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EXPOSURE TO AIR POLLUTION AND DEVELOPMENT OF ALLERGIC RHINITIS AND ASTHMA

***Slavica Stevanović*[1], *Dragana Nikić*[2]**

[1]*JKP "Naissus", Niš, Serbia*
[2]*The Public Health Institute, Niš, Serbia*
E-mail: sslavica@ptt.yu

Summary. *Allergic airway diseases are related to exposure to atmospheric pollutants, which have been suggested to be one factor in the increasing prevalence of allergic rhinitis and asthma. This study was conducted in order to determine the relationship between long term exposure to air pollution and the prevalence of allergic rhinitis and asthma in the city of Niš (high concentrations of air pollutants) and the Niška Banja spa (zone with the lowest concentration of air pollution). The investigation was carried out at the Public Health Institute in the period between 1999 and 2005 .A sample of 500 participants from Niš and Niška Banja was split intro three age groups: up to 25, between 26 and 50, and above 51. A significance test was performed using a Mantel-Haenszel chi square (χ^2) statistic. This test was used to check for a statistically significant difference between the incidence of allergic rhinitis and asthma between the investigated group and the control group across all age groups. The odds ratio(OR) and relative risk (RR) were determined. Modified WHO, British MRC and American Thoracis Society questionnaires were run among the investigated and contol population sample group. The statistical significance between measured concentrations in the air at observed measured spots was determined using the Student's T-test. Statistics parameters such as arithmetic mean, median, standard deviation were employed in the assessment process. The study has proven that the allergic asthma incidence ($p < 0.05$) was significantly higher among Niš inhabitants (investigated group) across all age categories. The highest value of the chi square test was determined in the age group 26-50 years (RR = 2.18, OR = 2.69), in the group up to 25 years RR = 1.93, OR = 2.46 and in the group above 51 years RR = 1.88, OR = 2.37. The highest value of the chi square test (allergic rhinitis) was determined in the age group 26-50 years (RR = 13.00, OR = 22.18), in the group up to 25 years RR = 5.80, OR = 8.53 and in the group above 51 years RR = 1.26, OR = 1.38. The obtained results prove that the incidence of allergic rhinitis and asthma is significantly higher in the exposed population than in the non-exposed.*

Key words: *Air pollution, allergic rhinitis, allergic asthma*

Introduction

Air pollution is a major environment health problem in the city environment. The highest concentration of air pollutants has been measured in big cities and industrial areas.

The prevalence and incidence of allergic rhinitis and asthma have increased in Europe during the last decades, as in most industrialized countries in other parts of the world.

The state of the air is an important factor in the quality of life in our cities. It directly influences the sustainability of our lifestyles and affects the health of the community.

The major air pollutants in urban settlements are industry, traffic and thermal power plants. The industry is a source of a number of pollutants: fine particulate matter, soot, suplhur dioxide (SO_2), carbon monoxide (CO), etc. The development of traffic apart from its positive aspects, leads to destruction of the environment. Taking into account that traffic is the chief air pollutant with over 60% contribution, it has a major impact on the emission of Nitrogen Oxide (NO_x), Carbon Monoxide (CO), Lead and formaldehyde. This is the reason why the World Health Organisation concludes cautiously that traffic related air pollution may increase the risk of allergy development and may exacerbate symptoms in susceptible subgroups in particular (1).

Thermal power plants are sources of soot, SO_2, particularly in wintertime.

Such air pollution has reached a level detrimental to people's health (2,3), leading not only to acute and chronic diseases, but also to genetic changes and decrease of immunologic capabilities of the organism (4,5). Changes in genetic pool are an unlikely to explain for the changes in the occurrence of allergic diseases in a short time interval. Therefore, attempts to identify environmental factors are useful for prevention (6).

Allergic airway diseases are related to exposure to atmospheric pollutants, which have been suggested to

be one factor in the increasing prevalence of allergic rhinitis and asthma (7).

Research Objective

The aim of this research is to investigate the potential relation between the long term exposure to air pollution as a risk factor and the development of allergic rhinitis and asthma in the population.

