



Tea Consumption and Health Beneficences of Green Tea Drinking- A Community-based Cross-sectional Study in Urban Chinese Men

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Authors' contributions

This work was carried out in collaboration between all authors. Author FC designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors LJ, LR and CK revised the protocol, and managed the analyses of the study. Authors WH and LL designed the study, revised the manuscript. Author XB designed the study, fined the protocol and revised the manuscript. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: To understand the exposure experiences of tea consumption in community male adult population of urban China and its potential beneficences in cardiovascular diseases and diabetes.

Study Design: A cross-sectional study.

Place and Duration of Study: Communities in Shanghai, Chengdu and Hangzhou, China between July to September, 2006.

Methodology: Face-to-face questionnaire interviews through household visit were carried out to collect information on tea consumption and health conditions in Chinese men. The amount of tea-leaves consumed per time was weighed in grams using identical balances.

Results: In this study, 73.7% (2156/2927) subjects met the criteria of present tea

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drinkers (PTDRs) at the time of interview, and the age-gender standardized proportion was 66.4%. Most of PTDRs drank tea every day and amounts of tea consumption did not vary over seasons. The average weekly amounts of tea consumption in grams for PTDRs varied from 55.2 grams green tea per week to 71.7 grams oolong tea per week. Also, green tea drinking was significantly inversely associated with cardiovascular disease and diabetes.

Conclusion: This study provides an informative and comprehensive description of tea drinking in urban Chinese male population. Findings from this study also present the possibility of health benefits of green tea for male Chinese population.

Keywords: Tea; community; male; diabetes; cardiovascular disease.

ABBREVIATIONS

PTDR: Present tea drinker; GTDR: Green tea drinker.

1. INTRODUCTION

It is estimated that about two-thirds of the world's population drink tea originated from southern China. Although there are hundred varieties of tea, most can be categorized into 3 sorts, depending on the level of fermentation or oxidation, i.e. 'non-fermented' green tea; 'semi-fermented' oolong tea; and 'fermented' black tea. There is also a fourth category known as 'scented teas', made by mixing various flowers and petals with green or oolong teas; the best known among these is jasmine tea [1-3]. Health effects of tea drinking, especially in cardiovascular disease and cancers, were studied in different setting with varied results, and most were focused on health beneficial effects of green tea in the context that green tea has higher antioxidant activity than black tea or oolong tea [1-5]. Apart from the potential confounding from the socioeconomic and lifestyle factors associated with tea drinkers, the difference in health effects estimation could result from lack of reliable and comparable way of quantifying tea intake.

It is no doubt that information in details on tea drinking such as sorts of tea, current and cumulative amounts of tea consumption, and ways of tea cooking in general population will be helpful for better understanding its health beneficences. In industrialized countries, there are some studies that reported the consumption habits of tea (mostly, black tea) in general population [6,7]. However, not like black tea that is prevalent principally in Europe and North America, green tea is preferred throughout Asia, especially in China [1]. There are difficulties in measuring tea consumption in green-tea drinkers considering most of green-tea drinkers taking the tea in loose leaves, rather than tea-bags. In China, almost all studies on the health effects of green tea were measured by self-reported average monthly or yearly amounts of tea consumed, or the daily cups of tea taken [8-14]. So far, epidemiological data on the characteristics of tea drinkers, and the amount of tea-leaves consumed in grams in general Chinese population have not been reported yet. The objectives of this study were to describe the characteristics of tea consumption, especially green tea consumption in Chinese male population, further, to analyze the health beneficences of green tea drinking in cardiovascular disease and diabetes.

2. MATERIALS AND METHODS

2.1 Study Population

This was a community-based cross-sectional study carried out in three cities of China: Shanghai, the commercial center of China, Hangzhou, the main green tea outputting area and Chengdu, a city well-known for tea consumption. Subjects of the study were sampled using a multi-stage design. The first stage unit was city: Shanghai, Chengdu and Hangzhou were selected purposively. The second stage unit was community stratified by socio-economic classes, and the last stage unit was building that was sampled randomly using cluster sampling.

