

**INFLEUENCE OF MATERNAL SMOKING DURING
AND/OR AFTER PREGNANCY ON BEHAVIORAL
OUTCOMES AND GROWTH DISORDERS IN
INFANCY**

[3]

*Mohamed Abed El Adl El Sawy⁽¹⁾, Mahi Mahmoud El Teheawy⁽¹⁾,
Mostafa Hassan Ragab⁽²⁾, Tarek Mahros Salman⁽³⁾, and Afaf
Mohamed Mohamed Saber⁽⁴⁾*

*(1) Faculty of Mediciene, Ain Shams University .(2) Institute of
Environmental Studies and Research, Ain Shams University.
(3) Faculty of Pharmacy, Al Azhar university . (4) Police Hospital.*

ABSTRACT

Numerous health consequences of infant's exposure to maternal smoking have been demonstrated, including increased rates of low birth weight, infant mortality and modest impairment of cognitive development also there is a link between maternal smoking and infant's behavior problems.

In this study 300 infants were examined as two groups, LBW groups (150 infants), and normal weight groups (150 infants). Their mothers were free from serious diseases or complications affecting pregnancy or outcomes, Mother's ages were between (20-30) years.

The study was done at Gynacology & obstetric hospital of Ain Shams university.

The infants were examined to measure their (weight, length and head circumference), also their behavior were examined by specific scale for infants.. Urine of mothers was examined for cotinine by radioimmunoassay method to detect cigarette smoking end product of nicotine which is cotinine to see its hazards on pregnancy outcome.

Among this study we find that maternal smoking during pregnancy decrease significantly body weight, length and head circumference also as regard infant behavioral disorders, it decrease significantly visual

alertness of infants, increase significantly activity of infants and the irritability of babies .

We found that during any trimester alone was similar to the effect of maternal smoking all through pregnancy and the results were approximately near each other.

Also we take in our consideration asking mothers about number of cigarette/day for both mother and father and if both parents were smokers or only one of them was smoker. We found that when mothers number of cigarette/day was increased (> 20 cig/day), all babies were LBW , and when fathers number of cigarette/day was increased (>20/day) the percentage of LBW was increased and normal weight infants was decreased . When both parents were smokers the parameters of growth was decreased significantly and the behavioral disorders of infants were significantly affected than when one of parents was only smoker. These data provided evidence suggesting that increased behavioral problems of infants added to the growing list of adverse infant health conditions which all associated with infant's prenatal passive exposure to smoking .Therefore , the study recommended that environmental professionals must increase their efforts to inform both parents about the hazards of tobacco smoke on their health and the health of their infants through written materials as posters , magazines and through Radio and T.V programs .

INTRODUCTION

Attention is being paid to the effect of smoking on health, as it is associated with a variety of harmful effects.

The possible harmful effects of tobacco smoke on the health of children have become of great concern to health professionals and lay public alike (Well et.al, 1985).

The neonates exposed to cigarette smoke have behavioral problems and intrauterine growth retardation represents in low birth weight,

decrease in length and small head circumference (Michael Weitzman *et al.*, 1992).

Many studies have documented a strong association of active smoking during pregnancy with fetal growth retardation. Also, increase interest has also been focused on whether there is an association between exposure of pregnant women to environmental tobacco smoke and low birth weight of their babies (Haruba D., Kachlik P., 2000, England *et al.*, 2001).

Tobacco smoke may influence the developing fetus either by alternations in maternal physiology that limit oxygen and nutrient flow to the fetus or by transplacental passage of components of cigarette smoke that may have a direct effect on fetus (Teasdal and Ghislain, 1989).

Nicotine and other components of cigarette smoke may also directly injure the developing brain. And there are specific nicotine binding sites within the brain with regional variation in their density (Nlsy, 1987, Bernstein *et al.*, 2000, Kallen *et al.*, 2000).

These findings may also suggest a possible psychoactive effect on infants and children of passive exposure to cigarette smoke during pregnancy and childhood period (Cole PV *et al.*, 1988, Wasserman *et al.*, 2001).

