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Fetal malnutrition in infants of smokers and passive smokers assessed by clinical assessment of nutritional status scoring

Aim: Studies have shown that maternal smoking during pregnancy is associated with low birth weight, height and head circumference in newborns. In the present study, along with these anthropometric measures we aimed to determine fetal malnutrition (FM), which is a less known outcome of antenatal tobacco exposure.

Materials and methods: Two hundred and sixty-six term singletons without anomalies were evaluated for their birth weight, height, and head circumference and for FM using the Clinical Assessment of Nutritional Status (CANS) scoring. A CANS score equal to or less than 24 is accepted as FM.

Results: Smokers' (n = 84) and passive smokers' (n =110) babies showed a birthweight deficit of -220.6 g (95% CI:-403.2 to -37.9) and -160.22 g (95% CI:-364.3 to -43.9), a birth height deficit of -0.42 cm (95% CI:-1.38 to -0.55) and -0.94 cm (95% CI:-2.03 to -0.16) and a head circumference deficit of -1.38 cm (95% CI:-1.91 to -0.86) and -0.89 cm (95% CI:-1.46 to -0.32) respectively, compared to nonsmokers' babies (n = 72). Smokers and passive smokers' babies also revealed decreases in CANS scorings, which were 22.7 (3.9) (P < 0.001) and 24.3 (4.3) respectively, compared to nonsmokers' babies who showed a CANS score of 27.6 (4.4). Babies whose mothers smoked more than 10 cigarettes/day had a much lower CANS score, which was 21 (3.97) (P = 0.013).

Conclusion: Our findings suggest that screening for fetal malnutrition is indicated in smoking women's and passive smokers' babies.

Key words: Smoking mothers, clinical assessment of nutritional status (cans) score, fetal malnutrition, passive smokers

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Sigara içen ve pasif içici annelerden doğan bebeklerde clinical assessment of nutritional status skorlama ile fetal malnütrisyon değerlendirmesi

Amaç: Bilimsel çalışmalar gebelikte sigara kullanımının doğum kilosu, boyu ve baş çevresi üzerine olumsuz etkilerini artık kanıtlamıştır. Biz çalışmamızda, bu antropometrik ölçümlerin yanısıra, daha az bilinen fetal malnütrisyonun (FM) gebelikte sigara kullanımı ile ilişkisini ortaya koymaya çalıştık.

Yöntem ve gereç: Anomalisi olmayan 266 term bebeğin doğum boyu, kilosu ve baş çevresi alındı ve CANS (Clinical Assessment of Nutritional Status) skorlaması ile fetal malnütrisyon bulguları araştırıldı. Yirmidört ve altındaki CANS skorları fetal malnütrisyon olarak değerlendirildi.

Bulgular: Sigara içen annelerin (n = 84) ve pasif içici annelerin (n = 110) bebekleri sigara içmeyen annelerin bebekleri (n = 72) ile karşılaştırıldığında doğum kilosu eksikliği sırası ile –220,6 g (% 95 CI:-403,2 ile –37,9 arası) ve –160,22 g (% 95 CI:-364,3 ile –43,9 arası), doğum boyu eksikliği sırası ile –0,42 cm (% 95 CI:-1,38 ile -0,55 arası) ve -0.94 cm (% 95 CI: -2,03 ile –0,16 arası) ve baş çevresi eksikliği sırası ile –1,38 cm (% 95 CI:-1,91 ile –0,86 arası) ve -0,89 cm (%95 CI:-1,46 ile –0,32 arası) olarak bulundu. Sigara içen ve pasif içici annelerin bebeklerinin CANS skorları (22,7 (3,9) (P < 0,001) ve 24,3 (4,3)) sigara içmeyen annelerin bebeklerinin skorlarından (27,6 (4,4)) daha düşüktü. Günde 10 adetten fazla sigara tüketen annelerin bebekleri çok daha düşük CANS skorları (21 (3,97) (P = 0,013)) göstermişlerdir.

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Sonuç: Biz bu çalışmamızda, bulgularımız ışığında, gebelikte sigara içen veya pasif içici olan annelerin bebeklerinde fetal malnütrisyon yönünden değerlendirme gerekliliğini vurguluyoruz.

