

# Relationship between birth weight and domestic maternal passive smoking exposure

M.A.A. Wadi<sup>1</sup> and S.S. Al-Sharbatti<sup>2</sup>

## علاقة وزن المولود بتعرض الأمهات قسرياً لدخان المدخنين الآخرين

مها وادي، شذى الشربتي

الخلاصة: أُجريت هذه الدراسة لتقييم علاقة وزن المولود بتعرض والدته للتدخين القسري (السليبي)، مع استقصاء بعض المحددات الأخرى لوزن المولود. وقد أُجريت هذه الدراسة الاستيعادية في مدينة بغداد بالعراق فيما بين شهري شباط/ فبراير وآب/ أغسطس 2004 على عينة عشوائية مكونة من ثلاثمائة من ربوات البيوت غير المدخنات، وتمت مقابلتهم في غضون أربع وعشرين ساعة بعد الولادة: مئة وخمسون أمماً لم يتعرضن قسرياً لدخان المدخنين في المنزل ومئة وخمسون أمماً تعرضن له. وقد كان متوسط وزن المواليد الذين تعرضت أمهاتهم للتدخين أقل بدرجة يُعتدُّ بها مقارنةً بمواليد غير المتعرضات للتدخين. وقد لوحظت علاقة عكسية يُعتدُّ بها بين وزن الوليد وعدد السجائر التي يدخنها أفراد الأسرة (معامل الارتباط  $r = -0.27$ ). وأظهر التحليل التحوُّفي المتعدد - بعد ضبط جميع المتغيرات المدروسة على متغيرات الشواهد - أن وزن المولود كان مترابطاً ارتباطاً عكسياً بدرجة يُعتدُّ بها مع تعرض الأمهات للتدخين القسري ولوجود رعاية ملائمة قبل الحمل.

**ABSTRACT** This study aimed to assess the relationship between birth weight and maternal exposure to passive smoking during pregnancy, and to investigate some other determinants of birth weight. A retrospective cohort study in Baghdad, Iraq was conducted during February to August 2004 on a random sample of 300 non-smoker housewife mothers, interviewed 24 hours after delivery: 150 were not exposed to passive smoking at home and 150 were exposed. The mean birth weight of exposed newborns was significantly lower than non-exposed newborns. In exposed newborns, a significant inverse relationship was noticed between birth weight and the number of cigarettes smoked by household members ( $r = -0.27$ ). Multiple regression analysis showed that after controlling for all the variables studied, birth weight had a significant inverse correlation with the maternal exposure to passive smoking and a positive correlation with adequate antenatal care.

## Association entre le poids de naissance du nouveau-né et l'exposition au tabagisme passif de la mère à son domicile

**RÉSUMÉ** La présente étude a évalué l'association entre le poids de naissance du nouveau-né et l'exposition au tabagisme passif de la mère pendant la grossesse, et a recherché d'autres déterminants du poids de naissance. Une étude de cohorte rétrospective a été conduite à Bagdad, en Iraq, entre février et août 2004 sur un échantillon sélectionné au hasard de 300 mères au foyer non fumeuses, interrogées 24 heures après l'accouchement : 150 mères n'avaient pas été exposées au tabagisme passif à leur domicile, contrairement aux 150 autres femmes. Le poids de naissance moyen des nouveau-nés exposés était significativement inférieur à celui des nouveau-nés non exposés. Chez les nouveau-nés exposés, une relation inverse significative a été observée entre le poids de naissance et le nombre de cigarettes fumées par les membres du ménage ( $r = -0,27$ ). L'analyse de régression multiple a indiqué qu'après le contrôle de toutes les variables étudiées, le poids de naissance était inversement et fortement corrélé au tabagisme passif, mais positivement et fortement corrélé au recours à des soins prénatals appropriés.

<sup>1</sup>Ministry of Health, Baghdad, Iraq.

<sup>2</sup>Department of Community Medicine, College of Medicine, Gulf Medical University, Ajman, United Arab Emirates (Correspondence to S.S. Al-Sharbatti: shatha\_alsharbatti@yahoo.com).

Received: 02/07/09; accepted: 05/10/09

## Introduction

Although tobacco smoke has long been linked to various diseases among smokers, it was not until 1964 that this association was publicly established by the landmark report of the US Surgeon General [1]. Twenty years later, attention turned to the possible effect of tobacco smoke on non-smokers [2]. Passive smoking is involuntary or forced smoking when non-smokers inhale environmental tobacco smoke [3–5].