SUBJECTS

Subjects of this study are three hundred full term newly born infants (one hundred and fifty of them were normal weight and one

hundred and fifty of them were $LBW \leq 2.5$ Kgm). Their mothers were free from diabetes, cardiac and renal or any blood diseases, T.B or any history of serious complications during pregnancy or delivery or drug intake . Mother ages were between (20 – 30) years.

The babies were born at Gynecology & Obstetric Hospital of Ain Shams University.

METHODS

- a. Anthropometric measurements of neonates were registered . It was carried out within 24 hours of birth the values approximated to the nearest 0.1 cm (Brozek, J. 1970), also calculation of :
pondral index = weight in gram X 100/length(cm)³ (Miller,1979).
- b. Behavioral assessment:
Each infant was observed within 24 hours of his age after breast feeding and diaper change, the session duration was 15 minute and the observer rated the infant every 0.5 minute at the three dimensions of neonatal behavior, visual alertness, activity and irritability. (Ricciuti and Breitmayer, 1985)
- c. Anthropometric measurements of mothers. (Cameron, 1978)
- d. Radioimmunoassay of cotinine in mother's urine (Larsson, 1986).
- e. Data were collected about parental education, occupation and socioeconomic state.

RESULTS**Table (1):** Comparison Between LBW and Normal Weight Infants As Regard The Relation Between Anthropometrics of Infants

	L B W (Cases) N=150		Normal Weight (Control) N=150		t	P
	Mean	±SD	Mean	±SD		
Infant Weight	2.3	0.2	3.4	0.5	27.6	< 0.0001
Infant Height	48.1	0.9	49.4	0.6	15.8	< 0.0001
Infant Head Circumference	34.5	0.55	34.7	0.4	3.2	< 0.001
Pondral index	2.1	0.1	3	0.3	25.2	< 0.0001

There is a highly significant($p < 0.0001$) decrease in anthropometrical of LBW infants.

Table (2): Comparison Between LBW Infants And Normal Weight Infants As Regard The Relation Between Behavior Of Infants

	L B W (Cases) N=150		Normal Weight (Control) N=150		t	P
	Mean	±SD	Mean	±SD		
Visual Alert	72.4	28.3	102.2	13.2	11.6	< 0.0001
Activity	99.3	44	43.2	26.1	13.4	< 0.0001
Affect	56	26	24	17	13	< 0.0001

There is a highly significant($p<0.0001$) decrease in visual alert and a significant($p< 0.0001$) increase in activity and irritability.

Table (3): Comparison Between LBW and Normal Weight Infants As Regard Cotinine Level in Mother's Urine.

	L B W (Cases) N=150		Normal Weight (Control) N=150		t	p
	Mean	±SD	Mean	±SD		
Cotinine µg/ml (N=38)	2105	1800.4	778	1259	3.7	<0.0001

There is a significant ($P< 0.0001$) increase in cotinine level in urine of mothers who delivered L B W infants .

Table (4): Distribution of LBW and Normal Weight Infants as Regard Mother's Smoking .

Mother Smoker	LBW (N=150)		Normal Weight (N=150)		χ^2	p
	No	%	No	%		
Non Smoker	97	64.0	136	91.0	36.7	< 0.0001
Smoker	53	36.0	14	9.0		

There is a highly significant ($p < 0.0001$) distribution between L B W and Normal Weight Infants as regard percentage of smoker and non smoker mothers.

Table (5): Distribution of L B W and Normal Weight Infants as Regard Mother's Number of Cigarette / day.

Mother Smoking	LBW		Normal Weight		Total (N=300)	%
	N	%	N	%		
<10/day	16	11.0	11	7.0	27	9.0
10-20/day	25	17.0	3	2.0	28	9.3
> 20/day	12	8.0	0	0.0	12	4.0

Showing the effect of number of cigarette / day on birth weight so , when number of cigarette/ day was increased , number of L B W was increased .

