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*Maria Tigka, Christina Nanou, Maria Tzeli, Alexandros Gryparis, Dimitra Metallinou, Aikaterini Lykeridou*

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## RESEARCH ARTICLE

## THE EFFECT OF MATERNAL CAFFEINE CONSUMPTION DURING THE PERINATAL PERIOD ON LACTATION

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**Abstract**

**Background:** Caffeine is a substance found in various seeds, foods, beverages and pharmaceuticals. We sought to assess perinatal caffeine consumption rates and the impact of maternal consumption on lactation.

**Material and Method:** This is a prospective, descriptive cohort study conducted in Greece. Women were recruited from five tertiary maternity hospitals throughout 2020. A total of 847 mothers participated and data were collected during their hospitalization in the maternity hospital using a structured questionnaire. Follow-up included a telephone interview in the first, third and sixth month after delivery.

**Results:** A significant decrease in caffeine consumption was reported during pregnancy (84.7%) compared to the period before pregnancy (96.3%,  $p < 0.001$ ). On the fourth day postpartum, caffeine intake (65.8%) was reduced significantly compared to the pre-pregnancy period ( $p < 0.001$ ), remaining relatively unchanged over a period of three months postpartum (1st month: 71%, 3rd month: 64.7%). Moreover, there was a significant decline in caffeine intake at six months postpartum (54.2%,  $p < 0.001$ ) and after discontinuation of breastfeeding (42.7%,  $p < 0.001$ ). Our findings showed that women who ceased breastfeeding at any stage over the six-month follow-up consumed less caffeine during the first three months after delivery ( $p < 0.001$ ) in comparison to those who maintained breastfeeding at six months. In addition, higher pre-pregnancy caffeine consumption ( $\beta = 0.04$ , SE: 0.02,  $p = 0.032$ ) had a positive association with longer breastfeeding duration.

**Conclusions:** This study was the first to record caffeine intake in the perinatal period in the Greek setting. The results demonstrate that perinatal maternal caffeine consumption was reduced compared to the pre-pregnancy period and that there was a positive correlation between caffeine consumption and breastfeeding duration.

**Keywords:** Maternal, caffeine consumption, perinatal, lactation, breastfeeding, pregnancy, Greece.

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## INTRODUCTION

Caffeine is a substance acting as a central nervous system stimulant and is present in various seeds, foods, beverages and pharmaceuticals. Chocolate, kola nuts, coffee, tea, soft and energy drinks, and some over-the-counter medicines contain caffeine. Coffee is possibly the most common high-caffeine intake source.<sup>1</sup> Globally, approximately 80 percent of the population are consumers of caffeinated products and regarding pregnant women, caffeine is a common substance daily consumed by the majority of them.<sup>2</sup>

Although caffeine appears to be beneficial in many areas of human health, as it has positive effects on neurological, cardiovascular and liver diseases as well as type 2 diabetes<sup>3,4</sup>, it should be consumed with caution during pregnancy due to the fact that excessive consumption has been significantly associated with an increased risk of adverse pregnancy outcomes, neonatal disturbances<sup>5</sup> and adverse long-term effects in childhood.<sup>6</sup> The recommended daily caffeine intake during the gestational period should not be greater than 200 mg/day according to the American Pregnancy Association<sup>7</sup>, while the World Health Organization<sup>1</sup> and the Centers for Disease Control and Prevention<sup>8</sup> advocates not exceeding 300 mg/day. Caffeine is a substance that crosses the placenta and increases the levels of catecholamines and thus, can potentially increase the risk of adverse outcomes. In addition, pregnant women have a slower metabolism and an increased half-life of caffeine.<sup>9</sup> Overconsumption during pregnancy has been correlated with preterm deliveries, low birth weight neonates, intrauterine death and miscarriage. It is worth noting though that as research on caffeine progresses it is becoming apparent that even mothers consuming less than 200 mg/day are still at risk of adverse outcomes.<sup>9-11</sup> Additionally, caffeine appears to have a long-term effect, as an association between maternal caffeine consumption and the development of childhood obesity has been reported.<sup>12,13</sup> Finally, with regards to the impact of maternal caffeine intake on the nursing neonate, there are references that report irritability and sleep disturbances in the neonate<sup>5</sup>; yet, a recently published study indicates that the existing literature data are insufficient and controversial, therefore preventing firm conclusions on this topic.<sup>14</sup> Particular

attention should be paid to preterm neonates as they metabolize caffeine more slowly than term breastfeeding neonates and therefore have similar plasma caffeine levels to maternal plasma caffeine levels.<sup>14</sup>

To enhance the quality of perinatal care, healthcare professionals should provide appropriate direction for intervention programs that focus on issues beyond substance abuse and offer integrated care that addresses every aspect of a woman's life. We sought to evaluate maternal caffeine consumption during the perinatal period and to investigate possible correlations among maternal caffeine intake, breastfeeding status at six months postpartum, duration and discontinuation of breastfeeding.

