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The Effects of Second-hand Smoke Exposure on Asthma Symptoms in Children

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Abstract

Objective – The aim of study was to evaluate the effects of parental smoking and tobacco smoke exposure (TSE) on asthma symptoms in children, and to raise awareness of the detrimental effects of TSE for asthmatic children. **Methods** – A modified and validated questionnaire on TSE was completed by 76 parents and their children who were being treated at Srebrnjak Children's Hospital for asthma. Patients filled in a standardized ACT questionnaire about their asthma symptoms, whereas parental smoking data were derived from a questionnaire filled in by the parents. The answers were structured as ordinal and categorical variables. The non-parametric Mann-Whitney U test and Kruskal-Wallis test were performed. **Results** –There are statistically significant differences in the frequency of asthma symptoms in children depending on whether household members smoked cigarettes, with statistically significant differences in the frequency of asthma symptoms in children depending on whether their parents smoked cigarettes outside the house, only in one/certain room or everywhere in the house. 34.1% of smoking parents vs 9.4% of non-smoking parents allow smoking in a car while the child is riding in it. 40.9% of parents who smoke vs 21.9% of non-smoking parents believe that their child is exposed to tobacco smoke somewhere other than in their household or car. **Conclusion** – TSE is associated with more symptoms and worse asthma control in asthmatic children.

Key Words: Childhood Asthma ▪ Second-Hand Smoke ▪ Exposure ▪ Asthma Symptoms, Wheezing.

Introduction

According to the World Health Organization, about half of the world's pediatric population, or about 700 million children, are significantly exposed to tobacco smoke (1). The prevalence of smoking in Croatia is among the highest in Europe. Currently, the prevalence of smoking in Croatia is higher among men than women (38% vs. 32%), while the EU average among men is 30% vs. 22% among women (2). Housing and living in families with smoking parents remain a major source of second-hand smoke (SHS) exposure for children (3). Tobacco smoke is a mixture of toxic and carcinogenic components, with over 5000 different chemicals (4). Children are particularly susceptible to the effects of second-hand smoke due to their high respiratory rates, and immature respiratory organs and immune response (5).

Asthma is a major chronic disease that seriously affects child health worldwide (6). In recent years, the morbidity and mortality caused by asthma are increasing (7). Tobacco smoke is an important factor inducing asthma (8). There is no doubt that children living in smokers' families are exposed to cigarette smoke and will be affected by passive smoking. Understanding the relationship between SHS exposure and asthma in children is of great significance in disease phenotyping, and the control and prevention of the development of childhood asthma (9). Smoking has significant negative effects on the respiratory system of asthmatic patients, not

only causing frequent asthma and destroying their lung function, but also reducing the therapeutic results of oral glucocorticoids (10).

The aim of our study was to evaluate the effects of parental smoking and tobacco smoke exposure (TSE) on asthma symptoms in children. Our aim was also to highlight the need for raising awareness about the detrimental effects of SHS to asthmatic children, both of health professionals who are included in their treatment, and of parents, especially those who expose their children to tobacco smoke.

Methods

In this study a cross-sectional study was performed on 76 children who were being treated for asthma at Srebrnjak Children's Hospital, Zagreb, Croatia. A modified and validated questionnaire on TSE was completed by the parents/legal guardians and their children during clinical assessment at the tertiary pediatric asthma clinic over the month of February 2019. Participation was voluntary and anonymous so additional ethical permission was not needed from the Ethics Committee. We assessed SHS exposure through the parental questionnaires for all parents of children aged 4-16 involved in the study. Exposure at age 17 was assessed using adolescent questionnaires if the participants had moved out of their parents' home. Residential SHS exposure was assessed in relation to reports of anybody smoking inside the home (yes; yes, but less than once a week; never).

All participating patients filled in a standardized ACT questionnaire about their asthma symptoms (children older than age 12 completed the questionnaire on their own, and younger children with the help of their parents/legal guardians) (11). Seven outcomes were analysed: asthma control level, asthma control during physical activity, cough due to asthma, waking up at night due to asthma, any asthma symptoms during the day in the past 4 weeks, daytime wheezing in the past 4 weeks, and nighttime wheezing in the past 4 weeks.