Table (6): Comparison Between Growth and Behavior among LBW Infants in Smokers (N=53) and Non Smokers Mothers (N = 97)

	State of Smoking				t	p
	Smoker		Non Smoker			
	Mean	±SD	Mean	±SD		
Infant Weight	2.2	0.12	2.4	0.13	9.6	<0.0001
Infant Length	47.6	0.76	48.5	0.89	5.8	<0.0001
Infant H.C	34.1	0.4	35	0.5	7.6	<0.0001
Pondral Index	2.0	0.13	2.3	0.2	5.6	<0.0001
Visual Alert	46.8	19.4	86.3	22.1	10.8	<0.0001
Activity	128.5	12.1	83.4	46.6	6.9	<0.0001
Irritability	73.3	10.2	47.2	27.4	6.6	<0.0001

There is a highly significant($p < 0.0001$) decreased in growth and visual alert also a significant ($p < 0.0001$) increase in activity and irritability among LBW infants.

Table (7): Comparison Between Growth and Behavior among Normal Weight Infants in Smokers (N=14) and Non Smoker Mothers (N =139)

	State of Smoking				t	p
	Smoker		Non Smoker			
	Mean	±SD	Mean	±SD		
Infant Weight	2.9	0.48	3.4	0.43	4.11	<0.0001
Infant Length	48.8	0.53	49.5	0.53	4.6	<0.0001
Infant H.C	34.2	0.32	34.7	0.37	5.2	<0.0001
Pondral Index	2.5	0.36	2.8	0.33	3.3	<0.0001
Visual Alert	96.6	18.1	105.5	6.2	15.8	<0.0001
Activity	107.8	36.4	36.6	12.2	15.9	<0.0001
Irritability	65.3	21.8	19.4	7.8	16.5	<0.0001

There is a highly significant ($P < 0.0001$) decrease in growth and visual alert also a significant increase ($p < 0.0001$) in activity and irritability among Normal Weight Infant.

Table (8): Statistical Comparison Between LBW and Normal Weight Infants as Regard Mother and/or Father Smoking

	One Parent only Smoke		Both Parent Smoke		t	p
	Mean	±SD	Mean	±SD		
Infant Weight	3.0	0.6	2.3	0.4	8.4	<0.0001
Infant Length	49	0.9	47.8	0.9	9.8	<0.0001
Infant H.C	34.7	0.4	34.1	0.4	10.1	<0.0001
Pondral Index	2.5	0.4	2.1	0.3	7.3	<0.0001
Visual Alert	97.6	17.7	51.9	21.1	17.8	<0.0001
Activity	55.8	29	124	21	13.8	<0.0001
Irritability	30.9	23	71.0	14	13.7	<0.0001

There is a significant association between smoking of parents and pregnancy outcome , When both parents are smokers , the mean values of growth parameters and visual alert were significantly ($p<0.0001$) decreased and the mean values of infants activity and irritability were increased .

DISCUSSION

Maternal cigarette smoking around conception and during pregnancy is associated with two established effects which are increased miscarriage rate and fetal growth restriction. These effects are linked to alterations in placental structure and function induced by tobacco smoke compounds. The effect of smoking on fetal growth is related to the level of cigarette consumption (Jauniaux *et al.*, 1999).

Intrauterine growth retardation, one of the major consequences of antenatal smoking, is manifested by reduced values for weight, length, and/or head circumference at birth depending on the intensity of the exposure (Wand *et al.*, 1997).

Tobacco smoke compounds such as nicotine and carbon monoxide were shown to act indirectly on the fetus through uteroplacental vasoconstriction and directly by crossing the placenta and entering fetal tissues. Carbon monoxide has a strong affinity for fetal hemoglobin, resulting in higher fetal levels of carboxyhemoglobin than maternal levels which shifts the oxygen- hemoglobin saturation to the right, reducing oxygen delivery and release into fetal tissues (Jauniaux *et al.*, 1999).

Wen *et al.*, (1990) and Wisborg *et al.*, (1996) showed an increased risk associated with smoking among older women. This may be explained by the fact that in smokers, increasing maternal age usually means a longer lifetime exposure to cigarettes that might interact with the direct toxic effects of tobacco smoke.

