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Original Article

The Caffeine Consumption among Turkish Pregnant Women

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ABSTRACT

Background: Caffeine consumption during pregnancy has effect on newborn anthropometry therefore the amount of maternal caffeine consumption is important. **Aim:** This study aims to determine caffeine consumption during pregnancy and related factors. **Subjects and Methods:** This study was carried out in a maternity hospital located in Eastern Turkey from September 2018 to June 2019 with 300 healthy primiparous women and babies. Data were collected by the researchers with a socio-demographic questionnaire and caffeine consumption frequency semi-quantitative questionnaire using the face-to-face interview technique. Postpartum weight and height of the women and length, weight, and head circumference of the newborns were measured. Evaluation of the data was carried out with Kruskal–Wallis and Mann–Whitney U test and binary logistic regression analysis was used for relationship analysis. **Results:** The mean daily caffeine intake of the pregnant women was determined as 344.9 ± 181.4 mg/day and 4.9 ± 2.6 mg/kg/day. The babies' mean birth weight was 2943.1 ± 407.4 g, mean length was 50.1 ± 2.2 cm, and mean head circumference was 32.3 ± 1.6 cm. A statistically significant negative correlation was found between caffeine consumption of pregnant women and newborn birth weight and length ($P = 0.049$; $P = 0.007$, respectively). After age, economic and educational status, and pre- and post-pregnancy BMI were corrected according to weight increase during pregnancy and after binary logistic regression analysis was performed, it was determined that caffeine consumption did not have an effect on low birth weight (Total caffeine consumption (mg/day), $P = 0.669$ OR = 1.00, 95% Cl = 0.997-1.002; caffeine consumption (mg/kg), $P = 0.549$ OR = 0.956, 95% Cl = 0.824-1.109). **Conclusion:** Caffeine consumption of pregnant women is higher than the recommended levels. Therefore, pregnant women should be informed about caffeine sources and consumption amounts.

Keywords: *Birth length, caffeine, low birth weight, pregnancy*

Introduction

Caffeine is a very small and highly lipophilic molecule known as a stimulant of the central nervous system. The metabolites of caffeine (paraxanthine, theobromine, and theophylline) have a wide range of physiological effects. Caffeine is rapidly absorbed in the gastrointestinal tract, crossing cell membranes such as blood, the hematotesticular barrier, and placental membranes with high selective permeability, by passive diffusion thus reaching biological tissues.[1,2] Sources of caffeine are cocoa beans, tea leaves, mate leaves, kola nuts, cocoa capsules, and guarana seeds and is naturally found in coffee, tea, cola, cocoa, dietary supplements, herbal products, cocoa and chocolate/coffee flavored desserts, soft drinks, energy drinks, and prescription and non-prescription drugs.[1]

The half-life of caffeine in humans can vary between 2 and 4.5 h and last up to 12 h.[1] Caffeine consumption during pregnancy is a subject that should be prioritized in terms of both maternal and fetal outcomes. Caffeine,

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which passes easily to the fetus via the placental membrane, cannot be metabolized by the liver of the fetus. Consequently, maternal serum caffeine concentrations are believed to be reliable indicators of fetal serum. Caffeine increases the level of cyclic adenosine monophosphate in cells by inhibiting phosphodiesterase, which can affect fetal growth and development.[3] Considering the fact that the negative effects of caffeine occur more in the fetus, pregnant women should be cautious about consuming caffeine.[2,4]

The U.S. Food and Drug Administration (FDA) stated after clinical studies with humans and animals that caffeine intake could be limited to 300 mg per day.[5] The European Food Safety Authority (EFSA) and American College of Obstetricians and Gynecologists (ACOG) reported that pregnant women should limit their caffeine intake to below 200 mg per day.[6,7] Other research groups suggest that the maximum intake in pregnancy should be 100 mg per day or less.[8-10] Despite these recommendations, there is currently no accepted reference standard for daily caffeine consumption for pregnant women.[11] Current studies are insufficient and many pregnant women consume too much caffeine.[2] It was reported that women aged 30 to 39 years in Japan consume on average 213 mg of caffeine per day and that 7% of women consume more than 400 mg daily.[12] In the United Kingdom, 18% of women of childbearing age consume more than 300 mg of caffeine daily.[13] A study carried out with a limited number of pregnant women in Turkey found that these women consumed an average of 97 mg of caffeine per day.[14]

