

Does tea consumption during early pregnancy have an adverse effect on birth outcomes?

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1 Does tea consumption during early pregnancy have an adverse effect on birth outcomes?

2

3 Abstract

4 **Background** Tea, a common beverage, has been suggested to exhibit a number of health
5 benefits. However, one of its active ingredients, caffeine, has been associated with preterm
6 birth and low birthweight. We investigated whether tea consumption during early pregnancy is
7 associated with an increased risk of preterm birth and abnormal foetal growth.

8 **Methods** A total of 8775 pregnant women were included from the Born in Guangzhou Cohort
9 Study. Tea consumption (type, frequency and strength) during their first trimester and social
10 and demographic factors were obtained via questionnaires administered during pregnancy.
11 Information on birth outcomes and complications during pregnancy was obtained from hospital
12 medical records.

13 **Results** Overall habitual tea drinking (≥ 1 serving/week) prevalence among pregnant women
14 was low, at 16%. After adjustment for potential confounding factors (e.g. maternal age,
15 educational level, monthly income) tea drinking during early pregnancy was not associated
16 with an increased risk of preterm birth, small or large for gestational age ($p > 0.05$).

17 **Conclusions** We did not identify a consistent association between frequency of tea
18 consumption or tea strength and adverse birth outcomes among Chinese pregnant women with
19 low tea consumption. Our findings suggest that occasional tea drinking during pregnancy is not
20 associated with increased risk of preterm birth or abnormal foetal growth. Given the high
21 overall number of annual births in China, our findings have important public health
22 significance.

23 **Keywords:** Tea: Preterm birth: Abnormal foetal growth: Chinese: Birth cohort

24 **Introduction**

25 Preterm birth and abnormal foetal growth (including small for gestational age [SGA] and
26 large for gestational age [LGA]) are important predictors of neonatal morbidity and mortality
27 as well as adverse health outcomes in childhood and adulthood (1-3). A recent study in seven
28 regions in China suggests a preterm birth rate of 7.1% in 2011 (4), and data from Guangzhou,
29 the largest city in southern China, indicate the prevalence of SGA and LGA being 8.6% and
30 8.5%, respectively (5). Whilst the rates are not particularly high compared to those of south
31 Asia (13.3%) and sub-Saharan Africa (12.3%) (6), given the large absolute number of live
32 births in China (12% of global total in 2010) (6), identification of risk factors associated with
33 preterm birth and abnormal foetal growth is of particular public health importance.

34 Tea is a beverage prepared from the leaves of the plant *Camellia sinensis*, and contains a
35 number of biologically active constituents, including polyphenols (e.g. catechins) and
36 alkaloids (e.g. caffeine). Tea is broadly classified into green, oolong and black tea according
37 to the degree of enzyme-mediated oxidation (known as fermentation) (7).

38 There has been some conflicting evidence on the health benefits of tea⁽⁸⁻¹⁰⁾, but much less
39 is known about the potential effects of tea drinking during pregnancy on foetal growth and
40 development. In vivo studies in rats suggested black tea(11) or green tea catechin(12) had no
41 effect on the weight of pups, but to our knowledge, no human studies have investigated the
42 effects of tea on preterm birth and birthweight. On the other hand, reports have suggested that
43 one of the active ingredients in tea, caffeine, is negatively associated with birthweight (13-17).
44 This relationship was confirmed in a recent meta-analysis (18), although there was no
45 association with preterm birth (18, 19). It should be noted, however, that tea consumption has
46 a lesser contribution than coffee for total caffeine intake in the Western populations studied
47 (13-17), whereas in China tea remains the most popular beverage (20).

48 The current Chinese dietary guidelines (21) do not comment on the frequency of intake and
49 the type of tea. As a substantial number of tea drinkers in China are of child-bearing age,
50 clarifying the potential association of tea consumption on gestational age and birthweight is of
51 public health importance. Using data from a large prospective birth cohort in China, we
52 investigated the effect of tea drinking during early pregnancy on foetal growth and preterm
53 birth.

