

Correlating household second-hand smoke exposure and respiratory symptoms in school children

Korelacija između izloženosti pasivnom pušenju u kućnom okruženju i pojave respiratornih simptoma kod školske dece

Branislava Matic¹, Dragana Vujanovic², Snezana Dejanovic¹, Verica Jovanovic¹, Nela Djonovic³

1. Institute of Public Health of Serbia, Belgrade, Serbia
2. Faculty of Pharmacy, Belgrade University, Serbia
3. Faculty of Medical Sciences, University of Kragujevac, Serbia

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Branislava Matić¹, Dragana Vujanović², Snežana Dejanović¹, Verica Jovanović¹, Nela Džonović³

1. Institut za javno zdravlje Srbije, Beograd, Srbija
2. Farmaceutski fakultet, Beogradski Univerzitet, Beograd, Srbija
3. Fakultet medicinskih nauka Univerziteta u Kragujevcu, Kragujevac, Srbija

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ABSTRACT

Objective. Aim of this paper was to correlate exposure to household second-hand smoke and respiratory symptoms in participating school children, who are attending ten primary schools in Belgrade, Serbia.

Method. In order to determine correlation between second-hand smoke exposure at home and respiratory symptoms in primary school pupils, a comparative cross-sectional study has been conducted. The study was conducted in ten primary schools on 735 children, in 44 classrooms in Belgrade, Serbia. A standardized questionnaire was distributed to parents/caregivers, on child's respiratory health, socioeconomic status and parents' lifestyle habits, primarily cigarette smoking.

Results. 78% of all exposed children have parents smoking up to 20 cigarettes/day, while more than 22% are exposed to parents' household second-hand smoke of more than 21 cigarettes per day ($p < 0.0001$). Respiratory disorders appear in 45.9% of children exposed to domestic second-hand smoke (CI 1.04-1.89), asthmatic symptoms in 33.5% (CI 0.94-1.78), while the least incidence of disorders is reported for continuous cough, which have lasted for 3 months (3.3%, CI 0.44-2.36), wheezing after exercise (4.5%, CI 0.38-1.41) and being awoken by wheezing in last 12 months (7.4%, CI 0.89-3.28).

Conclusion. Univariate logistic regression analysis proved that parental smoking exposure is a statistically significant predictor for childhood respiratory symptoms' manifestation.

Key words: tobacco smoke pollution; child; signs and symptoms, respiratory.

APSTRAKT

Cilj. Cilj ovog rada je uspostavljanje korelacije između izloženosti pasivnom pušenju u kućnom okruženju i pojave respiratornih simptoma kod dece koja pohađaju deset osnovnih škola u Beogradu, Srbija.

Metod. Istraživanje je sprovedeno po tipu komparativne studije preseka, u deset osnovnih škola, na uzorku od 735 dece, u 44 učionice, u Beogradu, Srbija. Roditeljima/starateljima distribuiran je standardizovani upitnik, sa pitanjima o respiratornom zdravlju dece, socio-ekonomskom statusu i navikama roditelja, pre svega o pušenju cigareta.

Rezultati. 78% dece koja su izložena duvanskom dimu ima roditelje koji puše do 20 cigareta/dan, dok je više od 22% izloženo duvanskom dimu od popušanih preko 21 cigareta/dan, od strane roditelja ($p < 0,0001$). Respiratorni poremećaji prisutni su kod 45,9% dece izložene pasivnom pušenju u kućnom okruženju (CI 1.04-1.89), astmatični simptomi kod 33,5% (CI 0,94-1,78), dok je najniža incidenca ovih poremećaja prijavljena u slučaju hroničnog kašlja, u trajanju od 3 meseca (3,3%, CI 0,44-2,36), vizinga nakon fizičke aktivnosti (4,5%, CI 0,38-1,41), kao i za slučaj buđenja usled viziga u poslednjih 12 meseci (7,4%, CI 0,89-3,28).

Zaključak. Univarijantnom logističkom regresionom analizom dokazano je da je izloženost roditeljskom pušenju duvana statistički značajan prediktor za pojavu respiratornih simptoma kod dece.

