model, and weighted with inverse of the variance. Statistical heterogeneity between studies was evaluated with I^2 statistic, and heterogeneity was considered significant when the two-tailed P value was less than 0.10 (Hedges et al., 2001).

Subgroup analysis were used to explore the heterogeneity source, including the type of study, the

Table 1. The Main Characteristics of Included Studies

NO.	Author	Year	Region	Type	Case	Control	NOS#	Included*
1	Dai	2010	Shanghai	Cohort	21507	51304	A	1
2	Li	2005	Shanghai	Cohort	130	1070	A	1
3	Wang	2006	Zhejiang	Cohort	84	269	A	1,2,3
4	Shrubsole	2011	Shanghai	Cohort	718	72519	A	2
5	Pronk	2011	shanghai	Cohort	717	72332	A	3
6	Shannon	2005	Shanghai	Cohort	378	1070	A	3
7	Wang	2013	Taiwan	Case-control	157	314	B	1,2,3
8	Zhang M	2012	Zhejiang	Case-control	252	248	B	1,2
9	Yu	2012	Shandong	Case-control	103	309	B	1,2,3
10	Shi	2010	Jiangsu	Case-control	223	223	B	1,3
11	Shrubsole	2009	Shanghai	Case-control	3454	3474	A	1
12	Wang	2008	Beijing	Case-control	429	781	C	1,2
13	Ren	2008	Liaoning	Case-control	200	200	B	1,2,3
14	Zhang	2007	Zhejiang	Case-control	1009	1009	B	1
15	Jin	2007	Jiangsu	Case-control	206	214	B	1,2,3
16	Lee	2005	Taiwan	Case-control	250	219	B	1
17	Tao	2002	Shanghai	Case-control	356	925	C	1
18	Zou	2002	Hubei	Case-control	112	112	B	1,2
19	Zhao	1999	Sichuan	Case-control	265	265	B	1,2
20	Xu	2012	Multi-center	Case-control	416	1156	B	2,3
21	Bao	2011	Shanghai	Case-control	3443	3474	A	2
22	Leu	2011	Taiwan	Case-control	255	324	C	2
23	Dai	2011	Tianjin	Case-control	1528	1605	B	2,3
24	Zhang	2011	Zhejiang	Case-control	1009	1009	B	2
25	Qian	2010	Jiangsu	Case-control	698	813	B	2
26	Wang	2009	Chongqing	Case-control	367	367	B	2
27	Zhang	2009	Guangdong	Case-control	438	438	B	2,3
28	Gao	2009	Jiangsu	Case-control	669	682	A	2
29	Ma	2007	Shandong	Case-control	105	100	B	2
30	Chou	2006	Taiwan	Case-control	146	285	B	2
31	Li	2006	Liaoning	Case-control	620	620	B	2
32	Huang	2006	Guangdong	Case-control	133	133	B	2
33	Chow	2005	HongKong	Case-control	198	358	B	2
34	Xu	1997	Hebei	Case-control	101	101	B	2
35	Lu	1992	Shanghai	Case-control	552	552	B	2
36	Hou	2012	Shandong	Case-control	200	400	B	3
37	Gao	2009	Jiangsu	Case-control	669	682	A	3
38	Kallianpur	2008	Shanghai	Case-control	3454	3474	A	3
39	Zhang	2003	Shanghai	Case-control	1517	1573	B	3

Note: NOS#: Newcastle-Ottawa Scale. A, NOS score = 8-9; B, NOS score = 5-7; C, NOS score ≤4; Included*: 1, included in the paper of green tea consumption; 2, included in the paper of alcohol drinking; 3, included in the paper of physical exercise

quality of articles, sample size (≥1000 vs. <1000), and publication year (After 2007 vs. before 2007). The potential publication bias was examined with Egger's test (Egger et al., 1997) and Begg's test (Begg et al., 1994) and represented by a funnel plot. The results were considered to indicate publication bias when any *P* value of these two tests was less than 0.05. All the analyses were performed using STATA version 12.0 software.

Results

Description of studies

A detailed diagram of the review process was presented in Figure 1. Totally 361 relevant articles were identified and reviewed in detail. Six studies were excluded because they involved the same study subjects included in other articles. After reviewing the full text of these studies in detail, a total of 39 articles, involving 100,452 participants from 14 provinces, municipalities and regions, were included in the final review (Appendix 1). Among these included studies, we identified 6 cohort studies (Li et al., 2005; Shannon et al., 2005; Wang et al., 2006; Dai et al., 2010; Pronk et al., 2011; Shrubsole et al., 2011;) and 33 case-control studies (Lu et al., 1992; Xu et al., 1997; Zhao et al., 1999; Tao et al., 2002; Zou et al., 2002; Zhang et al., 2003; Chow et al., 2005; Lee et al., 2005; Chou et al., 2006; Huang et al., 2006; Li et al., 2006; Jin, 2007; Ma, 2007; Zhang et al., 2007; Kallianpur et al., 2008; Ren, 2008; Wang et al., 2008; Gao et al., 2009; Gao et al., 2009; Shrubsole et al., 2009; Wang et al., 2009; Zhang et al., 2009; Qian et al., 2010; Shi et al., 2010; Bao et al., 2011; Dai et al., 2011; Leu et al., 2011; Zhang et al., 2011; Hou et al., 2012; Xu et al., 2012; Yu et al., 2012; Zhang et al., 2012; Wang et al., 2013). According to the NOS items, 11 studies were evaluated as high quality, 25 studies as modest quality, and 3 studies as low quality, respectively. The main characteristic of included studies was summarized in Table 1.

