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Effects of excessive tea consumption on pregnancy weight gain and neonatal birth weight

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Objective
Tea lovers are increasing worldwide. We hope that this report is the first to discuss the possible impacts of high black tea consumption on gestational weight gain (GWG) and birth parameters.

Methods
Throughout one year, a total of 7,063 pregnant ladies coming for first antenatal visit were screened in a major tertiary center. Of them, 1,138 were involved and divided according to their preference into 3 groups: excessive tea (ET), usual tea (UT), and mixed beverages group. The study included women who gave birth to healthy neonates.

Results
The rate of ET consumption was 4.13% with a total of 41 cases. The UT group (controls) comprised 94 women. ET was significantly associated (P<0.05) with maternal age, parity, occupation, smoking, and poor GWG starting from 30 weeks' gestation until delivery, low birth weight, and small for gestational age (SGA). Poor GWG had a higher relative risk (with 95% confidence interval) in the ET group than in the UT group in crude (1.84 [0.85–2.43]) and risk adjusted models (1.25 [0.28–2.26]). Further, similar results were obtained for SGA in the crude and 3 adjusted models, where the first model was adjusted for bio-obstetrical variables, the second for social parameters, and the third for all factors included in the previous models (1.53 [0.62–2.81], 1.52 [0.71–2.50], and 1.46 [0.78–2.39]), respectively.

Conclusion
Consumption of large amounts of daily black tea during pregnancy (≥1,500 mL) is a significant cause of poor GWG and SGA.

Keywords: Complications; Pregnancy; Tea; Weight gain

Introduction

Tea is a common drink throughout the world and is consumed at any time and situation, even during pregnancy. The leaves of *Camellia sinensis* are used to prepare tea and have 2 major ingredients: alkaloids (as caffeine) and polyphenols (catechins) [1,2].

Tea is generally divided into 3 main categories based on the fermentation status: black, green, and oolong. In most parts of the world, black tea is the most common consumed category. Tea is considered the most popular beverage after water [3,4].

It is well known that maternal lifestyle factors, such as smoking and nutritional habits, have a direct effect on the neonate, where certain chemicals cross the placenta to induce positive effects such as those induced by folic acid, or even harmful effects such as those caused by low vitamin A [5,6].

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Caffeine, as a principal chemical component of tea, moves freely from the placenta to the fetus where it remains non-metabolized and elevates the maternal and fetal concentrations of adrenaline, resulting in diminished placental blood flow with eventual hypoxia [7,8].

Further, the other major component of tea, namely polyphenols, could play an important role during gestation and adversely affect the outcomes. Preeclampsia, prematurity, and intrauterine growth retardation are examples of such outcomes [9,10].

Results of maternal tea consumption during pregnancy are conflicting, and some scientists found no strict and direct relationship between tea and pregnancy outcomes, while others observed associated risk factors including prematurity, abnormal fetal growth, and spontaneous abortions [11,12].

We aimed to study the potential effects of excessive tea consumption during pregnancy on maternal weight gain and newborn's weight at birth.

Materials and methods

All pregnant women who visited for a consultation during the first trimester to the department of obstetrics and gynecology at Medical City Hospital in Baghdad (which is the main tertiary center in the country) were screened from January 2, 2019 to February 1, 2020. Totally, there were 7,063 women.

1. Maternal data

Recruited mothers on presentation should have had singleton pregnancy, normal pre-gestational body mass index (BMI; kg/m^2) ≤24.99, and no chronic illnesses, such as diabetes mellitus, hypertension, thyroid disease, asthma, placental disease, and other maternal conditions such as kidney, rheumatic, pulmonary, and uterine disease, at the first visit and throughout pregnancy. In addition, cases with fetal genetic abnormalities and fetal infections were excluded whenever detected. Based on this, the total number of involved cases was 1,138.

During each visit for the regular antenatal care, full history was taken, and examination was performed by the attending obstetrician.