Ključne reči: zagadjenje duvanskim dimom; dete; znači i simptomi, respiratorni.

KORESPONDENCIJA / CORRESPONDENCE

Branislava Matic, Institute of Public Health of Serbia, Dr Subotića 5, 11000, Belgrade, Serbia, E-mail: brankicam@batut.org.rs
Branislava Matić, Institut za javno zdravlje Srbije, Dr Subotića 5, 11000, Beograd, E-mail: brankicam@batut.org.rs

INTRODUCTION

Second/hand smoke refers to mixture of side stream smoke and exhaled mainstream smoke which pollutes air at points where tobacco smoking is being performed.¹ To date, beyond 4,000 chemicals, comprising a combination of liquids, inhalable particles, and gases are identified in tobacco smoke. Among 4000 chemicals, more than 70 of them are recognized to cause, initiate or promote cancer.^{2,3} World Health Organization assess that around 1.3 billion people smoke.⁴ This number is predicted to increase in future due to continuous rise of smoking rates among youth, primarily among girls.⁵ According to the World Health Organization assessment, some half of the children in the world are exposed to environmental tobacco smoke (ETS), mostly in their homes. This caused substantial morbidity, potentially triggering development of asthma and exacerbating symptoms.⁶⁻¹² Children exposed to ETS are at an increased risk for lower respiratory infections, middle ear disease, more severe asthma, respiratory symptoms, slowed lung growth, and sudden infant death syndrome.^{13,14}

METHODS

Within the international SEARCH1 project (School Environment and Respiratory Health in Children, 2007-2009), a cross-sectional study took place in ten primary schools in Belgrade, Serbia. Study was performed on a sample of total of 735 children, aged 7 to 11 years. According to the project's methodology, schools were chosen (sampled) to be with heterogeneous characteristics: half of them in environmentally more advantaged areas and half in less advantaged ones, especially concerning the proximity of busy traffic, while children were chosen randomly.¹⁵ Besides the school's environment impact on respiratory health, we also used the data on home environment, household exposure to second-hand smoke, particularly, obtained through a standardized questionnaire distributed to parents/caregivers of the participating children (N=735). Concerning home environment of children, key questions in our study were on the extent of exposure to ETS of children, number of cigarettes smoked by parents on daily basis, number of smokers in the household (mother, father, or both), as well as on the respiratory status of children. These questions included data on wheezing, cough, and diagnosis of asthma.¹⁵

Statistical methodology

In order to summarize baseline, demographic and clinical symptoms and characteristics, of two groups of schoolchildren (exposed and non-exposed), a descrip-

tive statistics was used. Chi-square test was used for the comparison of categorical variables. For the comparison of continuous variables, an ANOVA-test, or Median test (for variables without normal distribution) were used. A significance of 0.05 was required. Odd ratios with the corresponding 95% confidence intervals (CI) were estimated. In order to determine the optimal cut off values of the daily smoked number of cigarettes in relation to the occurrence of respiratory disorders, ROC (Receiver Operating Characteristic) curve was used. For the estimation of predictor impact of ETS on health disorders in children, univariate logistic regression analysis (LRA) was used. Analyses were performed using SPSS for Windows version 22 (SPSS, Inc, Chicago, IL).

This study aimed to determine the prevalence of household ETS exposure in school children in Belgrade, Serbia, as well as the association between ETS exposure and respiratory symptoms among them.

RESULTS

This study has involved 735 students from 10 Belgrade primary schools, 364 (49.5%) girls and 371 (50.5%) boys. There is no statistically significant difference among exposed and non-exposed children, by age. Mean age of mothers of the participating children was from 38.93±5 years for non-ETS exposed children to 37.42 ± 5.57 years for ETS exposed children. Mothers exposing their children to ETS at home are significantly younger than mothers taking care not to expose their offspring ($p \leq 0.0001$). Fathers' mean age ranged from 42.32±5.86 years for non-ETS exposed children to 41.65 ± 6.17 years for ETS exposed children. Again, as in the case of mothers, fathers exposing their children to household ETS are much younger, with high statistical significance ($p \leq 0.013$). (Table 1).