Table 2. The Results of Subgroup Analysis Included All Studies of Tea

Subgroup	N	Exposure/Case	Exposure/Control	OR(95%CI)	I^2	*P* values
Type of study						
Case-control	13	2317/6929	3258/8198	0.71(0.58-0.87)	83.3	<0.001
Cohort	3	285/828	21875/73586	1.15(0.99-1.34)	0	0.765
NOS level						
High quality	4	1311/4199	22950/76966	1.06(0.91-1.23)	45.4	0.141
Moderate quality	10	1012/2777	1424/3112	0.69(0.56-0.85)	64.9	0.002
Low quality	2	279/781	759/1706	0.66(0.38-1.13)	89.1	0.003
Sample size						
≥1000	6	2021/5905	24320/79412	0.78(0.56-1.09)	94.5	<0.001
<1000	10	581/1852	813/2372	0.77(0.67-0.89)	0	0.61
Year of publication						
After 2007	8	1590/5349	23202/77702	0.77(0.61-0.96)	80.9	<0.001
Before 2007	8	1012/2408	1931/4082	0.82(0.59-1.12)	85.3	<0.001

Table 3. The Result of Subgroup Analysis Included All Studies of Alcohol Drinking

Subgroup	N	Exposure/Case	Exposure/Control	OR(95%CI)	I^2	*P* values
Type of study						
Case-control	24	1127/12312	1492/14301	0.86(0.72, 1.03)	66	<0.001
Cohort	2	16/802	1680/72788	0.73(0.29, 1.85)	26	0.245
NOS level						
High quality	4	209/4914	1891/76944	0.98(0.67-1.43)	51.9	0.101
Moderate quality	20	903/7516	1181/9040	0.89(0.72-1.10)	65.1	<0.001
Low quality	2	31/684	100/1105	0.46(0.31-0.71)	0	0.658
Sample size						
≥1000	10	951/9993	2893/83056	0.84(0.68-1.05)	76.5	<0.001
<1000	16	192/3121	279/4033	0.89(0.65-1.21)	51	0.01
Year of publication						
After 2007	15	786/10593	2798./84084	0.78(0.64-0.94)	59.9	0.002
Before 2007	11	357/2521	374/3005	1.01(0.75-1.37)	53.5	0.018

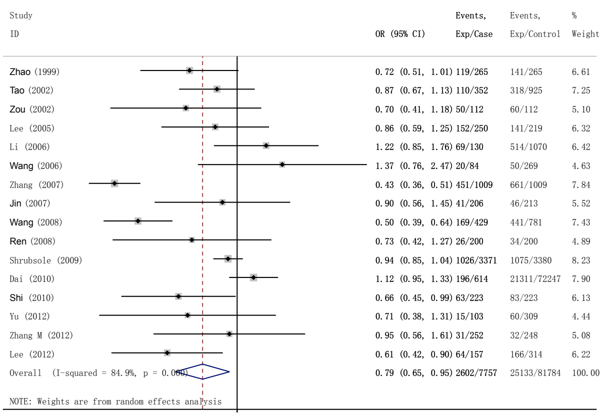

Figure 2. Forest Chart Based on All Studies of Tea Consumption (Yes Vs. No) with Breast Cancer

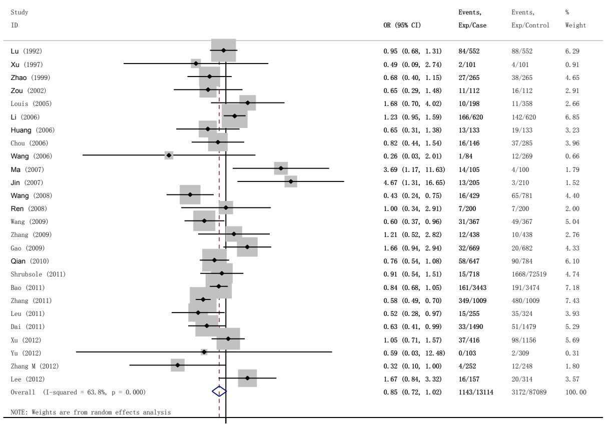

Figure 3. Forest Chart Based on All Studies of Alcohol Drinking (Yes Vs. No) with Breast Cancer

Tea consumption

Three cohort studies and thirteen case-control studies on tea consumption were included, involving 28,737 cases and 60,936 controls. Overall, there was a marginally significant reduction in risk of breast cancer among tea drinkers when compared to nondrinkers (OR = 0.79, 95%CIs: 0.65-0.95; I^2=84.9%, *P*<0.001; N=16) (Figure 2). Visual inspection of funnel plot with Egger's test (*P*=0.656) and Begg's test (*P*=0.893) did not show publication bias (Appendix 2a).