Anahtar sözcükler: Sigara içen anneler, clinical assessment of nutritional status (cans) skoru, fetal malnütrisyon, pasif içici

Introduction

Maternal smoking during pregnancy is already known to be associated with low birth weight, height, and head circumference in newborns. Previous studies reported that maternal smoking causes about 100-350 g decreases in newborns' birth weight (1–5). Also, newborns of mothers who smoked during pregnancy have a head circumference 0.2-1 cm lower and a birth length 1-1.5 cm lower than newborns of nonsmoking mothers (1, 6-8). Passive smoking also affects babies' birth weight, height, and head circumference as well as other anthropometric measures (1, 3, 9,10). However, there is no previous study about the fetal malnutrition (FM) in babies of smokers or passive smokers.

Fetal malnutrition (FM) is a term used to describe a clinical condition that is characterized with insufficient production or loss of muscle mass and subcutaneous fatty tissue during the intrauterine period (11–13). Neither SGA nor IUGR are synonymous with FM. Intrauterine growth retardation (IUGR) describes the fetus who has failed to reach its own theoretical normal growth potential. IUGR is the result of events that inhibit the normal growth potential of the fetus and is an ongoing process following FM (11-13). In contrast, the term SGA implies a static one-time measurement, which is defined as a birth weight less than that expected for gestational age. On the other hand, FM is a clinical diagnosis and is independent of birth weight and height; hence it may or may not be seen together with low birth measures. The Clinical Assessment of Nutritional Status (CANS) scoring is a simple and rapid clinical scoring system for diagnosing fetal malnutrition in term AGA newborns (11,17-19).

Fetal malnutrition may be associated with many maternal risk factors, such as adverse age, primiparity, low pre-pregnancy weight and height, a bad obstetric history, and pregnancy induced hypertension (14,16). Cigarette smoking during pregnancy is one of these risk factors as nicotine is known to be toxic toplacenta (14–16). Hence, babies of mothers who smoked during pregnancy may be term and AGA but were found to be malnourished based on CANS scoring.

This study aimed to compare FM status assessed by CANS scoring in term AGA newborns whose mothers smoked during pregnancy and whose mothers were passive smokers with newborns whose mothers didn't smoke.

Materials and methods

In this study, we recruited 325 pregnant women who attended antenatal exams within the same month at Şişli Etfal Education Hospital, İstanbul, Turkey. The women completed a detailed questionnaire while attending antenatal services. Data on their smoking habits, household members' usage of tobacco products, mother's education, parity, age, pre-pregnancy weight and height, paternal height, and their economic status were obtained from this questionnaire. The economic status of the families was determined by family income, type of residence, and the number of rooms in the residence.

The delivery room interview ascertained the information about mothers' smoking habits. Mothers were asked how many cigarettes they smoked per day. If they had quit smoking, they were asked when they quit and how many cigarettes they had smoked per day before they quit. The household members' smoking habits were also ascertained in the delivery room interview. Passive smokers were defined only from those who had a household member who smoked more than 10 cigarettes per day inside the house.

Out of 325 pregnant women, only 280 gave live births at Şişli Etfal Hospital, others in different hospitals. The initial examination of 280 newborns born to these mothers was performed within 24 hours of the birth. The initial examination included birth weight, length, and head circumference as well as CANS scoring for fetal malnutrition. The

examination of newborns was always performed by the same investigator (A. K. F.)

Fourteen newborns were excluded from the study because they were babies of diabetic mothers, multiple or complicated pregnancies, babies born with a congenital abnormality, or premature babies. Hence, a total of 266 healthy term AGA singletons were studied for fetal malnutrition. Out of these 266 babies, 84 were babies of smoking mothers, 72 were babies of nonsmoking mothers, and 110 were babies of passive smokers.

Newborns were weighed naked on a beam balance to the nearest 10 g using standard techniques, their crown-to-heel lengths were measured on a portable measuring board to the nearest 0.1 cm and their head circumferences were measured with a disposable tape to the nearest 0.1 cm at their longest occipitofrontal circumferences. We wanted to assure weight and length rates therefore Ponderal Index for the infants was calculated as weight (g) / length $(cm)^3 \times 100$ (6).