Table 1. Demographic data on children and parents

	ETS	N	Mean Mean	SD	95% Confidence Interval for Mean		Min	Max	F sign
					Lower Bound	Upper Bound			
AGE	No	315	9.70	0.95	9.59	9.80	0.00	11.00	0.606
	Yes	408	9.73	0.76	9.65	9.80	8.00	11.00	
	Total	723	9.71	0.85	9.65	9.78	0.00	11.00	
Mothers' age	No	308	38.93	5.00	38.37	39.49	27	57	0.0001
	Yes	399	37.42	5.57	36.87	37.96	19	55	
	Total	707	38.07	5.38	37.68	38.47	19	57	
Fathers' age	No	296	42.32	5.86	41.65	42.99	30	62	0.013
	Yes	388	41.14	6.36	40.50	41.77	29	72	
	Total	684	41.65	6.17	41.19	42.11	29	72	

To household ETS 412 pupils were exposed (56.2%), while the rest of them 321 (43.8%) were not exposed to this indoor air pollutant. Parents of the participating children smoke from 7.65±11.25 to 12.66±15.50 cigarettes/day (Table 2).

Table 2. Cigarettes/day smoked by parents correlated to household ETS of school children

Smoking habits	Total		Not exposed to ETS		Household ETS		x ²	sig
	N	%	N	%	N	%		
Mothers								
No smoking	321	43.8	321	100.0	0	0.0	733.00***	0.0001
Smoke 1-5 / day	68	9.3	0	0.0	68	100.0		
Smoke ≥6 /day	344	46.9	0	0.0	344	100.0		
Total	733	100.0	321	43.8	412	56.2		
Fathers								
No smoking	321	43.8	321	100.0	0	0.0	728.95***	0.0001
1-10 /day	196	26.7	0	0.0	196	47.6		
11-20 /day	124	16.9	0	0.0	124	30.1		
≥ 21/day	92	12.6	0	0.0	92	22.3		
Total	733	100.0	321	43.8	412	56.2		

Concerning the age distribution, no statistically significant difference among exposed and non-exposed children has been proven. As for their parents, both mothers (p<0.0001) and fathers (p<0.013) of children exposed to ETS at home are significantly younger than parents of non-exposed children. Number of cigarettes per day smoked by parents ranges from 7.65±11.25 to 12.66±15.50. As proved in this study, parents of most of the ETS exposed children smoke ≥ 6 cigarettes/day (p<0.0001). Namely, 78% of all exposed children have parents smoking up to 20 cigarettes/day, while more than 22% is exposed to parents' household second-hand smoke of more than 21 cigarettes per day (p<0.0001).

Children exposed to tobacco smoke are more often prone to respiratory disorders, allergy and asthma diagnosis, as shown in Table 3.

Table 3. Symptoms and disorders correlated to household ETS of school children

Respiratory symptoms	Exposed to ETS				Non-exposed to ETS				x ²	LRA Exp (B)	(95%) C.I.
	Yes		No		Yes		No				
	N	%	N	%	N	%	N	%			
Cough ever	95	23.7	306	76.3	63	20.1	251	79.9	1.346	1.237	0.86-1.77
Morning cough (autumn/winter)	45	11.3	355	88.7	32	10.2	282	89.8	0.205	1.117	0.69-1.80
Cough day/ night, (autumn /winter)	45	11.2	356	88.8	28	8.9	288	91.1	1.077	1.300	0.79-2.14
Continuous cough 3 months (autumn/winter)	13	3.3	384	96.7	10	3.2	302	96.8	0.003	1.022	0.44-2.36
Phlegm	39	9.7	362	90.3	30	9.6	284	90.4	0.006	1.020	0.62-1.68
Wheezing ever	96	23.6	310	76.4	58	18.6	253	81.4	2.606	1.351	0.94-1.95
Dry cough last 12 months	60	14.7	347	85.3	42	13.3	273	86.7	0.290	1.124	0.74-1.72
Woken by wheezing in last 12 months	30	7.4	375	92.6	14	4.5	299	95.5	2.643	1.709	0.89-3.28
Ever Dg asthma	55	13.5	351	86.5	39	12.5	272	87.5	0.157	1.093	0.70-1.70
Asthma therapy /last 12 months	39	9.6	368	90.4	29	9.3	282	90.7	0.014	1.031	0.62-1.52
Allergy	88	23.7	283	76.3	64	22.9	216	77.1	0.066	1.049	0.73-1.52
Ever Dg allergy	77	18.7	335	81.3	51	15.9	270	84.1	0.939	1.217	0.83-1.79
Symptoms of bronchitis	95	23.1	317	76.9	63	19.6	258	80.4	1.257	1.227	0.86-1.76
Asthmatic symptoms	138	33.5	274	66.5	90	28.0	231	72.0	2.508	1.293	0.94-1.78
Respiratory disorders	189	45.9	223	54.1	121	37.7	200	62.3	4.946	1.401	1.04-1.89