Many studies have been determining the potential risks and positive/negative health effects of high caffeine consumption. Epidemiological studies showed that 300 mg of caffeine consumption per day increases the risk of low birth weight (LBW), as well as other studies showing relatively high caffeine intake with the same effect.[15-22] This increase was calculated as 1.4% in women consuming little caffeine (1-150 mg/day), 2.3% in moderate consumption (151-300 mg/day), and 4.6% in high consumption (301 mg/day).[23] Greenwood *et al*.[18] reported in a systematic review that a 7% risk of LBW with 100 mg caffeine increase. Also, Chen *et al*.[19] reported a 13% risk of LBW with a 100 mg caffeine increase. These results show that as caffeine consumption increases during pregnancy, it may increase the risk of LBW. In the literature, studies are showing that caffeine consumption in the range of 200 to 400 mg/day may cause a decrease in fetal birth weight by approximately 100 g; however, there are also studies claiming that caffeine has no effect on birth weight.[16,24,25] In a study where the amount of caffeine was evaluated according to the daily preparation and consumption of beverages in Turkey, the highest caffeine amount was found in coffee and Turkish tea.[26] In another study, Turkish coffee ranks second in caffeine amount in all types of coffee brews obtained by different extraction methods.[11] It is an important situation in the Turkish population, which prefers brewed tea and coffee as the main beverage. Pregnant women need to know the amount of tea and coffee they consume (300 mg caffeine ~ 4 glasses of tea) and understand that the amount of caffeine consumed can have negative effects on the fetus and newborn.[26] For this reason, this study aimed to determine caffeine consumption during pregnancy and related factors.

Materials and Methods

Study population

This cross-sectional prospective single-center study included 300 primiparous women and their babies that were admitted to the maternity hospital located in Eastern Turkey between September 2018 and June 2019. Inclusion criteria were: having a single live birth, term delivery (38-40 weeks), and regular follow-ups. Exclusion criteria were: chronic or systemic diseases (hypertension, diabetes, chronic kidney disease, etc.), alcohol consumption or cigarette use, a BMI of >40 kg/m^2, preeclampsia/eclampsia, placental anomalies, a history of miscarriage and babies with anomalies such as chromosomal anomalies, dysmorphism, and so on. Pregnant women who met the research criteria were included in the study after giving their verbal consent.

Data collection

The content of the study was explained by the researchers to the pregnant women who applied to the hospital and met the inclusion criteria. Verbal consent was obtained from the pregnant women in the antenatal clinic. After birth, the anthropometric measurements of the babies were recorded by a single researcher to minimize the subjective error margin. Then, the questionnaires (sociodemographic and caffeine consumption questionnaire) were applied once with the face-to-face interview technique during the time period when the women stated that they felt good (within the first 24 h), and the women's height and kg were also measured during pregnancy and postpartum.

Data tools

The socio-demographic characteristics of the pregnant women (age, educational status, profession, etc.) and their pre-pregnancy weight were recorded via a questionnaire developed by the researchers. Postpartum weight and height of the mothers and the newborn's length, weight, and head circumference were measured.

