

## Is maternal smoking harmful to the physical growth of offspring at early childhood?

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**ABSTRACT** The effect of maternal smoking on birth weight of their babies, the effects of smoking during lactation and in the post-weaning period on growth in height and weight of children up to the age of 7 years were investigated. The sample consisted of 1511 children (778 boys and 733 girls) examined at two follow-up studies in May and December 1997. Retrospective data on birth-weight, height and weight up to the present investigation were available from the child's health record book. The results of the investigation revealed more frequent occurrence of lower birth-weight among children born to mothers smoking during pregnancy than among those born to non-smokers. Similar results were also gained for children in the pre-school period.

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### Introduction

A number of epidemiological studies have reported the effects of maternal smoking during pregnancy and lactation on the duration of breastfeeding, birth-weight, postnatal physical growth, health status and behaviour of offspring [KERN 1983, WOODWARD, HAND 1988, MATHESON, RIVRUD 1989, MANSBACH *et al.* 1991, GAJEWSKA *et al.* 1991, RUTISHAUSER, CARLIN 1992, MAJEWSKI *et al.* 1992, ŁYSIAK *et al.* 1993, HADANI *et al.* 1994, KOWALSKI 1994, CONTER *et al.* 1995, VIK *et al.* 1996, NITKA 1997, PASZKOWSKI 1997]. These relations were first described by MILLS [1950] and SIMPSON [1957]. It was found that among women smoking during pregnan-

cy there was higher frequency of births given to with weight lower than 2500g.

It was also found the causal relation between smoking in pregnancy and the shorter lactation. Moreover, recent studies have shown that smoking had reduced daily milk output about 250 – 300 ml and finally stopped the lactation. It has been suggested that the most probable mechanism responsible for early cessation of lactation is the increase of dopamine secretion in the hypothalamus leading to a reduction in prolactin levels [JANSSON *et al.* 1992, VIK *et al.* 1996].

However, there is divergence of opinions about the effects of maternal smoking on physical growth of offspring. Some authors have found differences in weight, length, and head circumference between newborns of smokers and non-smokers [WINGERD, SCHOEN 1974, NAYE 1981, RANTAKALLIO 1983, FOGELMAN, MANOR 1988, FOX *et al.*

1990]. The other did not find such difference [HARDY, MELLITS 1972, BARR *et al.* 1984, DAY *et al.* 1992, SCHULTE-HOBEIN *et al.* 1992]. Little is known about the effect of maternal smoking on children growth at early childhood. This inspired the authors to undertake the study to assess the relation between maternal smoking and physical growth of pre-school children. The objectives of this study were to determine the relation between maternal smoking habit and education, maternal smoking and the duration of breastfeeding and finally the influence of maternal smoking during pregnancy and lactation on birthweight and growth in height and weight from birth up to the age of 7 years.

### Materials and methods

Data reported here were obtained from two surveys carried out in a half year interval in all kindergartens in Kalisz in May and December 1997. A total of 1511 children (778 boys and 733 girls) born in majority in Kalisz between 1990 and 1994 were selected by the authors. The criteria were such that the children had to have been born at term (after 37-gestation week) and had to exhibit no severe anomaly or chronic diseases. Measurements of body weight, height, head and chest circumferences, some other somatic measurements such as arm and leg circumferences and skinfolds were taken according to the protocol of the growth survey "Dziecko Poznańskie" [CIEŚLIK *et al.* 1994]. The children were weighed on an electronic scale calibrated in the metric system in grams and to the nearest 100g. Body height was measured in standing position with GPM anthropometer and with accuracy to 1 mm.

These two characteristics were used for assessing physical growth of children. The values of birth weight were obtained from the child health record in "D" dispensary. Retrospective data of physical growth of children since birth was also possible thanks to detailed analysis of child health records. The background data was received in the questionnaire. The parents were asked for family type (single or two parent family), highest attained level of education, life-style and life conditions, cigarettes smoked daily by the person who cared for the child most of the time, and this person was almost always the mother (in 96.7%). In further questionnaire mothers were asked about number of smoking cigarettes per day and drinking alcohol during pregnancy and lactation, the type and duration of feeding a baby (breast- or bottle-feeding), mother's age at delivery, health status, parity (number of live births), number of foetal losses. From the background data collected in the questionnaire, the following variables were used in this study: maternal smoking during pregnancy, lactation, duration of breast-feeding, and mothers' highest educational level. Mother was acknowledged a smoker when she had smoked more than one cigarette a day.

