AIR POLLUTION (TOTAL SEDIMENT SUBSTANCES) AND RESPIRATORY FUNCTION IN CHILDREN

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The aim of this work was to find connection between airpollution – total sediment substances and respiratory function values in children. Our study group consisted of 512 pupils (251 boys and 261 girls, 8 to 12 years of age), attending three schools of different location (in a village, the perifery the and the center of Kragujevac).

The conducted analysis of respiratory functions was based on the following parameters: Forced vital capacity (FVC), Forced expiratory volumen in 1 sec (FEV1), Peak respiratory flow (PEF), Mid-expiratory flow at 25% of FVC (MEF25%), and calculating index FEV1/FVC (Tiffeneau index).

Starting from the fact that there was no influence of air pollution – total sediment substances from the city centre on children living in a village, we further noticed that the factor of air pollution registered in the city periphery school in September was 0,44 (in February f=0,67), and in the inner city school 0,50 (in February f=1,71). As it was previously expected, the last case points to the lowest grade of air pollution. The results of repeated spirometric examination indicated improvement of considered parameters VC and FEV1. On the basis of conducted research, we found a spirometric damage of respiratory tract in 22.69% of pupils, which, with a group having respiratory function parameters at the lower limit, made even 82.92%.

During one-year period with lower grade of air pollution – total sediment substances, significantly better results of respiratory function were evidented in children living in the city.
Acta Medica Medianae 2005;44(1):21–24.

***Key words**: air pollution, total sediment substances, respiratory function, children, spirometry*

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Introduction

Sufficient evidences suggest that allergic respiratory diseases such as rhinosinusitis and bronchial asthma have become more common worldwide in recent years and a great deal of etiologic and pathogenic research has been carried out to evaluate the possible causes of this increasing trend.

Because of their continuous emission, long acting and high concentrations, aerogenic pollutants can be the cause of either acute or chronic respiratory tract diseases. In the early phases the changes are reversibile, but in advanced phases, in case that airpollution exposition continues, the respiratory tract disease can be manifested as bronchitis chronica, asthma, emphysema pulmonum.

In fact, various studies have demonstrated that inhalation of air pollutants such as O_3, nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), either individually or in combination, can enhance the airway response to inhaled allergens in atopic subjects inducing asthma exacerbations. Moreover, experimental studies have shown that diesel exhaust particularly causes respiratory symptoms and is also able to modulate the immune response by increasing immunoglobulin (Ig)E synthesis in predisposed animals and humans. There is also some evidence that air pollutants can interact with aeroallergens in the atmosphere and/or on human airways, emphasising their effects. In fact, by inducing airway inflammation which increases epithelial permeability, some pollutants overcome the mucosal barrier inducing allergic responses. However, the air pollution and climatic changes may also have an indirect effect on the allergic response by influencing quantitatively and qualitatively the pollen production of allergenic plants.

During winter months, consumption of energy is increased, as well as emission of polluting substances like sulphur dioxide, nitrogen oxides, carbon monoxide and dioxide and firm particles. Little is known about particle pollution which is specific to urban environments. They consist of firm elements or drops from smoke, dust, flying ashes etc. and are classified into sediments, whose dimensions are greater than ten million parts of a meter, and suspended or so-called aerosols, which are smaller. In urban environment air there are six basic particle groups: organic and elementary carbon, sulfur, nitrats and ammonia salts and geological materials as oxides and salts of calcium, silicium, aluminium, and ferrum salts, that and they all originate from industrial processing, fuel combustion, road dust, building works, stone and land erosion because of wind blowing etc. There can be some specific particles, depending on industrial activity in that area. The influence of air particles on human health depends on their size. Greater particles are mainly made of geological materials and it is more difficult for them to reach deep into the respiratory tract. However, smaller particles, that carry many dangerous substances, can reach deeper into the lungs.

The aim of this work was finding the connection between air pollution and respiratory function values in children.

Material and methods

Our study group consisted of 512 pupils (251 boys and 261 girls, 8 to 12 years of age), attending schools of different location (in a village, the perifery and the center of Kragujevac).

The conducted analysis of respiratory functions was based on the fallowing parameters: Forced vital capacity (FVC), Forced expiratory volumen in 1 sec (FEV_1), Peak respiratory flow (PEF), Mid-expiratory flow at 25% of FVC ($MEF_{25\%}$), and calculating index FEV_1/FVC (Tiffeneau index). Because of the correlation between body hight, body weight, participants' age group and respiratory function parameters, we determined the matching referent values for the control group, which was the basis of examination of the diseased group. The difference between realized respiratory function values in the diseased group and values is classified into cathegories:

a) less than 80.0% (less than low limit of the referent value),

b) 80.0-99.9% of referent values,

c) 100.0-119.9% of referent values,

d) over 120.0% (over the upper limit of referent values).