2. Tea related data

A black teabag from Ahmad Tea Ltd. (London, England), containing 2 g of black tea, which was collected from Sri Lanka, and packed in United Arab Emirates in August 2018, was infused in a cup (150 mL) of hot water for 3–5 minutes according to the instructions of the manufacturer.

During the follow-up period, which was started soon after the initial presentation until delivery of a neonate, daily amounts of the above-mentioned black tea were calculated for all participants in terms of cups and converted into milliliters (mL). The usual serving cup in our local community contained 150 mL (just like the manufacturer's instructions), which is usually consumed 3 times daily after meals for most people. This was considered the usual tea (UT) consumption. Excessive tea (ET) consumption was defined as consumption of at least 1.5 liters (1,500 mL) per day [13].

3. Workup data

The included subjects were followed up through a twice-weekly phone call to document their daily beverage consumption, including tea (black, green, or oolong) and other caffeinated products such as coffee, chocolate, and carbonated sodas. Further, the women included in this study were observed to ensure the consumption of 2,200–2,900 kilocalories daily and a balanced diet containing 50–60% carbohydrate, 25–35% fat, and 10–20% protein from different food items including fruits, vegetables, meat, legumes, whole grains, and nuts. Participants were divided into 3 groups: the first 2 groups involved pregnant women who consumed black tea (prepared as above) as the only daily beverage in addition to water. The ET consumption group included pregnant women who consumed ≥1,500 mL/day of black tea, while the UT consumption group included pregnant women who consumed ≤3 cups (≤450 mL) of black tea daily. The third group had the following criteria:

- Consumption of any beverage type and non-tea caffeinated products such as coffee, carbonated soda, and chocolate powder or bar.
- Consumption of black tea from brands other than the above-mentioned brand, or other formulations such as green tea and oolong tea.
- Consumption of >450 mL and <1,500 mL of black tea daily.

This last group was excluded from the statistical analysis.

The decision to join the ET, UT, or the third group of mixed products was made freely by the involved pregnant women at first recruitment.

Participants in the ET and UT groups who failed to follow the strict inclusion criteria and instructions of each group during the follow-up period, or missed regular contacts with the researchers were further excluded from the study sample.

4. Neonatal data

The neonates should be alive, healthy, and full term (completed 37 weeks' gestation). The sex of the neonates, birth weight, birth gestation, and mode of delivery were documented by the attending pediatrician. Abortions, stillbirth babies, congenital malformations, and premature neonates were excluded.

Birth weight ≤10th percentile was assumed to be small for gestational age (SGA), while large for gestational age neonates were defined as weight ≥90th percentile for age. Appropriate for gestational age (GA) was considered when the birth weight was <90th and >10th percentile for age. Low birth weight (LBW) was defined as birth weight <2,500 g [14,15].

5. Analysis and statistics

Mean±standard deviation, frequencies (percentages), and relative risk (RR) with proportions (95% confidence interval [CI]) were used for data expression.

For discrete characteristics, the Pearson's χ^2 test was used. Student's *t*-tests were performed for continuous characteristics.

Multivariate logistic regression analysis was applied to control for risk factors of poor gestational weight gain (GWG) and SGA, which have already been revealed to have statistically significant values. Poor GWG was adjusted for maternal age, weight, height, pre-gestation BMI, parity, employment, smoking, and daily energy intake. Three separate adjusted models were created for the SGA. The first model was adjusted for bio-obstetric parameters (maternal age, parity, pre-pregnancy BMI, GWG, and GA at the first presentation, and at delivery). The second model was adjusted for social factors (education level, occupation, and smoking habit). The third model was adjusted for all parameters involved in the previously mentioned models. The absence of tea drinking was considered as a reference value. All statistical analyses were performed using IBM SPSS (version 23 for Windows; IBM, Chicago, IL, USA). A 2-tailed *P*-value <0.05. was considered statistically significant.

