Exposure to environmental tobacco smoke by healthy children aged below five (Preliminary study)

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Abstract

Aim: Children are commonly affected by environmental tobacco smoke. The presence of exposure can be deduced from urinary urine cotinine/creatinine ratio and history. The aim of this study was to investigate passive smoking in healthy children between one-month and five year old, and to determine the adverse effects of passive smoking on child health.

Material and Methods: Children between one-month and five year old who were regularly monitored for health were included following informed consent given by their parents. The questionnaire method was used. Demographic variables, respiratory tract infections, recurrent infections were questioned. The levels of cotinine, creatinine were measured and the cotinine/creatinine ratios were calculated in urine specimens taken from the children. Growth status and infection frequency were determined using demographic data, cotinine/creatinine ratios in urine, exposure rate to second-hand tobacco smoke of the children.

Results: The ratio of household smokers was 70.3%, the ratio of non-smokers was 29.7%. Fifty percent of the mothers were smokers. Urinary cotinine/creatinine ratios were found to be significantly higher in children of smokers compared with children of non-smokers ($p=0.011$). One third of the children was evaluated as passive smokers. The presence of a smoker at home and the increase in the number of cigarettes smoked during the day increased the frequency of acute respiratory infections ($p=0.047$).

Conclusion: In these regularly-monitored preschool children, we found frequent exposure to cigarette smoke. This study contributes to national data and will aid in increasing the awareness for the deleterious effects of passive smoking on child health.

Keywords: Child, cigarette, cotinine in urine, environmental tobacco smoke, passive smoking, second-hand smoking

Introduction

It has been reported that tobacco accounts for six million deaths annually and 11,000 deaths every day worldwide. Smokers constitute approximately five million of these deaths and passive smokers constitute about 600,000 (1). If no change occurs in the prevalence of smoking, it is predicted that 10 million individuals will lose their lives annually in the 2020s and 2030s, and 70% of the deaths will affect developing countries (2).

Environmental tobacco smoke (ETS) is a pollutant that is considerably highly harmful for human health and

which can be encountered everywhere. Exposure to environmental tobacco smoke is considerably important in terms of its prevalence and the fact that it can be prevented. Inspiration of all harmful substances included in tobacco smoke by nonsmokers by exposure to smoke of individuals who smoke at home, in workplaces, and in closed places where people are found collectively is defined as 'passive smoking.'

Worldwide, the incidence of passive smoking is high in children in developed and developing countries. Both worldwide and in Turkey, the number of children who are involuntarily exposed to tobacco smoke by being

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in the same environment with family members who smoke is increasing (3-6). Smoking by adults at home or near children is also important in terms of serving as a negative model (7).

Passive smoking (PS) is one of the issues currently being discussed intensively with different aspects ranging from its medical outcomes to sociologic and legal dimensions. When this issue is addressed in terms of exposure of children, it is generally observed that children are passive smokers because of close family members who smoke. Various health problems may emerge in children according to the degree of passive smoking. These problems include mainly intrauterine growth retardation, low birth weight, increased mortality at birth and in the neonatal period, decreased lung function, bronchitis, pneumonia, asthma, otitis media, neurodevelopmental delays, behavioral problems, reduction in academic success and sudden infant deaths (8-11). It is known that tobacco smoke has negative effects on the health of infants, especially in the first year of life (12). In addition, a relationship has been shown between PS and sudden infant death (8, 13). In children who are exposed to indoor or outdoor ETS, an increase has been found in the nasal mucociliary clearance time when compared with healthy children (14).

It is known that environmental tobacco smoke has more than 4000 chemical components. These components cause the formation of high amounts of exogenous free radicals. Cigarette smoke contains large amounts of free radicals (e.g., superoxide, hydroxyl radical, nitric oxide). Inhalation and exhalation of cigarette smoke just once causes the entrance of 10^{14} molecules or more free radicals into the environment and respiration. These radicals may act by directly increasing oxidative load. Increased oxidative load may harm various biologic macromolecules (15).