With the purpose of determing grades of air pollution, we considered three parameters: sulfur dioxide concentration (SO_2), soot, and total sediment substances (TSS).

Spirometric measuring was repeated at the beginning of September. Apart from 102 pupils with pathologic spirometric findings (vital capacity less than 80.0% of referent values), the repeated examination included 89 pupils. In data analysis, appropriate tests for statistical significance were used.

Results and discussion

The exploration of air pollution grades and measuring respiratory function parameters were conducted in February and in September.

Starting from the fact that there was no influence of air pollution - total sediment substances from the city centre on children living in a village, we further noticed that the factor of air pollution registered in the city periphery school in September was 0,44 (in February f=0,67), and in the inner city school 0,50 (in February f=1,71). As it was previously expected, the last case points to the lowest grade of air pollution (Figure 1).

According to the spirometric examination, it was noticeable that all respiratory function parameters in boys were slightly elevated in city schools, althgouth there were no significant statistical differences (Table 1).

In girls we recorded significant decreasing of parametar VC (<0.01) because of greater participation of parametar VC-less than 80.0%, which was specially pointed out at the city perifery school (Table 2).

Table 1. Respiratory function parameters in boys

Parameters	School	< 80.0%	80.0-99.9%	100.0-119.9%	>120.0%	P-value
VC	Village	9	52	14	1	>0.05
	City-periphery	17	56	13	0	
	City-center	18	45	24	1	
FEV_1	Village	5	40	28	3	>0.05
	City-periphery	11	40	35	0	
	City-center	11	42	25	0	
PEF	Village	10	32	29	5	>0.05
	City-periphery	14	30	31	11	
	City-center	15	28	29	6	
$MEF_{25\%}$	Village	6	11	23	36	>0.05
	City-periphery	3	16	32	35	
	City-center	9	14	28	37	

Table 2. Respiratory function parameters in girls

Para-meters	School	< 80.0%	80.0-99.9%	100.0-119.9%	>120.0%	P-value
VC	Village	9	53	15	1	<0.01
	City-periphery	29	41	11	0	
	City-center	12	53	24	1	
FEV_1	Village	8	36	33	1	>0.05
	City-periphery	15	42	24	0	
	City-center	5	51	32	2	
PEF	Village	17	33	24	4	>0.05
	City-eriphery	15	41	24	0	
	City-center	26	32	29	3	
$MEF_{25\%}$	Village	2	12	17	47	>0.05
	City-periphery	4	16	17	44	
	City-center	0	10	28	52	

In 82.92% of the total number of examined children from Kragujevac, VC was below referent values. Also, values of FEV_1 (62.51% below referent values) and PEF (53.06% below referent values), were indicators of the respiratory tract obstruction in children at city schools. Value of $MEF_{25\%}$ (25.61% below referent values) were conditionally satisfying.

Results of the repeated spirometric examination indicated improvement of considered parameters VC and FEV_1, while parameters PEF i $MEF_{25\%}$ remained at the same level or increased somehow, which need not be brought in direct connection with the aim of this study (Figure 2).

The potential health effects of long-term exposure to air pollution on the respiratory tract of children has been the focus of many researches in the recent period. Several authors reported a significant association between increased exposure to particulate matter (1, 2), SO_2 (2), O_3 and nitrogen oxides and the occurrence of respiratory tract illnesses. Recent epidemiological studies have tended to ascribe greater importance to pollutants such as fine particles (3). In six cities in the East and Midwest of the United States (1), the study included 10,106 white preadolescent children and each child underwent a spirometric examination, and a parent completed a standard questionnaire. Of this number, 8,380 children came for the second examination 1 year later. Rates of bronchitis and a composite measure of lower respiratory illness were significantly associated with average particulate concentrations (p less than 0.05).

Whereas evidence of adverse effects of air pollution on lower respiratory tract illnesses in children is increasing, little is known about the effects of high and moderate levels of air pollution on the incidence of upper respiratory illnesses. 9 to 11-year-old schoolchildren (n = 1,854) living in Leipzig, East Germany were analyzed (4). Parents of 1,500 (81%) children returned the questionnaire. Increased risks for the development of upper respiratory symptoms were registred during winter months for SO_2 mean concentrations (odds ratio (OR) = 1.72; 95% confidence interval (95% CI) 1.19-2.49). NOx mean concentrations (OR = 1.53; 95% CI 1.01-2.31) and PM maximum values (OR = 1.62; 95% CI 1.08-2.45). During summer, only NOx mean concentrations were