The diagnosis of fetal malnutrition was made within 24 hours following the delivery by using CANS scoring as proposed by Metcoff (11). CANS scores involves the assessment of the nine physical signs of nutrition which are: 1-hair's quality, 2-buccal fat in the cheeks, 3-neck and chin fatness; and loose, wrinkled skin with the absence of subcutaneous fat in: 4-arms, 5-legs, 6-back, 7-buttocks, 8-abdomen, and 9-chest. Each of the 9 signs was rated from 4 (best, no evidence of malnutrition in utero) to 1 (worst, definite evidence of malnutrition in utero). The score range was between 36 (highest) and 9 (lowest). Newborns with a total CANS score less than and/or equal to 24 were considered as fetal malnourished and those with CANS score between 25 and 36 were considered as well nourished (11, 12, 13, 17).

The clinical and anthropometric parameters of the study population were expressed as mean and ± standard deviation (SD). Nonparametric categorical data were compared with Chi-square test and parametric continuous data were compared with ANOVA (One Way Variance Analysis), Student's t test, and Kruskal Wallis test. P values less than 0.05 were considered statistically significant. The statistical analyses were performed using SPSS version 10.0 for Windows.

Results

Total of 266 pregnant women who gave birth at Şişli Etfal Education Hospital, İstanbul, Turkey were questioned for their habits of smoking and the household members' use of tobacco products. Seventy-two of them were nonsmokers, 110 of them were passive smokers, and 84 of them were smokers. As shown in Table 1, there were no meaningful statistical differences between these 3 groups in terms of maternal and paternal age, maternal and paternal height, maternal parity, pre-pregnancy weight, and weight gain during pregnancy. Only mother's education showed differences between groups. Mothers who smoked during their pregnancies had a higher education level compared to nonsmokers ($P < 0.01$). The economic status of the families also showed significant differences between groups. Smoker mothers' families were from a lower economic status compared to nonsmoker mothers ($P = 0.05$). The infant groups were similar with respect to gender and gestational age. Apgar scoring for all groups were within normal limits.

Table 2 demonstrates the comparison of birth weights, heights, and head circumferences between groups. Birth weight difference between babies of mothers who smoked during their pregnancies and babies of nonsmokers was found to be —220.6 g (95% CI: -403, 2 to -37.9), which is a statistically significant decrease ($P < 0.05$). Also, babies of passive smokers had a statistically meaningless birth weight deficit of -160.2 g (95% CI: -363.3 to -43.9) ($P > 0.05$) compared to babies of nonsmokers.

Birth height differences between groups were not statistically meaningful. However, babies of smoking mothers had a birth height deficit of -0.42 cm (95% CI: -1.38 to -0.55) when compared to babies of nonsmoking mothers. Again, babies of passive smokers had a birth height deficit of -0.94 cm (95% CI: -2.03 to -0.16) when compared to babies of nonsmokers (Table 2).

When the head circumferences were compared, the difference between babies of smoking and nonsmoking mothers was -1.38 cm (95% C I: -1.91 to 0.86), which was a highly significant decrease ($P < 0.001$). Again, the deficit of head circumference at birth between babies of passive smokers and

Table 1. Descriptive statistics for infants and their parents.

