Active and passive exposure of pregnant women to tobacco smoke

**Renata Adamek**, **Ewa Florek**, **Wojciech Piekoszewski**, **Grzegorz H. Bręborowicz**, **Andrzej Anholcer**

**Abstract**

Over the recent decade, the number of smoking young people, especially women has increased significantly. Exposure of fetus to tobacco smoke and its negative impact on the development and health of newborns is therefore not only a medical but also a social problem of great importance. That is why the evaluation of tobacco smoking incidence among pregnant women and its influence on the newborn health status was the aim of this study. A questionnaire survey was carried out in a population of 1528 pregnant women and urine cotinine concentration was determined in 15% of the study population. Smoking habit was declared by 18.2% of woman, and exposure to ETS was reported by 32.0% of respondents. A significant association between active and passive smoking and the socio-economic status of respondents was noticed. The birth weight of newborns born to smoking mothers was lower by about 332 g, however, the influence of passive smoking on the newborn birth weight was not observed. Urine cotinine concentration in smoking women was 923 ng/mg of creatinine and in passive smokers 49.8 ng/mg of creatinine, whereas in non-smokers it was below the limit of detection of the analytical method. The performed study with the participation of relatively large group of pregnant women with different socio-economic status, confirmed a key role of tobacco smoking in decreasing the birth weight of newborns. Application of urine cotinine determination as a biomarker of exposure to tobacco smoke rendered it possible to distinguish objectively smokers, passive smokers and non-smokers in the study population.

**Key words:** smoking, pregnancy, newborn, cotinine

**Introduction**

Tobacco smoking is considered to be one of the major, but at the same time preventable health risk factors in humans [19, 30]. Women constitute about 250 million smokers in the world. Approximately 22% of women smoke in the developed countries as compared to only about 9% of female smokers in the developing countries. In Poland, there were 42% of smoking men and 23% of smoking women at the end of the 20th century [10].

In the population of non-smokers, as many as 47 and 52% of men and women, respectively, were exposed to environmental tobacco smoke (ETS) at home and 55 and 27 percent, respectively, in the workplace. Over the recent decade, the number of smoking young people, especially women, has increased significantly. Exposure of fetus to tobacco smoke and its negative impact on the development and health of newborns is therefore not only a medical but also a social problem of great importance [18]. It is reported that the birth weight of newborns born to women smoking cigarettes during pregnancy is lower by 150-300 g and their length is decreased by 1 cm on average compared to those born to women not smoking during pregnancy [16]. As regards passive exposure, it is estimated that the birth weight of newborns is decreased by 10-100 g on average [20, 25].

The aim of the study was to evaluate the incidence of active and passive exposure of pregnant women to tobacco smoke, and to evaluate the health condition of newborns exposed parentally to chemical substances contained in tobacco smoke. The validation of the credibility of the questionnaire responses was also carried out by determining the concentration of cotinine in urine – a specific biomarker of exposure to tobacco smoke.

**Material and methods**

The study population comprised 1528 (what is equal 2.75% of women delivered in Wielkopolska and 29.18% in the Department of the Gynecological-Obstetrics Clinical Hospital) pregnant women admitted to the Department of the Gynecological-Obstetrics Clinical Hospital of the University of Medical Sciences in Poznań. The study protocol was approved by the Bioethical Committee at the University of Medical Sciences in Poznań.

Women, with a single pregnancy terminated after 22 weeks, who gave informed consent to participate in the investigations were qualified for the study.

On the very next day after admission to the hospital, morning portions of urine were collected in 230 women to determine the level of cotinine. Cotinine concentration was determined by previously developed and vali-
dated high performance liquid chromatography (HPLC) [4]. Three groups of women were distinguished, according to their declarations concerning tobacco smoke exposure during pregnancy: women smoking cigarettes during pregnancy (group I); women exposed to ETS during pregnancy (group II) and women who were neither active nor passive smokers during pregnancy (group III).