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Birth weight was measured on a 10-g sensitive scale after the newborn was cleaned and unclothed. The birth weights were classified into two groups. Babies with a birth weight under 2500 g were put in the low birth weight group and babies between 2500 and 4000 g were put in the normal birth weight group.[27] The birth length was determined using an infantometer. The head circumference was measured from the most protruding point on the back of the newborn's head to the forehead with a non-stretchable tape measure.[28]

Caffeine consumption

The caffeine consumption questionnaire was developed by the researchers for the purpose of the study. A semi-quantitative caffeine consumption frequency questionnaire including the amounts of caffeine-containing foods, consumption frequencies (every meal, every day, 1-2 times a week, 3-4 times a week, 5-6 times a week, every 15 days, once a month, and never), preparation methods, and brands were given to the pregnant women to determine caffeine consumption during pregnancy. The questions identified tea consumption as tea bags and brewed black and green tea and coffee consumption as coffee and Turkish Mocha (gold, classic), instant 3-in-1 coffee, espresso, cappuccino, and latte. Consumption of other sources of caffeine include the drinks such as energy drinks, cola (diet-normal), iced tea, milk and dark chocolate, cocoa, chocolate drinks and dessert, cakes, and cookies. In addition, the nutritional supplements and medication use of pregnant women were ascertained. Consumption amounts of each participant were determined by using photographs from a food atlas.[29] Along with the average daily caffeine consumption, the amount of caffeine per pregnancy body weight (mg/kg) was also calculated. Table 1 identifies the caffeine amounts of the drinks and food in the study.[26,30-32]

Data evaluation

Data were analyzed using the SPSS 22.0 software program. Non-parametric analyses were performed since data were not normally distributed as a result of normality analysis. Kruskal–Wallis and Mann–Whitney U tests were used to determine the difference between the groups and Spearman's correlation was used for relationship analysis. Bonferroni correction was made for post-hoc analysis. To reveal the effect of caffeine on birth weight, binary logistic regression analysis was performed. Birth weight and length classified as normal were defined as dependent variables. Potential confounding variables including age, economic status, educational status, pre-pregnancy BMI, post-pregnancy BMI, and weight gain during pregnancy were chosen as independent variables.

Ethical considerations

Ethics approval was obtained from the local ethics committee (Approval number 2017/03/05) from the Atatürk University Faculty of Health Sciences. Verbal consent was obtained from all participants. The Helsinki Declaration Principles were followed in all steps of the study.

Results

Table 2 compares the caffeine intake according to the socio-demographic data of pregnant women. The difference between body weight (mg/kg/day) and daily caffeine consumption (mg/day) by age groups was found statistically significant (0.004; 0.011, respectively). With the Bonferroni correction, Mann–Whitney U test was performed, and the groups were compared. The age group with least caffeine consumption was 24 to 29 years (3 ± 2.5 mg/kg/day and 313.3 ± 177.7 mg/day) and the group consuming the most caffeine was the age group >35 years (6.3 ± 2.7 mg/kg and 446.2 ± 186.2 mg/day) ($P < 0.00083$). When daily caffeine consumption was analyzed according to economic status, no difference was found between the groups. However, there was a statistically significant difference between caffeine consumption according to the body weight ($P = 0.021$). The caffeine consumption of those participants with a poor economic status was 5.9 ± 2.8 mg/kg/day, which was higher than of those with good economic status ($P < 0.017$; Bonferroni correction).

Of the pregnant women, 71.3 had a normal pre-pregnancy BMI. According to the pre-pregnancy BMI, caffeine consumption per body weight was different ($P = 0.028$) and daily caffeine consumption was similar ($P = 0.536$). After the Bonferroni correction, the difference between caffeine consumption (mg/kg) of normal and slightly obese pregnant women was found to be statistically significant ($P = 0.009$; 5.0 ± 2.6 mg/kg; 4.3 ± 2.9 mg/kg, respectively). According to the postpartum BMI, 60.0% were slightly obese and after the difference in caffeine consumption was examined, the difference between

Table 1: Caffeine amounts of different foods and drinks

Beverage/Food Group	Caffeine amount (mg/portion)
Black tea (brewed)	40 mg/100 ml
Green tea	15 mg/100 ml
Turkish Mocha	85 mg/100 ml
Coffee (classic/gold/instant 3 in 1/latte)	53-67/200 ml
Other drinks (cola/iced tea)	9-24/200 ml
Chocolate (bitter/milk)	80-100/100 g
Chocolate and cacao dairy products	4-10/200 ml (g)
Chocolate and cacao grain products	10-20/100 g