2.2 Subjects Recruitment and Data Collection

Subjects of the study were recruited continuously from July 1st to Sept. 30th, 2006. In total, 4804 subjects from Shanghai, Chengdu and Hangzhou responded to the questionnaire interview, with 2944 men and 1860 women. The eligible subjects were those who were at the age of 18 to 64 years old, and had been living in local cities for not less than two years. People unable to answer the questionnaires, or pregnant, or taking medicine related to tea products at the time of interview were excluded from the study. Considering the gender difference in tea drinking habits and health effects, results from male and female subjects are reported separately.

In this study, present-tea-drinker (PTDR) was defined as a subject who had been consuming tea at least twice per week continuously for not less than 3 months at the time of interview [13].

In each study city, 8-10 data collectors majored in medicine or preventive medicine were recruited. The data collectors were trained for interview with unified training protocol. All subjects were face-to-face interviewed through household visits by interviewers. A structured questionnaire was used in data collection. Information collected from the questionnaire included demographics, tea consumption history, current tea exposure in detail (if any), health status and major disease histories of subjects. The details of tea exposure covered data on frequency, amount, pattern, and preference of tea drinking. The weights of PTDR's routine and maximum tea consumption per time were measured in loose tea leaves with identical balance if he or she drunk loose tea leaves. The PTDRs were asked to take tea leaves, just like their usual way, out of a bag of tea that the interviewers brought with, and put the amount into a small bag labeled with unique code. The labeled bag of tea leaves were then weighted in grams using an identical balance by the investigators in each city. The identical balances were newly bought from the same producer and were adjusted before use.

The reliability and validity of the investigation were assessed through key information re-interview. After completion of general questionnaire interview for all subjects, 30 subjects were randomly sampled in each city for re-interview on key information such as education level, ever tea drinker, present tea drinker, smoking status. The duration between the two interviews was about 2-4 weeks. Kappa values for the two interviews were 0.829, 0.860, 0.860 and 0.780, respectively, which reflect a sound reliability of the study.

2.3 Data Analysis

The database was built in EpiData version 3.1 for Chinese and the statistical analysis was carried out in SPSS 11.0.1 (Sn: 3805233). For continuous data, Student-t test or ANOVA was used to test the differences in means and Jonckheere-Terpstra Test (J-T test) was applied to medians when variances were not equal. For category data, Chi-square test was applied. Statistical significance was defined as $p < 0.05$ for 2-tailed analysis. The age standardized prevalence of present tea drinkers and green tea drinkers was calculated based on data of China National Population Census 2000 and the average concentration of catechins in green tea infusions was crudely estimated at the basis of 0.12g/g (dry tea-leaves) [15].

3. RESULTS AND DISCUSSION

3.1 Description in General

A total of 2944 male subjects were recruited for questionnaire interview. Among them, 2927 (99.4%) subjects were eligible (1034 from Shanghai; 896 from Chengdu; 997 from Hangzhou). Seventeen subjects were excluded due to younger than 18 or older than 65 years old. The average age of the subjects in mean was 43.82 ± 13.29 years old, and the family size were 3.35 ± 1.16 persons in median. About two third (66.3%) of the subjects had more than 9 years schooling, and 19% had a salary higher than 3000 CNY per month.

3.2 Patterns and Amounts of Tea Consumption in Urban Male Chinese Population

As shown in Table 1 and 2, results of this survey suggested that there was a high percentage of tea drinking in Chinese male adults in cities, especially for green tea drinking. The percentage of PTDRs was 73.7%, and over four fifth of the PTDRs were green tea drinkers (GTDRs). Percentages of different tea PTDRs significantly varied over cities. Subjects from Shanghai and Hangzhou were dominantly GTDRs (over 96%); however, there were similar percentages of drinking green tea and Jasmine tea in Chengdu. Old people had a higher proportion of PTDRs in all three cities. People with less education years in Hangzhou and Chengdu, and people with higher salary in Shanghai had a higher percentage of PTDRS. The tea consumption habits of PTDRs were stable (in Table 3). Most of them drank tea every day and amounts of tea consumption did not vary over seasons. The average weekly amounts of tea consumption in grams for PTDRs varied from 55.2 grams green tea per week to 71.7 grams oolong tea per week. Also, most of PTDRs preferred loose tea leaf except for black tea drinkers of whom around 40% using black-tea bags. Almost all PTDRs made tea by soaking. Further, the general characteristics of green tea consumption of these sampled male subjects varied significantly over cities (Table 4).