Materials and Methods

The investigated population sample in Niš has been chosen from different age groups and locations. Dwellers in the areas with high concentrations of pollutants in the air (the Sindjelic square) are called the investigated group, and citizens of Niška Banja, which represents a zone with the lowest concentration of pollutants in the air, are called the control group. The above mentioned residential area of Niš has similar urban characteristics - this is an area with intense traffic, without significant migrations of the population. On the other hand, Niška Banja (spa), is an area with very low traffic intensity and also without significant migrations of the population (Table 1).

Table 1. Observed population sample structure by age and sex

Age (years)	Observed area				Total
	Niš		Niška Banja		
	Male	Female	Male	Female	
up to 25	40	40	40	40	160
26-50	45	45	45	45	180
above 51	40	40	40	40	160
Total	125	125	125	125	500

This research is based on a retrospective five year air pollution study on the above mentioned observed areas.

The air pollution was monitored during the period between 1996 and 2000 by observing the concentrations of SO_2 and soot in the air, in accordance with the Regulatiory Paper on limit emission values (8).

Modified WHO, British MRC and America Thoracis Society questionnaires (9) were run among the investigated and contol population sample group.

Statistics parameters such as arithmetic mean, median, standard deviation were employed in the assessment process.

The existence of the statistically significant difference between the incidence of the exposed and diseased and the incidence of the non-exposed and non-diseased was tested using the Mantel-Haenszel chi-square test (χ^2).

The odds ratio and relative risk were determined.

The statistical significance between measured concentrations in the air at observed measured spots were determined using the Student's T-test.

The investigation was carried out at the Public Health Institute in Niš.

Results

The results of air pollution by the common air pollutants SO_2 and soot at the places of measurement observed during the five-year period are given in Table 2 .

Using the T-test statistic it was proved that during those five years, there were statistically significantly higher average annual concentration of SO_2 and soot at investigated places of measurement compared to the control ones (Table 3).

Table 3. Statistically signifficant difference of the average annual concentrations of SO_2 and soot at investigated places of measurement

Year	SO_2			Soot		
	Niš	Niška Banja	p	Niš	Niška Banja	p
1996	86	24	<0.001	10	1	<0.001
1997	49	30	<0.001	8	1	<0.001
1998	19	7	<0.001	9	1	<0.001
1999	27	8	<0.05	21	2	<0.001
2000	7	2	<0.001	8	0	<0.001

Taking into account the statistically significant difference between average annual concentrations of all air pollutants, the observed places of measurements were found to be appropriate for tackling of the chronical effects of air contaminants on the health of the population exposed to them.

Results obtained by investigating the exposure to air pollutin and the incidence of allergic rhinitis and asthma in the observed population are shown in Table 4 and Table 5.

Using the chi square statistic, the signifficant difference between the incidence of allergic rhinitis and asthma in the exposed population compared to the non-exposed, was obtained. The term non-exposed refers to

Table 2. Annual concentrations of SO_2 and soot and in the air ($\mu g/m^3$) around the Sindjelic square (Niš) and Niška Banja

Year	SO_2								Soot							
	Niš				Niška Banja				Niš				Niška Banja			
	$\bar{x}$	C_{50}	C_{98}	% above GVI	$\bar{x}$	C_{50}	C_{98}	% above GVI	$\bar{x}$	C_{50}	C_{98}	% above GVI	$\bar{x}$	C_{50}	C_{98}	% above GVI
1996	86	72	229	12.82	24	17	102	1.20	10	4	55	3.21	1	0	11	0
1997	49	36	156	2.14	30	9	256	3.21	8	3	45	1.79	1	0	7	0.36
1998	19	5	87	0.30	7	0	45	0	9	2	67	4.17	1	0	12	0.30
1999	27	23	58	-	8	6	25	0	21	16	60	4.92	2	0	15	0
2000	7	38	32	-	2	1	18	0	8	1	75	4.38	0	0	9	0

Table 4. Exposure to risk factors from the air and development of allergic rhinitis in the population of all ages