Residential SHS exposure was assessed by reports from a questionnaire filled in by the parents. Nine questions aimed to analyze the smoking environment in their homes and in their car, thus giving us information about TSE in our patients. The answers were structured as ordinal and categorical variables.

Ethics Statement

Ethical approval is not applicable for this article. Verbal informed consent was obtained from a legally authorized representative for the anonymized patient information published in this article.

Statistical Analysis

We performed the non-parametric Mann-Whitney U test and Kruskal-Wallis test and obtained the results given below. The threshold value of $P<0.05$ was considered statistically significant for all performed tests. Statistical analyses were performed using SPSS Statistics, version 22 (IBM®, Corp., Armonk, New York, USA)

Results

There were statistically significant differences in the frequency of asthma symptoms in children depending on whether household members smoke cigarettes. The differences were observed in the following: any asthma symptoms during the day in the past 4 weeks (P=0.004) (Fig. 1), cough (P=0.005) (Fig. 2), waking up at night due to asthma (P=0.023) (Fig. 3), daytime wheezing in the past 4 weeks (P=0.026) and night-time wheezing in the past 4 weeks (P=0.045) (Table 1). 34.1% of smoking parents vs 9.4% of non-smoking parents allow smoking in a car while the child is riding in it. 40.9% of parents who smoke vs 21.9% of non-smoking parents believe that their child is exposed to tobacco smoke somewhere other than in their household or car.

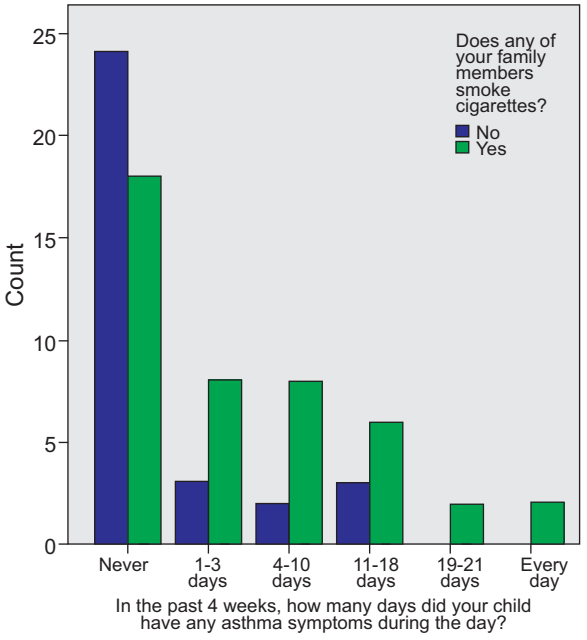

Fig. 1. *Correlation of having any asthma symptoms during the day in the past 4 weeks with having cigarette smokers in the family.*

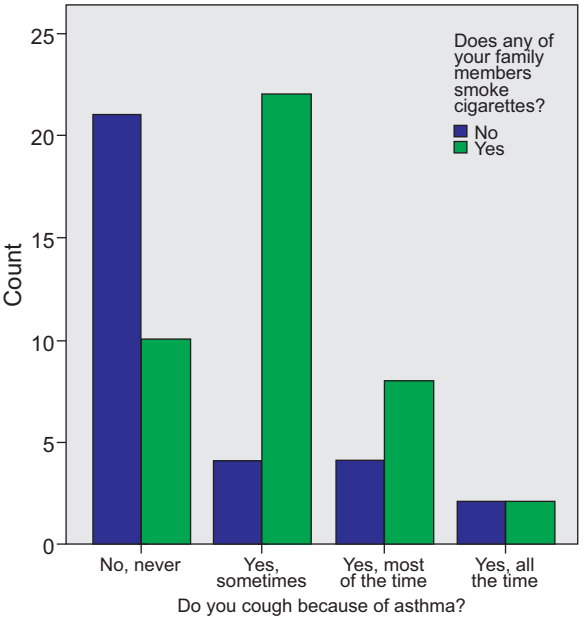

Fig. 2. *Correlation of coughing because of asthma with having cigarette smokers in the family.*