The most important and reliable biologic indicator of nicotine is cotinine in smokers and individuals who are exposed to environmental tobacco smoke (16).

The objective of this study was to determine the prevalence of passive smoking and level of exposure to smoke in young children aged between 1 month and 5 years who were under regular follow-up.

Material and Methods

This cross-sectional study was conducted between October 2016 and January 2017 in Dokuz Eylül University,

Faculty of Medicine, Department of Pediatrics, Pediatric Follow-up Outpatient Clinic.

Ethics committee approval was obtained for the study from Dokuz Eylül University, Faculty of Medicine, Non-interventional Research Studies Ethics Committee (file number: 2696-GOA) (dated 05.12.2016, decision number 2016/13-12).

Children aged between 1 month and 5 years who presented to the Pediatric Follow-up Outpatient Clinic were included in the study. Informed consent forms were given to the families of the children who presented and it was ensured that they were read by the families. Subsequently, written informed consent was obtained from the families. A questionnaire using the face-to-face interview technique was applied to 64 families who accepted to respond to the questionnaire questions and to give urine samples of their children during the day. The families were asked about the history of exposure to ETS by their children.

The independent variable obtained by way of the questionnaire was determined as the state of exposure of the children to environmental tobacco smoke and the dependent variables were determined as demographic properties, presence of history of respiratory infection, presence of a diagnosis of asthma, and the number of hospitalizations.

A total of 33 questions were included in the questionnaire. The questions related with the interviewed individual included the degree of proximity, maternal age, maternal employment status, paternal age, employment, education status, social security, presence and number of indoor smokers, the total number of cigarettes smoked daily, how long indoor smoking continued, if the mother smoked during pregnancy, the number of daily cigarettes during pregnancy, and if the child had a room for themselves.

The other questions involved the child's age, sex, gestational week, birth weight, the time of exclusive breastfeeding, how many hours the child spent at home, if the child attended kindergarten, if the child was diagnosed as having upper or lower respiratory infection and ear infection, the number of these diagnoses, if they were hospitalized, the number of hospitalizations, and the diagnoses of these hospitalizations. On physical examination, the body weights and heights of the children and head circumferences of children aged below 2 years were measured and recorded.

In addition, a sample of urine of approximately 10 mL was obtained in a urine collection bag or a sterile urine container from all children included in the study for measuring urine cotinine levels. The urine samples were kept at -80°C after they were centrifuged. Urine cotinine measurements were performed using a Im-mulite 2000 XPi device with a chemiluminescence immunoassay (Siemens, New Jersey, USA). Creatinine levels were also measured in the urine samples. Cotinine/creatinine ratios (UCCR) were calculated (ng/mg) by measuring urine creatinine levels because 24-hour urine was not collected.

A urine cotinine threshold value (ng/mL) below 10 was considered 'no exposure,' a value of 10-500 was considered as 'passive smoker,' and a value above 500 was considered as 'active smoker.' A urine cotinine/creatinine ratio of 30 and below was considered as 'no exposure' and a value above 30 was considered as 'passive smoker' (17, 18).

Urine cotinine levels and cotinine/creatinine ratios were associated with maternal smoking status (current and during pregnancy), presence of indoor smokers, number of cigarettes smoked indoors, and presence of history of respiratory tract infection and asthma.

Statistical Analysis

A licensed SPSS 22.0 package program was used for statistical analysis of the data obtained in our study. The Chi-square test was used to compare the proportional values of the categorical variables. A p value of <0.05 was considered statistically significant.

Results

Forty-seven (73.4%) children aged between 1 and 12 months, nine (14.1%) children aged between 13 and 24 months, three (4.7%) children aged between 25-36

months, and five children (7.8%) aged between 37 and 60 months were included in the study. Fifty (78.1%) of the subjects were male and 14 (21.9%) were female. The mean gestational age of the subjects was found as 38.2 ± 1.3 weeks. The mean birth weight was 3347 ± 548 grams.