	Nonsmokers (n = 72) Mean (SD)	Passive Smokers (n = 110) Mean (SD)	Smokers (n = 84) Mean (SD)	P values
Infants				
Gender (M /F) (%)	49.2/50.8	56.9/43.1	39.0/61.0	0.173
Gestational age(wk)	38.65 (2.05)	39.12 (1.71)	38.8 (1.85)	0.217
Apgar 1'	8.6 (0.68)	8.4 (0.86)	8.6 (0.64)	0.237
Apgar 5'	9.7 (0.52)	9.6 (0.65)	9.7 (0.55)	0.210
Parental Characteristics				
Maternal age (y)	25.6 (5.88)	26.5 (5.78)	25.11 (5.04)	0.201
Paternal age (y)	29 (6.00)	29.8 (6.78)	29 (5.46)	0.633
Maternal parity	1.3 (1.5)	1.3 (1.6)	1.0 (1.5)	0.267
Maternal height(cm)	160.9 (5.1)	162.3 (4.5)	160.1 (4.8)	0.091
Paternal height (cm)	172.9 (6.9)	172.0 (6.9)	170.6 (4.7)	0.218
Pre-pregnancy weight(kg)	58.8 (10.50)	55.5 (7.75)	54.5 (8.12)	0.202
Weight gain during pregnancy (kg)	12.4 (4.86)	12.1 (4.54)	12.5 (3.80)	0.980
Mother's education				
1-5 years (%)	51 (70.8 %)	81 (73.6 %)	42 (50.0 %)	0.015[1]
>5 years (%)	13 (18.1%)	11 (10.0 %)	24 (28.6 %)	0.003[2]
No education (%)	8 (11.1 %)	18 (16.4 %)	18 (21.4 %)	0.223
Economic status of the Family				
Low class (%)	29 (40.3 %)	63 (57.3 %)	46 (54.8 %)	0.051
Middle class (%)	39 (54.2 %)	42 (38.2 %)	35 (41.7 %)	0.094
High class (%)	4 (5.6 %)	5 (4.5 %)	3 (3.6 %)	0.622

[1]P < 0.05 smokers vs. nonsmokers
[2]P < 0.01 smokers vs. nonsmokers

nonsmokers was -0.89 cm (95% CI: –1.46 to -0.32). This result was also a statistically significant decrease (P < 0.001) (Table 2).

Babies of mothers who smoked during their pregnancies showed a statistically significant decrease in CANS scoring compared to babies of nonsmokers (27.6 (4.4) versus 22.7 (3.9)) (P = 0.000).

Newborns of smoking mothers were also classified according to the number of cigarettes smoked per day during their pregnancies (Table 3). Babies whose mothers smoked more than 10 cigarettes per day had a much more lower CANS score (21.0) as compared with babies of mothers who smoked 1- 5 cigarettes/day (CANS score, 24.2). The difference between these 2 groups was found to be a statistically significant decrease (P = 0.013).

None of the newborn groups was found to have a low Ponderal Index (<2.25). However, newborns of mothers who smoked more than 5 cigarettes per day (PI = 2.62) were found to have a statistically significant decrease in Ponderal Index (P < 0.01) when compared to newborns of nonsmokers (PI = 2.78).

Table 2. Anthropometry of newborns by mothers' smoking habits.

	Mean (SD)	Difference (95% Confidential Interval)
Birth weight (g)		
Nonsmokers (n = 72)	3323.61(640.6)	
Passive smokers (n = 110)	3163.39(711.8)	-160.22 (-364.3 to -43.9)
Smokers (n = 84)	3103.01(509.6)[1]	-220.60 (-403.2 to -37.9)[1]
Birth length (cm)		
Nonsmokers (n = 72)	49.10(3.3)	
Passive smokers (n = 110)	48.16(3.9)	-0.94 (-2.03 to -0.16)
Smokers (n = 84)	48.68(2.8)	-0.42 (-1.38 to -0.55)
Birth head circumference (cm)		
Nonsmokers (n = 72)	34.94(1.9)	
Passive smokers (n = 110)	34.05(1.9)[2]	-0.89 (-1.46 to -0.32)[2]
Smokers (n = 84)	33.56(1.3)[3]	-1.38 (-1.91 to -0.86)[3]

[1]P < 0.05 smokers vs. nonsmokers
[2]P < 0.01 passive smokers vs. nonsmokers
[3]P < 0.001 smokers vs. nonsmokers

Discussion

In this study, we observed that in term AGA newborns of mothers who were smokers during their pregnancy, there were deficits in birth weight and head circumference compared to babies of nonsmokers (Table 2. In addition, we found that these term AGA babies of smokers also are those labeled as fetal malnutrition (Table 3). Also, we showed that the degree of FM increased as the number of cigarettes smoked per day increased. The Ponderal Index of our newborns who were found to have FM was within normal limits. We also determined that passive smoking during pregnancy caused a deficit of head circumference in term and AGA newborns and also,

Table 3. CANS scoring of newborns by mothers' smoking habits and the number of cigarettes smoked per day.