In the survey, the questionnaire developed by the authors was applied. The survey comprised three parts. First, the questionnaire concerning the socio-economic status of women. Second, the questions concerning tobacco smoking by and ETS exposure of women before and during pregnancy. Third, the neonatologist evaluated the health condition of the newborns.

Statistical analysis

All statistical calculations were done using STATISTICA 6.0 computer program. The results were assessed by the analysis of variance and the Chi² test. The homogeneity of variance was verified by the Levene test. Correlations between the respective variables were indicated on the basis of the Spearman coefficient. In addition, the Fisher-Freeman-Hamilton and the Mann-Whitney tests were used in the calculations.

Results

Within the studied population, 18.2% of women declared tobacco smoking during pregnancy (278 respondents), whereas exposure to ETS was declared by 31% of women (474 respondents). More than a half of the studied population covered non-smoking women and women not exposed to ETS (776 respondents).

Among the women smoking cigarettes during pregnancy and women passively inhaling tobacco smoke, the greatest percentage included women aged up to 25: 47.4% in the first group and 46.7% in the second one. Among the respondents from the nonsmokers group, over 45% of women were aged 25-29. The greatest number of married women was recorded among the women from the nonsmokers group – 91.7%, 78.5% in the group of smokers and 86.5% in the group of passively smoking women. The women, who smoked cigarettes during pregnancy, had primary or vocational education most frequently that is – 29.2% and 40.1% respectively. Women with secondary education, who were exposed to ETS constituted 40.8% of the studied patients. Higher education was declared by non-smoking – 34%. Within group of exposed to ETS and nonsmokers group, the greatest number of women covered those in whose case the average gross income per family member was at an average level. On the other hand, in the group of smoking women, the average gross income was low among more than a half of patients. A high average gross income per family member was declared most often by women exposed to passive smoking – 36.6% respondents. 85.5% of smoking women were professionally active during pregnancy (69.8% of them performed blue collar work), 81.6% of women were exposed to ETS (56% of them performed white collar work) and 81% of women belonged to the nonsmokers group (62% of them performed white collar work). 50.6% of women from group of smoking women and 55.5% of women from the nonsmokers group were inhabitants of a large city – Poznań. 52.6% of women exposed to ETS lived away from Poznań (Table 1).

<table>
<thead>
<tr>
<th>Smoking during pregnancy [%]</th>
<th>Exposure to ETS [%]</th>
<th>Non-smokers [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [years]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 25</td>
<td>47.4</td>
<td>46.7</td>
</tr>
<tr>
<td>25-29</td>
<td>33.6</td>
<td>33.4</td>
</tr>
<tr>
<td>30-34</td>
<td>10.5</td>
<td>12.5</td>
</tr>
<tr>
<td>35 and more</td>
<td>8.5</td>
<td>7.4</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>78.5</td>
<td>86.5</td>
</tr>
<tr>
<td>Single</td>
<td>17.4</td>
<td>12.8</td>
</tr>
<tr>
<td>Widow</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Divorce</td>
<td>4.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>29.2</td>
<td>11.5</td>
</tr>
<tr>
<td>Vocational</td>
<td>40.1</td>
<td>30.5</td>
</tr>
<tr>
<td>Secondary</td>
<td>19.8</td>
<td>40.8</td>
</tr>
<tr>
<td>Higher</td>
<td>10.9</td>
<td>17.2</td>
</tr>
<tr>
<td>Income per member of family</td>
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<td></td>
</tr>
<tr>
<td>Low (below 500 PLN)</td>
<td>50.2</td>
<td>15</td>
</tr>
<tr>
<td>Medium (501-1000 PLN)</td>
<td>38.5</td>
<td>48.4</td>
</tr>
<tr>
<td>High (above 000 PLN)</td>
<td>11.3</td>
<td>36.6</td>
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<tr>
<td>Employment</td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>85.8</td>
<td>81.6</td>
</tr>
<tr>
<td>No</td>
<td>14.2</td>
<td>18.4</td>
</tr>
<tr>
<td>Type of work</td>
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<tr>
<td>White collar</td>
<td>30.2</td>
<td>56</td>
</tr>
<tr>
<td>Blue collar</td>
<td>69.8</td>
<td>44</td>
</tr>
<tr>
<td>Place of residence</td>
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<td></td>
</tr>
<tr>
<td>Large city (Poznań)</td>
<td>50.6</td>
<td>47.4</td>
</tr>
<tr>
<td>Small town or village</td>
<td>49.4</td>
<td>52.6</td>
</tr>
</tbody>
</table>