The question raised here: Is there a direct relation of maternal smoking exposure and pregnancy outcome and if this relation is quantitative i.e. a direct relation between amount of smoking exposure and the magnitude of fetal effects?

In the present study weight of infants were affected by smoking of mothers during pregnancy so in LBW group mean weight of infants of smoker mothers was $(2.2 \pm 0.14 \text{ kg})$ which was high significant ($P < 0.0001$) lower than $(2.4 \pm 0.13 \text{ kg})$ in non smoker mothers so, lowering in mean weight was 200 g, and in normal weight infants group mean weight of infants of smoker mothers was $(2.9 \pm 0.48 \text{ kg})$ which was highly significant ($P < 0.0001$) lower than mean weight of infants of non smoker mothers $(3.4 \pm 0.43 \text{ kg})$ so lowering in mean weight was 500 g.

There are plenty of reports that agree with our results, which included Samaha et al., (1990), El Sawy et al., (1995); Bortman, (1998); Steuerer et al., (1999) and El Ghannam et al; (1999). Yeung et al; (1981) found that infants who were born to smoking mothers during pregnancy were 230 g lighter than infants of non smoking mothers and the greater the number of cigarettes smoked the smaller the birth size. Also Hrubá D. and Kachlik P.; (2000) found that the average birth weight of babies born to women who smoked during pregnancy was lower by 119 g than that of the babies born to never smokers mothers.

Yeung et al., (1981) found that infants who were born to smoking mothers during pregnancy were 230 g lighter than infants of nonsmoking mothers and the greater the number of cigarettes smoked the smaller the

birth size. This result is near to ours as the mean difference between active smokers and control group was 300 g.

Scbeliscbeidt et al., (1998) in a study done on the effect of heavy maternal smoking on intrauterine growth patterns, they found that mothers who smoked heavily (> ten cigarettes per day) had a significantly lower birth weight (2911g vs. 3148 g).

Luciano et. al., (1998) studied 112 newborn infants who were divided into three groups, non-exposed, passively exposed and light smoking mothers. They reported that newborns of active smoking and passive smoking groups had a statistically significant reduction of birth weight ($p<0.013$).

In Shehata et al., (1997) study, they tried to evaluate the effect of variable degrees of environmental exposure to tobacco smoke during pregnancy in 152 non-smoking pregnant women, based on a questionnaire fulfilled by the parents, newborns were classified into five groups depending on degree of exposure. Birth weight of babies born to mothers significantly exposed to tobacco was 230g less than those babies born to non exposed mothers. Also, there was a difference of 176g in birth weight between babies born to mothers significantly exposed to tobacco smoke and babies born to mothers occasionally exposed to tobacco smoke. It was concluded that passive smoking has a negative influence on intrauterine fetal growth and that the duration of exposure is more important than intensity exposure.

In our study mothers smoked ≥ 10 cigarettes/day delivered 25% from LBW infants of smoker mothers vs. (2%) normal weight infants delivered to smoker mothers, as regard father smoking ≥ 10 cigarettes/day

52.6 % had LBW infants of smoker fathers vs. (3%) normal weight infants was delivered to smoker fathers. This is coincide with studies of Muscati et al.; (1988) and David et al.; (1994) who said that, mothers who smoked heavily (> 10 cigarette/day) had LBW infants more than lighter smoking mothers (< 10 cigarette/day).

In testing comparison between parents smoking habit either when both parents were smokers or only one of them was smoker, it was observed that a significant association between smoking habits of parents and the pregnancy outcome i.e. one can simply observed that when both parents were smokers the mean values of infant weight, length, head circumference and pondral index was significantly ($p < 0.0001$) decreased and the mean values of infants visual alertness, activity and irritability (the three dimensions of infant behaviour which was done by Riccicuti and Breitmayer 1985) became more worse, these were coincide with the observation of Hrubá D. and Kachlik P.; (2000).