Subgroup analysis had showed significant inverse association between tea consumption and breast cancer among case-control studies (OR = 0.71, 95%CIs: 0.58-0.87), studies of moderate quality (OR = 0.69, 95%CIs: 0.56-0.85), studies with sample size less than 1000 (OR = 0.77, 95%CIs: 0.67-0.89), and studies published after 2007 (OR = 0.77, 95%CIs: 0.61-0.96), but no significant associations observed in other subgroup studies.

Alcohol drinking

Two cohort studies and twenty-four case-control studies on alcohol drinking were included, involving 13,204 cases and 87,248 controls. No significant association between alcohol drinking and breast cancer was found (OR = 0.85, 95%CIs: 0.72-1.02; I^2=63.8%, *P*<0.001; N=26) (Figure 3). As showed in the funnel plot (Appendix 2b), combing with Egger's test (*P*=0.092) and Begg's test (*P*=0.290), there was no publication bias

Table 4. The Result of Subgroup Analysis Included All Studies of Physical Activity

Subgroup	N	Exposure/Case	Exposure/Control	OR(95%CI)	I^2	*P* values
Type of study						
Case-control	12	2440/9027	3467/10562	0.69(0.59-0.82)	77.8	<0.001
Cohort	3	561/1179	26328/73671	0.89(0.72-1.11)	42.4	0.176
NOS level						
High quality	5	1965/5300	28005/77827	0.82(0.72-0.94)	53.6	0.072
Moderate quality	10	1036/4906	1790/6406	0.68(0.53-0.86)	81.2	<0.001
Sample size						
≥1000	7	2412/8596	28834/81870	0.75(0.65-0.87)	77.8	<0.001
<1000	8	589/1610	961/2363	0.71(0.51-0.99)	79.1	<0.001
Year of publication						
After 2007	114	2397/8021	28464/81108	0.73(0.60-0.87)	82.2	<0.001
Before 2007	4	604/2185	1331/3125	0.75(0.60-0.93)	45.5	0.139

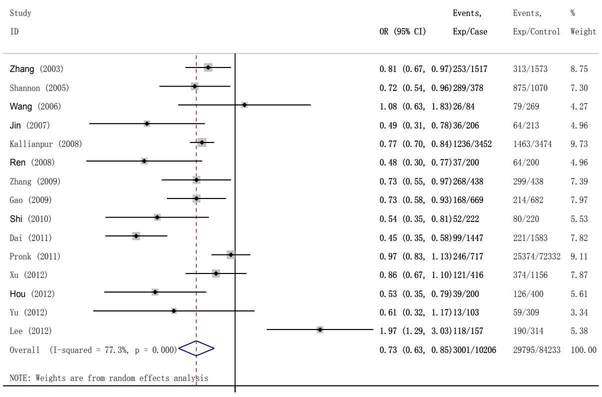

Figure 4 . Forest Chart Based on All Studies of Physical Activity (Yes Vs. No) with Breast Cancer

among these included studies.

Subgroup analysis had showed consistent no relationship between alcohol drinking and breast cancer for most of subgroup studies, except studies of low quality and studies published after 2007 (Table 3).

Physical activity

Three cohort studies and twelve case-control studies on physical activity were included, involving 10,290 cases and 84,259 controls. A significant protective effect was observed between physical activity and breast cancer risk (OR = 0.73, 95%CIs: 0.63-0.85; I^2=77.3%, *P*<0.001; N=15) (Figure 4). There was no publication bias from funnel plot, Egger's test (*P*=0.909) or Begg's test (*P*=0.488) (Appendix 2c).

Subgroup analysis had showed consistent protection effects of physical activity on the risk of breast cancer for most of subgroup studies with the exception of cohort studies (Table 4).

Discussion

This systemic review evaluated the impact of three common modifiable exposures on breast cancer risk for Chinese female. And we found that tea consumption and physical activity were significantly associated with a decreased risk of breast cancer. Alcohol drinking, however, was not associated with the risk of breast cancer.