Results

Of the 1,138 pregnant women, 41 women were categorized in the ET group, while 94 mothers included in the UT group were considered as controls. The rate of excessive tea con-

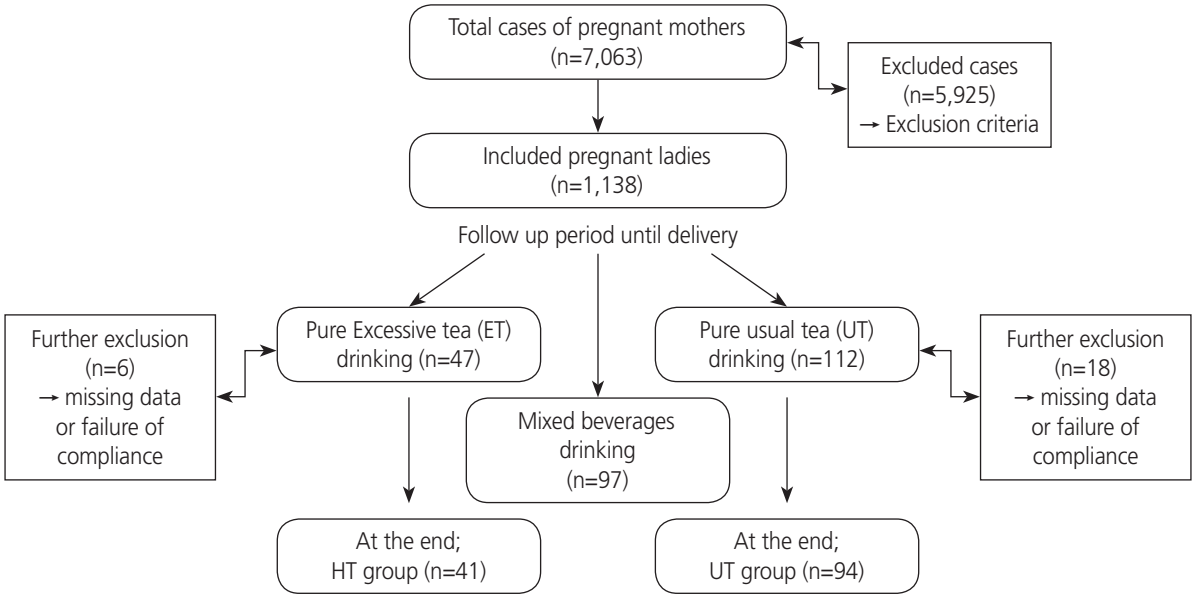

Fig. 1. Flowchart of the study.

sumption was 4.13%. Details of recruitment are shown in Fig. 1.

In the ET group, maternal age, parity, employment, and smoking were statistically significant (P<0.05), as shown in Table 1.

Table 2 presents a schematic of the GWG. For the first trimester visit at early gestation, 10th and 20th gestational weeks, the weight gain was comparable between the ET and UT groups. From the 30th week of gestation until delivery, women in the ET group began to have a significantly poorer GWG.

Table 1. General characteristics of the pregnant women included in this study

Variables	ET group (n=41)	UT group (n=94)	*P*-value
Age (yr)	34.3±5.8	25.7±5.1	<0.05
Parity	5.9±0.4	3.2 ± 0.1	<0.05
Gestational age (wk) at presentation	7.4±1.2	7.1±1.6	0.46
Pre-pregnancy BMI	24.7±3.4	24.9±4.2	0.89
Gestational age (wk) at delivery	38.7±1.4	38.9±0.9	0.10
Education level			0.67
Literate	37 (90.24)	86 (91.49)	
Illiterate	4 (9.76)	8 (8.51)	
Occupation			<0.05
Housewife	10 (24.39)	58 (61.70)	
Employed	31 (75.61)	36 (38.30)	
Smoking status			<0.05
Smoker	39 (95.12)	12 (12.77)	
Non-smoker	2 (4.88)	82 (87.23)	

Values are presented as mean±standard deviation or number (%).
ET, excessive tea; UT, usual tea; BMI, body mass index.

