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## Maternal smoking during pregnancy and effects on neonatal anthropometry: a prospective study

### Authors

FATİH BOLAT, ÖZGE EREN, GÜHER BOLAT, EMRAH CAN, SERDAR CÖMERT, HASAN SİNAN USLU, and ASİYE NUHOĞLU

## Maternal smoking during pregnancy and effects on neonatal anthropometry: a prospective study

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**Aim:** To identify risk factors associated with cigarette smoking during pregnancy and to evaluate the effect of smoking on anthropometric measurements.

**Materials and methods:** This study was carried out prospectively in selected women who gave birth to a healthy, term infant at Şişli Etfal Education and Research Hospital from January 2009 to January 2010. Smoking status during pregnancy was categorized into 3 groups: nonsmoker; smoker; passive smoker. Regression analysis was performed to compare risk factors with cigarette smoking.

**Results:** A total of 1175 mothers were enrolled. Active and passive smoking rates were 14.9% and 32.3%, respectively. In univariate analysis, maternal active and passive smoking were associated with maternal age, parental education level, first pregnancy, ethnic origin, and partner's smoking status. Among anthropometric measurements, the only significant difference was related to birth weight. The mean difference between babies born to mothers who smoked and those who did not was 111 g ( $P = 0.01$ ). The difference between babies born to mothers who did not smoke and who were passive smokers was 96 g ( $P = 0.04$ ).

**Conclusion:** This study reveals that the cigarette smoking rate among mothers who gave birth in our hospital has gradually decreased and the most obvious effect of maternal smoking was on birth weight.

**Key words:** Pregnancy, smoking, newborn, anthropometric measurements

### Introduction

Cigarette smoking remains an important public health problem for almost all countries worldwide. It is the leading preventable cause of death in many countries. In Turkey, more than 100,000 people die every year as a consequence of smoking; the number is estimated to rise to 240,000 per year by 2030. Cigarette smoking has recently become more popular among women and adolescents. Nearly 1 in every 6 Turkish women smokes (1,2).

A valid estimate of the prevalence of smoking during pregnancy has been reported in developed

countries, but in less-developed countries reliable data remain limited. During the previous 2 decades, smoking by pregnant women in the developed world is reported to have declined by about 60%-75%, but in Turkey it seems to be increasing in rural areas. Socioeconomic and psychogenic factors such as race, economic status, emotional stress, and insufficient education are associated with the higher prevalence of cigarette smoking in women (3).

We aimed to assess the prevalence and characteristics of smoking in pregnant women in our hospital and to determine the effect of smoking on neonatal anthropometric measurements.

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## Materials and methods

### Study site and population

This prospective study included 1175 term neonates delivered over a 1-year period from January 2009 to January 2010 in the obstetrics clinic of Şişli Etfal Education and Research Hospital. The hospital is located in the European part of Turkey's biggest city, İstanbul. During the study period, newborns were consecutively selected at the time of their first visit to the clinic after they were born in the Obstetric Department of our hospital. Preterm deliveries, pregnancies with multiple gestations, mothers with medical disorders, neonates with congenital anomalies, and mothers who stopped smoking during or before pregnancy were not included in the study. The study protocol was approved by the local ethics committee. Before enrollment, all study participants provided written informed consent.

### Data collection

A detailed questionnaire was administered by trained interviewers using a standard form, which included maternal ethnicity, number of pregnancy, parental education, family income, prepregnancy weight, and weight gain during pregnancy. Data of birth outcome (including gestational age, required resuscitation at delivery, Apgar scores, admission to neonatal intensive care unit, birth weight, height, and head circumferences) were collected from the Medical Birth Registry of our hospital. Gestational age was determined by date of the last menstrual period and/or early ultrasound scan and confirmed by the New Ballard Score. All neonates in our study were weighed on an electronic scale by nursing personnel, and other anthropometric measurements (such as length and head circumference) were completed by the same nurse, who was unaware of study-group assignments.