## METHODOLOGY

This is a prospective, descriptive cohort study carried out throughout the year 2020 (January - December) from two private and three public tertiary hospitals in Attica, Greece. This survey forms part of a larger research protocol that studies the causes of shortened duration of lactation and breastfeeding discontinuation.<sup>15</sup> Preliminary results on the maternal use of addictive substances during the perinatal period, in a smaller study sample have been published previously.<sup>16</sup> The study was conducted in compliance with the guidelines of the Declaration of Helsinki. The ethics committees of all hospitals also approved the study.

The methods of the survey have been described in detail in a previously published article<sup>16</sup> and a brief summary will be presented:

The population of the study included women who gave birth in the maternity hospital. The excluded mothers were deficient in their understanding of the Greek language, did not possess a fixed number for postpartum telephone follow-up, had complications during childbirth that required hospitalization in an intensive care unit, and gave birth to infants with congenital malformations that impeded breastfeeding. For improved precision of the study, the method of stratified sampling was applied to include observations from all sociodemographic strata (Figure 1). The response rate was 91% for the participation in the study.

Mothers filled in the questionnaire during their hospitalization after they had signed the informed consent form. Subsequently, follow-up was conducted by telephone communication in the first, third and sixth month after delivery. Data were collected using a structured questionnaire developed by the research team considering the requirements of the study. The draft questionnaire was developed after a robust review of the relevant literature.<sup>17-19</sup> The content of the questionnaire was evaluated by five experts and then was pilot tested on a sample of 50 mothers ("pilot study participants" were excluded from this study). The researchers approved the final version of the questionnaire which included both open- and closed-ended questions. The questionnaire provided information on demographic and socio-economic characteristics, obstetric and lactation history and maternal caffeine intake during the perinatal period. Caffeine consumption was measured as the average caffeine intake (milligrams per day) from drink sources and food (tea, coffee, soft and energy drinks and chocolate). The coding for all participants was auto-generated via the database used for maintaining the de-identification.

Qualitative variables are displayed as absolute and relative frequencies (%), whereas quantitative variables are displayed using descriptive statistics [median (maximum, minimum), mean  $\pm$  SD (Standard Deviation)]. Wilcoxon-signed rank test and McNemar's test have been used for comparing participants' caffeine consumption between different time-points. Mann-Whitney test has been used to investigate the correlation between two quantitative variables. Multiple linear regression models have been used to investigate variables correlated with breastfeeding duration and results are presented as adjusted regression coefficients ( $\beta$ ) and standard errors (SE). Multiple logistic regression analysis has been used to explore independent factors correlated with breastfeeding cessation at six months postpartum and results are presented as adjusted odds ratios (AOR) with 95% confidence intervals (95% CI). Statistical analysis was performed using the IBM SPSS v.28 statistical package (IBM Corp. Released 2021; IBM SPSS Statistics for Windows, Version 28.0; Armonk, NY, USA: IBM Corp.) at a significance level of  $p \leq 0.05$ .

## RESULTS

The study sample consisted of 847 mothers, of which 91.4% had Greek citizenship and 22% resided in the provinces. All women had a mean age of 33.7 years ( $33.7 \pm 4.7$ ) whereas for primipara women it was 32.5 years ( $32.5 \pm 4.7$ ). A large proportion of the study population were graduates of tertiary education (47.2%) and were employed prior to pregnancy (80.9%). About half of the women (54.8%) had delivered in a private hospital. The majority of the participants reported being married (94.7%) and almost all unmarried mothers lived with a partner, thus 99.8% of the entire sample was actually assisted by a partner in the household. Approximately half of the women were primipara (52.3%), 38.5% were secundipara, and the remaining had at least three children (9.2%). The majority of mothers had singleton pregnancies (98.5%) and the mean gestational age was 38.3 weeks ( $38.3 \pm 1.5$ ). The mean maternal body mass index (BMI) was  $24.2 \text{ kg/m}^2$  ( $24.2 \pm 5.0$ ) before pregnancy and  $28.6 \text{ kg/m}^2$  ( $28.6 \pm 4.8$ ) prior to childbirth. Regarding neonatal baseline characteristics ( $N = 859$ ), the majority of them were born by cesarean section (66.8%), were full-term (90.3%) and with an appropriate birth weight for gestational age (92.5%). The mean duration of breastfeeding was 123 days ( $123.88 \pm 70.08$ ).