54

55 Methods

56 Recruitment

57 The Born in Guangzhou Cohort Study (BIGCS) is an ongoing prospective study conducted by
58 the Guangzhou Women and Children's Medical Center (GWCMC), China, which
59 commenced in February 2012. Details of the recruitment can be found elsewhere (22). Briefly,
60 all pregnant women residing within Guangzhou who attended their first routine antenatal
61 examination (usually around week 16) at two campuses of GWCMC, and who intended to
62 remain in Guangzhou with their child for ≥ 3 years were invited to participate in BIGCS. At
63 baseline recruitment, demographic and socio-economic information were obtained via self-
64 completed questionnaires, as well as data on workplace and home exposures, lifestyle,
65 medical histories, and health status before and during pregnancy. BIGCS has received
66 approval from the Institutional Ethics Committee of GWCMC. All participants gave written
67 informed consent.

68 For this analysis, data from pregnant women recruited between February 2012 and
69 December 2014 ($n = 10277$; 73.6% of those eligible) were used. We excluded those who
70 dropped out before delivery ($n = 435$), or terminated their pregnancies or had stillbirths ($n =$
71 111), or had multiple gestation ($n = 212$), or who had missing delivery data ($n = 155$),
72 resulting in 9364 singleton births in this report (Figure 1).

73 Tea consumption

74 Participants were asked at baseline (around 16 weeks of gestation) whether they regularly
75 consumed tea during pregnancy. Subsequently, participants were asked to specify the type of
76 tea they drank (green, oolong, black [known as “red tea” in China], and dark [a variety of
77 post-fermented tea in China]), how many servings they consumed each type in a typical week
78 (one serving was defined as 150 mL of tea), and the strength of tea (defined subjectively:
79 weak, moderate, strong) they preferred. We grouped the types of teas into green
80 (unfermented), oolong (semi-fermented) and black and dark tea (fermented) teas. Frequency
81 was categorised into <1, 1–3, and >3 servings/week, and tea strength was dichotomised into
82 weak and moderate/strong.

83

84 Birth outcomes

85 Birthweight among other birth outcomes (gestational age, parity, mode of delivery, and foetal
86 sex) were obtained from the Guangzhou Perinatal Health Care and Delivery Surveillance
87 System which records all births within the municipality. Gestational age at birth was
88 determined based on ultrasound examination within the first- or early second-trimester.
89 Preterm birth was defined as delivery before 37 weeks gestation. Those births with gestational
90 age 37 weeks or above were considered as term. SGA and LGA were defined as a gestational
91 age-adjusted birthweight below the 10th and above the 90th percentile, respectively, derived
92 from a local population-based birthweight reference (23). The **remaining** births were
93 considered as appropriate for gestational age (AGA).

94

95 Covariates

96 From the questionnaire, we derived maternal age (continuous), highest education level and
97 maternal monthly income. Both education level and monthly income category were used as

98 proxies for socio-economic status. Maternal smoking three months before pregnancy and
99 during pregnancy (number of cigarettes per day) was assessed. Participants were considered
100 to have environmental tobacco smoke exposure if they were either exposed to second-hand
101 smoke at home or at work during early pregnancy. Folic acid supplement use was recorded in
102 the questionnaire. Pre-pregnancy maternal height (cm) and weight (kg) were self-reported at
103 recruitment, from which body mass index (BMI; kg/m²) was derived. Information on
104 complications during the current pregnancy, including pre-eclampsia, pregnancy-induced
105 hypertension, pre-pregnancy hypertension, gestational diabetes and pre-pregnancy diabetes,
106 was obtained from medical records after delivery.

107

108 Statistical analysis

109 Differences in characteristics by frequency of tea consumption **during early pregnancy** were
110 evaluated using Student's t-test, χ^2 test or Mann-Whitney U test where appropriate. Logistic
111 regression models were constructed in order to assess the relationship between tea
112 consumption **during early pregnancy** (frequency and strength) and birth outcomes, adjusting
113 for known determinants of foetal growth (maternal age, complications during pregnancy,
114 parity, and foetal sex), as well as potential confounders relating to tea consumption (socio-
115 economic status, exposure to tobacco smoke, and folic acid supplement use) based on
116 evidence from the literature. **We also explored the dose-response relationship between tea**
117 **consumption and risk of adverse pregnancy outcomes, by including frequency of tea drinking**
118 **as continuous variable into the regression models.** We examined the effects of individual
119 types of tea in two ways: (i) we included additional variables indicating other types of tea to
120 take into account the total tea intake, and (ii) we restricted the analysis to those who only
121 consumed one type of tea to avoid contamination bias. We compared distributions of Z-score

122 of birthweight and gestational age at birth (both continuous) using the Kruskal-Wallis test,
123 among women with different levels of tea consumption (<1, 1–3, and >3 servings/week).