The mean current body weight was found as 8.3 ± 3.4 kg and the mean current height was 70 ± 13.5 cm. Fifty-six (87.5%) children were found to have a weight-for-height value above 90 and eight (12.5%) children had a weight-for-height value between 81 and 90. The weight percentile and the height percentile were between 3% and 97% in 57 subjects (89.1%).

When the urine cotinine levels were measured, it was found that 33 (51.6%) children had a urine cotinine level below 10, which indicated 'no exposure,' and 31 children (48.4%) had a urine cotinine level between 10 and 500. Forty-seven children (73.4%) were found to have a urine cotinine/creatinine level of 30 and below and 17 children (26.6%) had a urine cotinine/creatinine level above 30.

Among 32 mothers who smoked, a history of respiratory tract infection was present in the children of 17 mothers. Fifteen of 32 nonsmoker mothers reported that their children had previously had a respiratory tract infection. There was no significant difference between the two groups ($p=0.209$).

The UCCR values of the subjects by maternal smoking status are shown in Table 1. The UCCR value was above 30 as a positive marker in the children of 13 of 32 mothers who smoked and in the children of four of 32 nonsmoker mothers. A statistically significant difference was found between the two groups ($p=0.011$). Seventeen (26.6%) of the subjects were considered as passive smokers.

Table 1. Urine cotinine/creatinine ratios of the subjects by maternal smoking status

			UCCR (ng/mg)		Total	p
			30 and below	Above 30		
Maternal smoking status	Smoker	Number (n)	19	13	32	0.011
		Percentage	59.4%	40.6%	100.0%	
	Non-smoker	Number (n)	28	4	32	
		Percentage	87.5%	12.5%	100.0%	
Total	Number (n)	47	17	64		
	Percentage	73.4%	26.6%	100.0%		

UCCR: urine cotinine/creatinine ratio

($\chi^2=6.488$)

Table 2. Urine cotinine/creatinine ratios by presence of indoor smokers

			UCCR (ng/mg)		Total	p
			30 and below	Above 30		
Presence of indoor smoker	Yes	Number (n)	29	16	45	0.012
		Percentage	64.4%	35.6%	100.0%	
	No	Number (n)	18	1	19	
		Percentage	94.7%	5.3%	100.0%	
Total	Number (n)		47	17	64	
	Percentage		73.4%	26.6%	100.0%	

UCCR: urine cotinine/creatinine ratio ($\chi^2=6.284$)**Table 3. History of respiratory tract infection by urine cotinine/creatinine ratios**

			ARTI		Total	p
			Yes	No		
UCCR (ng/mg)	30 and below	Number (n)	19	28	47	0.192
		Percentage	40.4%	59.6%	100.0%	
	Above 30	Number (n)	10	7	17	
		Percentage	58.8%	41.2%	100.0%	
Total	Number (n)		29	35	64	
	Percentage		45.3%	54.7%	100.0%	

ARTI: acute respiratory tract infection; UCCR: urine cotinine/creatinine ratio;
($\chi^2=1.705$)**Table 4. History of respiratory tract infection by the number of cigarettes smoked indoor**

			ARTI		Total	p
			Yes	No		
Number of cigarettes smoked indoor	<6	Number (n)	7	19	26	0.015
		Percentage	26.9%	73.1%	100.0%	
	6 and above	Number (n)	22	16	38	
		Percentage	57.9%	42.1%	100.0%	
Total	Number (n)		29	35	64	
	Percentage		45.3%	54.7%	100.0%	

ARTI: acute respiratory tract infection
($\chi^2=5.976$)

The UCCR values of the subjects by indoor smoking status are shown in Table 2. A significant difference was found between the UCCR values ($p=0.012$).