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Table 2: The pregnant women's caffeine consumption according to socio-demographic characteristics (*n*=300)

Characteristics	*n*	%	Caffeine consumption (mg/kg/day) Mean and SD (min-max)	Caffeine consumption (mg/kg/day) Test *P*	Caffeine consumption (mg/day) Mean and SD (min-max)	Caffeine consumption (mg/day) Test *P*
Age						
18-23	88	29.3	5.2±2.7 (0.5-11.9)		334.9±165.7 (39.5-818.4)	
24-29	109	36.3	4.3±2.5 (0.03-11.4)	KW=13.2 *P*=0.004	313.3±177.7 (3.1-844.7)	KW=11.1 0.011
30-35	81	27.1	5.0±2.6 (0.4-11.7)		370.9±190.7[b] (34.0-823.7)	
>35	22	7.3	6.3±2.7[b] (2.0-11.4)		446.2±186.2[a.b] (136.9-826.5)	
Educational Status						
Primary School	74	24.7	5.2±2.8 (0.03-11.7)	KW=2.6 *P*=0.483	381.5±202.8 (3.1-844.9)	
Middle School	85	28.3	4.9±2.8 (0.5-11.4)		349.9±192.1 (39.5-823.7)	KW=3.7 0.296
High School	95	31.7	4.8±2.5 (1.3-11.9)		332.2±163.2 (105.4-818.4)	
Bachelor's Degree	46	15.3	4.3±2.2 (0.9-10.2)		303.4±151 6 (70.3-717.1)	
Work status						
Working	34	11.3	4.3±2.0 (0.9-8.6)	MU=4042.0 *P*=0.314	309.3±141.3 (70.3-613.7)	MU=4134.0 *P*=0.415
Not working	266	88.7	4.9±2.7 (0.03-11.9)		349.5±185.6 (3.1-844.7)	
Perception of the economic situation*						
Poor	39	13.0	5.9±2.8 (1.4-11.4)	KW=7.7 *P*=0.021	393.5±187.2 106.2-826.5	
Moderate	202	67.3	4.8±2.7 (0.03-11.9)		342.8±184.7 (3.1-844.7)	KW=3.2 *P*=0.206
Good	59	19.7	4.3±2.1[x] (0.9-11.3)		320.0±161.6 (70.3-823.7)	
Pre-pregnancy BMI classification (kg/m^2)						
Underweight (16.0-18.49)	11	3.7	5.0±1.9 (2.3-9.7)		314.1±122.6 (157.4-618.6)	
Normal (18.5-24.99)	214	71.3	5.0±2.6 (0.6-11.9)	KW=7.2 *P*=0.028	347.2±168.2 (42.2-826.5)	KW=1.2 *P*=0.536
Slightly obese (25-29.99)	75	25.0	4.3±2.9 (0.03-11.7)		343.1±222.1 (3.1-844.7)	
Postpartum BMI classification (kg/m^2)						
Normal (18.5-24.99)	69	23.0	5.5±2.6 (1.8-11.0)	KW=14.6 *P*=0.001	339.5±154.4 (115.1-627.9)	KW=2.5 *P*=0.289
Slightly obese (25-29.99)	180	60.0	4.9±2.6 (0.57-11.9)		355.7±186.2 (42.2-844.7)	
Obese (30-40.00)	51	17.0	3.8±2.4[b] (0.03-10.0)		314.1±196.5 (3.1-823.7)	
Daily caffeine intake (mg/day)	300	100.0	344.9±181.4 (3.1-844.7)			
Caffeine consumption per body weight (mg/kg)	300	100.0	4.9±2.6 (0.03-11.9)			

* Women's own expressions

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Table 3: The relationship between the caffeine consumption of pregnant women and anthropometric measurements of the pregnant women and the newborn

