Effect of secondhand smoke exposure during pregnancy on anthropometric measurements of term infants

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Abstract:

Background: Similar to smoking during pregnancy, a pregnant woman's exposure to secondhand smoke (SHS) affects many aspects of fetal development, from conception to birth. It increases the risk of having a low birth weight baby and premature delivery.

Objective: To evaluate the effect of exposure to secondhand smoke during pregnancy on newborns' anthropometric measurements (birth weight, length and head circumference).

Methods: A Retrospective cohort study was conducted in Baghdad, Iraq between first of December2013 to the first of May 2014 on a purposive non-random sample of 620 non-smoker mothers, interviewed within 24 hours after delivery and included two groups, first group included 310 non-smoker mothers who were not exposed to secondhand smoke and the second group included 310 non-smoker mothers who had history of such exposure.

Results: The mean birth weight of infants born to mothers who were exposed to secondhand smoke (2.912±0.421) was significantly lower than infants of non-exposed women (3.010±0.411) (P=0.004). The mean head circumference of the infants of exposed mothers was smaller and length was shorter than that of infants of non-exposed mothers. The incidence of low birth weight (LBW) was higher in exposed women (15.8%) compared to non-exposed women (8.1%) (P=0.025; RR= 1.95).

Conclusion: The study found a significant association between secondhand smoke exposure during pregnancy and decreased birth weight.

Keywords: Secondhand smoke, prenatal exposure, low birth weight**,** neonatal length, head circumference.

Introduction:

The negative impact of tobacco smoking on birth outcomes is not limited to its direct use by the mother. Maternal exposure to secondhand smoke (SHS) in pregnancy has also been associated with a modest reduction in birth weight, shorter length and smaller head circumference [1] and can increase the risk of low birth weight (LBW) by 22%[2]; a problem that may not be known to people as clearly or widely as activematernal smoking.

The few published reports about tobacco use and SHS exposure during pregnancy in the Arab World are limited by either the small number of participants[3], or the difference in culture and social norms between geographical areas which limit generalization of results[4].

SHS is formed from the sidestream (SS) smoke emitted into the environment from the smoldering of cigarettes and other tobacco products between puffs and from the mainstream (MS) smoke exhaled by the smoker [5,6].Sidestream smoke constitutes about 85% of the smoke present in a room where active smokers smoke, and contains many potentially toxic componentsin greater concentration than mainstream smoke, although SHS diluted by ambient air[7,8].

SHS is a mixture of at least 4,000 chemical compounds[9], dozens of which are known or suspected reproductive toxins[10], including nicotine, carbon monoxide and at least 70 known human carcinogens (chemicals that cause, initiate or promote cancer)[11].

The toxins in SHS generally have high water solubilityand low molecular weight that allows non-facilitated transfer across the placenta to the fetus [12].

Nicotine can decrease the blood flow to the unborn baby. This can affect the unborn baby's heart, lungs, digestive system and central nervous system [13].

Carbon monoxide is known to deplete fetal oxygen supplies and can affect the baby's growth and may lead to low birth weight [14].

The study was done aiming to evaluate the effect of exposure to SHS during pregnancy on newborns' anthropometric measurements (birth weight, length and head circumference).

Methods:

A Retrospective cohort study was conductedbetweenfirst of December 2013 to the first of May 2014.

A purposive non-random sample of 620 women was selected from the postpartum ward in two hospitals in Baghdad/Al-Karakh: Imamein Kadhimein Medical city & Al-Yarmouk hospital and included two groups, first group included 310 non-smoker mothers who were not exposed to SHS and the second group included 310 non-smoker mothers who had history of such exposure.

Inclusion criteria

1. Women with singleton pregnancy.
2. Term delivery (≥ 37 gestation week) [15].

Exclusion criteria

Women with history of:

1. Unknown smoking status.
2. Hypertension (essential and/or pregnancy induced)
3. Renal diseases.

4. Gestational diabetes mellitus
5. Heart diseases

After obtaining the hospitals' permission for data collection, women who gave written consent for participation were interviewed by the researcher as soon as possible after delivery; and before leaving the hospital using a predesigned data collection sheet constructed for this study.

The questionnaire form consists of four sections**:**

Section **A** includes information on the socio- demographic characteristics of the mothers. The variables of interest were mother's age, residence, parent's level of education and occupation, number of household members and number of rooms used for calculation of crowding index.