Firstly, numerous animal studies have investigated the effects of tea and tea polyphenols on mammary cancer and shown beneficial results, including delaying mammary tumor onset, and reducing the number of invasive tumors (Liao et al., 1995; Sartippour et al., 2002; Baliga et al., 2005; Kaur et al., 2007). The population-based studies also found a protective effect of tea consumption against breast cancer (Tao et al., 2002; Wu et al., 2003). Our results were similar to a recently published systematic review, which found that green tea consumption significantly reduced the breast cancer risk by 19% (OR = 0.81; 95%CI: 0.68-0.99) (Ren et al., 2013). However, other four population-based systematic reviews showed inconsistent results. One meta-analysis found that green tea but not black tea consumption was associated with a weak reduction risk of breast cancer (OR = 0.78; 95%CI: 0.61-0.98) (Sun et al., 2006). Another meta-analysis of all studies reported no association between green tea and breast cancer, but case-control studies suggested the beneficial effect of green tea (OR = 0.81, 95%CI: 0.75-0.88) (Ogunleye et al., 2010). Another two systematic reviews also did not support the protective effect of green tea on breast cancer (Seely et al., 2005; Wu et al., 2013). After revising the previous five systematic reviews (Seely et al., 2005; Wu et al., 2005; Sun et al., 2006; Ogunleye et al., 2010; Ren et al., 2013), all of them included two Japanese cohort studies (key et al., 1999; Suzuki et al., 2004) which reported no relationship between tea consumption and breast cancer. One study by Key et al reported that majority of subjects were atomic bomb survivors of Hiroshima and Nagasaki, Japan (Key et al., 1999), the other study by Suzuki et al reported that subjects with higher tea intake tended to be postmenopausal, slightly older and had a higher body mass index which may be confounding variables (Suzuki et al., 2004). Therefore, including these studies would inevitably incur bias in these previous systematic reviews. That might be the most important reasons for the differences between our study and previous studies. Besides, type of tea, dose of daily intake, years of drinking, might also contribute to the differences (Wu et al., 2013), though current systematic review could not provide the direct evidence of the differences.

Secondly, the results of our review on breast cancer in relation to alcohol drinking were in agreement with two Japanese cohort studies, which demonstrated that alcohol drinking had no effect on breast cancer risk (Chisato et al., 2007; Kawai et al., 2011;). A meta-analysis showed drinking alcohol may slightly decrease the risk of breast cancer among Chinese female (Li et al., 2011), but it only included four articles and omitted 9 major important studies on this association, including a population-based prospective study from the Shanghai Women's Health Study (Shrubsole et al., 2011), a large population-based case-control study from the Shanghai Breast Cancer Study (Bao et al., 2011), two studies of high quality (Gao et al., 2009; Dao et al., 2011), and five studies with large sample size (Lu et al., 1992; Li et al., 2006; Wang et al., 2009; Qian et al., 2010; Xu et al., 2012). Omission of these studies would necessarily incur publication bias and finally biased the pooled results. Beside, previous Western studies indicated that alcohol drinking was associated with an elevated risk of breast cancer (Smith-Wamer et al., 1998; Hamajima et al., 2002). The differences between our study and western studies probably were due to the prevalence of alcohol drinking, the daily dose of alcohol, the type of alcohol drinking and some unknown biologic effects. For example, the reported prevalence rate of alcohol drinking among Chinese female had increased from 2.58% in 1993 (PRC, 1995) to 4.5% in 2002 (Ma et al., 2005), while the prevalence is reported to be 59.9% in American women, 81.9% in British women, 89.6% in French women, respectively (WHO). In addition, the daily dose of distilled spirits among Chinese female was about 50-100 gram, which was less than those reported in the Europe and American. According to the alcohol consumption data provided by World Health Organization in 2003-2005, the pure alcohol consumption per capita was approximately 5.19 liters for Chinese females 15 years and older (WHO), which was much lower than average 10 liters for Western females, such as 8.45 liters for American women, 9.46 liters for British women, 8.79 for French women, 8.43 liters for Swedish women, 15.58 liters for Spanish women, 7.78 for German women, and 5.75 liters for Japanese women (WHO). Moreover, distilled spirits was the first choice for 50.3%current drinkers in China. But in Europe and American, beer and wine were more preferred for drinkers (WHO). Likewise, racial differences in the metabolism of alcohol (Yu et al., 1995) and estrogen (Taioli et al., 1996) had also been reported to affect the relationship between alcohol drinking and breast cancer in different ethnics. For example, 10398G allele in the mitochondrial genome was reported to influence the alcohol metabolism, which may also modify the association between alcohol drinking and breast cancer (Pezzotti et al., 2009).

Additionally, consistent J-shaped curve of alcohol drinking on the risk of diseases was found in many cardiovascular diseases (White et al., 1999; Gmel et al., 2001). Whether the J-shaped curve also existed in the incidence of breast cancer, it really deserved further studies. And whether the type of alcohol drinking could bring different effect on the risk of breast cancer, it also needed more representative studies. In a word, though small drinking of alcohol might bring health benefits, especially for preventing cardiovascular disease, it was not suggested as a strategy for the prevention of breast cancer, because of more potential health harms against benefits. In fact, stay away from alcohol may be one of the healthiest lifestyle.