Characteristics	Mean and SD (min-max)	Caffeine intake (mg/day)		Caffeine intake (mg/kg/day)	
		r	*P*	*r*	*P*
Pre-pregnancy BMI (kg/m²)	23.0±2.8 (16.2-29.0)	-0.03	0.628	-0.17	0.003
Postpartum BMI (kg/m²)	27.3±3.0 (20.6-36.5)	-0.05	0.348	-0.23	<0.001
Birth weight (g)	2943.1±407.4 (2045.0-4000.0)	-0.11	0.049	-0.21	<0.001
Birth length (cm)	50.1±2.2 (38.0-55.0)	-0.16	0.007	-0.25	<0.001
Head circumference (cm)	32.3±1.6 (29.0-35.0)	-0.09	0.135	-0.16	0.005

SD Standard deviation, BMI body mass index

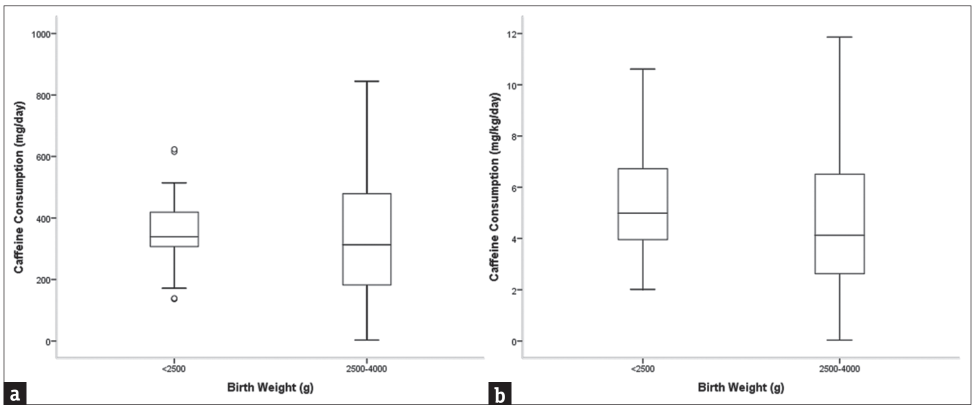

Figure 1: Caffeine consumption of pregnant women according to the birth weight of the newborns; (a) caffeine consumption (mg/day), (b) caffeine consumption (mg/kg), low birth weight <2500 g; normal birth weight (2500-4000 g). Results according to Mann–Whitney U analysis $P > 0.05$

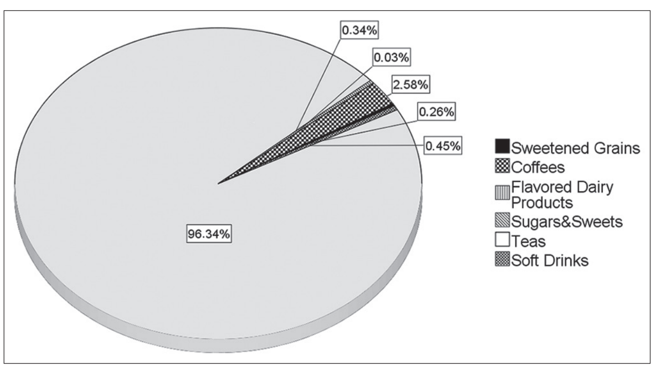

Figure 2: Contribution (%) of different sources of caffeine to caffeine consumption

postpartum BMI and caffeine consumption per body weight was statistically significant ($P = 0.001$). Post-hoc analysis showed that the difference arose from the obese group ($P < 0.017$; Bonferroni correction). The mean caffeine consumption of the obese group was 5.5 ± 2.6 mg/kg/day, which was found to be lower than the caffeine consumption of the slightly obese and normal weight pregnant women ($P < 0.017$; Bonferroni correction).

The difference between caffeine consumption according to education and working status of the pregnant women was not statistically significant ($P > 0.05$).

Table 2 gives the daily caffeine intake and caffeine consumption per weight of pregnant women. The mean daily caffeine intake of the pregnant women was determined as 344.9 ± 181.4 mg/day and 4.9 ± 2.6 mg/kg/day.