Section **B** provides information about obstetric and newborn characteristics that includes: LMP before this pregnancy for calculating the gestational age (Estimated gestational age was calculated as the interval between the date of delivery and the date of recalled last normal menstrual period, when the last menstrual period date was missing, an early ultrasound scan was used)[16], parity, previous pregnancy outcomes, adequacy of antenatal care will be evaluated depending on number of visits to Primary Health Care Centers(PHC)and / or private clinic in which the least number of visits to antenatal care to be considered as adequate was four visits during whole pregnancy periodas recommended by WHO[17] and sex of the baby.

Section **C** includes 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.

Section **D** includes anthropometric measurements of the babies and their mothers that were done by the investigator and includes the following:

1-Maternal measurements:

Weight after delivery: each mother was weighed bare footed with light clothes while standing on the center of a beam balance weighing scale (made in Germany) which has been adjusted to zero before use.

Height: the height was measured by standing the mother without shoes using a measuring tape. Each mother was asked to stand straight next to the wall, with the heels, buttocks, shoulders and occiput touching the wall. The head was kept erect and a ruler was placed on the upper part of the head then the measuring tape was stretched slightly to measure the height to the nearest 0.5cm.

From the maternal height and weight, BMI was calculated according to the following equation; (BMI= weight (Kg)/height (m) ^{2}) [17].

2-Newborn measurements:

Weight: the baby was weighed with minimal clothes using a well calibrated digital scale (Portable electronic weighing scale, made in Italy) to the nearest 10g and checked that the scale is on a flat, level surface with no obstructions.

Length: A Rolbametre (Raven equipment limited, made in England) was used for measuring the length in centimeters to the nearest 0.1cm by laying the baby supine on it with fully extended lower limbs, straight back and feet together with a headboard placed against the baby's head and a moveable footboard is pressed gently against feet.

Head circumference: was measured to the nearest 0.1cm by using a non-stretchable measuring tape at the level of occiput , parietal prominence and Supra-orbital ridge.

Data analysis was performed using SPSS version 22. Descriptive statistics such as the means and standard deviation (SD) for continuous variables and frequencies and percentages for categorical data were determined. Comparisons of variables between the exposed and the non-exposed groups were assessed by independent t- tests for continuous variables and chi-square tests for categorical variables. Multiple regression analysis was used to eliminate the effects of potential confounders.

Results:

The incidence of low birth weight infants (<2.5 kg) in the exposed and non-exposed women was 15.8%, 8.1% respectively and the difference reaches statistical significance, (P=0.025), (RR= 1.95).

Eighty percent of the participants reported that their husbands as the main source of SHS in the home and 47.1% of the participants reported other than husband as a source of SHS.

Table 1 shows the anthropometric indicators of newborn of the exposed and non-exposed women. The mean birth weight of infants born to women who were exposed to SHS (2.912±0.421) was significantly lower than infants of non-exposed women (3.010±0.411). The mean head circumference of the infants of exposed mothers was smaller and length was shorter than that of infants of non-exposed mothers; however the difference did not reach statistical significance.

Table 2 summarizes the socio-demographic characteristics of the study sample. Most of the study sample were young, housewives and had lower level of education.

Out of 620 women studied, 454 women (73.2%) are urban residents and 166 women (26.8%) are rural residents. The proportion of women exposed to SHS was higher in women with urban residence (76.5%) compared to those with rural residence (23.5%).

Table 1: Anthropometric indicators of newborn of exposed and non-exposed women

	Exposed to SHS	Non-Exposed	P value
Birth weight (Kg)	2.912±0.421	3.010±0.411	0.004*
Length (cm)	48.481±1.383	48.610±1.446	0.257
Head circumference (cm)	34.000±1.021	34.094±1.046	0.260
*Significant difference using Student-t-test for two independent means at 0.05 levels.			

Table 2: Socio-demographic characteristics of the study sample

		Exposed to SHS		Not		P-value
		No	%	No	%	
Mother age (years)	<20	41	13.2	34	11.0	0.288
	20—24	127	41.0	111	35.8	
	25—29	78	25.2	84	27.1	
	30—34	44	14.2	49	15.8	
	=>35years	20	6.5	32	10.3	
	Mean±SD(Range)	25.0±5.3(15-41)		25.8±5.9(15-42)		
Residence	Rural	73	23.5	93	30.0	0.070
	Urban	237	76.5	217	70.0	
Mother education	Primary	198	63.9	186	60.0	0.563
	Secondary	90	29.0	97	31.3	
	College	22	7.1	27	8.7	
Mother occupation	Employed	14	4.5	15	4.8	0.982
	Housewife	292	94.2	291	93.9	
	Other	4	1.3	4	1.3	
Husband occupation	Employed	98	31.6	91	29.4	0.218
	Worker	210	67.7	212	68.4	
	Other	2	0.6	7	2.3	
Crowding index	<3	198	63.9	198	63.9	0.706
	3-5	101	32.6	97	31.3	
	>5 (over crowded)	11	3.5	15	4.8	
*Significant difference between proportions using Pearson Chi-square test at 0.05 level						

Table 3 shows mean and SD values for the infants' birth weight (gm) distributed by maternal and newborn characteristics and status of exposure.