Data on caffeine consumption of the women surveyed during the perinatal period is presented in detail in Table 1. Caffeine intake was significantly reduced during pregnancy (84.7%) in comparison to the period before pregnancy (96.3%,  $p < 0.001$ ). On the fourth day postpartum, caffeine intake (65.8%) was reported to be significantly reduced compared to the pre-pregnancy period ( $p < 0.001$ ), remaining relatively unchanged over a period of three months postpartum (1st month: 71%, 3rd month: 64.7%). There was a significant decline in caffeine intake at 6 months postpartum (54.2%,  $p < 0.001$ ) and after breastfeeding discontinuation (42.7%,  $p < 0.001$ ).

We first applied the Mann-Whitney test to correlate daily caffeine intake with breastfeeding at six months postpartum, and compared women who were breastfeeding at six months with those who had weaned at any time point over the six-month follow-up. Findings showed that women who ceased breastfeeding at any time point over the six-month follow-up consumed significantly less caffeine during the first three months

after delivery ( $p<0.001$ ) in comparison with women who continued to breastfeed at six months (Table 2).

Implementing multiple regression model with caffeine intake during the perinatal period as independent variable and duration (linear regression model) and discontinuation of breastfeeding (logistic regression model) as the dependent variables, we obtained the following results (Table 3). Mothers consuming less caffeine during breastfeeding were more likely to discontinue breastfeeding ( $OR = 0.99$ ; 95% CI: 0.99 – 0.99,  $p = 0.005$ ). In addition, higher pre-pregnancy caffeine consumption ( $\beta = 0.04$ , SE: 0.02,  $p = 0.032$ ) had a positive association with longer breastfeeding duration.

## DISCUSSION

In the last few years interest has increased on the maternal use of addictive substances during the perinatal period. This study records for the first time caffeine consumption during the perinatal period in the Greek setting, demonstrating further correlations with the status, duration and discontinuation of breastfeeding.

The results of the survey indicated that a relatively high rate of mothers (96.3%) were consuming caffeine products prior to pregnancy, followed by a decrease during pregnancy (84.7%) and even more so on the fourth day after delivery (65.8%), with a gradual decrease in the third (64.7%) and sixth (54.2%) month postpartum and after discontinuation of breastfeeding (42.7%). In the USA, about 80% of women continue to use coffee products during pregnancy, a rate close to that of our study<sup>20</sup>, while other European countries have recorded lower rates during the gestational period (Finland: 31%, Italy: 42.3%, France: 47.1%).<sup>21</sup> A recent study conducted in Poland assessed the prevalence of maternal caffeine consumption during pregnancy and lactation and the results demonstrated that 26.2% of pregnant and 48.1% of lactating women exceeded the daily caffeine threshold of 200 mg, while less than half of the participants knew the recommended amount of daily caffeine intake in their nutrition.<sup>22</sup> For the Greek setting in particular, no previous study has documented coffee consumption during the perinatal period.

The findings of the present study demonstrated a positive association between maternal caffeine consumption and breastfeeding duration, a finding also reported in the study by Mattar et al.<sup>23</sup> This finding contradicts the studies carried out by other researchers<sup>17,24</sup>, who reported a negative association between caffeine consumption and breastfeeding duration. However, an earlier study conducted by Ludvigsson et al. involving 10205 infants showed no correlation between caffeine intake and duration of breastfeeding.<sup>25</sup> Research on caffeine intake during lactation focuses primarily on adverse effects on neonates/infants<sup>26,27</sup>, rather than on the effect it may have on exclusivity and duration of breastfeeding. Thus, further research should be conducted to reach safe conclusions on the association of maternal caffeine intake with the duration of lactation.

The strengths of our study lie in the prospective longitudinal design and the high response rates obtained both during hospitalization and during the follow-up process. The distribution of the questionnaire directly by the research team, contributed to gaining the trust of the participants in the study and providing clarifications to them, which increased the reliability and therefore the advantages of the study. In addition, data were collected from five tertiary referral maternity hospitals making the study sample more representative. However, the generalizability of the findings to the nationwide level is restricted because the sample involved participants from only one large city. Another limitation is that the data were obtained through self-reporting by the mothers, which may have resulted in an under- or overestimation of prevalence and quantity of substance consumption.