124 We also examined whether any relationships were modified by maternal pre-pregnancy
125 BMI by including interaction terms in the models. Although previous studies have suggested
126 that caffeine intake is associated with adverse birth outcomes (13-16), the prevalence of
127 habitual coffee drinking (≥ 1 serving/week) was extremely low in this cohort (0.9%), and
128 hence we did not include coffee consumption as a confounding factor. However, we
129 conducted a sensitivity analysis restricting those included in the analyses to non-coffee
130 drinking participants. All analyses were performed using SAS statistical software version 9.2
131 (SAS Institute Inc., Cary, NC, USA). A two-tailed p-value of less than 0.05 was considered
132 statistically significant in all statistical analyses.

133

134 Results

135 Of the 9364 eligible singleton pregnancies, 8775 (93.7%) had available information on tea
136 consumption **during early pregnancy** and were included in the analysis. Those who were
137 excluded were more likely to have a higher educational level and income compared to those
138 included in the final analyses (Supplementary Table 1). Table 1 presents the characteristics of
139 pregnant women at enrolment and selected pregnancy outcomes. In this sample, 1420 women
140 (16.2%) reported drinking tea at least once per week (median 3, interquartile range 2-5)
141 during early pregnancy. Most of the tea-drinking participants (71.8%) consumed only one
142 type of tea (median 2 servings/week), 22.7% two types (4 servings/week), and 4.2% three
143 types (6 servings/week). Those who consumed tea habitually (at least 1 serving per week)
144 were more likely to be slightly older, have a higher educational level, be exposed to second
145 hand tobacco smoke (34.8 vs. 29.7%), have a higher mean (\pm SD) pre-pregnancy BMI ($20.6 \pm$
146 2.8 vs. 20.3 ± 2.6 kg/m²) and to be multiparous (14.9 vs. 10.8%) compared to those mothers

147 who did not consume tea regularly. Overall, there were no significant difference in
148 birthweight and the proportions of SGA and LGA between children whose mothers did or did
149 not consume tea regularly at baseline.

150 Results of logistic regression of birth outcomes on tea consumption **during early pregnancy**
151 are presented in Table 2. There was no association between tea consumption during early
152 pregnancy and the birth outcomes we measured (preterm birth, SGA and LGA), after
153 adjustment for potential confounding factors (maternal age, educational level, monthly
154 income, exposure to environmental tobacco smoke and folic intake during early pregnancy,
155 pre-pregnancy BMI, parity, complications during pregnancy and foetal sex). Among the three
156 types of tea examined, frequent green tea consumption was significantly associated with LGA
157 (fully adjusted OR = 1.67; 95% CI, 1.01, 2.75; p=0.045), but non-significant risk estimates
158 were found for preterm birth (0.54; 0.18, 1.63) and SGA (0.57; 0.21, 1.51). We did not
159 observe any statistically meaningful relationship between oolong tea and dark/black tea
160 consumption and birth outcomes. **When we included frequency of tea drinking as continuous**
161 **variable into the regression models, there was also no apparent dose-response relationship**
162 **between tea consumption and risk of adverse pregnancy outcomes.** When we used Z-score of
163 birthweight instead of the binary SGA and LGA variables, we did not see a positive
164 association between green tea consumption and birthweight, although there was a decreasing
165 trend in gestational age at birth among Oolong tea-drinking women (Supplementary Table 2).