There were 62 men who had drunk tea for at least 3 months, but they did not drink tea at the time of interview. Thirty-eight of them reported the reason for quitting tea drinking. The first three reasons were health conditions (23.7%), feeling discomfort after drinking tea (15.8%), and no time or feeling troublesome to make tea (13.2%).

Table 1. Current status of tea-drinking behaviors in Chinese male subjects (n=2927)

Characteristic	PTDRs [†] (%)	Non-PTDRs(%)	Total(%)	χ^2, P
Age group(years)				
18-24	145 (41.2)	207(58.8)	352(100)	329.66, <0.001
25-34	287 (59.2)	198(40.8)	485(100)	
35-44	469 (80.9)	111(19.1)	580(100)	
45-54	635 (82.0)	139(18.0)	774(100)	
55-64	620 (84.2)	116(15.8)	736(100)	
Education level‡ (years)				
0-9	796 (81.0)	187(19.0)	983(100)	61.29, <0.001
-12	653 (75.2)	215(24.8)	868(100)	
>12	702 (65.9)	363(34.1)	1065(100)	
Personal income (CNY/month) [‡]				
<=1000	741 (73.4)	269(26.6)	1010(100)	0.74,0.864
-3000	977 (74.6)	332(25.4)	1309(100)	
-5000	293 (73.3)	107(26.7)	400(100)	
>5000	107 (75.4)	35(24.6)	142(100)	
City				
Shanghai	683(66.1)	351(33.9)	1034(100)	52.85, <0.001
Chengdu	719(80.2)	177(19.8)	896(100)	
Hangzhou	754(75.6)	243(24.4)	997(100)	
Total	2156(73.7)	771(26.3)	2927(100)	

[†]: Present tea drinkers; [‡] Missing data in education level and personal income were 11 and 66 respectively.

Table 2. Sort-specific percentages of PTDRs in Chinese male subjects (n=2927)

Variables	Green tea	Jasmine tea	Black tea	Oolong tea
City				
Shanghai	65.0(670/1030)	0.6(6/1030)	1.0(10/1030)	1.4(14/1030)
Hangzhou	73.0(726/994)	0.3(3/994)	5.0(50/994)	0.3(3/994)
Chengdu	39.3(351/894)	40.8(365/894)	0.9(8/894)	1.1(10/894)
χ^2, P	241.27, <0.001	905.03, <0.001	48.29, <0.001	6.70,0.04
Age group(years)				
18-24	33.1(116/350)	7.1(25/350)	2.6(9/350)	0.6(2/350)
25-34	49.0(236/482)	9.3(45/482)	1.7(8/482)	2.1(10/482)
35-44	64.3(373/580)	14.8(86/580)	2.9(17/580)	1.2(7/580)
45-54	69.9(540/773)	11.9(92/773)	2.2(17/773)	0.6(5/773)
55-64	65.8(482/733)	17.2(126/733)	2.3(17/733)	0.4(3/733)
X_{trend}^2, P	127.99, <0.001	22.08, <0.001	0.00,0.97	3.60,0.058
Education level (years)				
0-9	60.7(595/981)	18.7(183/981)	3.3(32/981)	0.5(5/981)
-12	61.5(532/865)	13.5(117/865)	2.4(21/865)	0.8(7/865)
>12	58.0(615/1061)	7.0(74/1061)	1.4(15/1061)	1.4(15/1061)
X_{trend}^2, P	1.39,0.24	61.31, <0.001	7.54,0.006	4.42,0.04
Personal income (CNY/month)				
<=1000	50.9(513/1008)	21.3(215/1008)	2.9(29/1008)	0.3(3/1008)
1001-3000	64.4(840/1305)	10.0(130/1305)	1.8(24/1305)	0.6(8/1305)
3001-5000	65.0(260/400)	5.8(23/400)	2.0(8/400)	3.0(12/400)
>5000	70.7(99/140)	2.9(4/140)	3.6(5/140)	2.9(4/140)
X_{trend}^2, P	38.59, <0.001	83.72, <0.001	0.12,0.73	23.85, <0.001
Total	59.9(1747/2918)	12.8(374/2918)	2.3(68/2918)	0.9(27/2918)