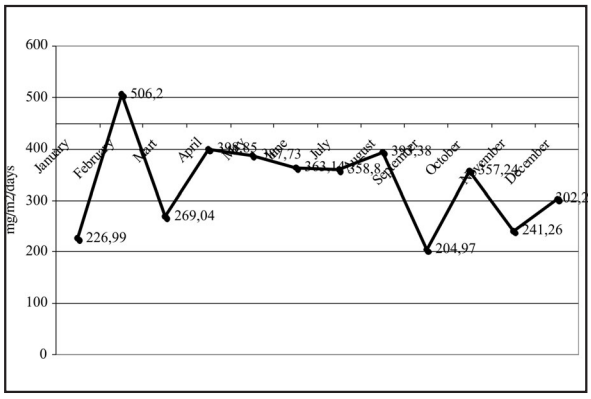

Figure 1. The airpollution (total sediment substances) level, followed through months

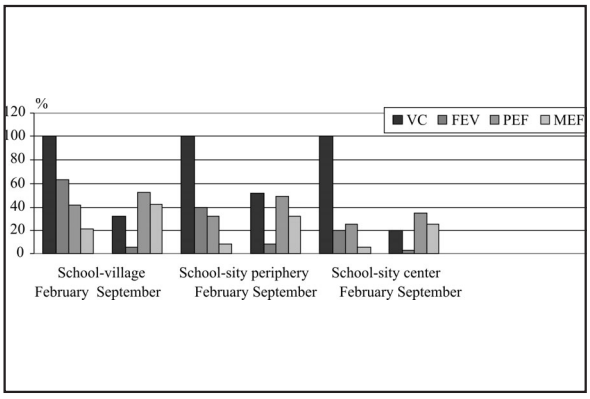

Figure 2. Comparison of the first and repeated spirometric test according to schools

associated with a significantly increased risk (OR = 1.82; 95% CI 1.21-2.73). A combination of high mean levels of different pollutants resulted in the highest risk (OR = 2.10; 95% CI 1.30-3.37 during winter, and OR = 2.16; 95% CI 1.23-3.81 during summer). We conclude that high concentrations of SO_2, and moderate levels of particulate matters and NOx were associated with an increased risk of developing the upper respiratory symptoms in childhood.

Romero-Placeres M. et all. (5) found that the levels of atmospheric pollutants were generally low. The 24-hour mean values for PM10 levels, smoke, and SO_2, were 59.2 microg/m3 (SD=29.2), 27.7 microg/m^3 (SD=21.2), and 21.1 microg/m^3 (SD=20.1), respectively. An increase of 20 microg/m^3 of the daily average concentration of black smoke was associated with a 2.2% increase (95% CI 0.9-3.6) in the number of emergency visits for ABAC. A 20 microg/m^3 increase in the daily average of black smoke and SO was associated with an increase in ARI of 2.4% (95% CI 1.2-3.6), and 5% (95% CI 1.3-5.3), respectively.

Conclusion

On the basis of the conducted research, we found a spirometric damage of the respiratory tract in 22.69% pupils, which, with a group having respiratory function parameters at the lower limit, made even 82.92%.

During one-year period marked with a lower grade of air pollution, significantly better results of respiratory function were evidented in city children.

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AEROZAGAĐENJE (UKUPNE TALOŽNE MATERIJE) I DISAJNA FUNKCIJA KOD DECE

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Rad ima za cilj sagledavanje povezanosti stepena aerozagađenja – ukupnih taložnih materija i vrednosti disajne funkcije kod dece. Studijska grupa je uključila 512 dece (251 dečaka i 261 devojčicu, uzrasta od 8 do 12 godina), koji su pohađali tri škole (u selu, na periferiji i u centru grada Kragujevca).

Analiza respiratorne funkcije je sprovedena na bazi osnovnih parametara: Forsirani vitalni kapacitet (Forced vital capacity – FVC), Forsirani ekspiratorni volumen (Forced expiratory volumen in 1 sec – FEV_1), Vrh ekspiratornog volumena (Peak exspiratory flow – PEF), Srednji ekspiratorni volumen (Mid-expiratory flow at 25% of FVC – $MEF_{25\%}$), kao i određivanjem indeksa FEV_1/FVC (Tiffeneau index).

Polazeći od činjenice da u seoskoj školi nije bilo uticaja aerozagađenja – ukupnih taložnih materija iz centralnog dela grada, u septembru je faktor zagađenja (f=vrednosti > MDK/MDK) za školu na periferiji grada iznosio 0.44 (u februaru f=0.67), a za školu u najužem centru grada je iznosio 0.50 (u februaru f=1.71), što ukazuje, kao što se i očekivalo, na manji stepen aerozagađenja.

Na osnovu sprovedenog ispitivanja, nađeno je spirometrijsko oštećenje disajnih puteva kod 22.69% učenika, što sa grupom koja je imala parametre disajne funkcije na donjoj granici čini čak 82.92%.

U periodu godine sa nižim stepenom aerozagađenja kod gradske dece su zabeleženi značajno bolji rezultati disajne funkcije. *Acta Medica Medianae 2005; 44(1):21–24.*

Ključne reči: *aerozagađenje, ukupne taložne materije, respiratorna funkcija, deca, spirometrija*