The analysis of results of the study demonstrated a statistically significant dependence between the tobacco smoking during pregnancy by women and the age of the studied patients, education of respondents and professional activity during pregnancy, type of performed
work, marital status and average gross income per one family member. A statistically significant dependence was observed between the exposure of women to ETS and age, education and type of performed work, place of residence, marital status and average gross income per one family member.

More than a half of the group consisted of women, who smoked 1-5 cigarettes a day. One third of the studied women smoked 6 to 10 cigarettes a day, 10.4% of respondents smoked 11 to 15 cigarettes a day. The smallest group was represented by pregnant women smoking over 15 cigarettes a day – 5% of the studied patients.

The largest group of women exposed to ETS was formed by women, whose partners smoked 6-10 cigarettes a day – 31%. More than 15 cigarettes a day was smoked by 27% of husbands, 11-15 cigarettes a day – by 24% of them and 17.7% smoked 1-5 cigarettes a day.

During the study, 742 newborns of female sex (48.6%) and 786 newborns of male sex (51.4%) were born. Within the studied population of newborns there were 88.5% of newborns delivered on time, whereas 11.5% were delivered before time.

The smallest percentage of newborns delivered on the planned date of pregnancy completion was recorded among the children of women smoking tobacco during pregnancy – 16.8%, which constituted 35% less in comparison with the group of newborns of mothers who did not smoke, and 14.6% less in relation to the group of newborns of mothers exposed to ETS.

Analyzing the risk factors of premature newborn deliveries, a statistically significant difference in the socio-economic status of mothers of premature babies was demonstrated (age, professional activity during pregnancy, place of residence, marital status and average gross income per one family member).

The mean birth body weight of all newborns amounted to 3369 ± 554 g. Among the newborns of the male sex, the mean birth body weight amounted to 3391 ± 578 g (Fig. 2). The mean birth body weight of newborns with the weight below 2500 g amounted to 1951 ± 530 (minimal body weight 410 g, maximal body weight 2495 g).

The babies of mothers smoking during pregnancy were lighter by 332 g on average in comparison with the newborns of women who did not (Fig. 2).

In the case of the passive inhalation of tobacco smoke by women, the mean birth body weight of newborns approximated the body weight of newborn who did not smoke (Fig. 2). The group of newborns with low birth body weight was represented by 7.9% of the studied population (121 newborns).

Almost 48% of newborns with low birth body weight were delivered by mothers smoking cigarettes during pregnancy, 20.7% – newborns of mothers exposed to ETS and 31.4% – babies of mothers who did not smoke and were not exposed to tobacco smoking (Fig. 3).

Analyzing the risk factors of the low birth body weight, a statistically significant difference was observed
in the socio-economic status of mothers of these newborns (age, education, professional activity during pregnancy, marital status and average gross income per one family member).

60.3% of newborns constituted newborns, who obtained 7-10 points and 39.7%, obtained 0-6 points during the first minute after delivery in the Apgar scale.

The analysis of risk factors of the low score of newborns in the Apgar scale demonstrated a statistically significant difference in the socio-economic status of mothers of these newborns (age, education, professional activity during pregnancy, type of performed work, marital status and average gross income per one family member).

Among the newborns, who obtained 7-10 points, the babies of mothers who did not smoke during pregnancy constituted the greatest percentage – 52% in comparison with the newborns of mothers exposed to ETS – 30.9% and newborns of smoking mothers – 17.1%. This difference amounted to 34.9% in comparison with the newborns of smoking mothers and 21.1% in comparison with the newborns of mothers exposed to ETS. The difference between the newborns of tobacco smoking mothers, and mothers exposed to ETS amounted to 13.8%.