Table 3 shows the relationship between the caffeine consumption of pregnant women and anthropometric measurements of pregnant women and the newborns. This shows that the pre-pregnancy BMI of the women was 23.0 ± 2.8 kg/m^2 and the postpartum BMI was 27.3 ± 3.0 kg/m^2. The babies' mean birth weight was 2943.1 ± 407.4 g, mean length was 50.1 ± 2.2 cm, and mean head circumference was 32.3 ± 1.6 cm.

The table illustrates a statistically significant negative correlation between caffeine consumption of pregnant women and newborn birth weight and length ($P < 0.001$ r = -0.21, $P < 0.001$ r = -0.25; $P = 0.049$ r = -0.11; $P = 0.007$ r = -0.16, respectively). Even though there

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was a negative correlation between caffeine consumption and head circumference, it was not statistically significant ($P > 0.05$).

Figure 1 shows the difference between newborn weight and caffeine consumption of women. There was no statistically significant difference in terms of daily caffeine intake and women with low birth weight babies and women with normal birth weight babies ($P > 0.05$). When binary logistic regression analysis was performed by adjusting for confounding factors such as age, economic status, educational status, pre-pregnancy BMI, post-pregnancy BMI, and weight gain during pregnancy, there was no effect of caffeine consumption on low birth weight (data not shown/total caffeine consumption (mg/day), $P = 0.669$ OR = 1.00, 95% Cl = 0.997-1.002; caffeine consumption (mg/kg), $P = 0.549$ OR = 0.956, 95% Cl = 0.824-1.109). LBW incidence is 11.7% (data not shown).

Figure 2 shows the analysis of the sources of caffeine consumption in pregnant women. The source of daily caffeine consumption of the women was tea at 96.34% and coffee at 2.58%.

Discussion

Caffeine is consumed in large amounts and has both positive and negative effects on health. Caffeine is currently a frequently researched and discussed subject.[4] Caffeine consumption during pregnancy is a subject that should be prioritized in terms of both maternal and fetal outcomes. This study data determined the relationship between caffeine intake during pregnancy and anthropometric measurements of the newborn and was presented with related literature findings.

Examination of caffeine consumption according to age groups showed that pregnant women aged 24 to 29 years consumed the least caffeine and pregnant women aged 35 years and older consumed the most. The study showed that as age increased (excluding the age range 24-29 years), the daily caffeine intake also increased ($P < 0.05$). Sengpiel *et al.*[17] also reported that caffeine consumption increased together with age excluding the age group 25 to 29 years. Caffeine consumption in the younger age group is lower than in the other age groups and can be explained by the younger women's educational profile.

Even though there was no statistically significant difference between educational status and caffeine consumption in the current study ($P < 0.05$), both the caffeine intake per kilogram and daily caffeine intake decreased as the educational level increased. Education is an important parameter in adopting awareness and a healthy lifestyle. Almost half of the study group graduated from high school or above. As the education levels increased, the desire to keep both maternal and fetal health at the highest level increased and habits that are thought to be harmful are either reduced or given up completely. In literature, there are studies that are similar to the current results;[33] however, there are also studies stating the exact opposite that caffeine consumption increased as the education year increased.[34]

As the economic situation improved, caffeine consumption decreased and there was a statistically significant difference between caffeine consumption per body weight ($P = 0.021$). Economic status is closely related to education. If an assumption is made that people with higher economic status will have in parallel increased education levels, it can be noted that caffeine consumption is lower in the group with good economic status (poor economic status: 5.9 ± 2.8, good economic status 4.3 ± 2.1). There are studies in the literature that support this result[34] and some that do not.[17]

More than half of the pregnant women in the study had a normal BMI before pregnancy and a slightly obese BMI after pregnancy. In today's society, women's BMI is changing and obesity is increasing.[35] According to the Turkey Demographic and Health Survey (TDHS) (2018), 6 out of every 10 women are either overweight or obese.[36] Reasons for this include overeating or weight gain during pregnancy.[35] Another reason may be intrauterine caffeine exposure. Literature states that intrauterine caffeine exposure is associated with a higher risk of becoming overweight at the ages of 3 to 5 years with increased weight gain up to 8 years of age with high caffeine exposure.[37] More specifically, a genotype of rapid caffeine metabolism is associated with low birth weight but no relationship was found for CYP1A2 C164A polymorphism.[34] Prenatal caffeine consumption is associated with a high risk of adiposity and obesity in children.[38] The risk of becoming overweight in the early years of life may continue to increase and combined with other risk factors throughout life may be a significant factor in the increasingly overweight/obese population worldwide.