In Table 3, a comparison of the states of having infection by UCCR is shown. Accordingly, a significant difference was not found between the groups with and without infection in terms of the UCCR value ($p=0.19$).

Comparison of the histories of previous respiratory tract infection by the number of cigarettes smoked indoors is shown in Table 4. Accordingly, a significant difference was found between the children who lived

in homes where nobody smoked or less than six cigarettes were smoked daily and the children who lived in homes where more than six cigarettes were smoked daily in terms of presence of history of respiratory tract infection ($p=0.015$).

Discussion

Children are mostly affected by ETS at younger ages. It is known that tobacco smoke has negative effects on the health of babies especially in the first year of life (5). The subjects included in our study were aged between 1 month and 1 year. Boys constituted the majority. This

difference was related with the fact that urine sample could be obtained more easily from the boys. However, it was observed that the difference in sex distribution did not affect the results in terms of passive smoking. Fifty boys and 14 girls were included in the study. The number of passive smokers who had a UCCR above 30 was 11 among 50 boys and 6 among 14 girls. No significant difference was found in passive smoking in terms of sex ($p=0.17$). In the literature, no studies have investigated sex difference in passive smoking.

Studies have shown that the cotinine level, which is an objective measure, should be used together with information given by families when determining the rates of passive smoking in children. In our study, the rate of passive smoking was found as 26.6%. The prevalence of passive smoking determined with cotinine measurement in children ranged between 53% and 85% in studies conducted in Turkey (4-6). The low prevalence of passive smoking found in our study might be related with the low number of samples.

In our study, a questionnaire was applied to the families primarily to assess exposure to ETS; subsequently cotinine and creatinine levels were measured in urine samples obtained from the children and the cotinine/creatinine ratios were calculated. Various studies have reported that the information given by parents about their children's exposure to ETS are not associated with cotinine levels measured in urine and thus history by itself cannot be sufficient (19, 20). In our study, no significant difference was found between the children of smoker mothers and nonsmoker mothers in terms of urine cotinine levels. Karadağ et al. (21) emphasized that the answers given by the parents of children who presented with asthma attack were not compatible with cotinine levels measured in urine samples and therefore, the information obtained from parents about exposure to ETB by itself was not reliable. Epidemiologic studies have reported that incompatibilities are observed between the presence of ETS determined by familial report the presence of ETS determined after numeric measurement similar to our study (22-24).

In our study, no significant difference was found between the groups when the smoking states were compared by maternal education level. In the study conducted by Çınar et al. (25), it was shown that the children of one-fifth of the smokers were exposed to indoor ETS, even though the majority of parents knew the negative effects of ETB on children. This points to the scarcity

of awareness raising studies and that insufficient attention is being drawn to this issue independent of the socioeconomic level. Social campaigns and raising the awareness of the public are very important in this issue.

In the study conducted by Çobanoğlu et al. (26) with children aged between 9 and 12 years, urine cotinine levels were found to be significantly higher in students whose fathers smoked compared with those whose fathers did not smoke. Irvine et al. (27) found a positive relation between the number of indoor smokers and the number of cigarettes smoked and urine cotinine levels. Arvas et al. (28) reported that children of mothers who smoked had a history of significantly higher number of acute respiratory infections (ARTI) compared with children of nonsmoker mothers, and children who were exposed to indoor smoking had a history of significantly higher number of acute upper respiratory infections compared with those who were not exposed to indoor smoking. Keskinoglu et al. (18) specified a positive correlation between UCCR and the frequency of respiratory tract infection. In our study, it was found that the frequency of respiratory tract infection increased with the presence of indoor smoking and with increased numbers of cigarettes smoked.

As a result of our study, no significant difference was found in urine cotinine levels between children whose mothers smoked and children whose mothers did not smoke. However, a significant difference was found in the UCCR. This finding indicates why the use of the UCCR instead of cotinine is more reliable in conditions where 24-hour urine cannot be collected in children (29).