Maternal exposure to tobacco smoke has been associated with increased levels of nicotine and cotinine in the serum or urine of the mother and the neonate and in the amniotic fluid [6]. These substances constitute a hazard to the fetus as they cross the placental barrier and may act to inhibit fetal growth [6–8]. Maternal passive and light active smoking has been associated with significant reductions in birth weight, crown–heel length, upper- and lower-arm length and head circumference of neonates [9]. The relation between maternal smoking and fetal development is thought to arise from a direct toxic effect of smoke or from an indirect effect mediated by a reduction in maternal weight gain. The relation between birth weight and passive smoking via the father and/or other household members is more difficult to explain; one theory is that smoke inhaled passively has the same effect on the fetus as maternal smoking [10].

No previous studies on this subject have been conducted in Baghdad, Iraq. Hence, the aim of the current study was to assess the relationship between birth weight and home exposure to passive smoking during pregnancy, and to ascertain the influence of selected factors on neonatal birth weight.

## Methods

A retrospective cohort study was conducted during February–August 2004.

## Sample

The study included a convenience sample of 300 non-smoker housewife mothers who delivered in the labour ward of Al-Yarmok hospital, Baghdad. Only women who were housewives were selected in order to overcome the confounding effect of possible exposure at the work place.

The women were interviewed within 24 hours after delivery. A systematic random sampling method was used to select the women. None of the women invited refused to participate in the study. The study included 2 groups of 150 women: the first group were non-smoker mothers who were not exposed to passive smoking at home during pregnancy; the second group were non-smoker mothers who had a history of smoke exposure.

Mothers' home exposure to passive smoking was defined as 5 or more cigarettes smoked per day by others in the mother's presence [11]. Women who were healthy (no history of acute or chronic diseases), had accurate information about their last menstrual period, age and prepregnancy weight, had a singleton pregnancy and gave birth to a full-term baby with no obvious congenital anomalies were included in this study.

## Data collection

Direct interview of the participants was done by the research team using a specially designed questionnaire which included the following information: mother's age and residence, parents' level of education (primary school or less; intermediate or secondary school; college or higher education), number of household members and number of rooms (used for calculation of crowding index). Parents' education and crowding index were used as indicators for socioeconomic status. Information about the current pregnancy was collected (gestation; last menstrual period) and expected date of delivery

was determined depending on information concerning the last menstrual period. Adequacy of antenatal care was evaluated depending on the number of visits to a primary health care centre (adequate = 5 or more visits during the whole pregnancy [12]). Data about the smoking habit of the child's father and the smoking habit of all household members in the presence of the pregnant woman were collected.

The birth weight of the baby and the mother's weight before delivery were measured and weight gain during pregnancy was calculated by subtraction of the prepregnancy weight from the predelivery weight. Mother's height was also measured and recorded.

The study was approved by the Scientific Council of Community and Family Medicine. The study was discussed with the participants and verbal consent was taken from them before enrolment in the study.

## Statistical analysis

The data analysis was carried out using SPSS, version 13. The statistical significance of the difference between the mean and standard deviation (SD) values was assessed using the independent sample *t*-test, and the significance of the association between the frequencies of other variables was assessed using the chi-squared test. Multiple regression analysis was used to control for interrelations between potential predictors of birth weight.

$P < 0.05$  was used as the cut-off level for statistical significance.

## Results

A total of 300 women were included in this study: 150 women not exposed to passive smoking at home and 150 women exposed to passive smoking. The number of low birth weight babies (< 2500 g) in the exposed and non-exposed groups were 17 (11.3%) and 6 (4.0%) respectively. The odds

ratio was 3.07 (95% confidence interval: 1.17–8.01), i.e. exposed women had a 3.07 higher risk of having a low birth weight baby ( $P < 0.05$ ).

The mean birth weight of the passive smoke-exposed babies was significantly lower [3183 (SD 550) g] than that of the non-exposed babies [3381 (SD 531) g] ( $t = 3.786, P < 0.001$ ) (Table 1).

In the exposed neonates, a significant inverse relationship was noticed between birth weight and the number of cigarettes smoked by household members ( $r = -0.27, P = 0.002$ ) (Figure 1).

The proportion of males and females in the non-exposed babies was 54% and 46% respectively, while for the exposed group it was 35% and 65% respectively ( $z = 3.37, P < 0.05$ ). The mean birth weights were lower in the exposed male and female subgroups compared with their counterparts in the non-exposed groups; the differences were significant for both males and females (Table 1).

