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MATERNAL COFFEE INTAKE AND ASSOCIATED RISK FACTORS

Effects on Fetal Growth and Activity

Ana CONDE, Cláudia TEVES, Bárbara FIGUEIREDO

SUMMARY

Empirical studies have shown that fetal growth and activity can be affected by several risk factors, such as maternal anxiety, depression and tobacco or alcohol consumption. Caffeine intake has received less attention in the literature, as well as the analysis of the mutual interplay of the range of such risk factors. This study aimed to examine effects of mother's coffee intake and associated risk factors during early pregnancy on fetal growth and activity. The sample involved 47 fetuses (51.1% male and 48.9% female) with gestational ages between 20-22 weeks whose mothers were recruited in a portuguese antenatal obstetric unit. Repeated measures of mother's anxiety (STAI-S) and depression (EPDS) and information about socio-demographics and substances consumption were collected during the first and second trimesters of pregnancy. Fetal activity and biometry were measured during the 2nd trimester ultrasound. Results showed that 1) 23.4% of the pregnant women ($N = 11$) had regular coffee intake; 2) no significant differences were found neither on fetal growth nor on fetal movements considering mother's coffee intake; 3) when mother's socio-demographics and substances consumption were considered, tobacco consumption and anxiety at the 2nd trimester appeared as significant predictors of fetal growth and mother's coffee intake and anxiety symptoms at the 2nd trimester emerged as significant predictors of fetal movements. An adverse impact of maternal coffee intake during pregnancy was found on fetal activity but not on fetal growth. A deeper understanding of the multiple pathways by which these risk factors affect fetal growth and activity is needed.

RESUMO

CONSUMO DE CAFÉ E FACTORES DE RISCO ASSOCIADOS

Efeitos no Crescimento e Actividade Fetal

Estudos empíricos têm mostrado que o crescimento e a actividade fetal podem ser afectados por vários factores de risco, tais como a ansiedade, depressão e o consumo materno de tabaco ou álcool. O consumo de cafeína tem recebido menos atenção na literatura, do mesmo modo que o estudo das mútuas relações entre os diferentes factores na determinação do referido risco. O presente estudo pretendeu analisar os efeitos do consumo materno de café e factores de risco associados durante a gravidez no desenvolvimento e actividade fetal. A amostra é constituída por 47 fetos (51.1% do sexo masculino e 48.9% do sexo feminino) com idades gestacionais entre as 20-22 semanas, cujas mães foram recrutadas numa unidade obstétrica pré-natal portuguesa. Medidas repetidas da sintomatologia ansiosa (STAI-S) e depressiva (EPDS) e informações sócio-demográficas e relativas ao consumo materno de substâncias foram recolhidas durante o primeiro e segundo trimestres da gravidez. A medição da biometria e da actividade fetal foi efectuada durante a ecografia morfológica do 2^o trimestre. Os resultados mostram que 1) 23.4% das gestantes ($N = 11$) apresentava um consumo regular de café; 2) não se observaram diferenças

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significativas no crescimento e actividade fetal tendo em conta o consumo materno de café; 3) quando considerados os dados sócio-demográficos e relativos ao consumo materno de substâncias, o consumo de tabaco e a sintomatologia ansiosa materna no 2º trimestre surgiram como preditores significativos do crescimento fetal e o consumo de café e a sintomatologia ansiosa materna no 2º trimestre emergiram como preditores significativos da actividade fetal. Efeitos do consumo materno de café durante a gravidez foram encontrados na actividade fetal, mas não no crescimento fetal. Sugere-se a necessidade de uma análise detalhada dos mecanismos através dos quais estes factores de risco afectam o crescimento e a actividade fetal.

INTRODUCTION

The study of human development usually considers childbirth as the starting point. However, several research studies have suggested that psychological development begins during the gestational period, and prenatal influences can explain a significant part of the child's behavioral and developmental variability.

Fetal growth and fetal activity have been widely analyzed to describe normal development across pregnancy and to identify potential risk factors. Fetal movements have been found to reflect the integrity and activity of the central nervous system (CNS), as the more frequent movement patterns follow a clear developmental course¹.