Table 3. Sort-specific characteristics of tea consumption behaviors in Chinese male PTDRs (n=2156)

Variables	Green tea (%)	Jasmine tea (%)	Black tea (%)	Oolong tea (%)
Seasonal variation	205(11.7)	39(10.4)	17(25.0)	6(23.1)
Everyday drinker	1585(91.2)	349(95.6)	51(79.7)	15(65.2)
Age to start(years) †	22.2±7.8	19.6±7.5	21.3±7.3	-
Cumulative duration(years) †	23.5±11.8	26.1±12.4	22.6±12.9	-
Duration(years)†	21.5±12.3	25.1±13.0	17.5±14.8	-
Times per week†	10.6±6.7	11.4±4.9	10.4±7.7	-
Grams per time†	5.7±4.0	6.4±3.7	5.8±6.0	-
Max grams per time†	6.2±4.3	6.5±3.7	6.7±6.2	-
Cups per time†	4.0±2.3	6.2±13.0	5.8±16.7	-
Volume of cup (ml) †	411±227	354±156	484±606	-
Max cups per time†	5.1±2.8	7.5±13.8	9.9±22.9	-
Soaking time(hour)†	6.3±3.1	6.8±4.2	5.3±3.4	-
Tea type				
Leaf tea	1688(97.3)	362(97.6)	39(60.0)	-
Bag tea	46(2.7)	9(2.4)	26(40.0)	-
Other	1(0.1)	0	0	-
Method				
Boiling	106(6.1)	2(0.5)	3(4.6)	-
Soaking	1635(93.9)	368(99.2)	62(95.4)	-
Other	1(0.1)	1(0.3)	0	-
Taste preference				
Strong	632(36.8)	180(48.5)	29(44.6)	-
Proper	727(42.3)	131(35.3)	27(41.5)	-
Light	360(20.9)	60(16.2)	9(13.8)	-
Grams/Week†	64.2±67.7	75.6±58.3	57.9±53.5	93.4±153.7
Total	1747	374	68	27

†: Mean±SD

Although tea drinking has become a popular life style in both western and eastern countries, the ways of measuring tea consumption are in diversity. It is easy to measure the frequency of tea drinking rather than the amount of tea consumed. In most studies conducted among Westerners and Japanese, 'cups of tea consumed' was the most common indicator for quantifying the amount of tea consumption [2,4,7]. Tea consumption has also been measured by the number of tea bags consumed. Unlike Westerners who usually consume tea bags, Chinese prefer to loose tea-leaves. In contrast, most studies conducted in mainland China have used the weight of loose tea leaves consumed monthly or yearly [10,12]. It is obvious that the monthly or yearly estimation is liable to incurring recall bias and measuring bias when using loose tea leaves, especially when several family members are tea drinkers. In fact, male daily GTDRs reported the consumption of 394.2 g/month tea-leaves in this study, i.e. the average daily tea consumption would be about 13g, much higher than the 10g/day measured by the identical balance. The problem in using cups as an indicator for tea consumption is that the size of the teacups varied dramatically in China. In this study, the cups used by the subjects sized from 8 ml to 5000 ml. In fact, some tea drinkers such as tax drivers use a little pot or barrel as 'cup' in China. The problem in using volumes as an indicator is similar to cups. Among male GTDRs of this study, the average volumes of green tea per day varied over individuals ranged from 66ml to 16800ml and the Pearson correlation coefficient was only 0.354 between the average grams and volumes per

day. As a result, weights of tea consumption per day should be a good indicator to evaluate the tea consumption in China.