	CANS score Mean (SD)	Difference (95% Confidential Interval)
By smoking habits of mothers		
Nonsmokers (n = 72)	27.6 (4.4)	
Passive smokers (n = 110)	24.3 (4.3)[2]	-3.3 (-0.07 to -5.6)[2]
Smokers (n = 84)	22.7 (3.9)[3]	-4.9 (-0.21 to -7.4)[3]
By the number of cigarettes smoked per day		
1-5 cigarettes/day (n = 34)	24.20 (3.92)	
6-10 cigarettes/day (n = 30)	22.07 (3.50)[1]	-2.13 (-0.04 to -3.3)[1]
>10 cigarettes/day (n = 20)	21.00 (3.97)[1]	-3.2 (-0.11 to -6.7)[1]

[1]P < 0.05 >5 cigarettes/day vs. <5 cigarettes/day
[2]P < 0.01 passive smokers vs. nonsmokers
[3]P < 0.001 smokers vs. nonsmokers

these babies of passive smokers were found to have mild FM.

Cigarette smoking during pregnancy is one of the major factors affecting newborns' weight, length, and head circumference. There are numerous studies investigating the adverse effects of maternal smoking on babies' anthropometric measures (1-8). It is also well known that smoking causes SGA and prematurity (1,2,10). However, the presence of FM was never studied in term AGA newborns of smoking mothers although cigarette smoking was found to be a causative factor in FM (14-16, 19). Our study is unique in terms of involving FM in term, AGA newborns whose mothers were smokers or passive smokers during their pregnancies.

Our newborns of smoking mothers were neither SGA nor preterm but showed a birth weight deficit of -220.60 grams compared to newborns of nonsmoking mothers. However, certain infants of smoking mothers may be genetically pre-disposed to be large. Therefore, some babies of smoking mothers may not show any birth weight deficit compared to babies of nonsmoking mothers, but they may manifest FM by soft tissue wasting (14). Conversely, other babies of smoking mothers may be smaller than babies of nonsmoking mothers due to genetic reasons but may not show any soft tissue wasting, hence no FM.

Head circumference is the most important growth parameter during the intrauterine period and in the first postpartum 6 months period because it is the body part growing fastest during this period of development. The growth of head circumference is important in terms of brain development (7, 8, 10, 13). The deficit of head circumference in babies of smoking mothers compared to babies of nonsmokers may be an indication of future neurological problems in these babies (6–8, 13).

Previously published studies indicate controversial findings about the effects of passive smoking during pregnancy on anthropometric measures of the newborns (1, 4, 8, 9, 10). As some of these studies claim significant deficits in birth weight, length, and head circumference by passive smoking during pregnancy, others suggest very small deficits in these anthropometric measures of newborns by passive smoking. In our study, we found that passive smoking, as well as smoking during pregnancy, may cause deficits in newborns' head circumference measures, which is very important for future neurological outcome. Also, a mild FM was determined in the newborns of passive smokers although they did not show any significant birth weight deficit.

Current studies show that newborns that have lower Ponderal Index either have deficits in growth parameters or have lower scores in CANS (2, 15, 18). Usually, these studies claim that prenatal cigarette smoking has no effects on Ponderal Index (2, 6, 7). In our study, Ponderal Index was in normal limits for both smoking and passive smoking groups. However, same babies whose mothers were exposed to cigarette smoke during pregnancy were found to have fetal malnutrition independent of Ponderal Index. Consequently, we believe that Ponderal Index is an insufficient measure for the growth or nutritional assessment of babies in utero, instead CANS scoring is much more accurate in this regard.

There are studies performed on postnatal catch-up growth of babies born to mothers who smoked during their pregnancies and these studies show controversial results on this issue (5, 8). Prospective studies about FM showed that catch-up growth of babies with fetal malnutrition is different from babies who are non-FM and also have different neurological outcome (13).

In conclusion, we claim that newborns of smoking mothers and passive smokers may be malnourished even though they are term AGA. The assessment of FM should be carried out in these babies and smoking women who intend to become pregnant or who are pregnant should be well informed about the future outcomes of cigarette smoking during pregnancy.

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