Due to the higher sensitivity of fetal brain early in gestation, fetuses are especially vulnerable to small changes in the intra-uterine physiological environment, induced by internal and/or external factors. Both animal and human studies have shown that prenatal influences can have long lasting effects on development and health. A number of risk factors have been identified which may account for abnormal growth and activity including maternal socio-demographic, substance consumption and psychological symptoms. Considering socio-demographic risk factors, maternal age² and parity³ were the factors most studied with increased probability to affect fetal development, being related to several measures of early child morbidity and mortality, include intrauterine growth retardation, low birth weight and premature delivery, although the direction of these effects, as well as the mutual interplay of the risk factors awaits further elucidation.

There is conflicting data regarding the effect of maternal psychological distress on fetal growth and activity. Some findings in this domain pointed out the negative impact of the stress experience and anxiety during the prenatal period, namely in the increment of fetal activity and in the occurrence of growth delays. An example of these studies is the one of Field et al⁴ (2003) in which was found that the fetuses of the high anxiety women were noted to

be more active and to experience growth delays (lower estimated fetal weight – about 34% of infants born weighing less than 2500 grams – and smaller abdominal circumference) when compared with the fetuses of low anxious mothers. There are also many researchers engaged in the study of the effect of depression on fetal development. More recently, Field et al⁵ (2006) observed that mothers with depressive symptoms during pregnancy have fetuses who were more active and had smaller biparietal distance, head circumference and abdominal circumference. Although studies presented before seem to be consensual in showing a negative impact of maternal psychological distress on fetal development, several others didn't find this effect, neither for fetus's growth⁶ nor for fetus's behaviour⁷.

Studies examining the association between maternal substance consumption and early infant development have mostly suggested the potential short and long term teratogenic and neurodevelopmental consequences of nicotine^{8,9} and alcohol use during pregnancy¹⁰. Implications of coffee intake during pregnancy on fetal growth have been the target of numerous investigations, but do not reach the consensus among researchers. While some studies found a negative impact of coffee intake during gestation on fetal growth¹¹, others, such as Bracken et al¹² (2003), didn't found any effect of this consumption in the first and third pregnancy trimesters neither in intrauterine growth retardation, low birth weight nor with preterm delivery. Others, like Peacock et al¹³ (1991), observed that caffeine intake during pregnancy had adverse effects on fetal growth, though the results were no longer significant when the effects of tobacco and alcohol consumption were controlled. Moreover, it can also be observed, when associations between coffee intake and fetal development were found, that they were significant only when referring to high doses of coffee. Fenster et al¹⁴ (1991), for example, sought to study the correlation between caffeine consumption during the gestational period and fetal development, found that excessive caffeine ingestion (more

than 300 mg/day) was associated with a greater likelihood of having a baby with lower weight, delays in fetal growth and increased risk of premature birth.

Although not focused on fetal movements, an effect of caffeine intake on fetal activity was also suggested. Empirical evidence showed that maternal regular coffee consumption was associated with a twofold increase in the incidence of fetal breathing activity and a significant fall in baseline fetal heart rate. The same results were found for decaffeinated coffee which also increased the incidence of fetal breathing activity and produced a slight reduction of fetal heart rate¹⁵.

Trying to clarify non consensual results related to the effect of caffeine consumption during pregnancy, the present study aimed to determine possible differences on fetal growth and activity (movement patterns), taking into account mother's antenatal coffee intake (number of espressos/day). Since socio-demographics, and mother's tobacco consumption and anxiety and depression symptoms were suggested as risk factors of fetal growth and activity in previous studies, these variables were also included in present analysis in order to examine the cumulative effect of coffee intake and associated risk factors during pregnancy on fetal growth and activity.

METHODS

The present study followed the Declaration of Helsinki set of principles. After approval by the Research Review Board of the institution, participants were recruited at the antenatal obstetric unit (Júlio Dinis Maternity Unit, Porto, Portugal). Medical records were consulted to identify women up to 14 weeks of gestation, excluding multiple gestations and with medical and/or obstetric complications. Voluntary participation was requested and after informed consent, which included permission for recording fetal behaviour at 20-22 weeks of gestation, mother's socio-demographics were collected. Repeated measures of anxiety (STAI-S) and depression (EPDS) were obtained at the 1st and 2nd pregnancy trimesters. At the 2nd pregnancy trimester, fetal biometry was collected from clinical reports and a video tape of the fetal behaviour was made by the research team's obstetrician, during ultrasound examination.

Information about demographic factors, such as age, ethnicity, nationality, employment and occupation, marital status, household arrangements, educational attainment, medical and obstetrical history, psychological status and substance consumption (tobacco consumption measured by number of cigarettes per day and coffee consumption

measured by number of espressos per day), was obtained through a standardized interview.