Table 4. City-specific characteristics of tea consumption behaviors in Chinese male GTDRs (n=1747)

Characteristic	Shanghai (%)	Chengdu (%)	Hangzhou (%)	Total (%)	χ^2 , P
Seasonal variation	48(7.2)	27(7.7)	130(18.0)	205(11.8)	45.9, <0.001
Everyday drinker	597(89.5)	314(90.8)	674(93.0)	1585(91.2)	5.29, 0.071
Age to start(years) [§]	23.7±7.3	19.8±7.2	22.1±8.1	22.2±7.8	486972.0, <0.001 [‡]
Cumulative duration(years) [§]	22.6±11.6	22.9±12.6	24.7±11.5	23.5±11.8	485387.5, <0.001 [‡]
Duration(years) [§]	22.4±11.6	14.5±12.0	24.2±11.6	21.5±12.3	84.2, <0.001 [†]
Times per week [§]	9.1±4.7	11.1±8.8	11.7±6.9	10.6±6.7	483646.0, <0.001 [‡]
Grams per time [§]	6.0±3.6	5.5±3.5	5.7±4.5	5.8±4.0	2.1, 0.12 [†]
Max grams per time [§]	6.1±3.6	5.7±3.7	6.7±5.1	6.2±4.3	6.8, 0.001 [†]
Cups per time [§]	4.1±2.3	4.4±2.3	3.7±2.2	4.0±2.3	11.3, <0.001 [†]
Volume of cup (ml) [§]	384±161	367±292	459±235	411±227	483589.5, <0.001 [‡]
Max cups per time [§]	5.0±2.8	5.4±2.6	5.0±2.8	5.1±2.8	467098.0, 0.84 [‡]
Soaking time(hours) [§]	6.4±3.0	6.7±3.1	5.9±3.3	6.3±3.1	8.59, <0.001 [†]
Tea type					Fisher's p=0.009
Leaf tea	659(98.5)	334(95.2)	695(97.2)	1688(97.3)	
Bag tea	10(1.5)	17(4.8)	19(2.7)	46(2.7)	
Other	0	0	0	1(0.1)	
Method of preparation					Fisher's p<0.001
Boiling	53(7.9)	4(1.1)	49(6.8)	106(6.1)	
Soaking	615(91.9)	347(98.9)	673(93.2)	1635(93.9)	
Other	1(0.1)	0	0	1(0.1)	
Taste preference					25.9, <0.001
Strong	206(31.1)	132(37.6)	294(41.7)	632(36.8)	
Proper	319(48.1)	128(36.5)	280(39.7)	727(42.3)	
Light	138(20.8)	91(25.9)	131(18.6)	360(20.9)	
Grams/Week [§]	58.5±58.2	64.1±62.1	69.5±77.4	64.7±69.5	476156.5, 0.01 [‡]
Total	670	351	726	1747	

[§]: Mean±SD; [†]: One way ANOVA; [‡]: J-T test

As discussed above, due to the poor comparability of tea-related studies, it's difficult to assess the tea consumption according to the findings from studies in other countries. Based on data from the US National Health and Nutrition Examination Survey 1999-2002, Maureen et al (2006) reported that the average amounts of tea consumption were 193.9 grams per day in 20-39 years old, 203.8 in 40-59 years old and 172.3 in ≥ 60 years old respectively in US male population, however, the main sort of tea consumed was not mentioned. Compare to Maureen's findings, the average daily tea consumption in Urban Chinese male population was lower if the tea consumption in grams in this US survey was not estimated according to milliliter [6]. Based on data of over 7,000 adults aged from 19 to 64 years old from the UK National Diet and Nutrition Survey (NDNS), Henderson et al (2002) indicated that 77% of men drank tea (68%, 73%, 80% and 82% in 19-24 years old, 25-34 years old, 35-49 years old and 50-64 years old respectively), with a median consumption of 3024 ml per day, which is higher than results from this study, and the percent of tea consumption increased as age, which is similar to this study, however, the main sort of tea consumed was not mentioned in NDNS [7]. The possible reasons are the differences in the definition of tea drinking, research

methods and the age-sex distribution of populations between UK and our study. Also, the proportions of tea drinking in Japan were higher than that in our subjects (69.6%, 81.1%, 70.3% vs. 59.9%, respectively) under the same considerations in definition, i.e. a cup or above per day [16-18].