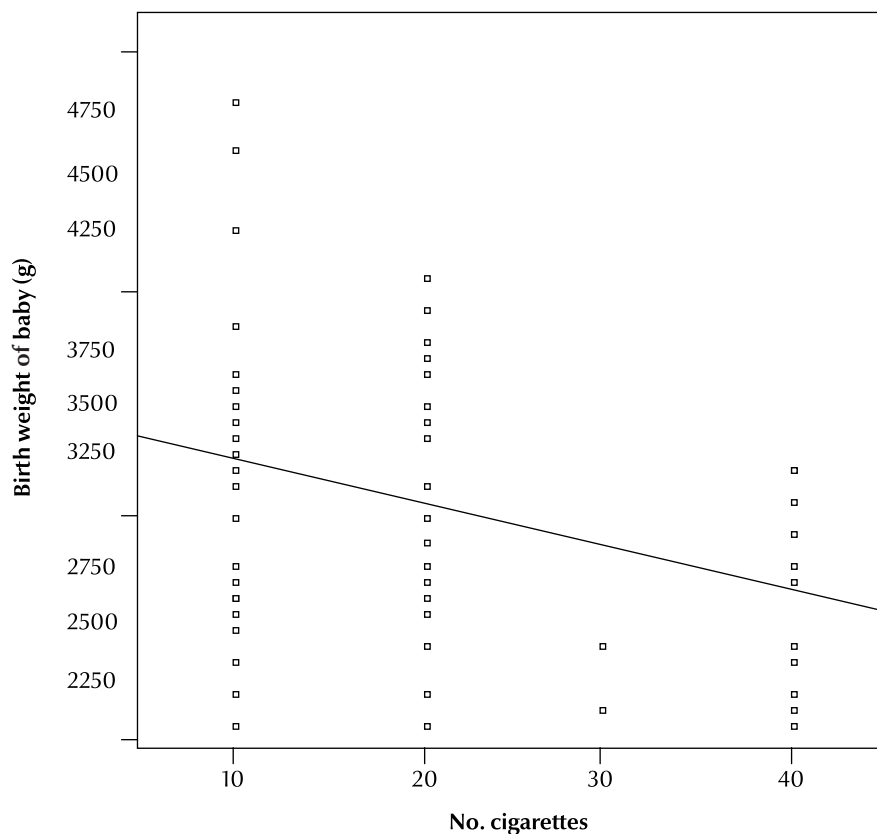
**Table 1** Distribution of neonatal birth weight by sex and maternal passive smoking exposure

Sex/exposure	No. of neonates	Mean (SD) birth weight (g)	<i>t</i> -value	<i>P</i> -value
<b>Males</b>				
Non-exposed	81	3325 (509)	2.570	< 0.001
Exposed	53	3061 (573)		
<b>Females</b>				
Non-exposed	69	3319 (602)	2.192	0.03
Exposed	97	3112 (552)		
<b>Both sexes</b>				
Non-exposed	150	3381 (531)	3.786	< 0.001
Exposed	150	3183 (550)		

*SD* = standard deviation.

Most of the 300 women studied, 86%, resided in urban areas. In these areas the proportion of women exposed to passive smoking was higher than those who were not exposed (52% versus 48%); for women with rural residence the reverse was found (38% versus 62%). No significant association was found between residence and exposure

to passive smoking ( $\chi^2 = 2.77, P = 0.1$ ). No significant differences were noticed between the mean birth weights of the exposed and non-exposed babies from the rural residence group (Table 2). However, the mean birth weight of the exposed babies in the urban residence group was significantly lower than their counterparts in the non-exposed group.



**Figure 1** Relationship between birth weight and number of cigarettes smoked by household members ( $r = -0.27; P = 0.002$ )

Analysis of birth weight according to parents' education level (Table 3) showed that the mean birth weights were lower in the exposed group for all education levels of mothers and fathers. The differences between the mean birth weights of the exposed and non-exposed groups were significant in neonates whose parents had lower levels of education.

Concerning history of iron/folic acid supplement intake during pregnancy, the frequency of women who had such a history in the non-exposed and exposed groups were 49.3% and 50.7% respectively ( $P > 0.05$ ). The mean birth weight values were significantly lower among the smoke exposed versus non-exposed babies, regardless of whether the mothers had or had not received iron/folic acid supplements during their pregnancies (Table 4).

### Multiple regression analysis

To control for interrelations between different variables, a multiple regression analysis was done with birth weight as the dependent variable and selected independent variables (Table 5). After controlling for all the variables studied, only passive smoking exposure and utilization of primary health care services (adequate antenatal care) had a statistically significant correlation with birth weight ( $P < 0.001$  and  $P = 0.03$  respectively).