Lastly, the protective effect of regular physical activity on the risk of breast cancer was also consistent with a previous meta-analysis, which found that a decreased breast cancer risk of approximately 50% in Asian women (Friedenreich et al., 2008). Another meta-analysis, however, reported that this protective effect was not statistically significant among Asian women (OR = 0.82; 95%CI: 0.62-1.08) (Wu et al., 2013). Although the latter meta-analysis had included three prospective studies on Asian women, an important large population-based cohort study from Shanghai Breast Self-Examination study has been omitted (Shannon et al., 2011). Moreover, it included some articles which only provided the multivariate-adjusted relative risk (RR) with 95% confidence intervals (CIs). Due to different confounding variables were adjusted in different studies, pooling these results from different calculation methods might bring more confounding rather than get a clearer result. Furthermore, Chinese National Nutrition and Health Survey in 2002 reported that the current prevalence of exercise was only 15.1% for Chinese residents in urban, which was great lower than 50.6% for American female (WHO). Along with the low rate of exercise and increasing incidence of breast cancer, it is beneficial and meaningful to initiates health promotion campaigns for Chinese female. In addition, some studies also reported that common daily activities also could slightly reduce the risk of women breast cancer, when comparing to sedentary lifestyle (McTieman et al., 2003; Friedenreich et al., 2008). Hence, mild exercise was also suggested for Chinese female who were mainly responsible for daily housework. Besides, Tai Chi, a Chinese martial art, was also thought to promote health through slow moving exercise and breathing techniques. In overall, the results of the current study show that physical activity is an important protective factor for Chinese female. National physical activity promotion programs should be developed and tailored to the needs for women as a public health recommendation.

There were several potential limitations to be considered in this meta-analysis. Primarily, due to lack of enough information, results from our studies could not provide more detailed information of dose-response relationship between three lifestyles and risk of breast cancer, though we made great efforts to get relative information. Secondly, our results were likely to be affected by heterogeneity, because the tests for heterogeneity between different studies suggested that there was a strong heterogeneity. In order to explore the potential sources of heterogeneity, a lot of subgroup analyses were conducted according to the majors attributes of primary studies. And the results of different subgroups were relatively consistent with the major results, which meant that our results were relatively credible. Finally, it is possible that an observed association might suffer from publication bias in a meta-analysis, because studies with null results tend not to be published. However, no significant publication bias was detected most of results.

In conclusion, tea consumption and physical activity are significantly associated with a decreased risk of breast cancer for Chinese female. However, alcohol drinking may not be related with the risk of breast cancer. It's very necessary to promote tea consumption and physical activity for the purpose of preventing breast cancer, but it's not recommended to prevent breast cancer with alcohol drinking among Chinese female.

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References

Begg CB, Mazumdar M (1994). Operating characteristics of a rank correlation test for publication bias. *Biometrics*, **50**, 1088-101.

Baliga MS, Meleth S, Katiyar SK (2005). Growth inhibitory and antimetastatic effect of green tea polyphenols on metastasis-specific mouse mammary carcinoma 4T1 cells in vitro and in vivo systems. *Clin Cancer Res*, **11**, 1918-27.

Bao PP, Shu XO, Gao YT, et al (2011). Association of hormone-related characteristics and breast cancer risk by estrogen receptor/progesterone receptor status in the shanghai breast cancer study, *Am J Epidemiol*, **174**, 661-71.

Cochrane J, Chen H, Conigrave KM, et al (2003). Alcohol use in China. *Alcohol* , **38**, 537-42.

Chow LW, Lui KL, Chan JC, et al (2005). Association between body mass index and risk of formation of breast cancer in Chinese women, *Asian J Surg*, **28**, 179-84.

Chou YC, Wu MH, Yu JC, et al (2006). Genetic polymorphisms of the methylenetetrahydrofolate reductase gene, plasma folate levels and breast cancer susceptibility: a case-control study in Taiwan. *Carcinogenesis*, **27**, 2295-300.

Chisato N, Mizoue T, Al E, et al (2007). Alcohol drinking and breast cancer risk: an evaluation based on a systematic review of epidemiologic evidence among the Japanese population. *Jpn J Clin Oncol*, **8**, 568-74.

Dai Q, Shu XO, Li H, et al (2010). Is green tea drinking associated with a later onset of breast cancer? *Ann Epidemiol*, 20, 74-81.

Dai H, Zhang L, Cao M, et al (2011). The role of polymorphisms in circadian pathway genes in breast tumorigenesis. *Breast Cancer Res Treat*, **127**, 531-40.

Ewertz M, Gill C (1990). Dietary factors and breast-cancer risk in Denmark. *Int J Cancer*, **46**, 779-84.

Egger M, Davey SG, Schneider M, et al (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, **315**, 629-34.