166 Among the regular tea drinkers at baseline, 22.7% and 4.2% consumed two and three or
167 more types of tea, respectively. To avoid potential attenuation of observed effect sizes due to
168 consumption of multiple tea types, we repeated the analysis by restricting to those who
169 reported to drink only one specific type. Overall, the risk estimates for preterm birth, SGA,
170 and LGA were very similar to those obtained from the analysis using the full sample although
171 the confidence intervals were slightly wider (Supplementary Table 3).

172 We also investigated the possible effects of tea strength (Table 3). Consumption of weak
173 Oolong tea was associated with reduced risk of preterm birth (OR: 0.21; 95% CI: 0.06, 0.76).
174 We did not find significant association between adverse birth outcomes and strength of green
175 or dark/black tea in multivariate analysis.

176 As tea drinking may be favoured by women who intend to lose weight, we also tested for
177 potential interaction between pre-pregnancy BMI and tea consumption by including an
178 interaction term in the regression model. This, however, did not change the risk estimates
179 (results not shown). Restricting the analysis to non-coffee drinking participants also did not
180 alter the conclusion (results not shown).

181

182 Discussion

183 In a contemporary sample of Chinese pregnant women **with low consumption of tea**, we did
184 not find evidence suggesting an adverse effect of tea consumption on gestational age or
185 birthweight of offspring after adjusting for potential confounding factors. **Although higher**
186 **consumption of unfermented tea (green tea) was associated with an increased risk of LGA,**
187 **this finding was of borderline significance, and may be a result of multiple comparisons. As**
188 **the official Chinese dietary guidelines do not comment on tea intake during gestation (21),**
189 pregnant women are likely to consult internet-based information for dietary advice, which
190 often delivers mixed messages without any scientific evidence, and many women might opt to
191 avoid tea drinking altogether. Our findings do not support the need for pregnant women to
192 abstain from tea drinking during early pregnancy, at least when it is consumed at a low to
193 moderate level.

194 To our knowledge, our study is the first to investigate the effects of tea consumption on
195 birthweight in an Asian setting with a large prospective birth cohort study. Surprisingly, we
196 observed a low prevalence (only 16%) of tea drinking in the study population. In fact, results

197 from the China Health and Nutrition Survey (CHNS) suggest the prevalence of tea drinking
198 had fallen by 10% between 1993 and 2009 (from 44% to 34%), and that the most prominent
199 decline has occurred in the 18–29 years age group (by about 20%) (20). Another study of
200 5133 adults from the three largest Chinese cities (Beijing, Shanghai, and Guangzhou) also
201 found a lower prevalence of tea drinking among those 20–29 years (27%) compared to 30-39
202 years (46%) (24). These figures support our observation that tea drinking is less popular
203 among the younger generation (particularly those of child-bearing age).

204 Whilst previous studies have attempted to assess the effect of tea consumption in relation to
205 birthweight (13-17), the focus was generally on caffeine intake and not the beverage per se. A
206 small case-control study of 155 women in Beijing, China found an increased risk of SGA
207 associated with tea consumption at least twice a week during pregnancy (25). Potential recall
208 bias and the lack of adjustment for SGA risk factors (e.g., complications during pregnancy,
209 parity) in the analyses may explain the inconsistency with our own findings.

210 To date there has been no definitive conclusion on whether tea consumption in pregnant
211 women could affect offspring. **It is proposed** that excessive caffeine intake might be
212 teratogenic (26). However, a recent review by Brent et al. concluded that results from both
213 epidemiological and animal studies suggest caffeine intake is “unlikely to have reproductive
214 and developmental effects” (27). On the other hand, accumulating findings from animal and
215 human studies have pointed to a possible weight reduction effect by tea. Green tea extracts or
216 (-)-epigallocatechin-3-gallate (EGCG), one of the tea catechins, have been shown to reduce
217 weight gain, blood glucose or insulin levels in obese/diabetic animals or those on high-fat
218 diets (28). In humans, a number of small randomised-controlled trials have been conducted, as
219 summarised by two recent meta-analyses (29, 30). Most of the studies included administered
220 green tea or green tea extracts with caffeine in normal weight or overweight individuals and
221 showed weight reduction compared with caffeine-free controls, hence leading to a question of