The Spielberger State-Trait Anxiety Inventory (STAI)¹⁶ was used to measure anxiety symptoms. The STAI is a self-report questionnaire consisting of two subscales, the state anxiety subscale and the trait anxiety subscale, each containing 20 items. Only the state anxiety subscale (STAI-S), which measures anxiety at the moment of scoring, was used in the analyses. The scores in this subscale range from 20 to 80 and higher scores indicate higher state anxiety (conceptualized as a transient emotional condition of the individual, characterized by subjectively experienced feelings of tension, together with a heightened activity of the autonomous nervous system). The Portuguese version of the State-Trait Anxiety Inventory showed good internal consistency (State and Trait Cronbach's alpha in women = 0.88 and 0.87, respectively) and construct validity demonstrated by substantial differences in scores obtained under stressful and neutral conditions¹⁷.

The Portuguese version of the Edinburgh Postnatal Depression Scale (EPDS)^{18,19}, a self-report questionnaire composed by 10 items in a likert scale of 4 points (0-3), was used to assess depressive symptoms. Psychometric studies of the EPDS Portuguese version showed good internal consistency (Cronbach α = 0.85), test-retest reliability (Spearman Correlation = 0.75), and external validity with the Schedule for Affective Disorders and Schizophrenia (SADS psychiatric interview) (r = 0.86)²⁰.

Fetal growth and activity were assessed during the morphological ultrasound of the 2nd trimester of pregnancy. Fetal growth measures included biparietal distance (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL). These measures were obtained by the obstetrician of the research team, using standard clinical measurement protocols²¹. The spontaneous motor activity of fetuses, which reflects the activity of the central nervous system (CNS)¹, was video recorded during the 2nd trimester of pregnancy real-time ultrasound (General Electric, model Voluson c730 expert) following the same procedures and fetal activity categories used in previous research^{5,22}. Since the nature and pattern of fetal movements can be determined by gestational age, mother's feeding and circadian rhythm²³, conditions for fetal movements assessment were standardized. All fetuses had gestational ages between 20 and 22 weeks. All video recordings were performed in the afternoon, between 2:30 p.m. – 4:00 p.m., with the mother in a semisupine position. Women shouldn't have had food intake, coffee, tea, smoking or alcohol consumption for one hour and thirty minutes prior to the recording. For the fetal movements assignment the obstetri-

cian positioned the ultrasound transducer to obtain a lateral view of the fetus, including visualization of the head, trunk and limbs. Taking into account the high percentage of time in which some of the fetuses were not accurately viewable, leading to the repositioning of the transducer (which induced non spontaneous fetal behavior), a maximum period of 3 consecutive minutes of good viewing of the fetus, achieved in all participants, was selected for fetal behavior scoring. The 3-min period of video recording was subdivided into 3-sec *windows*, in which observers should signal the occurrence of the following fetal activity categories including: a) Single limb movement (isolated arm, leg or head movement, without movements in other body parts); b) Multiple limb movement (movement which implies changes in position of the limb segments towards each other, with limb joints being active and moving simultaneously); and c) Gross body movement (movement involving the whole body and/or limbs of the fetus lasting a variable period of time). No movement classification should be coded when no fetal movements occurred for a period of 3 seconds. Two consecutive bursts of fetal movements were considered as independent when a complete absence of movements was observed between them. For the data analyses, the percentage of time (% time) the fetus engaged in total movement, as well as in each movement category, was calculated. Records of five fetuses were used in the training of three observers. Final coding of these records was reached after the achievement agreement between the three observers. The remaining records were rated by two observers, with the achievement of excellent inter-observers reliability (Kappa of Cohen greater than or equal to 0.75) in 20 fetal assessments and good agreement (Kappa of Cohen between 0.40 e 0.75) in 22 fetal assessments. In this case, a third observer was used in order to obtain the final quotation.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 17.0. Descriptive analysis was performed for fetal growth (BPD, HC, AC and FL) and activity (No movement, Single limb movement, Multiple limb movement and Gross body movement) at 20-22 weeks of gestation, taking into account means, standard-deviations, minimum and maximum and percentiles (25-75). Multivariate analyses of