### Cigarette smoking

Based on maternal self-reporting, mother's smoking status was categorized into 1 of 3 groups: nonsmoker (did not smoke throughout the pregnancy); smoker (smoked during pregnancy); and passive smoker (had a household member who smoked more than 10 cigarettes per day inside or outside of the house) (4). Mothers who smoked were divided into three groups according to quantity of maternal cigarette

consumption: mild smokers (smoked 1 to 5 cigarettes per day); moderate smokers (smoked 6 to 10 cigarettes per day); and heavy smokers (smoked more than 10 cigarettes per day).

### Statistical analysis

Statistical analysis was performed using SPSS 15.0 (SPSS Inc., Chicago, Illinois, USA). The characteristics of the study subjects were analyzed with the chi-square test or Student's t-test to assess the significance of the statistical association between the independent variables. Multivariate analyses were performed separately by using logistic regression to analyze the risk factors of maternal cigarette smoking.

## Results

During the study period, a total of 3500 mothers gave birth in our hospital. Of these, 1175 mothers who met the study criteria were enrolled in the study. The mean maternal age was  $27.93 \pm 6.28$  years. The majority of the mothers were between 25 and 30 years. Out of 1175 mothers participating in the study, 620 (52.8%) were nonsmokers, 380 (32.3%) were passive smokers, and 175 (14.9%) were active smokers. Of the active smokers, 73 women smoked 1-5 cigarettes per day, 65 smoked 6-10 cigarettes per day, and 37 smoked more than 10 cigarettes per day. These mothers had smoked during their pregnancy, with a mean of 6.4 cigarettes per day.

The rate of passive smoking among employed mothers was significantly higher than in unemployed ones. Of passive smokers, 45% reported having exposure from home, 25% from home and outside, and 30% from outside. The mean birth weight and gestational age of the infants were  $3190 \pm 459$  g (1730-4260 g) and  $38.3 \pm 1.0$  weeks (37-41 weeks), respectively. Compared with nonsmoking in univariate analysis, active and passive smoking habits during pregnancy were associated with maternal age, maternal and paternal education levels, first pregnancy, ethnic origin, and partner's smoking status (Table 1).

The multivariate logistic regression analyses for outcome in relation to smoking during pregnancy showed that maternal educational level of university degree, maternal East Anatolian or Black Sea ethnic origin, and a partner who is a nonsmoker were

Table 1. Univariate analysis of sociodemographic characteristics of the study participants.

Sociodemographic characteristics	Nonsmoker (n = 620)	Smoker (n = 175)	P	Passive smoker (n = 380)	P
Maternal age, years, n %					
<20	153 (24.7)	65 (37.1)		45 (11.8)	
20-25	177 (28.5)	25 (14.3)	<b>&lt;0.001</b>	130 (34.2)	<b>&lt;0.001</b>
26-30	203 (32.7)	55 (31.4)		44 (11.6)	
>30	87 (14.0)	30 (17.1)		161 (42.4)	
Prepregnancy weight (kg) <sup>1</sup>	65 ± 5.4	60 ± 3.4	<b>0.004</b>	63 ± 4.7	0.06
Weight gain during pregnancy (kg) <sup>1</sup>	13.5 ± 3.5	12.6 ± 2.1	0.07	13.1 ± 2.4	0.1
Ethnicity, n %					
Mediterranean region	57 (9.2)	13 (7.4)		29 (7.6)	
Aegean region	31 (5.0)	14 (8.0)		24 (6.3)	
Central Anatolian region	82 (13.2)	21 (12.0)		53 (13.9)	
Southeast Anatolian region	86 (13.9)	22 (12.6)	<b>0.039</b>	38 (10.0)	<b>0.006</b>
East Anatolian region	181 (29.2)	46 (26.3)		145 (38.2)	
Black Sea region	136 (21.9)	32 (18.3)		79 (20.8)	
Marmara region	47 (7.6)	27 (15.4)		12 (3.2)	
Maternal education level, n (%)					
Illiterate	80 (12.9)	23 (13.1)		45 (11.8)	
Primary school	242 (39.0)	97 (55.4)	<b>&lt;0.001</b>	225 (59.2)	<b>&lt;0.001</b>
Middle school	96 (15.5)	27 (15.4)		31 (8.2)	
High school	123 (19.8)	25 (14.3)		75 (19.7)	
University	79 (12.7)	3 (1.7)		4 (1.1)	
Father's education level, n %					
Illiterate	18 (2.9)	8 (4.6)		9 (2.4)	
Primary school	323 (52.1)	96 (54.9)		229 (60.3)	<b>&lt;0.001</b>
Middle school	111 (17.9)	11 (6.3)	<b>0.001</b>	35 (9.2)	
High school	98 (15.8)	43 (24.6)		83 (21.8)	
University	79 (11.3)	17 (9.7)		24 (6.3)	
Partner's smoking, n (%)	161 (16.3)	144 (82)		<b>&lt;0.001</b>	
First pregnancy, n %	350 (56.5)	55 (31)	<b>&lt;0.001</b>	120 (31.6)	<b>&lt;0.001</b>
Housewife, n (%)	517 (83.4)	165 (94)	<b>0.03</b>	325 (85.5)	0.14
Cesarean section, n (%)	385 (62.1)	105 (60)	0.61	245 (64.5)	0.45
Monthly family income, TL <sup>2</sup>	1129 ± 764	1032 ± 553	0.119	1128 ± 526	0.97
Sex (male), n (%)	320 (51.6)	94 (53.7)	0.62	194 (51.1)	0.86
Low birth weight, <2500 g	39 (6.3)	15 (8.6)	0.29	29 (7.6)	0.41
1-min Apgar score <sup>3</sup>	8.0 ± 0.2	7.8 ± 0.8	0.75	7.8 ± 0.7	0.65
5-min Apgar score <sup>3</sup>	9.1 ± 0.3	8.9 ± 0.9	0.66	8.9 ± 0.6	0.64
Need for resuscitation at birth, n (%)	7 (1.1)	2 (1.1)	0.98	5 (1.3)	0.79
Number of infants admitted to the NICU, n (%)	80 (12.9)	20 (11.4)	0.60	45 (11.8)	0.62