222 whether weight loss was an effect of caffeine in tea, or due to a combined effect of caffeine
223 and tea catechins. A meta-analysis demonstrated that while both caffeine alone and the
224 combination of catechins and caffeine increased daily energy expenditure, only the latter
225 could significantly increase fat oxidation (31). A recent Cochrane review further supported
226 this concept, concluding that green tea preparations may induce **little** loss of weight in obese
227 or overweight adults (9). As maternal glucose and lipid metabolism during pregnancy is
228 highly relevant to the fetal nutrient supply (32, 33), it is entirely plausible that tea (or
229 catechins in combination with caffeine) could have an adverse impact on birthweight.
230 Nevertheless, after adjusting for confounders we did not find compelling evidence that tea
231 consumption was associated with birthweight Z-score, SGA or LGA.

232 Results from analyses using tea strength as an exposure measure are somewhat inconsistent
233 with those using the frequency of consumption. Firstly it should be noted that the strength of
234 tea is a subjective indicator in this study and could not precisely represent the dose of tea.
235 Additionally, longer steeping time may not only strengthen the flavour, but may also
236 encourage the release of other components as well as contaminants in tea leaves, such as
237 heavy metals (34). This may introduce toxic effects in addition to the potential weight
238 reducing capacity of catechins and caffeine. For example, a recent case-control study in China
239 found an association between drinking strong tea and congenital birth defect (35).

240 **Strengths of this study include the prospective design, which to some extent reduced recall**
241 **bias. Our population has a low incidence of coffee drinking and this may avoid potential for**
242 **confounding due to the high caffeine content of coffee.** There are also some limitations that
243 should be considered. Tea consumption was investigated only at baseline during early
244 gestation. It is possible that pregnant women could have changed their exposure during later
245 stages of pregnancy, leading to misclassification and regression dilution bias. Despite the
246 relatively large sample size, only 16% of our sample reported drinking tea at least once a

247 week. The small number of frequent tea drinkers renders the estimates unstable with wide
248 confidence intervals, and we might not have sufficient statistical power to detect a true
249 association. Nevertheless, the opposing directions in the risk estimates for SGA and LGA
250 lend credibility to the findings. Furthermore, tea drinking in China is a social norm and any
251 misclassification is most likely random (rather than systematic or deliberate under- or over-
252 reporting), diluting the effect size towards the null. Although we have controlled for a range
253 of confounders, we acknowledge the possibility of residual and unmeasured confounding due
254 to other potentially relevant variables such as sleep duration and diet during pregnancy. We
255 were unable to specify whether the observed effect was due to components unique to tea,
256 caffeine in tea or caffeine from other sources such as coffee, and to a lesser extent soft drinks
257 and pain killers. However, the prevalence of regular coffee drinking in our sample was
258 extremely low, and given the lower caffeine content in tea (36), we hypothesised that tea
259 drinking should be responsible for the majority of caffeine (and catechin) intake, and
260 therefore our risk estimates were less likely to be confounded by other dietary factors.

261

262 Conclusions

263 Our results do not suggest an adverse effect of tea consumption at a low to moderate level
264 during early pregnancy on preterm birth or abnormal foetal growth **among Chinese women**.
265 Given the high overall number of annual births (~17 million in 2014) and the relatively low
266 prevalence of tea drinking among pregnant women in China, our findings have important
267 public health significance in the context of other potential health benefits of tea. Future
268 studies are warranted to confirm our findings and to re-examine **the dietary guidelines, which**
269 **currently do not provide guidance to pregnant women about tea drinking**.

270

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373 Table 1 Characteristics of the mothers and their children by frequency of tea drinking at
 374 enrollment in the Born in Guangzhou Cohort Study, 2012-2014 (n=8775)