The group of newborns, who obtained from 0 to 6 points constituted 49% of newborns belonging to mothers who did not smoke, 31.2% of babies delivered by mothers smoking passively and 19.8% of newborns of tobacco smoking mothers.

The mean pH value of arterial cord blood in the case of all newborns was almost the same and amounted to 7.24 ± 0.08.

The conducted determination of cotinine in a randomly selected group of women demonstrated that the concentration of this marker of active and passive tobacco smoking amounted to 203 ng/mg of creatinine only in the one case of one woman declaring non-smoking in the nearest surroundings. The spread of this marker of active and passive smoking is still related to a great percentage of smoking people and the habit of smoking cigarettes in the presence of non-smokers, especially small children [29].

In our own studies, 18.2% of women declared tobacco smoking during pregnancy, and almost one third of the study population reported exposure to ETS during pregnancy.

The results of our own studies coincide, among other things, with the results of Finnish studies, which demonstrated that tobacco smoking during pregnancy was particularly prevalent among younger women and among women having lower education [26]. A higher percentage of passively smoking women was recorded among the inhabitants of the Łódź (central Poland) region than in our own studies. It amounted to 68.6% but in our study around 45% [13]. The younger women constituted almost 75%, 51.9% claimed to have primary or vocational education, the unmarried women were prevalent among them. In Canada and USA, the exposure to ETS was declared by 49% and 44% of pregnant women, the highest percentage of passive exposure was in Sweden and Japan – 74% and 81.2% women respectively [5].

In the recent years, there have been many papers confirming the negative impact of exposure of pregnant women to tobacco smoke on the development of a fetus and the health condition of newborns [12, 16, 23, 24]. It is estimated that smoking one cigarette is related to lowering the birth body weight by 8-9 g on average. In our studies, the newborns of mothers smoking cigarettes during pregnancy were significantly lighter, even by 332 g on average, in comparison with the newborns of women who did not smoke. A small birth body weight was represented by 7.9% of the tested population. The mean birth body weight of newborns with the body weight below 2500 g amounted to 1951 ± 530 g. The mothers smoking cigarettes during pregnancy gave birth to newborns with low birth body weight more frequently in comparison with the newborns of mothers who did not smoke –16.5% and by 27.2% more frequently in relation to the newborns of passively smoking mothers.

The newborns with the body weight lower than 2500 g were delivered significantly more often by younger women: aged up to 25 – 38.8%, within the age of 25-29 – 40%, with vocational education – 30% and secondary education – 31.3%, professionally active during pregnancy – 78.8%, married women – 88.1%, and women with an average gross income per one family member at a low level – 31.6% and at an average level – 50%.

In all-Polish studies, dependence between tobacco smoking by pregnant women and education level was observed. It was claimed that 40% of women with primary education smoked cigarettes in relation to only 21% of women with higher education [27]. Apart from that, a very high percentage of smokers – 45% within
the group of the youngest women was demonstrated [13]. In the U.S. the highest increase in the percentage of women smoking during pregnancy was recorded among the youngest women, that is, in the age between 15 and 19 – 17.2%, and the lowest one was observed within the group of women aged 40-49 – 10.1% [1].

The exposure of a fetus to tobacco smoke in the prenatal period is one of the risk factors of premature deliveries. Within the studied population of newborns, premature babies constituted a group of 11.5% of the studied babies.

The newborns of mothers who did not smoke were dominant among them – 42.9%, then, there were newborns of mothers smoking cigarettes during pregnancy – 29.1%. The smallest percentage covered newborns of mothers inhaling tobacco smoke during pregnancy – 28%.

The obtained results did not allow observing the statistically significant dependence between tobacco smoking during pregnancy and the risk of occurrence of premature delivery, however, among the newborns born on time, the smallest group was formed by newborns of smoking mothers – 16.8%.