Table 2. Trajectory of gestational weight gain

GWG in kg	ET group (n=41)	UT group (n=94)	*P*-value
At first recruitment	0.5±0.8	0.6±0.2	0.29
10 weeks' gestation	1.6±0.1	1.7±0.3	0.31
20 weeks' gestation	4.9±0.9	5.8±0.7	0.57
30 weeks' gestation	9.0±0.8	11.6±0.5	<0.05
At delivery	11.7±0.7	16.1±0.9	<0.05

Values are presented as mean±standard deviation.
GWG, gestational weight gain; ET, excessive tea; UT, usual tea.

The significant finding of poor GWG in the ET group had a higher RR with (95% CI) than that in the UT group in the crude model and after controlling for risk factors (maternal age, weight, height, pre-gestation BMI, parity, employment, education level, smoking, and daily energy intake). No statistical significance was found between the crude and adjusted models. This is clearly depicted in Table 3.

Neonatal sex and delivery mode showed no significant association between the studied groups, although the frequency for normal delivery was higher in all participants. The ET group had significantly SGA and LBW neonates, as illustrated in Table 4. The significant finding of SGA in the ET group had a higher RR (95% CI) compared to that in the UT group. The crude RR of ET was 1.53 (0.62–2.81). However, the RR of 1.56 (0.69–2.32) was further higher in the first model that was adjusted for bio-obstetrical variables including maternal age, parity, pre-pregnancy BMI, GWG, and GA

Table 3. Poor gestational weight gain in association with tea drinking expressed by crude and adjusted relative risks (RRs)

Tea consumption	Crude RR	Adjusted RR[a)]	*P*-value
Absence of tea consumption	Ref.	Ref.	Ref.
ET group	1.84 (0.85–2.43)	1.25 (0.28–2.26)	0.43
UT group	1.10 (0.68–1.39)	0.92 (0.57–1.09)	0.78

Values are presented as RR (95% confidence interval).
ET, excessive tea; UT, usual tea.
[a)]Adjusted relative risk for risk factors including maternal age, weight, height, pre-gestation body mass index, parity, employment, education level, smoking, and daily energy intake.

Table 4. Neonatal characteristics

Variables	ET group (n=41)	UT group (n=94)	*P*-value
Sex			0.73
Male	21 (51.22)	52 (55.32)	
Female	20 (48.78)	42 (44.68)	
Birth weight (grams)	2,236±219	3,047±326	<0.05
SGA	32 (78.05)	5 (5.32)	<0.05
Mode of delivery			0.68
Normal (vaginal)	28 (68.29)	61 (64.89)	
Cesarean section	13 (31.71)	33 (35.11)	

Values are presented as number (%) or mean±standard deviation.
ET, excessive tea; UT, usual tea; SGA, small for gestational age.

at presentation and delivery. The second model (adjusted for social parameters including smoking, education level, and employment), and the third model (adjusted for all factors involved in the previous models) had RRs of 1.52 (0.71–2.50) and 1.46 (0.78–2.39), respectively, that were slightly lower than the crude and first models. All these findings are shown in Table 5.

Statistical significance was absent between the crude and adjusted models. For the first, second, and third adjusted models, the corresponding *P*-values were 0.58, 0.87, and 0.36, respectively.

Discussion

To the best of our knowledge, this is the first study to investigate the influence of high tea consumption on GWG and neonatal birth weight. As previously mentioned, tea is a common beverage worldwide, and it is considered the most commonly used beverage after water [1-4].

The incidence of excessive tea consumption (≥1,500 mL/day) in our sample was low (4.13%). Some scientists published further lower incidence of excessive tea consumption than what we have found (2.9%) in contrast to other scientists who documented a higher level of excessive tea drinking than our result (8.3%) [16,17]. These lower and higher rates were linked to caffeine consumption from sources not limited to tea, such as coffee.

In this cohort, the frequency of excessive tea consumption increased with the increase in maternal age and parity along with smoking and employment, similar to that reported in other studies [18-20].

The same holds true for individuals who are not pregnant where increased consumption of tea is associated with older age, smoking status, and stress associated with employment [21,22].