Women who are pregnant are more receptive to embracing healthier habits for themselves more than any other group within the community. Pregnancy and breastfeeding can act as motivators to stop using addictive substances. Healthcare professionals should exploit these periods to spread messages for public health with the aim to improve perinatal outcomes. In the course of antenatal care and parent education sessions, healthcare professionals should inform mothers about the adverse effects of the use of addictive substances during the perinatal period, considering scientific evidence from evidence-based sources and with reference to guidelines from scientific committees. The intervention on caffeine consumption aims to

reduce and comply with guidelines, not to abstain completely. Finally, further research should be conducted to enhance early intervention programs and improve their effectiveness. Emphasis should be placed on primary prevention of addictive substance consumption, which could be implemented through school-based health education programs and family planning clinics. The establishment of universal screening protocols for women of childbearing age is also of utmost importance. Finally, more research is required to examine the effects of maternal substance consumption on the initiation, duration and discontinuation of breastfeeding.

## CONCLUSIONS

In conclusion, a decrease in maternal perinatal caffeine intake was observed in comparison with the period prior to pregnancy. Additionally, a positive correlation between maternal caffeine consumption and breastfeeding duration was demonstrated. Further research is required to investigate the effects of caffeine consumption on breastfeeding initiation, duration and discontinuation, as data in the current literature are scarce.

**Ethical Approval and Informed Consent:** The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committees of the following hospitals: General and Maternity Hospital "HELENA VENIZELOU" (24285/29 October 2019), General University Hospital "ATIKON" (570/1 October 2019), General Hospital "ALEXANDRA" (511/20 July 2020), General Maternity and Gynecology Clinic "IASO" (30 May 2019) and General, Maternity and Gynecology Clinic "LETO" (174a/5 June 2019). Written informed consent was obtained from all participants of the study.

**Conflicts of Interest:** The authors declare no conflict of interest.

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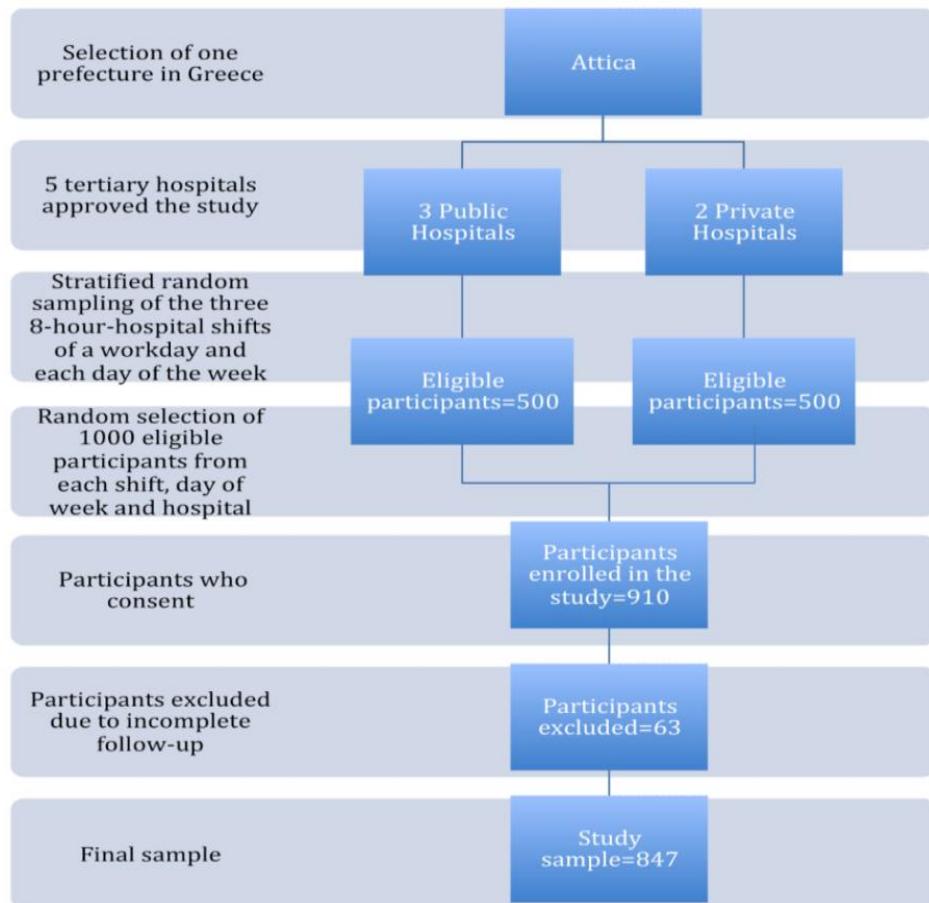
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## ANNEX