variance (MANOVA) were used to examine mothers' coffee intake group differences (no versus yes) across the fetal growth measures (BPD, HC, AC and FL; dependent variables) and fetal activity categories (No movements, Single limb movement, Multiple limb movement and Gross body movement; dependent variables) at the 2nd pregnancy trimester. Independent multiple regression analysis were performed to determine potential predictors of fetal growth and activity, each one considering the follow categories of factors: mother's substances consumption (tobacco and coffee consumption), sociodemographics (mothers age, living with partner, education, occupational status, parity and fetuses gender) and anxiety and depression (mother's total scores on STAI-S and EPDS at the 1st and 2nd pregnancy trimesters). The variables which obtained a p value < .150 in each multiple regression analysis were then included in a separate multiple regression analysis to analyse their effect in prediction of fetal growth and activity

RESULTS

The sample involved 47 fetuses almost equally divided by gender (51.1% male and 48.9% female). They had an average gestational age of 21 weeks and 2 days ($SD = 0.85$), with a minimum of 20 weeks and a maximum of 22 weeks and 6 days. The mean of each biometric parameter (BPD, HC, AC and FL) was within the normative range of values expected for the same menstrual age. Concerning fetal activity, the presence and absence of fetal movements occupied, on average, the same percentages of the time, and during the active periods, Gross body movement was the most prevalent category of fetal activity (see Table 1).

Table 1 – Fetal biometry and movements at 20-22 weeks of gestation (N = 47)

Biometry	Min-Max	Mean (SD)	25th-75th Percentiles
BPD (mm)	44.00-59.00	50.45 (3.72)	47.00-53.90
HC (mm)	164.90-216.00	186.71 (12.61)	177.00-196.00
AC (mm)	136.40-195.60	162.90 (13.20)	154.00-172.60
FL (mm)	28.50-44.20	34.55 (3.43)	31.90-37.00
Fetal movements	Min-Max	Mean (SD)	25th-75th Percentiles
No movement (% time)	1.7-98.30	54.20 (25.17)	33.30-75.00
Single limb movements (% time)	0-30.00	8.96 (7.85)	3.30-15.00
Multiple limb movements (% time)	0-16.70	3.39 (4.39)	0-6.65
Gross body movements (% time)	1.70-96.70	33.45(22.85)	13.30-45.00

Their mothers were between 15 years and 38 years old, ($M = 27$ years, $SD = 5.77$) and were almost equally distributed by primiparous (48.9%) and multiparous (51.1%). The majority of the participant's pregnant women were Portuguese (93.6%) and Caucasian and had (78.7%) nine years of school. The majority of the pregnant women were employed (78.7%), married (55.3%) or living on cohabitation (34.0%), and living with their partner (89.4%). From the 47 mothers-to-be, 11 (23.4%) reported coffee intake (a maximum of two espressos per day) and 7 (14.9%) were smoking during pregnancy. None of the pregnant women referred taking any drugs or alcohol consumption at the time (see Table 2).

Table 2 – Mother's socio-demographics (N = 47)

		%
Age	< 18 years	4.3
	≥ 18 and ≤ 35 years	91.5
	> 35 years	4.3
Education	< 9	21.3
	≥ 9 and ≤ 12	59.6
	Graduate	19.1
Occupational status	Employed	78.7
	Unemployed	21.3
Marital status	Married	55.3
	Co-habitation	34.9
	Single	10.6
Household arrangements	Living with partner	76.6
	Living with partner and extended family	12.8
	Living with extended family without the partner	10.6

Mothers' coffee intake group differences across fetal growth and activity at 20-22 weeks of gestation

No significant differences were obtained neither considering measures of fetal growth [Wilks' Lambda = .869, $F(4, 42) = 1.581$, $p = .197$] nor taking into account fetal movements' categories [Wilks' Lambda = .837, $F(4, 42) = 2.043$, $p = .106$] at 20-22 weeks of gestation, regarding to mother's coffee consumption during pregnancy.

Effects of coffee intake and associated risk factors during pregnancy on fetal growth and activity at 20-22 weeks of gestation

A final multiple regression analysis was performed taking into account the variables listed as potential predic-

tors of fetal growth in previous independent multiple regression analyses performed for socio-demographic factors, substances consumption and anxiety and depression symptoms.

The model composed by mother's tobacco consumption during pregnancy and first trimester EPDS total score was significant in predicting fetus BPD, explaining 14.9% of the observed variability, although at this model only mother's tobacco consumption emerged as significant predictor of higher BPD ($R^2 = .149$; $F = 3.862$, $p = .018$).