There were no significant differences between the mean birth weight values for exposed and non-exposed babies from the rural residence group. However; the mean birth weight of exposed babies from the urban residence group was significantly lower than their counterparts in the non-exposed group.

The mean birth weight values were lower in the exposed group than non-exposed group in all educational level categories of mothers. The differences between mean birth weight values of exposed and non-exposed groups were significant in babies whose mothers' and fathers' educational levels were secondary.

The mean birth weights for babies were lower in the exposed group than non-exposed group in all fathers' occupational categories. The difference between mean birth weight values of exposed and non-exposed groups were significant in babies whose mothers and fathers were housewives and workers respectively.

The mean birth weight values of exposed group were lower than non-exposed group for mothers with or without history of anemia during pregnancy and significant differences between mean birth weight values were noticed among infants born to mothers with history of anemia.

The mean birth weight values of exposed group were lower than non-exposed group for mothers within three categories of BMI and a significant difference was noticed among infants whose mothers were overweight. Within each group there was a significant difference in the mean birth weight values with maternal BMI.

The mean birth weight values were lower in male and femalenewborns in the exposed group compared with their counterparts in the non-exposed group, and the difference between the mean values was significant for male gender. Also the mean birth weight values for females were lower than males and a significant difference was noticed among non- exposed mothers.

Table 3: Mean and SD values for the birth weight (gm) distributed by maternal and newborn characteristics and status of exposure

		Birth weight (Kg)				P value
		Exposed to SHS		Not		
		No	Mean±SD	No	Mean±SD	
Residence	Rural	73	2.929±0.473	93	2.943±0.432	0.848
	Urban	237	2.906±0.405	217	3.038±0.400	0.001*
	P value		0.680		0.062	
Mother education	Primary	198	2.900±0.419	186	2.978±0.417	0.067
	Secondary	90	2.956±0.414	97	3.083±0.375	0.028*
	College	22	2.836±0.477	27	2.959±0.474	0.373
	P value		0.402		0.101	
Husband education	Primary	168	2.935±0.400	149	3.023±0.425	0.058
	Secondary	122	2.859±0.441	121	3.004±0.411	0.009*
	College	20	3.035±0.445	40	2.975±0.366	0.580
	P value		0.126		0.789	
Motheroccupation	Housewife	292	2.913±0.424	291	3.009±0.407	0.006*
	Employed	14	2.857±0.382	15	3.040±0.521	0.293
	Other	4	2.975±0.403	4	2.925±0.386	0.864
	P value		0.849		0.882	
Husband occupation	Employed	98	2.853±0.428	91	2.952±0.392	0.099
	Worker	210	2.941±0.418	212	3.041±0.411	0.014*
	Other	2	2.750±0.212	7	2.814±0.567	0.884
	P value		0.205		0.103	
Anemia	Y	168	2.899±0.433	143	3.010±0.438	0.025*
	N	142	2.927±0.408	167	3.009±0.388	0.071
	P value		0.562		0.978	
BMI (Kg/m2)	Normal (18.5-24.9)	96	2.830±0.457	75	2.879±0.422	0.478
	Overweight (25.0-29.9)	129	2.903±0.362	137	3.065±0.392	0.001*
	Obese (=>30)	85	3.017±0.446	98	3.032±0.411	0.813
	P value		0.030*		0.009*	
Gender of newborn	Female	136	2.897±0.392	155	2.926±0.374	0.532
	Male	174	2.923±0.444	155	3.094±0.430	0.0001*
	P value		0.602		0.0001*	
*Significant difference using Student-t-test for two independent means and ANOVA test for more than two independent means at 0.05 levels.						

Table 4: Multiple regression analysis summary for variables predicting neonate's birth weight.

	B	SE	β	P value
Gestational age	0.134	0.014	0.363	0.0001
SHS	-0.038	0.013	-0.112	0.003
BMI	0.013	0.003	0.151	0.0001
Note: R= 0.417, R^2= 0.173, P <0.05, adjusted R^2= 0.164				

Discussion:

Studies have documented a significant association between active smoking during pregnancy with fetal growth retardation which impairs not only weight gain, but also growth of body length, head and chest circumference [18].