For a series of respiratory symptoms there is a higher probability to develop, than in children not exposed to ETS at home, in the following order: cough ever 12.7%; morning cough in autumn/winter season 12.0%; cough day and night in autumn/winter season 30%; continuous cough during 3 months in autumn/winter season 2.2; continuous cough during 3 months in autumn/winter season, combined with phlegm 2.0%; wheezing ever 35.1%.

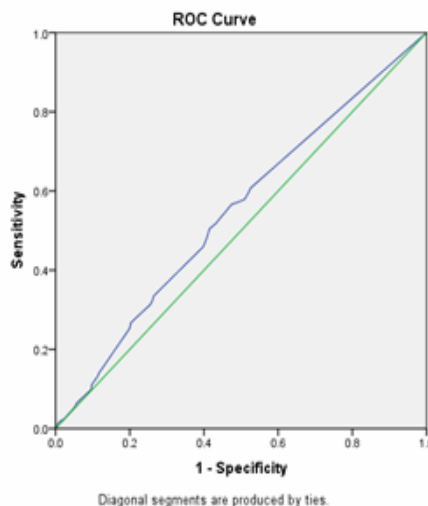
Development of the listed symptoms and disorders has a higher probability in ETS exposed children: "dry cough during 12 months", for 12.4%; "awakened by wheezing during last 12 months", for 71%; "cough ever combined with ever diagnosed asthma", for 9.3%; "asthma therapy in last 12 months", for 3.1%; "cough ever combined with ever diagnosed allergy", for 22%; "ever diagnosed allergy", for 5%.

Number of school children being exposed to household ETS, acquiring respiratory disorders is proven to be more frequent, with high statistical significance ($p < 0.026$). For all of these symptoms and disorders linked mostly to coughing per se, exposure to household ETS is not a predictor (univariate logistic regression analysis), with no statistically significant difference in the distribution of participating pupils, compared to the symptoms or the exposure itself (χ^2 test).

Probability for "cough ever" to occur is 23.7% higher in children exposed to ETS (OR=1.237, CI 95% 0.86-1.77); for "morning cough in autumn/winter season" it is 11.7% higher, (OR=1.117, CI 95% 0.69-1.80), "cough day and night in autumn/winter season" in ETS exposed subjects is 30% higher, (OR=1.300, CI 95% 0.79-2.14); for "continuous cough for 3 months during autumn/winter season" in children exposed to ETS, chance to acquire it is only 2.2% higher, (OR=1.022, CI 95% 0.44-2.36); "wheezing ever" occurs with probability of 35% in ETS exposed children (OR=1.351, CI 95% 0.94-1.95). There is a higher probability for developing following symptoms and disorders in ETS exposed children: "dry cough during 12 months" (OR=1.124, CI 95% 0.74-1.72); "awakened by wheezing during last 12 months", (OR=1.709, CI 95% 0.89-3.28); "ever diagnosed asthma", (OR=1.093, CI 95% 0.70-1.70); "asthma therapy in last 12 months", (OR=1.031, CI 95% 0.62-1.52); "ever diagnosed allergy", (OR=1.217, CI 95% 0.83-1.79).; symptoms of bronchitis, (OR=1.227, CI 95% 0.86-1.76); asthmatic symptoms (OR=1.293, CI 95% 0.94-1.78).