In the present study length of infants was affected also so in LBW infants of smoker mothers mean was (47.6 ± 0.76) which was highly significant ($P < 0.0001$) lower than (48.5 ± 0.89) in non smoker mothers so lowering in mean length by 0.9 cm, and in normal weight infants of

smoker mothers the mean length was (48.8 ± 0.53) which was highly significant ($P < 0.0001$)

lower than (49.5 ± 0.53) in non smoker mothers so lowering in mean length was 0.7 cm.

In the present study the mean head circumference of LBW of smoker mothers was (34.1 ± 0.4) which was highly significant ($P < 0.0001$) lower than (35 ± 0.5) in non smoker mothers so lowering in mean by 0.9 cm and in normal weight infants of smoker mothers the mean head circumference was (34.2 ± 0.32) which was highly significant ($P < 0.0001$) lower than (34.7 ± 0.37) in non smoker mothers so lowering by 0.5 cm.

In our study pondral Index was lowered due to smoking of mothers during pregnancy, the mean was (2.0 ± 0.13) in LBW infants of smoker mothers which was highly significant ($P < 0.0001$) lower than (2.3 ± 0.2) in non smoker and even in normal weight infants of smoker mothers the mean pondral index was (2.5 ± 0.36) which was highly significant ($P < 0.0001$) lower than (2.8 ± 0.33) in non smoker mothers.

In the present study behavior of infants affected by smoking of mothers during pregnancy and this affection was in three lines which were visual alertness of infant, activity of infant and irritability.

As regard visual alert the mean of visual alert of LBW of smoker mothers was (46.8 ± 19.4) which was highly significant ($P < 0.0001$) lower than (86.3 ± 22.1) in non smoker mothers and in normal weight infants of smoker mothers was (69.6 ± 18.1) which was highly significant

($P < 0.0001$) lower than (105.5 ± 6.2) in non smoker mothers, so we can obviously see that

visual alert of infants decreased by smoking of mothers during pregnancy.

Also, our study revealed that activity of infants was increased by smoking of mothers during pregnancy so in LBW infants of smoking mothers the mean of activity was (128.5 ± 2.1) vs. (83.4 ± 46.6) in non smoker mothers and in normal weight infants of smoker mothers was (107.8 ± 36.4) vs. (36.6 ± 12.2) in non smoker mothers so it was clear that activity of infants increased by smoking of mothers during pregnancy.

On the other hand irritability of infants was increased by smoking of mothers during pregnancy as we can see in LBW infants of smoking mothers mean of irritability was (73.3 ± 10.2) in smoker mothers vs. (47.2 ± 27.4) in non smoker mothers and normal weight infants of smoker mothers mean was (95.3 ± 21.8) vs. (19.4 ± 7.8) in non smokers mothers.

These changes of behavior of infants was found in studies of Beta et al; (1995) who published that poor visual orientation and more fussing and crying in infants exposed to smoking and cocaine intake during pregnancy the same was said by Michael et al; (1992) who suggested that increased behavior problems of children which should be added to the growing list of adverse child health conditions associated with maternal smoking during pregnancy.

Also, David et al; (1994) found in his study that intellectual impairment in children of women who smoke cigarettes during pregnancy.

In the study of Lindley et al; (2000) they found that neurobehavioral impairment due to smoking of mothers prenatal due to the effect of nicotine and carbon monoxide which caused vasoconstrictive effects on placental and fetal blood vessels; continuing exposure may result in chronic fetal hypoxia and decreased nutrient transfer. Thus newborn neurobehavior function may be compromised including attention deficit, increase activity and decrease orientation.

Es Kenazi et al; 1996 said that ETS (Environmental Tobacco Smoke) exposure during childhood may be more hazardous to neurodevelopment than prenatal exposure.

In the present study we found that the mean of cotinine was (2105 ± 1800) in LBW infants vs. (778±1259) in normal weight infants, There was a significant increase (p <0.0001) in cotinine level of LBW infants group than in normal weight infants group and because the number of LBW infants of smoker mother is highly significant (p <0.0001) increased than number of normal weight infants of smoker mothers we can see obviously that cigarette smoke of mothers during pregnancy has great effect of pregnancy outcome, as regard growth parameters and behavioral disorders.