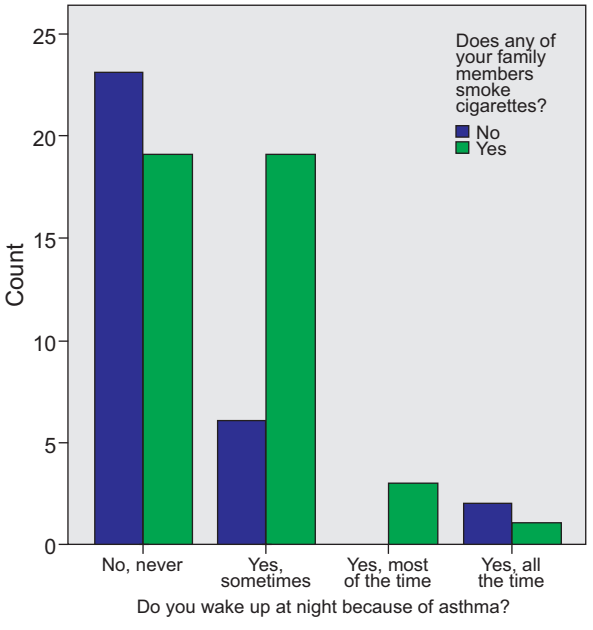

Fig. 3. *Correlation of waking up at night because of asthma with having cigarette smokers in the…?*

There are statistically significant differences in the frequency of asthma symptoms in the children depending on whether their parents smoke cigarettes outside the house, only in one/certain room or everywhere in the house (Table 2).

Table 1. Asthma Symptoms in Children Depending on Whether Household Members Smoke Cigarettes

Set of questions in the survey/ questionnaire	Smokers in household	Median*	Mean*	SD†	P‡
How is your asthma today? §	Yes (N=42)	2	1.71	0.71	0.149
	No (N=31)	1	1.55	0.89	
How much does your asthma bother you when you run, exercise or play sports? ǁ	Yes (N=42)	1	0.74	0.77	0.284
	No (N=31)	0	0.65	0.98	
Do you cough because of asthma?¶	Yes (N=42)	1	1.05	0.79	0.005
	No (N=31)	0	0.58	0.96	
Do you wake up at night because of asthma?**	Yes (N=42)	1	0.67	0.72	0.023
	No (N=31)	0	0.39	0.80	
In the past 4 weeks, how many days did your child have asthma symptoms during the day?††	Yes (N=44)	1	1.36	1.48	0.004
	No (N=32)	0	0.5	0.98	
In the past 4 weeks, how many days did your child wheeze when breathing during the day due to asthma?‡‡	Yes (N=44)	1	1.11	1.38	0.026
	No (N=32)	0	0.66	1.40	
In the past 4 weeks, how many days did your child wheeze when breathing during night due to asthma?§§	Yes (N=44)	0	0.91	1.34	0.045
	No (N=32)	0	0.53	1.32	

* The answers were structured as ordinal variables; † Standard deviation; ‡ Statistical analysis was done using a Mann-Whitney U test § 1- very good, 2-good, 3-bad, 4-very bad; ǁ 0-it doesn't bother me at all, 2-it bothers me a little, 3- it bothers me and I don't like it, 4- it bothers me a lot; ¶ 0-never, 1-sometimes, 3- most of the time, 4-all the time; ** 0-never, 1-sometimes, 3- most of the time, 4-all the time; †† 0-never, 1- (1-3 days), 2-(4-10 days), 3-(11-18 days), 4-(19-24 days), 5-every day; ‡‡ 0-never, 1- (1-3 days), 2-(4-10 days), 3-(11-18 days), 4-(19-24 days), 5-every day; §§ 0-never, 1- (1-3 days), 2-(4-10 days), 3-(11-18 days), 4-(19-24 days), 5-every day.

