Maternal Caffeine Consumption and Infant Nighttime Waking: Prospective Cohort Study

WHAT'S KNOWN ON THIS SUBJECT: Fetus and infants until 3 months of age are unable to metabolize caffeine, which crosses the placenta and in adults has a somnolytic effect. Little is known about the effect of caffeine consumption by pregnant or nursing mothers over infant sleeping.

WHAT THIS STUDY ADDS: In this setting where caffeine is largely consumed in pregnancy and by nursing mothers, heavy consumption (≥300 mg/day) did not increase the number of nighttime awakenings by their 3-month-old infants.

AUTHORS: Iná S. Santos,[a] MD, PhD,[a] Alicia Matijasevich, MD, PhD,[a] and Marlos R. Domingues, PhD[b,c]

[a]Postgraduate Program in Epidemiology and [b]Postgraduate Program in Physical Education, Federal University of Pelotas, Pelotas, Brazil; and [c]Physical Activity Epidemiology Research Group, Federal University of Pelotas, Pelotas, Brazil

abstract

OBJECTIVE: Coffee and other caffeinated beverages are commonly consumed in pregnancy. In adults, caffeine may interfere with sleep onset and have a dose-response effect similar to those seen during insomnia. In infancy, nighttime waking is a common event. With this study, we aimed to investigate if maternal caffeine consumption during pregnancy and lactation leads to frequent nocturnal awakening among infants at 3 months of age.

METHODS: All children born in the city of Pelotas, Brazil, during 2004 were enrolled on a cohort study. Mothers were interviewed at delivery and after 3 months to obtain information on caffeine drinking consumption, sociodemographic, reproductive, and behavioral characteristics. Infant sleeping pattern in the previous 15 days was obtained from a subsample. Night waking was defined as an episode of infant arousal that woke the parents during nighttime. Multivariable analysis was performed by using Poisson regression.

RESULTS: The subsample included 885 of the 4231 infants born in 2004. All but 1 mother consumed caffeine in pregnancy. Nearly 20% were heavy consumers (≥300 mg/day) during pregnancy and 14.3% at 3 months postpartum. Prevalence of frequent nighttime awakeners (>3 episodes per night) was 13.8% (95% confidence interval: 11.5%–16.0%). The highest prevalence ratio was observed among breastfed infants from mothers consuming ≥300 mg/day during the whole pregnancy and in the postpartum period (1.65; 95% confidence interval: 0.86–3.17) but at a nonsignificant level.

CONCLUSIONS: Caffeine consumption during pregnancy and by nursing mothers seems not to have consequences on sleep of infants at the age of 3 months. *Pediatrics* 2012;129:860–868

In infancy, nighttime waking is a common event,[1–3] and poor sleep may affect the functioning of both children and their parents.[4–7] Higher prevalence of night waking in infancy has been associated with male gender, higher number of naps per day, exclusive breastfeeding, bed-sharing, being nursed to sleep, lower socioeconomic groups, and infant-demanding parenting method of care (prolonged holding, frequent breastfeeding, rapid response to infant frets and cries, and cosleeping with infants at night).[3,5,8–10]

Caffeine is a central stimulant and somnolytic agent.[11] Studies have revealed that caffeine interferes with sleep onset in adults and has a dose-response effect similar to those seen during insomnia.[12] However, interindividual differences in sensitivity to the effects of caffeine on sleep have been described, and it is not clearly established whether these differences could be attributable to the development of tolerance[13] or depends on genetic modulation of its effect.[14,15] Habitual coffee drinkers show little sensitivity to its effects on sleep,[13,16] and sleep disturbances are unrelated to plasma caffeine concentrations.[17] Coffee and other caffeinated beverages are commonly consumed in pregnancy.[18–21] Maternal caffeine intake may affect the fetus for several reasons[11]: caffeine readily crosses the placenta, its half-life is increased in late gestation both in the mother and her fetus, the fetus has poor ability to metabolize caffeine, and there is a reuptake of caffeine from the amniotic fluid through fetal swallowing.[22] Caffeine is rapidly absorbed from the gastrointestinal tract[23] and is distributed to saliva and milk of lactating women,[24] turning the newborn exposed to caffeine through breastfeeding. Furthermore, infants until 3 months of age are unable to metabolize caffeine, which is excreted in nature through the urine.[25]

This study was planned to assess prevalence of heavy caffeine consumption by pregnant and nursing women, to describe nocturnal sleep pattern at 3 months of age, and to investigate whether maternal caffeine consumption during pregnancy and lactation would lead to more frequent nocturnal awakening episodes among infants at 3 months of age.