The current study found a statistically significant difference between caffeine consumption per kilogram and high BMI before and after pregnancy. It was seen that the caffeine consumption of slightly obese/obese pregnant women was higher than that of the other BMI groups. Similarly, Sengpiel *et al.*[17] reported that caffeine consumption decreased as pre-pregnancy BMI increased. Obesity significantly increases plasma half-life and reduces the elimination rate.[39,40] As caffeine consumption decreases, the risk of obesity may

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increase. Caffeine can be used to lose weight because it increases metabolic rate, energy expenditure, and lipid oxidation and offers lipolytic and thermogenic activities in weight management.[11,41] Also, caffeine acts as an appetite suppressant in appetite regulation. Moderate daily caffeine intake may lead to weight loss in obese people.[41] The fact that caffeine consumption is higher in the normal BMI group, may be due to caffeine being an adipogenesis inhibitor (if food consumption is kept constant) creating an energy deficit of approximately 75 to 110 kcal/day in 24 h,[39] which helps to maintain body weight and weight loss.

In determining caffeine intake, Bakker *et al.* used mg/cup, Kaiser and Allen and Sasaki *et al.* used mg/day, and Azzeh *et al.* used cup/day.[34,42-44] Studies on caffeine consumption in the literature have been carried out at different levels and based on different units. The EFSA and ACOG recommended that pregnant women should keep their daily caffeine below 200 mg. The FDA also stated an upper limit of 300 mg/day.[5-7] According to DePaula and Farah,[11] the International Life Science Institute (ILSI, 2010) recommended a daily average caffeine intake of less than 5 to 6 mg/kg for women of reproductive age mean 70 kg. In the current study, the amount of caffeine per weight is at the limit (4.9 ± 2.6 mg/kg/day) and the daily intake (344.9 ± 181.4 mg/day) is higher than recommended. This result may be due to some of the socio-demographic characteristics of the pregnant women included in the study (low educational levels for half of them, normal pre-pregnancy BMI for half of them). Also, another important factor is the cultural structure. In Turkey, tea is widely preferred at home and outside, which may cause an increase in caffeine intake. Also, the included pregnant women did not have any risk factors during pregnancy, which may also have affected the results. The presence of a risk factor in pregnancy can enable a healthier lifestyle to be adopted by the woman and her family from a doctor's recommendations to reduce harmful foods such as caffeine.

In the study, caffeine consumption during pregnancy effected negatively newborn birth weight and length. Sasaki *et al.*[34] reported similar newborn outcomes (2.962 g, 48.1 cm length, and 33.3 cm head circumference) with a daily caffeine intake of >300 mg/day. However, there was no statistically significant difference between neonatal outcomes and maternal caffeine intake. Caffeine increases the level of cAMP in the fetus and high cAMP prevents the development of fetal cells. In addition, caffeine lowers the amount of intervillous placental blood by raising the catecholamines in the maternal circulation,[45] which can result in decreased anthropometric measurements of the fetus. When birth weights were classified, caffeine consumption appears to have no effect on the risk of low birth weight [binary logistics regression analysis, adjusted for age, economic situation, educational status, pre-pregnancy BMI, postpartum BMI, and weight gain during pregnancy]. When the relevant literature was examined, there are many studies stating that there is a relationship between maternal caffeine intake and LBW.[15,17-21] Caffeine metabolizes more slowly during pregnancy and crosses the placental barrier.[1,2] It increases maternal 1 3'5'-cyclic monophosphate and epinephrine levels. This causes decreased intervillous blood flow due to uteroplacental vasoconstriction, and as a result, fetal growth is adversely affected.[24,46] These mechanisms may explain fetal development and the reason for LBW. Sengpiel *et al*. quoted and another hypothesis is that caffeine inhibits phosphodiesterase, leading to an increase in cellular cyclic adenosine monophosphate that may interfere with fetal growth.[17] Each additional 100 mg of caffeine consumed daily during pregnancy was reported to increase the probability of low birth weight by 3.0%, while over 100 mg increased LBW by 37.8%.[21] Sengpiel *et al.*[17] stated that each additional 100 mg of caffeine intake in daily consumption leads to a decrease in birth weight of 21 to 28 g, that an additional 200 mg leads to a decrease of 60 to 70 g and Bracken *et al.*[16] have reported a decrease of 28 g. Another study reported that, depending on the genotype, a mean decrease in birth weight of 277 g and a mean decrease in the head circumference of 1.0 cm with a ≥300 mg/day caffeine consumption.[34]