The premature deliveries were observed significantly more often in the case of younger mothers: aged up to 25-39.2%, aged between 25-29 – 40.2%, having vocational education – 31% and secondary education – 31.2%, professionally active during pregnancy – 79.2%, inhabitants of Poznan – 54.5%, married women – 88%, and also women whose average gross income per one family member was at a low level – 31.1% and average level – 49.7%.

A clear impact of tobacco smoking on the frequency of occurrence of premature deliveries was observed in the studies carried out by Karwan-Plonska. The greatest number of premature deliveries occurred between ages of 25-35. It was noticed that the risk of premature delivery doubled in the case of women giving birth for the first time after the age of 30, and increased six times in the case of women in the age of 35 [17]. According to Peacock and co-authors, premature deliveries are more frequently observed among women coming from lower social class, having lower education and lower incomes [21].

The premature babies as well as the newborns delivered more often in the case of younger mothers: aged up to 25-39.2%, aged between 25-29 – 40.2%, having vocational education – 31% and secondary education – 31.2%, professionally active during pregnancy – 79.2%, inhabitants of Poznan – 54.5%, married women – 88%, and also women whose average gross income per one family member was at a low level – 31.1% and average level – 49.7%.

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The premature babies as well as the newborns delivered on time are evaluated according to the Apgar scale just after the delivery. The analysis of data of the National Collaborative Perinatal Project concerning the height of the Apgar scale at the first and fifth minute after the delivery, demonstrated a 4-time increase in the risk of low score, if mothers smoked 41-60 cigarettes a day [11].

In the presented studies, the group of 1528 newborns consisted of 922 newborns, who obtained 7-10 points in the Apgar scale during the first minute after delivery, 606 newborns obtained from 0 to 6 points in the first minute after the delivery. On the other hand, among the newborns, who obtained 7-10 points, the greatest percentage covered the newborns of mothers who did not smoke and who were not exposed to ETS during pregnancy – 52% in comparison with the newborns of mothers exposed to ETS – 30.9% and newborns of smoking mothers – 17.1%. The difference amounted to 34.9% in comparison with the newborns of non-smoking mothers and 21.1% in comparison with the newborns of women exposed to ETS. The difference between these groups in the Apgar scale amounted to 13.8%.

The group of newborns, who obtained from 0 to 6 points, contained 49% of babies belonging to mothers who did not smoke. There were 31.2% of babies belonging to mothers smoking passively and 19.8% of babies of smoking mothers. Comparing the percentage of newborns from the nonsmokers group with the newborns of women exposed to ETS, the difference amounted to 17.8% and 29.2% when comparing the nonsmokers group with the newborns of women who did not smoke.

The analysis of risk factors of the low score of newborns in the Apgar scale demonstrated a statistically significant difference in the socio-economic status of mothers of these newborns (age structure, education, and professional activity during pregnancy, type of performed work, civil status and average gross income per one family member).

Cotinine as a biomarker is used by many authors [3, 14, 22]. In the studies which have been conducted by us for many years with the application of cotinine as a biomarker of tobacco smoking, depending on the studied group, the concentration of cotinine ranged from 0.0 to 6234 ng/mg of creatinine [6-9]. A relatively low concentration of cotinine in the group of smokers in comparison with women in the procreative age indicates a reduction in the number of smoked cigarettes by pregnant women.

To sum up the results of conducted study, it must be stated that only a slightly lower percentage of pregnant women smoke cigarettes (18.2%) in comparison with the general population of women in Poland (about 23%). On the other hand, less pregnant women were exposed to ETS than in the general population, where the percentages reach about 60%. The socio-economic characteristics of smoking women were in compliance with the ones described by other authors. Smoking women usually are younger with primary or vocational education, the ones who were worked during pregnancy and performed a blue collar work, and whose average gross income per one family member was at the low or average level.

In the case of smoking women, the risk of premature delivery was greater, and the newborns were lighter by about 330 g than the newborns of non-smoking women. On the other hand, the exposure to ETS did not affect the birth body weight.

The obtained results constitute the next confirmation of the necessity of total contraindication for tobacco smoking by pregnant women.
References

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