METHODS

A birth cohort was started in 2004 in the city of Pelotas (Southern Brazil) and all live births were included between January 1 and December 31. Mothers were interviewed at the hospital soon after birth, and children were examined (perinatal study). More details of the study can be found elsewhere.[26,27] The first follow-up of the cohort took place when children were 3 months old. The child's usual sleeping pattern was investigated for a subsample (all those born from October to December 2004). Mothers were asked to report for the 15 days before the interview the number of hours the infant had slept during the day and during the night, bed-sharing during the night (mother and child sharing the same surface to sleep),[28] who attended to nighttime waking, number of waking up episodes during the night, cause for nighttime waking (sickness or other reasons), and her subjective assessment of quality of the child's sleeping pattern. Night waking was defined as an episode of infant arousal that woke the parents during nighttime.

The main exposure in study was the maternal heavy caffeine consumption (≥300 mg/day).[29,30] Caffeine sources analyzed were coffee (instant and ground) and mate (a hot tealike beverage highly consumed in this region of Brazil). Caffeine intake was assessed considering all 3 trimesters of pregnancy and the first 3 months postpartum (to explore if it could influence

child's sleep behavior through breastfeeding). A caffeine consumer was defined as the consumption of caffeine from any of those 2 sources at least once a week in at least 1 trimester of pregnancy. Caffeine variables in milligrams were generated considering the source, preparing method, frequency, and amount consumed per serving to establish the average daily amount of caffeine per trimester, as used previously in another study[21]: samples of filtered coffee (without adding sugar or milk) and the used leaves of mate drink were collected at households and assessed for caffeine content by liquid chromatography. From these analyses, it was possible to infer the following average milligram of caffeine per milliliter: strong coffee, 0.25 mg/mL (45 mg per cup of 180 mL); medium strength coffee, 0.20 mg/mL (36 mg per cup); and weak coffee, 0.11 mg/mL (19.8 mg per cup). For mate drink, the analyses revealed an average concentration of 17 mg of caffeine per 100 mL of liquid (~10 mg per gourd). These results were used to estimate caffeine intake of the whole cohort. For instant coffee, mothers were asked about the size of the spoon used to serve and the number of spoons per serving. Spoon sizes were obtained from household measurements. Photographs of spoons were used during the interview to avoid misclassification. The manufacturer's information of an average 3 mg of caffeine per gram of instant coffee powder was used. Infants from mothers consuming ≥300 mg/day of caffeine (heavy consumers) were considered exposed.

Other exposures investigated were maternal age in complete years; skin color; schooling; parity; smoking (at least 1 cigarette per day everyday in at least 1 trimester of pregnancy); amount smoked per day; living with or without a partner; alcohol consumption during pregnancy; paid work; family monthly income; and

maternal depression according to the Edinburgh Postnatal Depression Scale.[31]

Only infants from singleton pregnancies were included in the analyses. The infants were categorized according to the number of night waking episodes in the previous 15 days. Frequent night waking infants were defined as those who woke up more than average in the previous 15 days. To establish a cutoff point, the rationale was that among infants presenting night waking, the mean number and SD of night waking episodes were calculated (1.8 ± 0.9). Values above the mean + 1SD were positive for this variable and, therefore, infants usually waking up more than 3 times a night were considered as presenting frequent night waking.

For the analyses, a hierarchical model was used to control for potential confounders, and only variables associated to the outcome ($P < .2$) were kept in the regression. Prevalence ratios and 95% confidence intervals (95% CIs) were obtained through Poisson regression with robust variance. Because the locally measured levels of caffeine in filtered coffee were substantially lower than the international reference levels of 80 mg of caffeine per 150 mL of filtered coffee,[11] analyses were repeated by using the latter. To explore possible dose-response relationship, caffeine intake was also analyzed as a continuous variable. The study protocol was approved by the Medical Research Ethics Committee of the Federal University of Pelotas, and mothers were requested to fill a written consent.