Frisch RE, Wyshak G, Albright NL, et al (1985). Lower prevalence of breast cancer and cancers of the reproductive system among former college athletes compared to non-athletes. *Br J Cancer*, **52**, 885-91.

Friedenreich CM, Cust AE (2008). Physical activity and breast cancer risk: impact of timing, type and dose of activity and population subgroup effects. *Br J Sports Med*, **42**, 636-47.

Gmel G, Rehm J, Frick U (2001). Methodological approaches to conducting pooled cross-sectional time series analysis: the example of the association between all-cause mortality and per capita alcohol consumption for men in 15 European states. *Eur Addict Res*, **7**, 128-37.

Gao CM, Tajima K, Ding JH, et al (2009). Body size, physical activity and risk of breast cancer - a case control study in Jiangsu Province of China. *Asian Pac J Cancer Prev*, **10**, 877-81.

Gao CM, Tang JH, Cao HX, et al (2009). MTHFR polymorphisms, dietary folate intake and breast cancer risk in Chinese women. *J Hum Genet*, **54**, 414-18.

Gao CM, Ding JH, Li SP, et al (2013). Active and passive smoking, and alcohol drinking and breast cancer risk in Chinese women. Asian Pac J Cancer Prev, **14**, 993-96.

Hedges LV (2001). The power of statistical tests in meta-analysis. *Psychol Methods*, 6, 203-17.

Hamajima N, Hirose K, Tajima K, et al (2002). Alcohol, tobacco and breast cancer--collaborative reanalysis of individual data from 53 epidemiological studies, including 58,515 women with breast cancer and 95,067 women without the disease. *Br J Cancer*, **87**, 1234-45.

Huang XM, Wang CX, Zhou YS, et al (2006). A elementary study on risk factors of breast cancer of women in Shenzhen Baoan area. *Central Plains Medical Journal*, **33**, 37-39. (in Chinese)

Hou ZG, Li GL, Ma XD, et al (2012). A study on prediction model of breast cancer risk factors in women living WeiFang. *Chin J Clinicians (Electronic Edition)*, **6**, 2181-83. (in Chinese)

Jin YL (2007). Case-control Study on the Association of Genetic Polymorphisms of ER and PR with the Risk of Breast Cancer. Zhejiang Medical University, Zhejiang, China. (in Chinese)

Key TJ, Sharp GB, Appleby PN, et al (1999). Soya foods and breast cancer risk: a prospective study in Hiroshima and Nagasaki, Japan. *Br J Cancer*, **81**, 1248-56.

Key J, Hodgson S, Omar RZ, et al (2006). Meta-analysis of studies of alcohol and breast cancer with consideration of the methodological issues. *Cancer Causes Control*, **17**, 759-70.

Kaur S, Greaves P, Cooke DN, et al (2007). Breast cancer prevention by green tea catechins and black tea theaflavins in the C3(1) SV40 T, tantigen transgenic mouse model is accompanied by increased apoptosis and a decrease in oxidative DNA adducts. *J Agric Food Chem*, **55**, 3378-85.

Kallianpur AR, Lee SA, Gao YT, et al (2008). Dietary animal-derived iron and fat intake and breast cancer risk in the Shanghai Breast Cancer Study. *Breast Cancer Res Treat*, **107**, 123-32.

Kawai M, Minami Y, Kakizaki M, et al (2011). Alcohol consumption and breast cancer risk in Japanese women: the Miyagi Cohort study. *Breast Cancer Res Treat*, **128**, 817-25.

La Vecchia C, Negri E, Franceschi S, et al (1992). Tea consumption and cancer risk. *Nutr Cancer*, **17**, 27-31.

Lu RF, Cai HP, Xu X, et al (1992). A case-control study for breast cancer of women in Shanghai. *Tumor*, **12**, 65-69.

Liao S, Umekita Y, Guo J, et al (1995). Growth inhibition and regression of human prostate and breast tumors in athymic mice by tea epigallocatechin gallate. *Cancer Lett*, **96**, 239-43.

Lin XY, Xu GF, Xu H (2001). Case-control study on the risk factors of breast cancer among women in Jinan. *Journal of Shangdong University (Health Science)*, **39**, 552-53. (in Chinese)

Lee MM, Chang IY, Horng CF, et al (2005). Breast cancer and dietary factors in Taiwanese women. *Cancer Causes Control*, **16**, 929-37.

Li W, Ray RM, Lampe JW, et al (2005). Dietary and other risk factors in women having fibrocystic breast conditions with and without concurrent breast cancer: a nested case-control study in Shanghai, China. *Int J Cancer*, **115**, 981-93.

Li N, He M, Zhang X, et al (2006). Breast cancer genetic epidemiology study and conditional logistic regression analysis of relative risk factors of female in hospital in Liaoning Province. *Chin J Cancer Prev Treat*, **13**, 101-06.