Table 2. Asthma Symptoms in Children Depending on Whether Smoking Cigarettes Is Allowed outside the House, Only in One/certain Room or Everywhere in the House

Set of questions in the survey/ questionnaire	Where is allowed to smoke in household	Median*	Mean*	SD†	P‡
How is your asthma today? §	Anywhere inside the house (N=8)	2	2.25	1.03	0.002
	Only in a certain rooms (N=8)	2	2.25	0.46	
	Only in one room (N=10)	2	1.70	0.67	
	Only outside the house (N=43)	1	1.42	0.70	
How much does your asthma bother you when you run, exercise or play sports? ǁ	Anywhere inside the house (N=8)	1	1.37	1.19	0.001
	Only in a certain rooms (N=8)	1	1.38	0.52	
	Only in one room (N=10)	1	0.7	0.67	
	Only outside the house (N=43)	0	0.42	0.76	
Do you cough because of asthma?¶	Anywhere inside the house (N=8)	1	1.25	1.03	0.003
	Only in a certain rooms (N=8)	1.5	1.75	0.89	
	Only in one room (N=10)	1	1.2	1.03	
	Only outside the house (N=43)	0	0.56	0.7	
Do you wake up at night because of asthma?**	Anywhere inside the house (N=8)	1	1.25	1.03	<0.001
	Only in a certain rooms (N=8)	1	0.88	0.35	
	Only in one room (N=10)	1	1.10	1.19	
	Only outside the house (N=43)	0	0.26	0.44	

Set of questions in the survey/ questionnaire	Where is allowed to smoke in household	Median*	Mean*	SD†	P‡
In the past 4 weeks, how many days did your child have asthma symptoms during the day?††	Anywhere inside the house (N=8)	0	0.37	0.74	0.002
	Only in a certain rooms (N=8)	3	2.75	1.67	
	Only in one room (N=10)	1.5	1.4	1.35	
	Only outside the house (N=43)	0	0.39	1.20	
In the past 4 weeks, how many days did your child wheeze when breathing during the day due to asthma? ‡‡	Anywhere inside the house (N=8)	0.5	1.12	1.73	0.006
	Only in a certain rooms (N=8)	2.5	2.37	1.68	
	Only in one room (N=10)	1	1.2	1.23	
	Only outside the house (N=43)	0	0.63	1.24	
In the past 4 weeks, how many days did your child wheeze when breathing during night due to asthma?§§	Anywhere inside the house (N=8)	0.5	1.00	1.69	0.005
	Only in a certain rooms (N=8)	1.5	2.12	1.73	
	Only in one room (N=10)	0	0.80	1.23	
	Only outside the house (N=43)	0	0.50	1.15	

*The answers were structured as ordinal variables; †Standard deviation; ‡ Statistical analysis was done using a Kruskal-Wallis test; §1- very good, 2-good, 3-bad, 4-very bad; ‖ 0-it doesn't bother me at all, 2-it bothers me a little, 3- it bothers me and I don't like it, 4- it bothers me a lot; ¶0-never, 1-sometimes, 3- most of the time, 4-all the time; **0-never, 1-sometimes, 3- most of the time, 4-all the time; ††0-never, 1- (1-3 days), 2-(4-10 days), 3-(11-18 days), 4-(19-24 days), 5-every day; ‡‡0-never, 1- (1-3 days), 2-(4-10 days), 3-(11-18 days), 4-(19-24 days), 5-every day; §§0-never, 1- (1-3 days), 2-(4-10 days), 3-(11-18 days), 4-(19-24 days), 5-every day.

Discussion

Our study aimed to link TSE with increased asthma symptoms in children. In a major study by Pattenden et al. a pooled analysis of 53,879 children from 12 cross-sectional studies found strong evidence linking nocturnal cough to parental smoking (12). Another study in Manchester reported a statistically significant increase in the risk of night cough for children who lived in a household with smokers (13).