**FIGURE 1.** Flow diagram of the multistage stratified random sampling method used in the study. (Attica/Greece 2020; N=847)

**TABLE1.** Caffeine consumption habits during the perinatal period. Athens/Greece, 2020 (N=847)

Variable	N (%)	Mean (SD)	Median (IQR)
<b>Caffeine consumption before pregnancy</b>	816 (96.3)		
Daily caffeine consumption (mg/day) <sup>1</sup>		144.8 (122.6)	105 (85 – 189)
<b>Caffeine consumption during pregnancy</b>	717 (84.7)		
Daily caffeine consumption (mg/day) <sup>1</sup>		68.9 (67.6)	74 (8 – 96)
<b>Caffeine consumption on 4<sup>th</sup> day postpartum</b>	557 (65.8)		
Daily caffeine consumption (mg/day) <sup>1</sup>		61.6 (55.4)	63 (6 – 92)
<b>Caffeine consumption on 1<sup>st</sup> month postpartum</b>	601 (71.0)		
Daily caffeine consumption (mg/day) <sup>1</sup>		63.3 (58.8)	72 (6 – 93)
<b>Caffeine consumption on 3<sup>rd</sup> month postpartum</b>	548 (64.7)		
Daily caffeine consumption (mg/day) <sup>1</sup>		65.9 (59.6)	90 (6 – 95)
<b>Caffeine consumption on 6<sup>th</sup> month postpartum</b>	459 (54.2)		
Daily caffeine consumption (mg/day) <sup>1</sup>		69.2 (59.0)	90 (7 – 96)
<b>Caffeine consumption after breastfeeding discontinuation</b>	362 (42.7)		
Daily caffeine consumption (mg/day) <sup>1</sup>		111.2 (73.0)	94 (81 – 180)

<sup>1</sup>refers to women consuming caffeine

**TABLE 2.** Association of daily caffeine consumption with breastfeeding at 6 months postpartum. Athens/Greece, 2020 (N=847)

<b>Breastfeeding status at 6 months postpartum</b>					
	<b>Continuation of breastfeeding</b>		<b>Breastfeeding cessation</b>		<b>P*</b>
	<b>Mean (SD)</b>	<b>Median (IQR)</b>	<b>Mean (SD)</b>	<b>Median (IQR)</b>	
<b>Daily caffeine consumption (mg/day)</b>					
Before pregnancy	141.94 (130.59)	100 (50 – 186)	137.10 (101.00)	101 (63 – 190)	0.698
During pregnancy	58.47 (67.22)	30 (3 – 93)	58.31 (40.00)	40 (3 – 94)	0.974
On 4 <sup>th</sup> day postpartum	47.54 (54.20)	15 (1 – 92)	37.09 (3.00)	3 (0 – 90)	<0.001
On 1 <sup>st</sup> month postpartum	54.44 (57.80)	30 (3 – 93)	43.32 (6.00)	6 (0 – 90)	<0.001
On 3 <sup>rd</sup> month postpartum	57.17 (58.25)	40 (3 – 94)	49.23 (10.0)	10 (0 – 90)	<0.001
On 6 <sup>th</sup> month postpartum	60.74 (59.16)	47 (3 – 95)	59.18 (40.00)	40 (2 – 92)	0.192
After breastfeeding cessation	—	—	105.28 (92.00)	92 (43 – 179)	—

\*Mann-Whitney test

**TABLE 3.** Associations of maternal caffeine consumption with duration and breastfeeding cessation. Athens/Greece, 2020 (N=847)

<b>Dependent variable</b>	<b>Independent variable</b>			
		AOR (95% CI)+		P
<b>Breastfeeding cessation</b>	Daily caffeine consumption during lactation (mg/day)	0.99 (0.99 – 0.99)		0.005
		β (SE)++		P
<b>Breastfeeding duration (days)</b>	Daily caffeine consumption before pregnancy (mg/day)	0.04 (0.02)		0.032

+AOR: adjusted odds ratio (95% Confidence Interval) ++ regression coefficient (Standard Error). Notes: Logistic regression was applied for breastfeeding cessation and linear regression for breastfeeding duration.