## Discussion

The negative effects of passive smoking on the health of the fetus or child continue to receive little attention in the Eastern Mediterranean Region, despite the large volume of research in this area. Passive smoking during pregnancy has been associated with a reduction in head circumference at birth, a higher incidence of sudden infant death syndrome, decreased lung function and increased risk of severe infections, including respiratory syncytial virus bronchiolitis;

**Table 2 Distribution of neonatal birth weight by residence and maternal passive smoking exposure**

Residence/ exposure	No. of neonates	Mean (SD) birth weight (g)	t-value	P-value
<b>Urban</b>				
Non-exposed	124	3364 (570)	4.186	< 0.001
Exposed	134	3073 (545)		
<b>Rural</b>				
Non-exposed	26	3228 (520)	0.293	0.771
Exposed	16	3281 (648)		

SD = standard deviation.

there is also a relationship between passive smoking and behavioural disorders, including attention deficit/hyperactivity disorder [13].

A significant relationship has been documented between active smoking during pregnancy and fetal growth retardation [14]. Increased interest has also been focused on the effect of passive smoking on birth weight [15]. The present study was conducted to assess

the relationship between birth weight and domestic exposure to passive smoking during pregnancy. Selection of the 300 women for the study was based on the history of home exposure to passive smoking during pregnancy.

None of the women in the sample worked outside the home and the estimation of smoke exposure in the current study was done by a questionnaire that involved the number of cigarettes

**Table 3 Distribution of neonatal birth weight by parents' education level and maternal passive smoking exposure**

Education level/ exposure	No. of neonates	Mean (SD) birth weight (g)	t-value	P-value
<b>Fathers</b>				
<b>Primary school or lower</b>				
Non-exposed	124	3349 (565)	3.440	< 0.001
Exposed	119	3103 (551)		
<b>Secondary school</b>				
Non-exposed	19	3298 (507)	1.253	0.22
Exposed	24	3077 (624)		
<b>College or higher</b>				
Non-exposed	7	3289 (728)	0.784	0.448
Exposed	7	3021 (532)		
<b>Mothers</b>				
<b>Primary school or lower</b>				
Non-exposed	111	3319 (552)	2.922	0.004
Exposed	99	3091 (579)		
<b>Secondary school</b>				
Non-exposed	23	3513 (557)	2.984	0.004
Exposed	36	3111 (469)		
<b>College or higher</b>				
Non-exposed	16	3239 (601)	0.667	0.510
Exposed	15	3087 (652)		

SD = standard deviation.

**Table 4 Distribution of neonatal birth weight by history of maternal iron/folic acid supplementation and maternal passive smoking exposure**

Iron/folic acid supplement/exposure	No. of neonates	Mean (SD) birth weight (g)	t-value	P-value (2-tailed)
<b>Supplements</b>				
Non-exposed	68	3378 (566)	3.035	0.003
Exposed	70	3094 (534)		
<b>No supplements</b>				
Non-exposed	82	3309 (561)	2.365	0.019
Exposed	80	3097 (583)		

SD = standard deviation.

smoked by household members and took into account several potential confounders. Other studies depend on measurement of urine cotinine level to evaluate the risk of exposure to passive smoking [16]. However, a study by the Centers for Disease Control and Prevention found that urine cotinine concentration did not explain more variability in birth weight than did self-reported number of cigarettes smoked per day [17].

Our data showed that exposure to passive smoking during pregnancy was associated with a significantly lower mean birth weight in neonates of exposed mothers than those of non-exposed mothers. This observation confirms other reports that passive smoking during pregnancy can adversely affect fetal growth [11,18].

In the present study the group of newborn infants exposed to passive smoking had a mean birth weight

198.4 g lower than non-exposed infants. This is consistent with another study which showed that the birth weight of babies of passive smoking-exposed mothers was 189 g lower than that of babies of the non-exposed mothers [19]. Similarly, a study in Denmark showed that maternal exposure to passive smoking was associated with a reduction in birth weight of 120 g per pack of cigarettes smoked per day by the father. This relationship remained statistically significant after controlling for mother's age, parity, alcohol and tobacco consumption, illness during pregnancy and sex of the baby [20].

We found that exposure to passive smoking during pregnancy increased the risk of having a low-birth-weight infant (< 2500 g) 3-fold. This finding is consistent with the study in Denmark, in which exposure to passive smoking during pregnancy significantly increased the risk of having a low birth

weight infant (relative risk 2.17, 95% CI: 1.05–4.50) [20].