Landis-Piwowar KR, Huo C, Chen D, et al (2007). A novel prodrug of the green tea polyphenol (-)-epigallocatechin-3-gallate as a potential anticancer agent. *Cancer Res*, **67**, 4303-10.

Leu JD, Wang CY, Tsai HY, et al (2011). Involvement of p53 R72P polymorphism in the association of MDM2-SNP309 with breast cancer. *Oncol Rep*, **25**, 1755-63.

Li Y, Yang H, Cao J (2011). Association between alcohol consumption and cancers in the Chinese population--a systematic review and meta-analysis. *PLoS One*, **6**, e18776.

Li N, Zheng RS, Zhang SW, et al (2012). Analysis and prediction of breast cancer incidence trend in China. *Zhonghua Yu Fang Yi Xue Za Zhi*, **46**, 703-07. (in Chinese)

McTiernan A, Kooperberg C, White E, et al (2003). Recreational physical activity and the risk of breast cancer in postmenopausal women: the Women's Health Initiative Cohort Study. *JAMA*, **290**, 1331-36.

Ma GS, Zhu DH, Hu XQ (2005). A case-control study on risk factors of female breast cancer in Guangzhou. *Acta Nutrimenta Sinica*, **27**, 362-65.

Ma RL (2007). The association of serum hormoned levels with both risk and prognosis of female breast cancer. Shandong