One of the objectives of our study was to verify the statement about the effects of infant feeding on health, physical growth and cognitive development. Therefore, 1511 mothers were investigated in order to describe the relation between smoking habit, type and duration of feeding and body height and weight of offspring during first year of live. Three groups of infants were distinguished: those who received both breast milk and another type of milk feeding (mixed-fed), merely

breast milk, fed no shorter than 6 months (breast-fed) and formula milk (formula-fed). Within these three groups fractions of mothers who smoked during pregnancy and lactation were distinguished.

The descriptive statistics and ANOVA were used for statistical elaboration of the data. The tendency in attained height and weight was estimated with the use of normalising procedure.

### Results

#### Maternal smoking habit and education level

Table 1 shows percent distribution by mothers' education of all children participating in the study. The largest group of mothers consists of those who were educated from secondary school – almost 60%, whereas the smallest was the group of mothers educated from primary school level – only 5%. It means that an average level of maternal education was satisfactory. Smoking habit among mothers of children participating in the study was rather strong. It is shown in Figure 1 that there is a fraction of 9.4% of the total sample of women who smoked during

**Table 1.** Education of mothers

Education	Girls		Boys	
	<i>n</i>	%	<i>n</i>	%
Primary	40	5.46	37	4.76
Vocational	128	17.49	158	20.31
Secondary	438	59.84	467	60.03
Academic	126	17.21	116	14.91

pregnancy, and 5.1% of them did not stop smoking during lactation. From the entire sample as much as 30.18% of women declared as had been regular smokers. It means that their children have been exposed to smoking from birth to the present examination.

Considering smoking habit and education level of mothers, shown in Figure 2, it may be seen that majority of smokers were women of primary education level. They constitute a fraction of 18.8% of a total sample. From among non-smokers, women educated from high school represent the largest group. Almost 82% of women of highest education level did not smoke at all. As may be seen from the results of chi-square test the relation between smoking habit and education is statistically significant. Those who were better educated had become more conscious about harmful effect of smoking and they did not smoke at all.

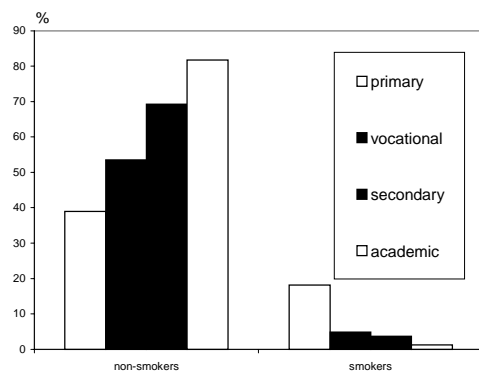


Fig. 1. Maternal smoking and education level

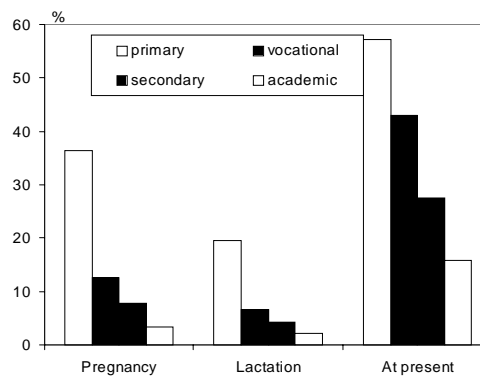


Fig. 2. Maternal smoking during pregnancy, lactation and up to present investigation

Studying this problem in more details, e.g. taking into consideration whether mothers have smoked in each examined period: pregnancy, lactation and interval to the present investigation, one may see the same pattern as previously. As it is shown in Figure 2, the greatest number of smoking mothers were those of primary education level. From among them 37% smoked during pregnancy, 19% during lactation and 57% in time interval up to the present investigation. Once more, this result support previous statement about higher health consciousness of women educated from high schools.

### Maternal smoking, education and feeding

The effects of infant feeding on health and physical growth have been discussed for decades. Benefits of breast-feeding in preventing infants from allergic diseases, gastrointestinal and respiratory infections, especially in high-risk environments are well known [VICTORIA *et al.* 1987, KRAMER 1988, HOWIE *et al.* 1990]. Beneficial effects of breast-feeding could be associated with the composition and bioavailability of breast milk proteins [STINI *et al.* 1980, KALISZEWSKA-DROZDOWSKA 1999] It is also associated with the mother-child relationship and infant stimulation, thus promoting child development [TEMBOURY *et al.* 1994].