Weight loss is associated with tea consumption, which in turn may cause anemia, thereby affecting the nutritional status of pregnant women and leading to inadequate GWG [23-26]; this is in line with our results of a significant negative effect on GWG when consuming large amounts of tea during pregnancy even after adjustment for risk factors.

In addition, tea, especially when consumed excessively, is associated with decreased intestinal absorption of vitamin C and maternal dietary abnormalities affecting weight gain [27,28].

Birth outcomes are affected by the GWG. Fetal and neonatal risks are expected with poor weight gain during pregnancy caused by different factors [29,30].

In the present study, excessive tea consumption was significantly associated with LBW and SGA. Multiple logistic regression models were built to study the association between SGA and other previously measured independent variables to estimate the RR and statistical significance. In crude and all other adjusted models, RR was higher in the ET group, with no statistical significance. We could not find published data relating excessive tea consumption with birth parameters. However, many reports have suggested that high maternal caffeine consumption (≥300 mg/day) was linked to SGA and other adverse pregnancy outcomes [19,31,32].

The tea consumed by our participants contained an average caffeine levels of 0.31 mg/mg/mL [33], with a total of ≥465 mg/day in the ET group. This supports the above observations.

Nevertheless, a large study from the United States revealed that caffeine from tea had attenuated results in comparison

Table 5. Small for gestational age in association with tea drinking expressed by crude and adjusted relative risk (RR)

Tea consumption	Crude RR	Adjusted RR		
		First model[a]	Second model[b]	Third model[c]
Absence of tea consumption	Ref.	Ref.	Ref.	Ref.
ET group	1.53 (0.62–2.81)	1.56 (0.69–2.32)	1.52 (0.71–2.50)	1.46 (0.78–2.39)
UT group	0.98 (0.76–1.12)	1.18 (0.52–1.86)	1.09 (0.90–1.32)	1.03 (0.89–1.15)

Values are presented as RR (95% confidence interval).
ET, excessive tea; UT, usual tea.
[a]First model was adjusted for maternal age, parity, pre-pregnancy body mass index, gestational weight gain, and gestational age in weeks at first antenatal visit, and delivery; [b]Second model was adjusted for education level; either literate or illiterate, employment, and smoking habit; [c]Third model was adjusted for all parameters included in upper models.

with other sources such as coffee [34]. This may be related to the type of tea used and the different preparation techniques used. The World Health Organization has indicated a cut-off value of 300 mg/day of caffeine during pregnancy as an etiological risk for SGA [35]. However, other reports confirmed the absence of caffeine effects on pregnancy outcomes, including birth weight [19,36]. These variations could be partly due to differences in study methodology, caffeine consumption estimations, measurements of associated confounders, and possible adverse effects of polyphenols, the other major ingredients of tea.

The study of certain risk factors during gestation to predict adverse pregnancy parameters is a common scientific attitude [37,38]. Tea (as a risk factor during pregnancy) is not an exception, and has been studied by many researchers [19,20]; however, examining the effect of excessive tea consumption among pregnant women in the context of GWG and birth weight variations is novel and is the strength of this study. Moreover, the strict follow-up of pregnant women through phone calls or direct visits throughout the study period and involving a large number of pregnant women in the initial screen are the other strengths of this study.

In contrast, this study has some limitations such as the absence of maternal anemia diagnosis, which might have helped in assisting our theory regarding poor GWG. In addition, failure to add monthly income estimations, which could have been added to the previously mentioned confounders of GWG and neonatal birth weight for GA, is another limitation. In fact, background community beliefs made it difficult for researchers to obtain accurate financial data. The inability to precisely calculate the amount of daily tea consumption before pregnancy is another limitation.

In conclusion, excessive tea drinking (≥1,500 mL/day) throughout pregnancy has been linked to restrict maternal weight gain and neonatal weight at delivery with the final result of LBW and SGA.

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Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

Ethical approval was obtained from the Scientific and Ethical Committee of College of Medicine (No. 675), Al-Kindy College of Medicine (No. 381), at the University of Baghdad. The study was conducted in accordance with the Helsinki Declaration.

Patient consent

Informed consent was obtained from all participants.

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