Exposure to ETS is a predictor for respiratory disorders. Namely, probability for the household second-hand smoke exposed children to acquire some of the respiratory disorders, analyzed in total, is 40% higher than in the case of ETS non-exposed children, participating in the study (OR=1.401, CI 95% 1.04 - 1.89), $p < 0.023$.

Additional ROC analysis of sensitivity and specificity of the respiratory disorders' occurrence vs. the ETS exposure at home, in the form of the daily smoked number of cigarettes, proves that ROC curve covers a statistically significant area under the curve, ROC=0.547±0.021, $p < 0.031$ (Graph 1, Table 4). In the case of school children exposed to household ETS, number of cigarettes smoked by parents daily (>10) has statistically significant impact on the occurrence of respiratory disorders. This data is confirmed in results of the correlation in between ETS and respiratory symptoms of exposed children, presented in Table 3.



Graph 1. CiROC curve - respiratory disorders vs. number of cigarettes smoked by parents/day

Table 1. Elements defining the ROC curve

Area Under the Curve				
Test Result Variable(s): Number of cigarettes/day				
Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.547	0.021	0.031	0.504	0.589
Cut off values				
Cut off	Sensitivity	Specificity		
1.5	59.80%	47.90%		
6.5	50.50%	58.50%		
11	33.40%	73.60%		
15.5	26.70%	79.70%		
21	13.80%	88.40%		

ROC analysis of sensitivity and specificity shows that exposure to larger number of cigarettes per day is related with occurrence of respiratory symptoms in children, with statistical significance. For exposure to < 2 cigarettes/day, sensitivity for the occurrence of respiratory disorders is 60%, specificity 47.9%; for >6 cigarettes/day, sensitivity is 50.5% specificity 58,5%; for exposure to >10 cigarettes/day, sensitivity drops below 35%, while for more than 15/day sensitivity drops below 27% and specificity increases to 80%, together with a rise in specificity beyond 88% for the occurrence of respiratory symptoms in the case children are exposed to ETS of > 20 cigarettes/day.

DISCUSSION

For better comprehension of the correlation between ETS and respiratory symptoms, it is important to be acquainted with other contributing factors. In their study, Oberg et al. indicated that exposure to ETS is among the most common indoor pollutants.¹⁶ While in our study household second-hand smoke of both parents complies with their smoking habits in 56.2% cases, in the Jordanian study out of 77% parents with smoking habits, them 61% practice it at home.¹⁷ According to the World Health Organization (WHO), over half of all children aged 13-15 years are exposed to household ETS in the majority of countries, for which comparable information is available. In the Balkans and the Caucasus, exposure is beyond 90%.¹⁸ The Global Youth Tobacco Survey was implemented only in the Southern Europe Countries, the Balkans and Caucasus, together with the Baltic countries, for the period 2002-2005 (GYTS). In Serbia, 97% of surveyed children were exposed to household ETS.¹⁹ When the same survey has been repeated in 2013, results showed a rather big improvement, with 63.4% surveyed children responding positively as being exposed to ETS at home.²⁰ As for other kinds of chemical substance exposures in school environment, fact is that most of the urban schools in Serbia were built and equipped by uniform standards, given in the Rulebook defining standards for the school environment, equipment and educational utensils in primary schools.²¹

In conclusion, univariate logistic regression analysis has proved that exposure to ETS is a statistically significant predictor for respiratory symptoms' occurrence. In this survey, chances that children who are exposed to household ETS have manifested any of listed respiratory symptoms are 40% higher than in the children not exposed to ETS in their home.

Until now, Serbian legal system has recognized only second-hand exposure to ETS in institutional facilities, public spaces, such as shopping areas, educational premises, offices, while there is no legal act dealing with living conditions within the private property, such as homes, apartments, and other locations where children could be exposed to environmental tobacco smoke.²² Finally, Serbia has legally adopted Children's Environmental Health Action Plan for 2010 – 2019, which was never to be implemented in practice.²³

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