University: Shandong, China. (in Chinese)
Ogunleye AA, Xue F, Michels KB (2010). Green tea consumption and breast cancer risk or recurrence: a meta-analysis. *Breast Cancer Res Treat*, **119**, 477-84.
PRC National Blood Pressure Survey Cooperative Group (1995). Alcohol consumption and blood pressure: a national-wide survey of 1991 in China. Chinese Journal of Hypertension, suppl, 50-54. (in Chinese)
Pezzotti A, Kraft P, Hankinson SE, et al (2009). The mitochondrial A10398G polymorphism, interaction with alcohol consumption, and breast cancer risk. *PLoS One*, **4**, e5356.
Pronk A, Ji BT, Shu XO, et al (2011). Physical activity and breast cancer risk in Chinese women. *Br J Cancer*, **105**, 1443-50.
Qian Y, Zhang JP, Dong J, et al (2010). Relationship between polymorphisms of X-ray repair cross-complementing group 1 gene Arg194Trp, Arg399Glin and susceptibility of breast cancer. *Chin J Prev Med*, **44**, 242-46.
Ren XN (2008). A 1:1 Case-control Study on Risk Factors of Breast Cancer. Dalian Medical University, Dalian, China. (in Chinese)
Ren GF, Yang JF (2013). Meta analysis of effect of green tea consumption on breast cancer risk, 34. *Nutrition and Health*, **34**,276-179. (in Chinese)
Smith-Warner SA, Spiegelman D, Yaun SS, et al (1998). Alcohol and breast cancer in women: a pooled analysis of cohort studies. *JAMA*, **279**, 535-40.
Stroup DF, Berlin JA, Morton SC, et al (2000). Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA*, **283**, 2008-12.
Sartippour MR, Heber D, Ma J, et al (2001). Green tea and its catechins inhibit breast cancer xenografts. *Nutr Cancer*, **40**, 149-56.
Sartippour MR, Shao ZM, Heber D, et al (2002). Green tea inhibits vascular endothelial growth factor (VEGF) induction in human breast cancer cells. *J Nutr*, **132**, 2307-11.
Suzuki Y, Tsubono Y, Nakaya N, et al (2004). Green tea and the risk of breast cancer: pooled analysis of two prospective studies in Japan. *Br J Cancer*, **90**, 1361-63.
Seely D, Mills EJ, Wu P, et al (2005). The effects of green tea consumption on incidence of breast cancer and recurrence of breast cancer: a systematic review and meta-analysis. *Integr Cancer Ther*, **4**, 144-55.
Shannon J, Ray R, Wu C, et al (2005). Food and botanical groupings and risk of breast cancer: a case-control study in Shanghai, China. *Cancer Epidemiol Biomarkers Prev*, **14**, 81-90.
Sun CL, Yuan JM, Koh WP, et al (2006). Green tea, black tea and breast cancer risk: a meta-analysis of epidemiological studies. *Carcinogenesis*, **27**, 1310-15.
Shimizu M, Fukutomi Y, Ninomiya M, et al (2008). Green tea extracts for the prevention of metachronous colorectal adenomas: a pilot study. *Cancer Epidemiol Biomarkers Prev*, **17**, 3020-25.
Shrubsole MJ, Lu W, Chen Z, et al (2009). Drinking green tea modestly reduces breast cancer risk. *J Nutr*, 139, 310-16.
Shi P, Xu M, Qian Y, et al (2010). Matched case-control study for detecting risk factors of breast cancer in women living WuXi. *Modern Preventive Medicine*, **37**, 2428-31. (in Chinese)
Shrubsole MJ, Shu XO, Li HL, et al (2011). Dietary B vitamin and methionine intakes and breast cancer risk among Chinese women. *Am J Epidemiol*, **173**, 1171-82.
Taioli E, Garte SJ, Trachman J, et al (1996). Ethnic differences in estrogen metabolism in healthy women. *J Natl Cancer Inst*, **88**, 617.
Tao MH, Liu DK, Gao LF (2002). Association between green tea drinking and breast cancer risk. *Tumor*, **22**, 176-80. (in Chinese)
White IR (1999). The level of alcohol consumption at which all-cause mortality is least. *J Clin Epidemiol*, **52**, 967-75.
Wu AH, Yu MC, Tseng CC, et al (2003). Green tea and risk of breast cancer in Asian Americans. *Int J Cancer*, **106**, 574-79.
Wang YQ (2006). Case-control study on the risk factors of breast cancer in Jiashan County. Zhejiang University, Zhejiang, China. (in Chinese)
Wang LY, Liu L, Tao MF, et al (2008). The association between diet and breast cancer research. *Maternal and Child Health Care of China*, **23**, 4630-31.
Wang B, Mi M, Wang J, et al (2009). Does the increase of endogenous steroid hormone levels also affect breast cancer risk in Chinese women? A case-control study in Chongqing, China, *Int J Cancer*, **124**, 1892-99. (in Chinese)
Wells GEA (2012). The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses.
Wang L, Liao WC, Tsai CJ, et al (2013). The effects of perceived stress and life style leading to breast cancer. *Women Health*, **53**, 20-40.
Wu Y, Zhang D, Kang S (2013). Black tea, green tea and risk of breast cancer: an update. *Springerplus*, **2**, 240.
Wu Y, Zhang D, Kang S (2013). Physical activity and risk of breast cancer: a meta-analysis of prospective studies. *Breast Cancer Res Treat*, **137**, 869-82.
WHO (2009). World Health Organization. Available from http://www.who.int/substance_abuse/publications/global_alcohol_report/profiles/usa.pdf. [Accessed December, 2013.]
WHO (2009). World Health Organization. Available from http://www.who.int/substance_abuse/publications/global_alcohol_report/profiles/gbr.pdf. [Accessed December 2013.]
WHO (2009). World Health Organization. Available from http://www.who.int/substance_abuse/publications/global_alcohol_report/profiles/fra.pdf. [Accessed December 2013.]
WHO (2009). World Health Organization. Available from http://www.who.int/substance_abuse/publications/global_alcohol_report/profiles/chn.pdf. [Accessed December 2013.]
WHO (2009). World Health Organization. Available from http://www.who.int/substance_abuse/publications/global_alcohol_report/profiles/jpn.pdf. [Accessed December 2013.]
Yu MC, Tang BK, Ross RK (1995). A urinary marker of alcohol intake. *Cancer Epidemiol Biomarkers Prev*, **4**, 849-55.
Xu YJ, Meng YX, Zhang WJ (1997). A case-control study of female breast cancer in Tangshan rural area. *Pract J Cancer*, **12**, 293-96. (in Chinese)
Xu YL, Sun Q, Shan GL, et al (2012). A case-control study on risk factors of breast cancer in China. *Arch Med Sci*, **8**, 303-09.
Yu ZG, Jia CX, Geng CZ, et al (2012). Risk factors related to female breast cancer in regions of Northeast China: a 1:3 matched case-control population-based study. *Chin Med J (Engl)*, **125**, 733-40.
Zhao YB, Shi ZD, Liu LM, et al (1999). Matched case-control study for detecting risk factors of breast cancer in women living in Chengdu. *Chin J Epidemiol*, **20**, 91-94. (in Chinese)
Zhang ZB, Gao ES, Wu JQ, et al (2003). Relationship between physical activity and breast cancer risk in China. *Reprod Contrac*, **5**, 291-97. (in Chinese)
Zhang M, Holman CD, Huang JP, et al (2007). Green tea and the prevention of breast cancer: a case-control study in Southeast China. *Carcinogenesis*, **28**, 1074-78.
Zhang CX, Ho SC, Chen YM, et al (2009). Meat and egg consumption and risk of breast cancer among Chinese women. *Cancer Causes Control*, **20**, 1845-53.
Zhang M, Holman CD (2011). Low-to-moderate alcohol intake and breast cancer risk in Chinese women. *Br J Cancer*, **105**, 1089-95.
Zhang M, Jin M, Yu Y, et al (2012). Associations of miRNA polymorphisms and female physiological characteristics with breast cancer risk in Chinese population. *Eur J Cancer Care (Engl)*, **21**, 274-80.
Zhang ML, Huang ZZ, Zheng Y (2012). Estimates and prediction on incidence, mortality and prevalence of breast cancer in China, 2008. *Zhonghua Liu Xing Bing Xue Za Zhi*, **33**, 1049-51.