We found a significant inverse relationship between birth weight and number of cigarettes smoked/day by household members. This finding is consistent with that obtained in an intervention controlled study in the Czech Republic, where a strong dose–effect relationship was observed between amount of mothers' exposure to passive smoking and birth weight [19]. Similarly, the study conducted in Denmark showed a direct relationship between birth weight and average tobacco load when all variables had been controlled in the regression model [20].

The higher frequency exposure to passive smoking in mothers who were urban residents and the significant reduction in the mean birth weight among these mothers noted in our study suggests that the effect of passive smoking on birth weight is more pronounced in urban residents. Consumption of tobacco was less common in rural areas compared with urban areas in a study of smoking and lung cancer in England [10]. Similarly, a prospective cohort study carried out in the United States of America showed that urban populations were more likely to be exposed to passive smoking [21].

The present study showed that the mean birth weight of exposed neonates was lower than that in the non-exposed group, irrespective of their parents'

**Table 5 Multiple regression model with neonatal birth weight as the dependent variable and selected independent variables**

Independent variable	$\beta$	P-value
Maternal passive smoking exposure during pregnancy	-2-81.7	0.001
Residence (urban versus rural)	-119.7	0.305
Sex of newborn (male versus female)	-55.5	0.465
Maternal iron/folic acid supplementation (user versus non-user)	8.3	0.907
Antenatal care (adequate versus inadequate)	152.4	0.035
Maternal weight gain during pregnancy	12.1	0.559
Education level of mother ( $\leq$ primary school versus $\geq$ college)	67.9	0.69
Education level of father ( $\leq$ primary school versus $\geq$ college)	41.3	0.778
Parity (primiparous versus multiparous parity 3+)	33.2	0.757

$R^2 = 0.19$ .

education levels. The differences between mean values were significant in babies whose parental levels of education were lower. This suggests that the effect of exposure to passive smoking was less pronounced among neonates whose parents' education levels were higher, a finding which could be attributed to a lower intensity of exposure. In another study done in Poland, the prevalence of smoking was found to be higher among less educated men [22]. Also, a finding of the American Cancer Society study confirmed that passive smoking exposure was greater among households with lower levels of education [23].

In our study, we noted a significantly lower birth weight in the exposed babies, irrespective of maternal intake of iron/folic acid supplements during pregnancy. However, in the unexposed

babies, the mean birth weight of those whose mothers took iron/folic acid supplements was slightly higher than that of their counterparts whose mothers did not receive supplements during pregnancy. This is in agreement with the findings of a prospective cohort study in India to evaluate the effect of iron therapy in reducing maternal anaemia and to evaluate the association of maternal haemoglobin and fetal growth. The researchers concluded that iron supplementation was an effective mode of treating anaemia among pregnant women, and was inversely associated with fetal growth [24]. Another study in the United Kingdom to evaluate the influence of erythrocyte folate status on birth weight showed that maternal folate intake was a significant predictor of infant birth weight [25].

The multiple regression analysis in this study using birth weight as the dependent variable showed that after the controlling for all variables studied, only passive smoking and antenatal care were associated with birth weight. Passive smoking exposure of mothers during pregnancy was significantly associated with a lower mean birth weight in the exposed group compared with the non-exposed group, and adequate antenatal care for mothers was associated with a significantly higher mean birth weight compared with mothers receiving no antenatal care. Similarly, multiple regression analysis in the Danish study found that paternal smoking remained a significant influence on birth weight after controlling for mother's age, parity, alcohol and tobacco consumption during pregnancy, illness during pregnancy, social class and sex of the baby [20].

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### **Newborns: reducing mortality: Fact sheet N° 333**

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- Every year nearly 40% of all under-five child deaths are among babies in their first 28 days of life.
- Three quarters of all neonatal deaths occur in the first week of life.
- In developing countries nearly half of all mothers do not receive skilled care during and immediately after birth.
- Up to two thirds of neonatal deaths can be prevented if effective health measures are provided during the first week.

The vast majority of neonatal deaths take place in developing countries where access to health care is low. Most of these babies die at home, without skilled care that could greatly increase their chances for survival.

WHO and its partners agree that a core principle underlying maternal, neonatal and child health efforts is lifelong access to health care: a continuum of care for the mother starting from long before pregnancy (during childhood and adolescence) through pregnancy and childbirth. The continuum begins again with adequate care for the new life. As appropriate, care can be delivered in the home and community, as well as health clinics and hospitals.