	Weekly tea consumption		P-value
	<1 serving	≥ 1 serving	
	Mean ± SD or No. (%)	Mean ± SD or No. (%)	
n	7355	1420	
<i>Demographic and lifestyle</i>			
Maternal age at enrollment (years)	28.8 ± 3.3	29.1 ± 3.5	<0.01
Educational level			
Middle school or below	824 (11.2)	117 (8.2)	
College	1904 (25.9)	333 (23.5)	
Undergraduate	3803 (51.7)	804 (56.6)	
Postgraduate	824 (11.2)	166 (11.7)	<0.01
Monthly income (Yuan *)			
≤1500	733 (10.2)	143 (10.4)	
1501-4500	2365 (33.0)	414 (30.0)	
4501-9000	2967 (41.3)	591 (42.8)	
≥9001	1111 (15.5)	234 (16.9)	0.15
Missing	179	38	
Pre-pregnancy BMI (kg/m ²)	20.3 ± 2.6	20.6 ± 2.8	<0.01
Missing	121	21	
Environmental tobacco smoke exposure in early pregnancy			
Missing	6	5	
Folic acid intake in early pregnancy	6721 (91.5)	1300 (91.7)	0.79

<i>Missing</i>	7	2	
<u><i>Pregnancy-related</i></u>			
Parity			
Primiparous	6562 (89.2)	1208 (85.1)	
Multiparous	791 (10.8)	212 (14.9)	<0.01
<i>Missing</i>	2	0	
Mode of delivery			
Vaginal delivery	4805 (65.5)	888 (62.8)	
Caesarean section	2535 (34.5)	527 (37.2)	0.05
<i>Missing</i>	15	5	
Gestational age at birth (weeks)			
Median [25 th , 75 th percentile]	39 [38, 40]	39 [38, 40]	0.47
Preterm birth	364 (5.0)	65 (4.6)	0.55
<i>Missing</i>	41	6	
Birthweight (g)			
	3188 ± 432	3187 ± 422	0.95
<i>Missing</i>	27	5	
Birthweight for gestational age			
SGA	528 (7.2)	96 (6.8)	
AGA	5995 (81.8)	1170 (82.7)	
LGA	791 (10.8)	148 (10.5)	0.77
<i>Missing</i>	41	6	

Data presented as mean ± SD or n (%) unless otherwise specified.

AGA: appropriate for gestational age; BMI: body mass index; LGA: large for gestational age;

SGA: small for gestational age.

376 Table 2 Relationship between frequency of tea drinking and birth outcomes in the Born in Guangzhou Cohort Study, 2012-2014 (n=8775)

Weekly tea consumption (serving/week)	Preterm birth			SGA			LGA		
	n	OR (95% CI)		N	OR (95% CI)		n	OR (95% CI)	
	(Preterm /term)	Crude	Adjusted*	(SGA /AGA)	Crude	Adjusted*	(LGA /AGA)	Crude	Adjusted*
Any tea									
<1	364/6965	1.00 (Ref.)	1.00 (Ref.)	541/5995	1.00 (Ref.)	1.00 (Ref.)	791/5995	1.00 (Ref.)	1.00 (Ref.)
1-3	36/799	0.86 (0.61, 1.22)	0.86 (0.59, 1.25)	53/697	0.86 (0.64, 1.16)	0.94 (0.70, 1.28)	84/697	0.91 (0.72, 1.16)	0.88 (0.68, 1.13)
>3	27/526	0.98 (0.66, 1.47)	0.88 (0.57, 1.38)	40/451	1.01 (0.72, 1.41)	1.07 (0.75, 1.53)	62/451	1.04 (0.79, 1.37)	0.97 (0.72, 1.30)
<i>p</i> for trend		0.65	0.41		0.67	0.90		0.92	0.51
Green tea									
1-3	18/363	0.95 (0.58, 1.54)	0.80 (0.44, 1.45)	17/328	0.59 (0.36, 0.97)	0.59 (0.33, 1.05)	36/328	0.83 (0.59, 1.18)	0.89 (0.60, 1.34)
>3	5/132	0.73 (0.30, 1.78)	0.54 (0.18, 1.63)	6/108	0.63 (0.28, 1.44)	0.57 (0.21, 1.51)	23/108	1.61 (1.02, 2.55)	1.67 (1.01, 2.75)
<i>p</i> for trend		0.50	0.23		0.03	0.07		0.34	0.19
Oolong tea									
1-3	13/410	0.61 (0.35, 1.06)	0.61 (0.33, 1.14)	28/347	0.92 (0.62, 1.36)	0.92 (0.58, 1.47)	47/347	1.03 (0.75, 1.41)	0.97 (0.66, 1.41)