RESULTS

The entire cohort had 4231 newborns, and information on child sleeping was gathered for 885 infants in the subsample (Table 1). In comparison with the rest of the cohort, a higher proportion of infants in the subsample belonged to wealthier families and was from mothers with higher education and lower parity. Proportion of heavy consumers of caffeine in the first and second trimesters was higher in the subsample.

TABLE 1 Comparison Between the Subsample and the Remaining Cohort With Regard to Maternal Characteristics

Variables	Infants Not Included in the 3-Mo Subsample ($n = 3020$)	Infants Included in the 3-Mo Subsample ($n = 885$)	P
Family income (quintiles)			.009
1 (poorest)	630 (20.9)	157 (17.7)	
2	587 (19.4)	194 (21.9)	
3	614 (20.3)	147 (16.6)	
4	612 (20.3)	196 (22.2)	
5 (wealthiest)	577 (19.1)	191 (21.6)	
Living with partner			.739
Yes	2535 (83.9)	747 (84.4)	
No	485 (16.1)	138 (15.6)	
Schooling, y			.009
Up to 4	480 (16.0)	113 (13.0)	
5–8	1252 (41.7)	335 (38.6)	
9–11	976 (32.5)	326 (37.5)	
≥12	293 (9.8)	95 (10.9)	
Maternal age, y			.737
<20	570 (18.9)	171 (19.3)	
20–35	2125 (70.4)	626 (70.8)	
>35	324 (10.7)	87 (9.8)	
Maternal skin color			.190
White	2220 (73.5)	638 (72.1)	
Black	581 (19.2)	192 (21.7)	
Other	219 (7.3)	55 (6.2)	
Parity			.004
0	1151 (38.1)	390 (44.1)	
1–3	1559 (51.6)	423 (47.8)	
≥4	309 (10.2)	72 (8.1)	
Paid work during pregnancy			.318
No	1810 (59.9)	514 (58.1)	
Yes	1209 (40.1)	371 (41.9)	
Smoking during pregnancy			.522
No	2210 (73.2)	638 (72.1)	
Yes	810 (26.8)	247 (27.9)	
Daily cigarettes during pregnancy			.284
1–10	526 (70.2)	155 (66.5)	
>10	223 (29.8)	78 (33.5)	
Alcohol consumption			.218
No	2926 (96.9)	850 (96.1)	
Yes	94 (3.1)	35 (3.9)	
Heavy caffeine consumption in the first trimester of pregnancy			.014
No	2457 (81.6)	689 (77.9)	
Yes	556 (18.4)	196 (22.1)	
Heavy caffeine consumption in the second trimester of pregnancy			.019
No	2495 (82.9)	703 (79.4)	
Yes	516 (17.1)	182 (20.6)	
Heavy caffeine consumption in the third trimester of pregnancy			.064
No	2533 (84.1)	721 (81.5)	
Yes	479 (15.9)	164 (18.5)	
Heavy caffeine consumption at 3 mo postpartum			.186
No	2574 (85.2)	770 (87.0)	
Yes	446 (14.8)	115 (13.0)	

Caffeine Intake

Only 1 of the 885 women reported no caffeine consumption during pregnancy. Among the consumers, average

intake decreased with the progress of gestation: 178, 175, and 166 mg/day in the first, second, and third trimester, respectively. At 3 months postpartum, the amount reported by consumers was on average 144 mg/day. Heavy consumption was reported by ~20% of mothers, and the prevalence decreased from first to third trimester and to the third month postpartum: 24.1% (95% CI: 21.2%–27.1%), 22.4% (95% CI: 19.6%–25.4%), 20.3% (95% CI: 17.6%–23.1%), and 14.3% (95% CI: 12.0%–16.6%), respectively.

The characteristics of mothers reporting heavy consumption are presented in Table 2. Smokers and alcoholic beverage drinkers were more likely to be heavy caffeine consumers throughout gestation and during postpartum. An inverse linear trend was verified for heavy consumption and schooling and family income. The higher the schooling/income, the lower the proportion of heavy consumers. The prevalence of heavy consumption increased with parity and was higher among mothers who did not work during pregnancy and who bed-shared with their infants. After birth (3 months), heavy consumption was associated to higher maternal age and to maternal depression, with depressed mothers presenting a prevalence of heavy consumption almost twice as high as the observed among nondepressed mothers.