Our study showed that a high proportion of smoking parents allow smoking in the car while the child is riding in it. Exposure of children to tobacco smoke inside cars is especially concerning due to the very high concentrations of smoke in enclosed spaces (15). While many European countries have introduced very high fines for smoking in a vehicle with a minor (a child under 18 years old), unfortunately in Croatia this is not the case. Banning smoking in private vehicles carrying children has been successful in its main aim of reducing their exposure to tobacco smoke, but also to increase road traffic safety. A study conducted in UK in 2020 showed that banning smoking in cars with children in England was associated with a –4.1% absolute reduction (72% relative reduction) in exposure to tobacco smoke among children (16). Another study from Scotland elegantly demonstrated that banning smoking in vehicles correlated with a decline in asthma hospital admissions in preschool children (< 5 years old) over an 11 year period from when the legislation was introduced (17). We hope our study's data will contribute to the adoption of national legislation banning smoking in cars that carry children in Croatia.

Exposure to passive smoke is a common and avoidable risk factor for wheezing and asthma in children, and is absolutely preventable (18). The results of the KiGGS study in Germany show that the proportion of children in Germany who are exposed to SHS at home has declined significantly over the last few years. Smoke-free legislation has led to heightened awareness of the health risks of SHS, as well as to the denormalization of smoking. In this study, children whose parents smoke, and among them particularly children from socially disadvantaged families, were recognised as key target

groups when implementing future tobacco-control measures (19). The latest multiple cross-sectional study from Germany showed many positive outcomes. After 11 years of a smoking ban in Bavaria, smoking displacement to homes was disproved. Exposure of children to intrauterine SHS and at home is decreasing. The number of parents who do not actively smoke is increasing over time. The prevalence of health problems in children related to exposure to SHS is decreasing (20).

Limitations of the Study

There are some limitations to our work. Firstly, the amount of smoking could differ greatly from person to person. The number of cigarettes smoked per day was not included in this questionnaire. There might have been a direct dose-response relationship between the dose of smoking and respiratory outcomes (14). In further research, different variables characterizing the nature of exposure in more detail could be introduced, such as proximity, the type of cigarettes, exposure source, duration of exposure, and ventilation rates.

Secondly, there are limitations in the parental reports of TSE, which are subject to recall errors and desirability bias - for example, incentives to under- or overestimate exposure. Some non-smoking parents may exaggerate reports of exposure as a means of influencing another household member (a smoker) to quit smoking.

Thirdly, self-reported outcomes (questionnaires filled in by patients) with no scope for validation by a paediatrician may be subject to reporting errors. Our further research will be extended to evaluate the effect of TSE on lung function in asthmatic children, using lung function tests, such as spirometry. Furthermore, to determine SHS exposure in children better, tobacco smoke exposure quantification tests could be introduced in future studies (e.g. urine cotinine testing). The combination of parental and patient reports, together with intermittent confirmation by biological assays (spirometry, urine cotinine levels) could set the stage for reliable and valid measures of TSE which could be used in large-scale studies of tobacco control, and for additional exploration of the effects of TSE on health outcomes in asthmatic children.

Conclusion

TSE (exposure to SHS) is associated with increased symptoms in asthmatic children. Children whose parents do not smoke have less frequent asthma symptoms, such as wheezing and cough. Children whose parents smoke outside the home have less asthma symptoms than children whose parents smoke in the home. Children have little control over their environment, meaning legislation and enforcement of laws are crucial to protect their human right to health. Knowledge of the harm of secondhand smoke should be a major driver of smoking bans. Preventing parental smoking by engaging collaboratively with children and parents to increase awareness and challenge behaviour is essential to the prevention of asthma symptoms and childhood asthma management.

Authors' Contributions: Conception and design: AŠ and BN; Acquisition, analysis and interpretation of data: ML, AŠ and VD; Drafting the article: AŠ; Revising the article critically for intellectual content: MT and BN; Approved final version of the manuscript: MT.

Conflict of Interest: The authors declare that they have no conflict of interest.

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