>3	12/136	1.69 (0.93, 3.08)	1.30 (0.58, 2.89)	14/122	1.30 (0.74, 2.28)	1.38 (0.71, 2.66)	12/122	0.75 (0.41, 1.36)	0.63 (0.29, 1.36)
<i>p</i> for trend		0.81	0.73		0.66	0.59		0.53	0.35
Dark/black tea									
1-3	28/505	1.06 (0.72, 1.58)	0.98 (0.62, 1.55)	41/448	1.04 (0.75, 1.45)	1.20 (0.82, 1.76)	44/448	0.75 (0.54, 1.02)	0.82 (0.58, 1.16)
>3	9/182	0.95 (0.48, 1.86)	1.03 (0.49, 2.13)	16/156	1.17 (0.69, 1.96)	1.61 (0.92, 2.80)	19/156	0.92 (0.57, 1.50)	0.75 (0.41, 1.35)
<i>p</i> for trend		0.95	0.99		0.57	0.07		0.17	0.18

377 AGA: appropriate for gestational age; CI: confidence interval; SGA: small for gestational age; LGA: large for gestational age; OR: odds ratio.

378 *: Model adjusted for maternal age, educational level, monthly income, exposure to environmental tobacco smoke and folic intake during early
379 pregnancy, pre-pregnancy BMI, previous history of complications during pregnancy, parity, sex of offspring, and where appropriate, frequency of
380 other types of tea consumed.

381

382 Table 3 Relationship between strength of tea and birth outcomes in the Born in Guangzhou Cohort Study, 2012-2014 (n=8775)

Strength of tea	Preterm birth			SGA			LGA		
	n	OR (95% CI)		n	OR (95% CI)		n	OR (95% CI)	
	(Preterm /term)	Crude	Adjusted *	(SGA /AGA)	Crude	Adjusted *	(LGA /AGA)	Crude	Adjusted *
Non-habitual drinkers (<1 serving/week)	364/6965	1.00 (Ref.)	1.00 (Ref.)	511/5659	1.00 (Ref.)	1.00 (Ref.)	760/5659	1.00 (Ref.)	1.00 (Ref.)
Green tea									
Weak	6/156	0.74 (0.32, 1.68)	0.89 (0.32, 2.50)	9/137	0.75 (0.38, 1.47)	0.89 (0.36, 2.17)	16/137	0.89 (0.53, 1.49)	0.76 (0.39, 1.49)
Moderate/strong	16/336	0.91 (0.55, 1.52)	0.89 (0.42, 1.90)	14/295	0.54 (0.31, 0.93)	0.53 (0.24, 1.13)	43/295	1.11 (0.80, 1.53)	1.02 (0.63, 1.63)
<i>p</i> for trend		0.58	0.77		0.02	0.10		0.67	0.91
Oolong tea									
Weak	5/204	0.47 (0.19, 1.15)	0.21 (0.06, 0.76)	17/170	1.14 (0.68, 1.88)	1.07 (0.53, 2.17)	22/170	0.98 (0.63, 1.54)	0.85 (0.44, 1.66)
Moderate/strong	19/340	1.07 (0.67, 1.72)	0.79 (0.40, 1.58)	25/296	0.96 (0.63, 1.46)	0.88 (0.49, 1.59)	37/296	0.95 (0.67, 1.34)	1.09 (0.66, 1.79)
<i>p</i> for trend		0.76	0.64		0.98	0.66		0.76	0.71