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تأثير تدخين الأمهات أثناء وبعد الحمل على السلوكيات وعيوب النمو في الأطفال حديثي الولادة

[٣]

محمد عبد العدل الصاوي^(١) - مهي محمود التحيوي^(١) - مصطفى حسن رجب^(٢) -
طارق محروس سلمان^(٣) - عفاف محمد محمد صابر^(٤)
(١) كلية الطب، جامعة عين شمس. (٢) معهد الدراسات والبحوث البيئية، جامعة عين
شمس. (٣) كلية الصيدلة، جامعة الأزهر. (٤) مستشفى الشرطة .

المستخلص

تناول هذه الدراسة العلاقة بين تدخين الأمهات أثناء الحمل وتأثير ذلك على النمو
الجسماني والتصرفات السلوكية للأطفال المولود وقد أجريت هذه الدراسة على ٣٠٠ طفل
مولود بعد اكتمال شهور الحمل (١٥٠ منهم ناقصي الوزن عند الولادة أي وزنهم $\geq 2,5$
كجم ، ١٥٠ من طبيعي الوزن عند الولادة من ٣-٤ كجم) من مواليد مستشفى النساء
والولادة التابعة لجامعة عين شمس على أن تكون أمهاتهم خاليات من أمراض القلب و
ضغط الدم والكلية وأمراض الدم والجهاز التنفسي ولم يتعرضوا إلى أي مضاعفات أو تناول
أدوية أثناء الحمل.

وتشمل طريقة البحث في هذه الدراسة ما يلي:

- جمع البيانات الخاصة بتعرض الأطفال لتدخين الأمهات من خلال استمارة الاستبيان.
- المقاييس الطبيعية للأطفال من حيث الوزن والطول ومحيط الرأس ومعامل الكتلة
الجسمية.
- قياس الاضطرابات السلوكية للأطفال المولود باستخدام صحيفة ملاحظة خاصة بحديثي
الولادة.
- قياس نسبة الكوتينين في بول الأمهات.

وتوضح نتائج هذه الدراسة الآتي :

- أن تدخين الأمهات أثناء الحمل يؤدي إلى نقص ذو دلالة إحصائية في وزن المواليد وفي
الطول ومحيط الرأس وفي معامل الكتلة الجسمية.
- كذلك تأثر التصرفات السلوكية تأثرا ذو دلالة إحصائية من حيث زيادة مستوى النشاط
وقلة الانتباه البصري مع زيادة الحركة والاستثارة.

- هذا التأثير موجود سواء كان التدخين في أي مرحلة من مراحل الحمل أو طوال الحمل.
- أيضا زيادة عدد السجائر في اليوم يزيد من الاضطراب الذي يحدث في النمو والتصرفات السلوكية للمواليد.
- هذه النتائج قد تأكدت عند إجراء التحاليل المعملية لنسبة الكورتيزين في بول الأمهات فعند زيادة هذه النسبة يحدث التأثير الواضح في اضطراب النمو والسلوكيات للمواليد.
- لوحظ أن عمر الأمهات المدخنات أقل من غير المدخنات والعمر الرحمي للجنين يقل في المدخنات.
- التعليم المتوسط بالنسبة للوالدين هو الأكثر شيوعا وبالنسبة للأمهات المدخنات العاملات فأنهن الأكثر في إنجاب الأطفال ناقصي الوزن بالإضافة إلى انخفاض المستوى المعيشي لهم.
- وقد خلص البحث إلى أن تدخين الأمهات أثناء الحمل يؤدي إلى اضطراب في النمو الجسماني مصاحب لاضطرابات في سلوكيات الأطفال حديثي الولادة .
- ولذا يوصى البحث بأنه يجب العمل على منع تعرض الأمهات الحوامل للتدخين من خلال التوعية بأضرار التدخين من خلال المختصين بالصحة والبيئة سواء في المناهج الدراسية أو وسائل الإعلام المختلفة في الإذاعة و التلفزيون و المجلات .