The model composed by the 1st and 2nd trimesters STAI-S total scores, 2nd trimester EPDS total scores and parity was significant in predicting femur length, explaining 19.9% of the observed variability, despite 2nd trimester STAI-S total scores appeared as the unique significant predictor of FL ($R^2 = .199$; $F = 2.602$, $p = .013$): higher mother's anxiety at this trimester predicted smaller FL in foetuses.

Final regression models proposed to predict HC and AC were not statistically significant and coffee consumption didn't appeared as a significant predictor in any of the listed fetal growth measures (see Table 3).

A final multiple regression analysis was also performed with all variables listed as potential predictors of fetal activity in previous independent multiple regression analyses implemented for socio-demographic factors, substances consumption and anxiety and depression symptoms.

The model composed by mother's coffee intake during pregnancy and maternal age was significant in predicting fetus's Single limb movements, explaining 14.8% of the observed variability. At this model, however, mother's coffee consumption appeared as the unique significant predictor of this movement pattern ($R^2 = .148$; $F = 3.832$, $p = .015$): mother's coffee consumption during pregnancy significantly predicted less time spent by the fetus in single limb movements.

The model composed by mother's state-anxiety at the 1st and 2nd trimesters and maternal coffee intake was significant in predicting Multiple limb movements, explaining 18.1% of the observed variability, but only mother's anxiety at the 2nd trimester was a significant predictor of this category of movements ($R^2 = .181$; $F = 3.170$, $p = .021$): mother's anxiety at this trimester significantly predicted more time spent by the fetus in multiple limb movements. The final regression model proposed to predict time spent in No movement and Gross body movement categories were not statistically significant (see Table 4).

Table 3 – Predictors of fetal growth at the 20-22 weeks of gestation: Multiple regression analysis

Dependent variables	Model	Independent variables	B	Beta	t	p
BPD (R ² = .149)	F (2,44) = 3.862; p = .028	Tobacco use	3.535	.342	2.458	.018
		EPDS (1 st trim)	.134	.165	1.182	.244
		STAI-S (1 st trim)	.211	.204	.822	.416
HC (R ² = .159)	F (4,42) = 1.983; p = .115	STAI-S (2 nd trim)	-.407	-.391	-1.637	.109
		EPDS (2 nd trim)	.875	.316	1.564	.125
		Tobacco use	8.005	.228	1.602	.117
AC (R ² = .127)	F (3,43) = 2.076; p = .117	STAI-S (1 st trim)	.245	.225	.908	.369
		STAI-S (2 nd trim)	-.515	-.472	-1.969	.055
		EPDS (2 nd trim)	1.066	.368	1.808	.078
FL (R ² = .199)	F (4,42) = 2.602; p = .049	STAI-S (1 st trim)	.117	.413	1.838	.073
		STAI-S (2 nd trim)	-.202	-.711	-2.600	.013
		EPDS (2 nd trim)	.268	.371	1.726	.092
		Parity	1.670	.246	1.715	.094

as already suggested in previous reports, it is also true that the medical literature contains many distinct references that appear to indicate that human adverse reproductive/developmental effects are produced by caffeine. The fact of many caffeine users being subject to multiple con-

DISCUSSION

Espresso is one of the most popular beverages in Portugal, being widely consumed. Almost a quarter of the pregnant women of the sample had coffee intake. Thus, the understanding of the effect of this factor in the determination of early infant development is one of the major aims/contributions of the present study. An effect of mothers’ coffee intake during pregnancy on fetal activity was found, with fewer single movements being observed in fetuses whose mothers consumed coffee during gestation, when compared to mothers without this consumption.

Nevertheless evaluation of the human developmental risks of caffeine is difficult and findings are inconsistent,

foundings factors and the caffeine content of foods and beverages varying considerably can interfere with the attainment of valid interpretations. Even so, according to a few epidemiological studies it is assumed that one espresso contains 70-80 mg of caffeine, what was sufficient, according to some studies, to explain several reported effects in fetal development. The mechanisms through which this impact can be observed may include the acknowledged association between coffee intake and the consumption of other substances, such as alcohol and tobacco (for a revision see Christian and Brent, 2001)²⁴.