<sup>1</sup>BMI: body mass index, <sup>2</sup>Turkish lira, <sup>3</sup>mean ± standard deviation.

significant predictors associated with decreased smoking during pregnancy. Compared with nonsmokers, the lowest passive smoking rate was seen among women who had graduated from a university (Exp (B) 0.012, 95% CI = 0.002-0.069). There was

no significant difference in terms of maternal age between the mothers who actively smoked and who did not smoke. However, this difference was noted to be significant for the passive smoker in the 20-25 and >30 years age groups (Exp (B) 2.77, 95% CI =

1.69-4.54 and 5.37, 95% CI = 3.07-9.39, respectively). Mothers whose husband had a university education had 24 times higher risk to be a passive smoker (Table 2).

Among postnatal anthropometric measurements, the only significant difference was detected in birth weight. We observed that there was a significant difference in mean birth weight between mothers who smoked and those who did not ( $3126 \pm 337$  g vs.  $3238 \pm 481$  g). The mean difference was 111 g ( $P = 0.01$ ). There were also significant differences in

mean birth weight between nonsmoker and passive-smoker mothers. The difference of mean birth weights of babies born to nonsmoker and passive-smoker mothers was 96 g ( $P = 0.04$ ) (Table 3). There was an association between quantity of smoking and likelihood of delivery of a low-birth-weight infant ( $P = 0.031$ ). Low birth weight rate in mild, moderate, and heavy smoker mothers was 4.1%, 7.7%, and 18.9% respectively. A trend of decreased birth weight was noted with increased number of cigarettes smoked. In both male and female infants,

Table 2. Multivariate logistic regression analysis.