The present data showed that exposure to SHS during pregnancy was associated with significant reduction in birth weight, shorter length and smaller head circumference but the differences in length and head circumference did not reach statistical significance.

Effects on body length and head circumference might need larger sample size.

Similarly another study was conducted in Department of Obstetrics and Gynecology in Cairo, Egypt, and found that exposure to SHS during pregnancy was associated with reduction in anthropometric measurements but the differences were significant only for birth weight [19].

Another retrospective cohort study was conducted at postnatal ward of Department of Obstetrics and Gynecology in Kingdom of Saudi Arabia (KSA), and found that exposure of Saudi pregnant women to SHS was associated with significant reduction in birth weight, and length of the newborn[20].

Also another retrospective cohort study was conducted in Department of Obstetrics and Gynecology in Iraq and found that exposure to passive smoking was associated with significant reduction in birth weight [3].

The mechanisms for lower birth weight may be attributed to many factors, including the vasoconstriction properties of nicotine, elevated fetal carboxyhaemoglobin levels, fetal tissue hypoxia and reduced delivery of nutritional elements which were needed for the fetus to grow [21].

In the present study, newborn infants of exposed mothers to SHS during pregnancy had a reduction in mean birth weight of 98 g.

The present finding is consistent with a study done in Turkey which showed that birth weight of newborns of passive smoking exposed mothers was lower by 96 g in comparison with birth weight of newborns of non-exposed mothers [22].

In the present study, exposure to SHS during pregnancy has significantly increased the risk of LBW that agree with other studies in Jordan [23] and Canada [24].

While the study that was done in Malaysia was found that SHS exposure was not significantly associated with LBW [25].

There are obvious difficulties in comparing the results of different studies because of their many differences, including the location and nationality of study populations, the sample size and selection, the extent to which confounders were controlled, and the analytical methods used.

It was observed that there were no significant differences in socio-demographic characteristics between women exposed and those unexposed to SHS during pregnancy and majority of them were young, housewives and had lower level of education.

While the study that was done in Malaysia, there were observed significant differences in socio-demographic characteristics between women exposed and those unexposed to SHS. The exposed women were found to be younger, less educated and to have lower household incomes, possibly reflecting a poorer socioeconomic status [25].

About the residence, the present data showed that the difference in the mean birth weight was significant between newborn infants with urban residence.

This finding suggests that the effect of SHS exposure on birth weight is more pronounce in urban residence, similar to study done in Iraq [3], where the population density is higher and absolute number of smokers can be considerably large which creating a potential for greater exposure to secondhand smoke as well as to the harmful effects of tobacco smoke [26].

There were significant differences in mean birth weight values between newborns whose fathers' and mothers' occupation was workers and housewives respectively. These obvious differences could be due to the fact that the highest proportions of the study sample were housewives and their husbands were workers.

Regarding the husbands' education**,** the differences between mean birth weight values were significant for newborn whose fathers ‘educational levels were secondary.

This finding might be explained by higher proportion of paternal smoking (88.5%) among those with secondary level of education.

Lower levels of education have been related to higher rates of smoking [27-29].

Regarding anemia during pregnancy, it was noticed significant differences in mean birth weight values among infants whose mothers had history of anemia during pregnancy.

This significant difference in mean birth weight values might be explained by hypoxic effect of tobacco as a result of carbon monoxide and nicotine exposure [30] and the mothers' poor nutrition and health during pregnancy resulting in this obvious difference in birth weight between exposed and non-exposed mothers.

Anemia in pregnant women has multiple effects on pregnancy and fetal growth, as documented by a number of studies [31,32].

The mean birth weight of male newborns among exposed group was lower than the mean birth weight of male newborns among non-exposed group, and this difference was statistically significant (P=0.0001).

In non**-** exposed group, the mean birth weight of male newborns was significantly higher than female. This is similar to astudy that was conducted in Iran and found that sex of the newborn had a significant effect on birth weight of the neonate and the mean birth weight was significantly lower for females than males($P<0.05$)[33].

It was found after multiple regression analysis that SHS exposure during pregnancy was significantly associated with a reduction in mean birth weight (P=0.003), gestational age and mother BMI had a statistically significant effect on birth weight (P=0.0001) which is similar to a study done in Jordan [34].

We can conclude from this study that there is a significant association between SHS exposure during pregnancy and decreased birth weight.

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