Contrary to what was observed for fetal activity, the assumption according to which coffee consumption adversely affects fetal growth has been refuted by the presented results, with no differences on fetal growth meas-

Table 4 – Predictors of fetal activity at the 20-22 weeks of gestation: Multiple regression analysis

Dependent variables	Model	Independent variables	B	β	t	p
No movement						n.s.
Single limb movements (R ² = .148)	F (2,44) = 3.832 p = .029	Coffee intake	-6.467	-.353	-2.534	.015
		Maternal age	4.424	.159	1.143	.259
Multiple limb movements (R ² = .181)	F (3,43) = 3.170 p = .034	STAI-S (1 st trim)	-.126	-.348	-1.548	.129
		STAI-S (2 nd trim)	.194	.536	2.392	.021
		Coffee intake	-2.776	-.271	-1.954	.057
Gross body movements						n.s.

ures found considering this substance consumption. Although present results are opposing to findings of studies, such as the one from Fenster et al¹⁴ (1991), which found that coffee consumption during pregnancy adversely affects the growth of the fetus, causing intra-uterine retardation, the absence of negative outcomes may be due to the fact that excessive consumption was not observed in the mothers of the present study, who consumed no more than two espressos a day. This hypothesis can be supported by several authors who suggested that only excessive coffee consumption is likely to affect the development of the fetus¹². The other hypothesis is that the effect of the coffee intake may be masked by the effect of other risk factors, such as mother's anxiety and/or depression symptoms or tobacco consumption.

In line to what has been observed in another study⁹, our results showed that fetuses of women who smoked during pregnancy have higher BPD than fetuses of women who did not smoke. Lampl et al⁹ (2003) suggested that the higher head and abdominal circumferences in fetuses of mothers who smoked during pregnancy than in fetus of mothers who did not smoke, may be due of the ability of the fetus to adjust their growth to an adverse environment. According to these researchers, this unique pattern of fetal blood flow favouring upper body oxygen distribution and extraction, together with genetically adaptative strategies, will allow the fetus to adjust their own growth to the adverse environment to which they are exposed.

Presented results additionally showed that maternal prenatal anxiety was negatively related to fetal growth, as suggested by previous studies⁴. In fact, mother's anxiety at the 2nd trimester seemed to affect FL, such that the fetus of anxious mothers had a smaller FL, compared with the fetus of non-anxious mothers.

Considering fetal activity, present findings indicated, moreover, an effect of maternal prenatal anxiety, as was referenced in literature, such as in the study of Field et al⁴ (2003), who found that the fetuses of anxious mothers during pregnancy are those with greater fetal activity, compared with the fetuses of non-anxious mothers. From these results, we concluded that maternal anxiety, especially during the 2nd pregnancy trimester, can be related to fetal activity, in the way that fetuses of anxious mothers at this trimester were those with greater fetal activity (single movements and multiple limb movements), when compared with the fetuses of non-anxious mothers.

There is agreement that fetal development and behaviour are influenced by several factors, such as substance

consumption (especially tobacco consumption) and maternal anxiety and depression symptoms. However, the knowledge about the implications of coffee intake during the pregnancy was less consensual in the literature. While some believe that there is no effect of this consumption, positive or negative, others believe that the consumption of this substance can be harmful to fetus development and behaviour. From the results of the presented study, we can conclude that despite having no influence on fetal growth measures, coffee intake influences fetal activity, mainly when the mother is anxious. Coffee intake during pregnancy appears to be a significant predictor of fetal movements, particularly regarding less time spent in single movements. Literature suggested that, at the 2nd pregnancy trimester, more complex and diverse fetal movements, involving the entire body, and less indiscriminate movements were associated to increased neurobehavioral maturity^{25,26}. Thus, we recommended the deeply analysis of the mechanisms through which the coffee consumption during pregnancy has an impact on decrement of fetal movements.

As is the case in other studies seeking to evaluate coffee consumption and its effect on fetal development and behaviour, this research had some limitations. Socio-demographic questionnaire administered to participants only contained information about espressos' consumption and the daily intake and neglected the intake of other beverages that may contain caffeine (such as colas and teas). Moreover, the small sample size and the fact that the groups evaluated (group that drinks coffee and group that does not drink coffee) did not have an equivalent number of subjects, making these findings only preliminary and exploratory. Finally, the small coffee consumption by the participant mothers (minimum one coffee a day and the maximum two coffees per day) didn't allow determining the level through which the coffee consumption during pregnancy can be harmful to fetal growth and behaviour.

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