	Nonsmoker vs. smoker			Nonsmoker vs. passive smoker		
	Exp (B)	95 % CI	P	Exp (B)	95 % CI	P
Maternal age						
<20	1	1		1	1	
20-25	0.68	0.345-1.35	0.27	2.77	1.69-4.54	<0.001
26-30	0.57	0.31-1.05	0.07	0.39	0.21-0.72	0.003
>30	0.55	0.26-1.15	0.11	5.37	3.07-9.39	<0.001
Maternal education level						
Illiterate	1	1		1	1	
Primary school	1.8	0.7-4.3	0.17	0.91	0.52-1.60	0.75
Middle school	2.5	0.5-11.0	0.24	0.64	0.26-1.55	0.32
High school	4.0	0.9-16.7	0.06	0.62	0.29-1.70	0.35
University	0.05	0.06-0.5	0.01	0.012	0.002-0.069	<0.001
Father's education level						
Illiterate	1	1		1	1	
Primary school	0.28	0.05-1.45	0.13	0.92	0.23-3.68	0.91
Middle school	0.06	0.09-0.50	0.009	0.83	0.19-3.66	0.81
High school	0.08	0.01-0.61	0.014	0.82	0.17-3.96	0.81
University	1.17	0.98-14.7	0.89	24.3	3.5-167.42	0.001
Ethnicity						
Mediterranean region	0.51	0.18-1.42	0.19	2.49	0.94-6.56	0.65
Aegean region	0.87	0.28-2.67	0.81	3.67	1.24-10.7	0.18
Central Anatolian region	0.59	0.23-1.49	0.26	2.67	1.09-6.54	0.32
Southeast Anatolian region	0.43	0.17-1.07	0.07	1.98	0.80-4.87	0.13
East Anatolian region	0.37	0.16-0.85	0.02	3.67	1.71-8.73	0.001
Black Sea region	0.28	0.12-0.66	0.04	3.11	1.36-7.11	0.007
Marmara region	1	1		1	1	
Partner's smoking status						
Yes	1	1		1	1	
No	0.035	0.02-0.060	<0.001	0.75	0.05-0.1	<0.001
First pregnancy						
Yes	1	1		1	1	
No	7.25	3.87-13.6	<0.001	3.39	2.20-5.22	<0.001
Employment						
Unemployed	1	1		1	1	
Employed	1.78	0.62-5.19	0.28	4.22	2.09-8.51	<0.001

Table 3. Comparison of the effects of cigarette smoking (active or passive) on anthropometric measurements at birth.

	<b>Nonsmoker</b> (n = 620)	<b>Smoker</b> (n = 380)	<b>Passive smoker</b> (n = 175)	<b>P</b>
*Birth weight, mean ± SD*, g	3238 ± 481	3126 ± 337	3142 ± 465	<b>0.01</b>
Height, mean ± SD, cm	49.6 ± 1.7	48.4 ± 1.6	47.3 ± 1.8	0.067
Head circumference, mean ± SD, cm	34.3 ± 1.6	34.2 ± 1.2	34.4 ± 1.4	0.072

\*Nonsmoker vs. smoker (P = 0.01); nonsmoker vs. passive smoker (P = 0.04); smoker vs. passive smoker (P = 0.9), \*SD: standard deviation.

head circumferences and heights decreased as the mother's smoking increased, but the differences were not significant (P = 0.05) (Table 4).

## Discussion

Maternal smoking during pregnancy has long been known to be an independent risk factor for neonatal morbidity and mortality such as reduced birth weight, shortened gestation, preterm birth, intrauterine growth restriction, and in utero mort fetalis (5,6). A number of factors were found to be associated with smoking, including maternal age, parental education levels, ethnicity, smoking status of partner during pregnancy, first pregnancy, and mother's employment status. We also found that active and passive smoking was significantly associated with low birth weight.

For high-income countries, the percentage of mothers who smoked during pregnancy was 10.5%, with an average consumption of 7 cigarettes daily

(7). The percentage of mothers who smoked during pregnancy and average cigarette consumption are much higher in low-income countries (8). A recent study in eastern Hungary found that 54% of the women were smokers at the time they learned that they were pregnant (9). Data on cigarette smoking in women, particularly pregnant women, is scarce in Turkey. Some studies reported the incidence to vary from 16.4% to 26.4% for smoking during pregnancy (10-12). Another study suggests that smoking during pregnancy is increasing progressively in economically deprived parts of İstanbul, where the study was conducted (13).

In this study, smoking prevalence during pregnancy in both active and passive smoking was found to be lower than in a previous study conducted among 281 pregnant women in our hospital in 2009 (4). This change suggested that cigarette smoking in pregnant women was reduced by approximately 50% in our region over the previous 2 years. The

Table 4. Comparison between male and female infants of the impact of smoking during pregnancy on the anthropometric measurements.