Infant Nighttime Waking in the Previous 15 Days

During the previous 15 days, the infants had slept a mean of 13.4 ± 3.1 hours in 24 hours (9.4 ± 1.7 per night and 4.0 ± 2.7 in daytime). Bed-sharing was reported by 46.2% of the mothers. More than three-quarters (75.5%) had woken during the night in at least 1 night, and 54.7% of them had woken every night (generally twice or more at the same night). Prevalence of frequent

nighttime wakers was 13.8% (95% CI: 11.5%–16.0%). Generally, during nighttime waking, the mother was in charge of attending the child (69.3%). The quality of sleep of 11.1% of the infants was considered as regular or poor by their mothers.

Table 3 presents the distribution of frequent night waking according to maternal and child characteristics. Frequent night waking was more prevalent among boys than girls and among infants of nonwhite mothers, as well as among those born from mothers who smoked and consumed alcoholic beverages during pregnancy. Some mothers presented heavy caffeine consumption throughout pregnancy and during the 3 months postpartum (n = 62; 7.6%). Forty infants were exposed to caffeine in uterus and through breastfeeding. Prevalence of frequent night waking was higher among these infants in comparison with those who were not exposed to maternal heavy caffeine consumption; however, this association was nonsignificant (22.5% against 13.5%, respectively; P = .114).

In adjusted analyses through Poisson regression (Table 4), none of the heavy consumption variables were associated to frequent night waking. However, infants of mothers reporting heavy consumption at the third trimester of pregnancy and at the 3 months postpartum presented increased (nonsignificant) prevalence ratios. The highest prevalence ratio was observed among breastfed infants from mothers consuming ≥300 mg/day during the whole pregnancy and during the postpartum period (1.65; 95% CI: 0.86–3.17) but at a nonsignificant level. Looking at caffeine consumption as a continuous variable in milligrams per day or employing international parameters to estimate caffeine consumption from filtered coffee did not change these results.

DISCUSSION

This study revealed that prevalence of caffeine consumption is almost universal during pregnancy. Prevalence of heavy consumption (≥300 mg/day) was 20% in pregnancy and 14.3% in postpartum. Most of the 3-month-old infants wake up during the night, and 14.1% of them are frequent nighttime awakeners. With regard to the prevalence of caffeine consumption and of heavy caffeine consumption during pregnancy, it is similar to that observed almost a decade ago in this same city,[21] reinforcing the notion that coffee and mate consumption are deeply rooted cultural behaviors, as already highlighted by others.[32,33]

Maternal caffeine consumption, even in large amounts during gestation and lactation, had no consequences on sleep of the infant at 3 months of age. The reason for no association is not clear. It is possible, however, that infant from heavy consumers develop tolerance to caffeine. An experimental study[34] revealed that in comparison with caffeine-naive fetuses, those regularly exposed to caffeine presented a differential performance in active wakefulness, general movements, and heart rate variation before and after maternal coffee loading suggesting fetal tolerance in response to maternal habitual coffee ingestion. However, as previously mentioned, tolerance to caffeine is not clearly defined, and interindividual differences in the subjective response to caffeine may be modulated by distinct polymorphisms in genes identified as contributing factors to sleep architecture, vulnerability to sleep loss, and subjective and objective effects of caffeine on sleep.[14] We assessed the effect of caffeine on child's crying (a symptom of infant activity) and colic at 3 months of age for the entire cohort (n = 3985), as well as for frequent night waking at 12 months (n = 3907) and found no association in

TABLE 2 Prevalence of Heavy Caffeine Consumption (≥300 mg/day) During Pregnancy and at 3 Mo Postpartum According to Maternal and Infant Characteristics