Although beneficial effects of breast-feeding are widely known, in our material, shown in Table 2, mixed-fed infants constitute a majority (54.3% girls and

**Table 2.** The way of infant feeding in the investigated sample

Feeding	Girls		Boys	
	<i>n</i>	%	<i>n</i>	%
Breast	87	11.9	64	8.2
Mixed	398	54.3	436	56.0
Formula	248	33.8	278	35.7

**Table 3.** Education of mothers and the way of feeding (%)

Education	Girls		Boys	
	Bottle	Breast	Bottle	Breast
Primary & Vocational	91.9	8.1	94.1	5.9
Secondary	73.3	26.7	79.5	20.5
Academic	50.0	50.0	54.3	45.7
$\chi^2$	31.69*		28.24*	

\*- significance on the level 0.01

56.0% boys), followed by the formula-fed infants (33.8% girls and 35.7% boys). The numbers of breast-fed infants were the smallest, only 11.9% girls and 8.2% boys. Moreover, our findings confirmed that breast-feeding is strongly connected with the schooling of mother. The results are shown in Table 3. In an investigated sample the smallest number of breast-feeding mothers were those who graduated from primary and vocational schools (8.1% and 5.9% in girls and boys respectively), the largest, those who graduated from high schools (50% and 45.7% in girls and boys respectively). The differences were statistically significant.

The relation was also found between smoking during lactation and schooling of mothers (Table 4). The highest number of smoking mothers during lactation were those who graduated from elementary schools (16.2% in girls and 25.0% in boys), the smallest those who graduated from university (2.4% in girls and 1.8% in boys). This finding supports previous statements about an important role of education in infants' breast-feeding and maternal smoking habit.

### Birth-weight among children born to smoking and non-smoking mothers

The results presented in Table 5 indicate negative influence of maternal smoking during pregnancy on weight of newborns. When we compare birthweight

**Table 4.** Education of mothers and smoking during lactation (%)

Education	Smoking mothers	
	Girls	Boys
Elementary	16.2	25.0
Vocational	4.9	8.8
Secondary	4.2	4.6
Academic	2.4	1.8
$\chi^2$	13.25*	30.59*

\* – significance on the level 0.01

**Table 5.** Birth-weight of babies born to non-smoking (NSM) and smoking (SM) mothers

	<i>n</i>	NSM (g)	SM (g)	<i>p</i>
Girls				
	729	3286	3061	0.000
Boys				
	766	3433	3303	0,054

**Table 6.** Standardized weight and height of pre-school children in relation to maternal smoking habit (SM – smoking and NSM – non-smoking mothers).

Standardized characteristic	SM	NSM	<i>t</i>
Girls – weight	-0.32	-0.79	4.75**
Girls – height	0.012	-0.38	3.72**
Boys – weight	0.013	0.18	-1.50
Boys – height	0.001	-0.25	2.43*

\*\* – significance on the level 0.01

\* – significance on the level 0.05

of babies born to smoking mothers with those born to non-smokers, we may see that the latter were significantly heavier. The same tendency was found in boys and girls. In girls the difference was around 225g, in boys it was 130g.

### Growth in weight and height up to the age of 7 years

In the next step of our analysis we investigated the effects of maternal smoking on growth in weight and height of offspring up to the age of 7. Table 6 shows standardised values of height and weight of boys and girls. It is evident that girls of non-smoking mothers are heavier and taller than those of smoking mothers. The same was found for body height in

boys. However, our studies did not confirm the harmful effect of smoking on body mass in pre-school boys. The sons of mothers who smoked during pregnancy, breast-feeding, and until present investigation turned out to be heavier than sons born to non-smoking women are.

## Discussion

Smoking is the most spread bad habit among people. It has been estimated that heavy smokers make up one third of inhabitants of earth, and Poland is the leading country in this statistics. What particularly bothers physicians, is constantly growing number of smoking women at reproductive age and of pregnant women. According to various statistics, active and passive pregnant smokers comprise 25-50%.

The results of our study on the effects of maternal smoking on growth in height and weight in pre-school children provided us with quite interesting observations. We observed that smoking has a harmful influence on physical growth in that period. Girls and boys born to non-smoking mothers exceed their peers born to smokers in height and (with the exception of boys) in weight. Boys of smoking mothers were heavier than their peers in group of non-smokers, although we would expect an opposite finding. These results confirm the data of latest studies conducted by VIK *et al.* [1996]. In an attempt for a possible explanation of this finding we quote LITTLE *et al.* [1994]. The authors observed that infants who were breast-fed by smoking mothers gained more weight in first year of life than infants who were breast-fed by mothers who did not smoke or infants who were bottle-fed by smoking mothers.

They suppose that either the milk composition of mothers who smoke is different from that of mothers who do not smoke or mothers who smoke are less able to maintain milk supply, and thus might introduce solid food earlier. Finally, that weaning implies withdrawal of nicotine from child, which might make the child hungrier or fussier, to which mothers react by giving more solid food. Nicotine withdrawal may decrease energy expenditure, increasing the weight, similar to the weight gain seen in adults who quit smoking. Probably boys born to smoking mothers show at this age total make up for height. Smoking effects in prenatal period may have long term effects also in subsequent time of childhood.