	<b>Mild smoker</b> (n = 73)	<b>Moderate smoker</b> (n = 65)	<b>Heavy smoker</b> (n = 37)	<b>P</b>
Male n, %	39 (53.4)	35 (53.8)	20 (54)	
Birth weight <sup>1</sup>	3200 ± 296	3171 ± 356	2933 ± 297	<b>&lt;0.001</b>
Height	49.7 ± 1.6	49.6 ± 1.6	49.5 ± 1.8	0.718
Head circumference	34.5 ± 1.1	34.3 ± 1.1	34.2 ± 1.1	0.725
Female n, %	33 (46.6)	30 (46.2)	17(46)	
Birth weight <sup>2</sup>	3178 ± 266	3170 ± 370	2907 ± 365	<b>&lt;0.001</b>
Height	49.8 ± 1.6	49.5 ± 1.5	49.2 ± 1.4	0.435
Head circumference	34.6 ± 1.2	34.3 ± 1.2	34.1 ± 1.1	0.940

<sup>1</sup>mild vs. moderate: 29 g, P = 0.9; mild vs. heavy: 267 g, P = 0.01; moderate vs. heavy: 237 g, P = 0.02. <sup>2</sup>mild vs. moderate: 6.5 g, P = 0.7; mild vs. heavy: 271 g, P = 0.02, moderate vs. heavy: 264 g, P = 0.025.



possible reasons for this reduction are thought to be multifactorial. During recent decades, society has become more aware of health concerns associated with cigarette smoking; the decrease in cigarette smoking might also be related to the prevalence of advertisements by the Ministry of Health for cigarette smoking cessation in the past few years in Turkey (14).

Several risk factors for maternal cigarette smoking had been defined in previous studies, although not always consistently: maternal age (8,10,15,16); maternal education (10,15-17); maternal working status (15); financial problems (8); ethnicity (16); marital status (17); mother's parity (10,11,16); partner's smoking status (10); and alcohol use (18). Our results showed that having a university-level education, ethnic origin in the East Anatolia or Black Sea regions, and a nonsmoking partner were significant predictors associated with decreased smoking by women during pregnancy.

There are limited data available from Turkey about passive smoking, but our analyses show that passive smoking status is important. Strategies to prevent passive smoking should include women's health protection legislation and social support and education programs, especially in houses or workplaces where pregnant women live and work. According to a study in Turkey, there was at least 1 smoker in 79% of homes where pregnant women lived (16). In the present study, the incidence of passive smoking was 32%; the mean birth weight of the neonates born to the mothers exposed to passive smoking was 96 g less than that of those who were unexposed to cigarette smoking. In a study published in 2004, the mean birth weight of newborns born to mothers exposed to passive smoking was lower, though no difference was noted as significant (19). In addition to birth weight, another concern

regarding smoking is neurotoxin exposure of the central nervous system. A recent study has explored the link between passive smoking during pregnancy and long-term neurodevelopmental outcome. The researchers found that exposure to passive smoking has a significant deleterious effect on infant cognitive ability (20). In a previously published study (5), the metabolic processes that are responsible for intrauterine growth and mental retardation were found to be associated with decreased levels of the concentrations of insulin, IGF-I and IGFBP-3, and oxygen transport to the fetus. All these adverse effects impair neuronal development.

A major limitation of the present study was that we did not assess the long-term outcomes on growth and neurodevelopment. Data on passive smoking during pregnancy were also evaluated through questionnaires; thus, biochemical effects could not be measured and level of exposure to smoking could not be assessed quantitatively. However, some studies have found that self-reporting is a satisfactory valid indicator of passive smoking (21,22).

Smoking of mothers during pregnancy remains an important public health concern in Turkey, with potential implications for newborns. In our hospital, active smoking during pregnancy decreased progressively from 30.6% in 2009 to 14.9% in 2010. Women having a university education and East Anatolian or Black Sea ethnic origin, and whose partners did not smoke during pregnancy, were found to be actively smoking less and to have less exposure to cigarette smoking. The amount of smoking during pregnancy was associated with adverse anthropometrical measurements. This effect was most pronounced on birth weight. Smoking cessation prior to pregnancy will reduce neonatal morbidity and mortality.

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