Variables	First Trimester		Second Trimester		Third Trimester		3 Mo Postpartum		Whole Pregnancy + Postpartum	
	%	P	%	P	%	P	%	P	%	P
Maternal characteristics										
Family income (quintiles)		<.001		<.001		<.001		<.001		<.001
1 (poorest)	24.0		22.2		20.1		17.3		8.3	
2	24.8		23.2		21.3		17.2		9.0	
3	21.9		21.0		19.9		16.8		8.2	
4	16.2		14.2		13.2		12.1		4.2	
5 (wealthiest)	9.6		9.0		9.1		8.5		2.6	
Living with partner		.267		.429		.252		.007		.214
Yes	19.0		17.7		16.2		15.0		6.7	
No	20.9		19.0		18.1		10.9		5.3	
Schooling, y		<.001		<.001		<.001		<.001		<.001
Up to 4	32.9		31.1		28.9		26.5		12.9	
5–8	23.5		21.8		20.4		16.5		8.4	
9–11	11.3		10.5		9.2		8.4		2.5	
≥12	8.8		8.0		7.2		8.0		2.6	
Maternal age, y		.174		.244		.380		<.001		.111
<20	16.9		15.8		15.3		8.6		4.8	
20–35	19.7		18.5		17.0		15.2		6.8	
>35	20.7		17.9		15.2		19.2		7.1	
Maternal skin color		.009		.018		.012		.315		.778
White	18.2		16.9		15.5		13.9		6.3	
Black	21.8		20.5		18.8		15.9		7.0	
Other	24.1		21.5		20.8		15.3		6.2	
Parity		<.001		<.001		<.001		<.001		<.001
0	13.0		12.1		11.4		7.9		2.9	
1–3	21.5		20.0		18.4		16.1		7.4	
≥4	33.5		30.7		27.8		31.8		15.9	
Paid work during pregnancy		<.001		<.001		<.001		.010		.009
No	21.6		20.0		18.4		15.5		7.3	
Yes	15.8		14.9		13.7		12.6		5.2	
Smoking during pregnancy		<.001		<.001		<.001		<.001		<.001
No	12.7		11.5		10.3		9.3		3.2	
Yes	37.1		35.2		33.3		28.1		15.3	
Daily cigarettes during pregnancy		<.001		<.001		.001		<.001		<.001
1–10	32.2		30.7		29.7		23.5		12.1	
>10	48.3		44.5		41.0		39.2		22.4	
Alcohol consumption		<.001		<.001		<.001		<.001		<.001
No	18.8		17.5		16.0		14.0		6.2	
Yes	35.2		31.3		30.5		25.6		14.8	
Maternal depression 3 mo postpartum		.102		.114		.095		.006		.229
No	21.3		19.7		17.7		11.9		6.6	
Yes	28.4		26.5		24.5		21.6		9.8	
Infant characteristics										
Gender		.913		.628		.940		.190		.554
Boy	19.4		17.6		16.5		13.7		6.2	
Girl	19.2		18.2		16.5		15.1		6.7	
Maternal bed-sharing		<.001		<.001		<.001		<.001		.001
No	15.7		14.8		13.6		12.5		5.2	
Yes	23.5		21.5		19.8		16.5		7.9	
No, of h slept at daytime (tertiles)		.946		.993		.938		.537		.311
1	22.3		20.3		17.9		14.2		7.1	
2	22.5		20.6		18.5		11.4		5.5	
3	21.4		20.6		19.1		13.7		8.8	

crude or adjusted analyses (data available upon request).

Previous studies have revealed that regular night waking is common throughout the first year after birth and that the number of awakenings per night is a function of the age.[3,35] A study in Israel revealed that 46% at 3 months, 39%, 58%, and 55% of the infants at 6, 9, and 12 months, respectively, woke during the night.[35] Most infants wake at night in the first months, but the

TABLE 3 Prevalence of Frequent Night Waking (>3 Times Per Night in the Previous 15 Days) According to Maternal and Infant Characteristics