There are many controversies about the effects of maternal smoking on growth in height and weight in pre-school children. BOSUIZEN *et al.* [1988] in their findings observed that differences in weight and the length of the body were mainly seen between newborns of smokers and non-smokers. Neither direct exposure to tobacco by-products through breast milk nor late effects on growth after withdrawal of the exposure to tobacco by-products through breast milk were observed.

Interesting conclusions were also provided by MASCOLA *et al.* [1998]. These authors claim that breast-feeding is the determinant of urine cotinine levels in infants born to smoking mothers. What is more, infants born to smoking mothers are more exposed to environmental tobacco smoke than infants of passive smokers, and breast-feeding dramatically increase this exposure.

Similar results were also provided by HORTA *et al.* [1997], who claimed that children of smoking mothers were not

breast-fed till 6th month of live. Moreover, stronger influence of active maternal smoking than passive one on biological development of a child was observed.

The results of our studies indicate that smoking is to some significant extent connected with the level of education. The fact that the higher education the higher values of somatic features in offspring has been emphasized in many recent studies [CHRZĄSTEK-SPRUCH 1979; BIELICKI *et al.* 1981; HULANICKA *et al.* 1990; KACZMAREK 1995]. There are fewer publications devoted to problems of correlation between the level of mother's education and smoking habit. We should, though, conduct researches that would confirm the vital role of mother's educational level in giving up smoking, and what is the result of it, providing children with conditions which will enable them normal and healthy growth. We found in our studies, that majority of women prefer bottle-feeding to breast-feeding. Only the small number of women resorts to natural way of nourishing their offspring. What is worth paying our attention is that breast-feeding is to great extent connected with schooling of mother. These women who graduated from high schools and have profound knowledge are more aware that breast-feeding is more profitable and has unique properties to young organism. The idea of feeding children in natural way should spread and reach also these women who graduated from primary school.

Many authors emphasize the fact that the most known consequences of smoking during pregnancy is the retardation of intrauterine growth and development of fetus, what makes that the newborns have less body mass. Our data provided us with similar findings.

## Conclusions

On ground of the results obtained in our study following conclusions may be formulated:

1. The effects of maternal smoking during pregnancy are revealed in birth-weight of offspring.

2. Newborns of non-smoking mothers are significantly heavier in comparison with those born to smoking mothers.

3. It was observed that smoking has a prolonged effect on growth in pre-school period. Children born to smoking mothers are shorter and lighter. This rule is not confirmed by weight of boys.

4. Women educated from primary schools are heavier smoker general, during pregnancy and lactation than those graduated from high schools are.

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## Streszczenie

Zbadano wpływ palenia papierosów przez matki na rozwój fizyczny ich dzieci w okresie od urodzenia do siódmego roku życia. Analizie poddano 1511 dzieci (778 chłopców i 733 dziewcząt) uczęszczających do przedszkoli w Kaliszu. Badania o charakterze przekrojowym przeprowadzono dwukrotnie: w maju i grudniu 1997 roku. Wykonano podstawowe pomiary antropometryczne – wysokości, masy ciała, obwodu głowy, klatki piersiowej i kończyn oraz fałdów skórno-tłuszczowych. Dane retrospektywne – urodzeniową masę ciała oraz pomiary antropometryczne charakteryzujące rozwój dziecka od urodzenia do chwili badania – spisano z kart zdrowia dziecka. Informacje o warunkach życia dziecka uzyskano przeprowadzając wywiad z matkami dzieci. Pytano równocześnie o sposób karmienia dzieci, czas karmienia piersią i dane o nałogu palenia papierosów. Stwierdzono wpływ palenia papierosów przez matki w czasie ciąży na urodzeniową masę ciała potomstwa. Noworodki płci żeńskiej i męskiej matek niepalących były cięższe w porównaniu z noworodkami matek palących. Wyniki niniejszych badań wykazały także, że również w wieku przedszkolnym dzieci matek palących były niższe i lżejsze od swych rówieśników, których matki nie paliły papierosów. W badanej próbie zaobserwowano związek między wykształceniem a paleniem papierosów oraz sposobem karmienia. Kobiety z wykształceniem podstawowym zdecydowanie częściej paliły papierosy, także w czasie ciąży oraz karmienia piersią. W porównaniu z kobietami wykształconymi w stopniu wyższym, preferowały one karmienie dzieci mieszankami pokarmowymi, rzadko karmiąc je piersią.