Similar studies in the literature convey similarity with the current study results showing that caffeine causes a decrease in neonatal weight, but there was no statistically significant relationship between caffeine intake and LBW.[33,47] The reason why caffeine consumption did not affect LBW risk in the current study may be due to the fact that the number of babies below 2500 g was low and that the energy intake of the mothers was not considered. As seen, there are many studies in the literature that either show or do not show a relationship between caffeine intake and LBW. There may be several reasons for the differences between the studies. The first is the wrong classification of caffeine intake. Improper classification of caffeine consumption makes it difficult to determine the effects of caffeine on health and reduces the comparability of studies.[1] The content and amount of caffeine change according to preparation. Even though the caffeine content of different foods and beverages is defined correctly, the problem is in not remembering the intake correctly. As it is known, the metabolism of caffeine shows individual differences. In addition, there are differences between the amount

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of caffeine consumption determined by food diaries or caffeine assessing tools.[1]

The most common global source of caffeine intake is roasted coffee beans and tea leaves.[39] Tea is the most consumed beverage after water worldwide,[48,49] and more than half (78%) of all tea consumed is black tea.[50] Sengpiel *et al.*[17] classified caffeine consumption sources as chocolate (for the low consuming group), black tea (for the medium consuming group), and coffee (for the high consuming group). A study conducted in England concluded that black tea consumption makes up most of the daily caffeine intake (62%).[51] Turkey is among the top five countries in the world in tea consumption and about half of the people consume more than five cups of tea per day.[52] The caffeine content of foods varies depending on the type, amount, and method of preparation of the beverage or food consumed. For example, the caffeine ratio of tea/coffee depends on the type (green, black, white/Turkish, Arabica, Robusta, etc.) and the preparation method (brewing, filter, espresso, and instant). Black tea brewed for 5 min contains 40 to 80 mg of caffeine.[4] Upon examining the sources of caffeine for women included in the current study, it was determined that almost all of them (96.3%) drank black tea and only a few drank coffee [Figure 2]. Culturally and traditionally brewed black tea consumption is high in the region where the study was conducted, so the amount of caffeine consumption is due to tea.

Strengths and Limitations

The current study is powerful and has the potential to lead to other studies because of the detailed research on caffeine consumption, all newborn measurements being made by a single researcher, the amount of caffeine per body weight considered, and the study being the first of its kind in Turkey.

Limitations of the study include the following: maternal and placental serum caffeine levels were not examined, the energy intake of the pregnant women was not questioned, postpartum body weight was used when calculating caffeine consumption per body weight, pregnant women with any risk factors during pregnancy were excluded, no evaluation was carried out according to trimesters, and it was a single-center study. In addition, the data collection tools were administered only one time.

In conclusion, the caffeine consumption of the pregnant women included in this study is higher than the recommended levels and the major caffeine source was tea. Caffeine consumption during pregnancy can negatively affect the newborn's weight and length. Decreasing the amount of consumed caffeine may be a factor for more healthy pregnancies. For this reason, pregnant women should be informed about caffeine sources, consumption amounts, and its effects on the fetus.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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