Variables	Frequent Night Waking, %	P
Maternal characteristics		
Family income (quintiles)		.151
1 (poorest)	19.2	
2	16.0	
3	14.5	
4	12.2	
5 (wealthiest)	9.8	
Living with partner		.077
Yes	13.2	
No	19.2	
Schooling, y		.139
Up to 4	21.3	
5–8	13.3	
9–11	13.6	
≥12	10.8	
Maternal age, y		.274
<20	10.0	
20–35	15.1	
>35	14.6	
Maternal skin color		.031
White	12.1	
Black	18.8	
Other	20.4	
Parity		.733
0	13.8	
1–3	14.9	
≥4	11.4	
Paid work during pregnancy		.702
No	14.5	
Yes	13.6	
Smoking during pregnancy		.029
No	12.4	
Yes	18.3	
Daily cigarettes during pregnancy		.717
1–10	19.1	
>10	17.1	
Alcohol consumption		.044
No	13.6	
Yes	25.7	
Maternal depression 3 mo postpartum		.217
No	13.6	
Yes	18.2	
Heavy consumption first trimester		.417
No	13.6	
Yes	15.9	
Heavy consumption second trimester		.408
No	13.6	
Yes	16.0	
Heavy consumption third trimester		.337
No	13.6	
Yes	16.5	
Heavy consumption 3 mo postpartum (all infants)		.241
No	13.6	
Yes	17.7	
Heavy consumption whole pregnancy and postpartum (all infants)		.108
No	13.6	
Yes	21.0	
Heavy consumption 3 mo postpartum (breastfed only)		.146
No	13.3	

proportion decreases until about 6 months. From 6 to until 9 months, there is an increase and from then until 12 months decreases again.[3] In fact, this study revealed that 41.0% of the sample woke up every night by the age of 3 months, whereas from previous analyses with the whole cohort at age of 12 months this prevalence was 46.1% (95% CI: 44.6%–47.7%).[2]

The mean frequency of awakening episodes per night reported by mothers of night awakener infants in Pelotas (1.8 ± 0.9) was lower than the observed in other studies.[8,36] Burnham et al[36] in the United States monitoring night sleep with use of a VHS videotape reported 2.78 ± 1.75 episodes of night wakening. Anuntaseree et al[8] studying Thai infants of the same age and employing the same definition of night waking as used in the current study found a mean of 2.7 ± 1.1 episodes of nighttime awakenings. Maternal perception of the child wakefulness is a function of several factors, including proximity. More than two-thirds of the Thai infants shared a bed with their parents. Although bed-sharing is a common sleep practice in Pelotas, the prevalence at age of 3 months (46%) is lower than the observed in Thailand. Physical proximity during sleep promotes prompt response from the mother to small signals of child's arousal what may in part explain the difference between the results. Moreover, as observed by Goodlin-Jones et al,[37] during the course of a typical night for any single infant, several awakenings may be observed and infants may vocalize or not when awaken. In the current study, noncrying awakenings in which the infant returns to sleep without help as self-soothing awakenings were not distinguished from awakenings in which the infant cries and needs assistance to return to sleep. So it is possible that some noncrying awakenings may have passed unnoticed to

TABLE 3 Continued

Variables	Frequent Night Waking, %	P
Yes	19.5	
Heavy consumption whole pregnancy and postpartum (breastfed only)		.114
No	13.5	
Yes	22.5	
Infant characteristics		
Gender		.033
Boy	16.7	
Girl	11.5	
Maternal bed-sharing		.231
No	13.0	
Yes	16.1	
No. of h slept at daytime (tertiles)		.379
1	16.5	
2	12.7	
3	13.3	

TABLE 4 Prevalence Ratios and 95% CIs for Frequent Night Waking (>3 Times Per Night in the Previous 15 Days) Among Infants of Mothers With Heavy Consumption of Caffeine (≥300 mg/day) According to the Trimester of Pregnancy and Postpartum Period

Caffeine Consumption	n[a]	Frequent Night Waking			
		Crude Analysis		Adjusted Analysis	
		PR (95% CI)	P	PR (95% CI)	P
Heavy consumption first trimester			.414		.907[b]
Yes	195	1.17 (0.80–1.71)		0.98 (0.66–1.45)	
No	626	1.00		1.00	
Heavy consumption second trimester			.405		.970[c]
Yes	181	1.18 (0.80–1.74)		1.01 (0.67–1.51)	
No	640	1.00		1.00	
Heavy consumption third trimester			.334		.487[d]
Yes	164	1.22 (0.82–1.80)		1.15 (0.77–1.71)	
No	654	1.00		1.00	
Heavy consumption 3 mo postpartum (all infants)			.234		.271[d]
Yes	113	1.31 (0.84–2.03)		1.30 (0.82–2.05)	
No	708	1.00		1.00	
Heavy consumption whole pregnancy and postpartum (all infants)			.098		.080[e]
Yes	62	1.55 (0.92–2.59)		1.64 (0.94–2.86)	
No	759	1.00		1.00	
Heavy consumption 3 mo postpartum (breastfed only)			.138		.128[d]
Yes	77	1.46 (0.88–2.41)		1.49 (0.89–2.51)	
No	548	1.00		1.00	
Heavy consumption whole pregnancy and postpartum (breastfed only)			.102		.135[e]
Yes	40	1.67 (0.90–3.07)		1.65 (0.86–3.17)	
No	585	1.00		1.00	