3.3 The Relationship between Green Tea Drinking and Cardiovascular Diseases and Diabetes Mellitus

Green tea drinking was significantly related to a low risk of cardiovascular disease (OR=0.024, 95% CI=0.012-0.048) and diabetes (OR=0.038, 95% CI=0.012-0.120). After adjustment for age, education level, smoking, and personal incoming level, such protective effect was found stronger (Table 5). Results of this study were similar to results from many other studies in China and western countries [5, 16, 19-24]. Considering the potential protect effect of tea drinking to health will not take effects until the subjects has been drinking tea continuously for some time, we excluded those subjects having a diagnosis of cardiovascular or diabetes before or within 0.5 years after they began to drink tea. The health benefits of green tea are attributed to the polyphenols, particularly the catechins, which are present in higher quantities in green tea than in black or oolong tea [1-5]. The estimated average of catechins intake was 0.86g/day for those daily GTDRs, which could contribute to such inverse relationships partly [15,24]. In additions, it was observed that green tea had the beneficial effects on body mass index, blood glucose and lipid profile in obesity people [25]. However, self-reported disease information might subject to information bias in estimating the protect effects of green tea drinking in this study.

Table 5. The relationship between green tea drinking and risk of cardiovascular diseases and diabetes

Disease	GTDR [†]		OR (95%CI)	P	OR (95%CI) [‡]	P [‡]
	Yes	No				
Cardiovascular diseases						
Yes	8	308	0.024(0.012,0.048)	<0.001	0.011(0.005,0.024)	<0.001
No	1514	1089	1.000		1.000	
Diabetes						
Yes	3	56	0.038(0.012,0.120)	<0.001	0.027(0.008,0.089)	<0.001
No	1687	1129	1.000		1.000	

[†]: GTDR with age of starting to drink tea younger half year or more of diagnosis.

[‡]: Current education levels, age, personal incoming levels and smoking status were adjusted in nonconditional Logistic Regression model.

3.4 Methodology Considerations

This was a cross-sectional study implemented in urban Chinese male population. To have a better representativeness, three major cities located in different areas of China with different perceived tea-drink patterns have been purposively selected. The sample size and sampling effects were estimated according to previous studies in China. This should be a first population-based survey comprehensively in assessing the characteristics and amounts of tea consumption in Chinese urban men. However, China is a huge country with great diversified socioeconomic status and life styles in its population. Larger sample size and wider coverage of cities are demanded for a sound generalizability in further studies on tea consumption in Chinese population. In additions, a cross-sectional study could only be used

for describing the association between green tea drinking and the studied health outcomes, rather than for making causation.

In this study, daily tea consumption was comprehensively assessed with regard to sort of tea, duration of tea consumption, way of preparing tea extracts, volume in cups, amount in grams and frequency of daily and weekly tea consumption. Due to the limited studies on tea consumption in China, there was no well-accepted definition for present tea drink. In this study, the present-tea-drinker (PTDR) was defined as a subject who had been consuming tea at least twice per week continuously for not less than 3 months at the time of interview. This definition has been used in a health-related epidemiological study in urban China [13].

4. CONCLUSION

In summary, this population-based cross-sectional study is informative and comprehensively in assessing the characteristics and amounts of tea consumption in Chinese urban men. Findings from this study indicate the health beneficences of green tea drinking in cardiovascular diseases and diabetes.

CONSENT

Written informed consent was obtained after complete description of the study to subjects.

ETHICAL APPROVAL

The study has been approved by the IRB of Fudan School of Public Health.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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