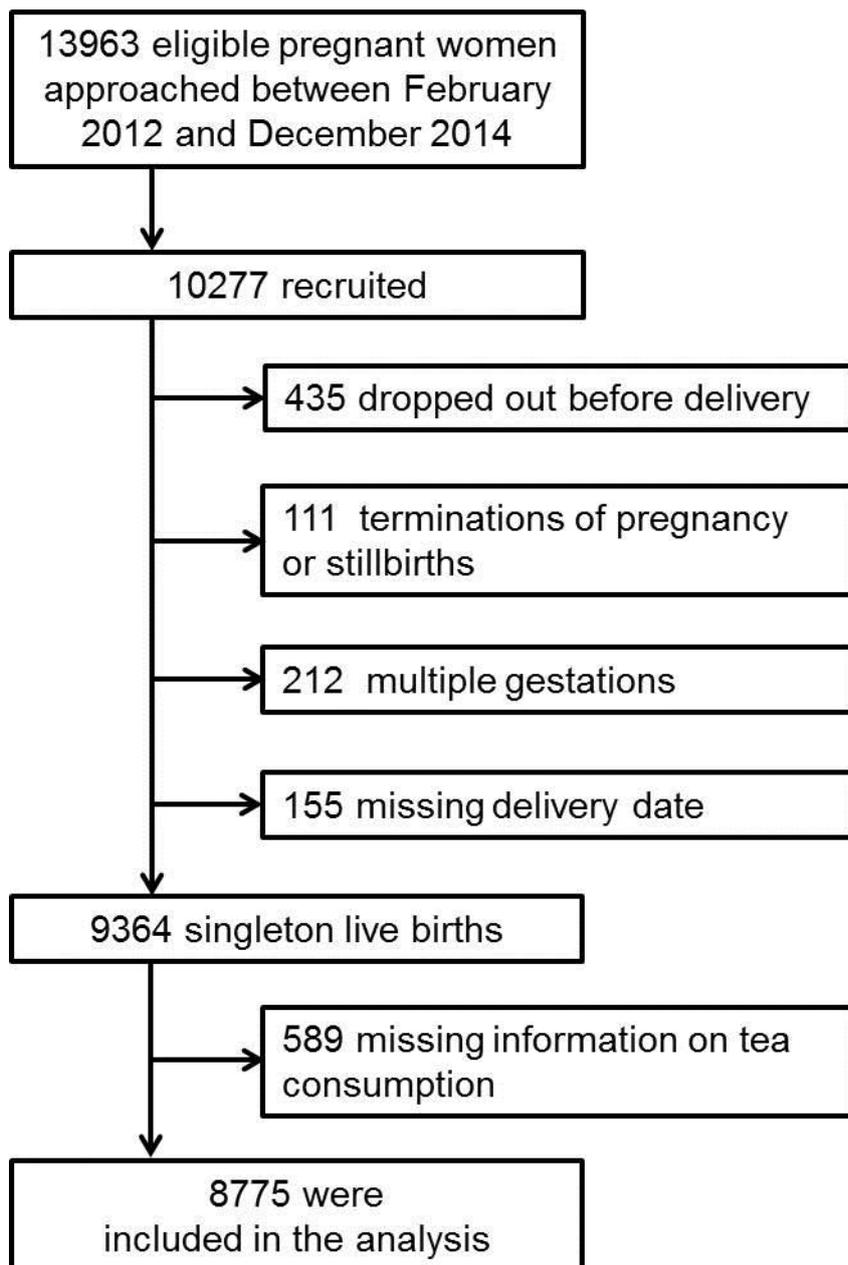
Dark/black tea									
Weak	14/313	0.86 (0.50, 1.48)	0.87 (0.43, 1.76)	23/272	0.96 (0.62, 1.48)	1.02 (0.58, 1.81)	32/272	0.89 (0.61, 1.30)	1.05 (0.61, 1.80)
Moderate/strong	22/372	1.13 (0.73, 1.76)	1.04 (0.57, 1.89)	34/329	1.17 (0.82, 1.69)	1.12 (0.69, 1.84)	31/329	0.72 (0.49, 1.04)	0.84 (0.51, 1.38)
<i>p</i> for trend		0.78	0.92		0.48	0.65		0.07	0.49

383 AGA: appropriate for gestational age; CI: confidence interval; SGA: small for gestational age; LGA: large for gestational age; OR: odds ratio.

384 *: Model adjusted for maternal age, educational level, monthly income, exposure to environmental tobacco smoke and folic intake during early
 385 pregnancy, pre-pregnancy BMI, previous history of complications during pregnancy, parity, sex of offspring, and total tea consumption frequency.

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387



389 Figure legends

390 Figure 1 Flowchart of participant recruitment in the Born in Guangzhou Cohort Study, 2012-

391 2014 (n=8775).