PR, prevalence ratio.

[a] Data available for caffeine consumption and night waking.

[b] Controlled for maternal age, skin color, parity, smoking, alcohol consumption, child's gender, and family income.

[c] Controlled for maternal age, skin color, parity, smoking, alcohol consumption, child's gender, and family income.

[d] Controlled for maternal age, skin color, parity, alcohol consumption, child's gender, and family income.

[e] Controlled for maternal age, skin color, schooling, parity, alcohol consumption, child's gender, and family income.

non-bed-sharing mothers in Pelotas. Furthermore, because night waking in this study was defined as an episode of infant arousal that woke the parents during the nighttime, the parents' sleep behavior may affect the chance of being awakened by the child. A study conducted in São Paulo (Brazil) comparing sleep habits revealed that adults went to bed later in 1995 than in 1987 and that there was a decrease in total hours slept by day in 1995 in comparison with 1987.[38]

Also, nighttime sleep duration and number of awakenings may be a function of the infants' daytime sleep duration. Nocturnal sleep consolidation occurs during the first 12 months after birth with a decreasing trend of daytime sleep duration.[39] In Pelotas, nighttime sleep duration was on average half an hour shorter than the observed in a birth cohort in Zurich (9.4 ± 1.8 and 10.0 ± 1.5 hours, respectively; $P < .001$) at the same age. Furthermore, another possible reason for difference in mean number of wakening episodes is the overrepresentation of wealthier families in the subsample because prevalence of frequent awaking among infants from the wealthiest families was 50% lower than the observed among infants from the poorest families.

Although large amounts of caffeine intake by school-aged children, usually from sources other than coffee, can result in increased restlessness, excitability, and inattention,[40] there are few studies investigating the effect of caffeine and other methylxanthine derivates by the mother on sleep of infants. Only 1 study explored the effect of discontinuation of coffee intake among iron-deficient toddlers employing a randomized design.[32] None of these studies revealed any differences in sleep difficulty or number of times waking at night. In clinical settings, studies in which caffeine was used to treat apnea of prematurity revealed that caffeine did not modify either the duration of active sleep[41] or the total sleep time or the sleep stage durations of preterm infants.[42]

Furthermore, there is no consensus between the authors with regard to the

amount of caffeine available to the infant through breast milk. Berlin et al[43] reported that the total amount of caffeine available to the infant through the milk is on average 0.53% ± 0.53% of the maternal dose and that no caffeine or methylxanthine metabolites are detected in the urine of nursing infants after the ingestion of modest doses of caffeine by the mothers, suggesting that absorption is minimal or absent. In the same way, Ryu[44] in a small crossover trial, in which mothers received decaffeinated coffee or decaffeinated coffee with added caffeine, infant performance was not significantly different with respect to sleep time.

Methodological aspects of this study might be kept in mind when interpreting the results. The main strength of this study is its population-based prospective design. The main weakness is its inadequate sample size to detect a relationship especially for the subgroup analysis of mothers who consumed heavily throughout pregnancy and at postpartum and breastfed their infants ($n = 40$), for which the available sample allowed to detect only relative risks ≥2.4 with a power of 80% significance at $\alpha = .05$.

CONCLUSIONS

In this setting where coffee and mate are largely consumed by women during and after pregnancy, heavy consumption did not increase the number of nighttime awakenings by their 3-month-old infants. These findings confirm the fact that the advised limit of caffeine consumption during pregnancy at a level of 300 mg/day as recommended in some countries can be kept, at least as the sleeping behavior of infants is concerned.

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