It is thought that smoker mothers and/or cohabitants are responsible of 15% of premature deliveries, 20-30% of low birth weight infants, and a 15% increase in perinatal and neonatal mortality rates (30). In our study, no difference was found in terms of respiratory tract infections or birth weight in the children of nine mothers who smoked during pregnancy.

Epidemiologic studies show that children exposed to ETS have more frequent and more severe respiratory tract diseases. In our study, a significant increase in lower respiratory tract infections was found in the presence of indoor smokers. In these children, no significant difference was found between urine cotinine levels, but a significant difference was obtained between the cotinine/creatinine ratios. In a study conducted with a total of 609

children with acute bronchiolitis and healthy children, UCCR values were found to be significantly higher in the children with bronchiolitis compared with the healthy children (31). In a study in which passive smoking was investigated, the mean urine cotinine level was found as 10 ng/mL in children with asthma and 4.8 ng/mL in healthy children, and this difference was found to be statistically significant (32). In another study, the urine cotinine levels measured in children with asthma aged below 10 years were found to be higher in children who were exposed to ETS compared with those who were not exposed to ETS (33). It was found that cotinine was determinative for severe asthma.

Exposure to environmental tobacco smoke is an important and preventable risk factor for respiratory tract diseases in children. It has been found that exposure to ETS is associated with an increase in respiratory symptoms including wheezing and cough in children of all ages. In the study conducted by Çınar et al. (30), it was found that the frequency of hospitalization in children with pneumonia and bronchiolitis was 2-fold higher in children who were exposed to smoke compared with those who were not exposed to smoke, and three-fold higher in children who were hospitalized because of asthma (31-39).

In the study conducted by Habesoglu et al. (11), it was found that the nasal mucociliary time increased in children who were exposed to indoor or outdoor ETS compared with healthy children. Therefore, they concluded that nasal obstruction and various structural changes in the nasal mucosa might occur in children exposed to ETS, and ETS had negative effects on ciliary efficiency and mucociliary function.

The strengths and limitations of our study

Exposure to environmental tobacco smoke remains a current issue because it is a preventable problem and the outcomes result when it is not prevented have threatening dimensions. In Turkey, there is a limited number of studies investigating exposure to ETS in pre-school children. Therefore, our study has a contribution to the national literature.

When using questionnaires, there is a probability that information obtained from families may be misremembered or incorrect answers may be given even though a face-to-face interview technique is used. The sample size in our study was limited because most of the families did not give consent to obtaining urine samples from their children.

Conclusion and recommendations

- Exposure to environmental tobacco smoke is common in children aged below five years who are under regular follow-up.
- This condition can be demonstrated with the measurement of cotinine levels in urine besides history taken from families. However, this measurement is not determinative by itself. Therefore, the UCCR should be calculated by measuring urine creatinine levels.
- The frequency of acute respiratory infection increases in proportion to the presence of indoor smokers and increased number of cigarettes smoked in children exposed to environmental tobacco smoke.
- Exposure to ETS should be addressed in the scope of 'child neglect.'
- The status of exposure to ETS should definitely be investigated in children who present to healthcare institutions with any reason or who are hospitalized and individual consultancy service should be provided to parents in this issue.
- Aeration and methods including dividing public areas as smoking and non-smoking areas do not prevent ETS. One hundred percent smoke-free environments should be established to remove environmental tobacco smoke from the environment.
- It should be enabled that public areas and all workplaces are 100% smoke-free and smoking should also be forbidden in open areas in healthcare institutions and schools.
- It should be enabled that regulations are implemented.
- Effective education methods should be developed.
- Mothers should be informed about the issues of not smoking and protecting themselves from ETS, especially during pregnancy and breastfeeding periods.

Ethics Committee Approval: The Ethics Committee of The Faculty of Medicine approved the study (12.05.2016, 2016/13-12).

Informed Consent: Written informed consent was obtained from the parents of the children.

Peer-review: Externally peer-reviewed.

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