Age (years)	up to 25				26-50				above 51				Total	
Exposure	Diseased *		Healthy		Diseased *		Healthy		Diseased *		Healthy			
	number	%	number	%	number	%	number	%	number	%	number	%	number	%
Yes	29	36.25	51	63.75	39	43.33	51	56.67	24	30.00	56	70.00	250	50.00
No	5	6.25	75	93.75	3	3.33	87	96.67	19	23.755	61	76.25	250	50.00
Total	34	21.25	126	78.75	42	23.33	138	76.67	43	26.88	117	73.12	500	100.00

*In the diseased group there are not any persons that suffer from chronic obsrtuctive lung diseased

Table 5. Exposure to risk factors from the air and development of allergic asthma in the population of all ages

Age (years)	up to 25				26-50				above 51				Total	
Exposure	Diseased *		Healthy		Diseased *		Healthy		Diseased *		Healthy			
	number	%	number	%	number	%	number	%	number	%	number	%	number	%
Yes	29	36.25	51	63.75	32	35.56	58	64.44	24	30.00	56	70.00	250	50.00
No	15	18.75	65	81.25	17	18.89	73	81.81	11	13.75	69	86.25	250	50.00
Total	44	27.50	116	72.50	49	27.22	131	72.78	35	21.88	125	78.12	500	100.00

*In the diseased group there are not any persons that suffer from chronic obsrtuctive lung diseased

the population exposed to very low concentrations of air pollutants (Table 6 and Table 7).

Results for exposure to other risk factors are given in Table 8.

Table 6. Statistical significance of the difference in development of allergic rhinitis

Age (years)	χ^2	RR	OR	p
Up to 25	21.38	5.80 2.23<RR<14.22	8.53 2.89<OR<27.03	<0.05
26-50	38.04	13.00 4.17<RR<40.54	22.18 6.14<OR<95.04	<0.05
Above 51	0.51	1.26 0.75<RR<2.12	1.38 0.64<OR<2.95	>0.05

Table 7. Statistical significance of the difference in development of allergic asthma

Age (years)	χ^2	RR	OR	p
Up to 25	5.30	1.93 1.31<RR<3.32	2.46 1.13<OR<5.92	<0.05
26-50	5.50	2.18 1.15<RR<4.15	2.69 1.14<OR<6.44	<0.05
Above 51	5.27	1.88 1.13<RR<3.14	2.37 1.14<OR<4.96	<0.05

Table 8. Statistical significance of the difference in the exposure to other risk factors

Risk Factors	χ^2	p
Hazzardous materials at work place	2.35	> 0.05
Indoor smoking	0.92	> 0.05
Heating on wood or coal	2.05	> 0.05
Atopic constitution	0.01	> 0.05

Discussion and Conclusions

Based on the average annual concentrations of the percentile values of C_{50} and C_{98}, it can be said that the population in Niš, especially in the proximity of the mentioned places of measurement, has been exposed to the moderately high concentrations of the observed pollutants. As opposed to them, the inhabitants of Niška Banja were exposed to significantly lower concentrations of air pollutants.

It is known that even small increases in the average annual concentrations of air pollutants (for soot only 10μg/m^3) can cause health problems despite the fact that there has not been an evidence for these concentration to be above their limit values (10,11).

These results are in compliance with the results of similar studies in the literature. The study form Marcelle (12) points to the fact that there is a correlation between the exposure to air pollution and allergic effects in sensitive patients, especially in patients with asthma. Asthma in children and young adults is seen more often in cities while adult asthma is not affected by the place of residence. The asthma prevalence and mortality is increased in minorities living in financial difficulty in cities with inadequate health systems (13). Other studies (14) also show that air pollution can increase the allergic sensitivity.

In animal as well as in human experiments, air pollutants, especially diesel exhaust particulates, are able to trigger an IgE-response (15). Ig E levels are high in 75-83 % of children with allergic asthma (16). It is considered that NO_2 or SO_2, together or separately, can have a contributing role in the above mentioned reaction (17) and this occurs for concentrations characteristic for the traffic of heavy vehicles (18). Persistent exposure to NOx, CO, and SO_2 may increase the prevalence of allergic rhinitis in children (19,20).

During the investigation of the allergic rhinitis and asthma developed because of air pollution, it is important to exclude some other environmental factors that can also contibute to the diseases. Namely, it is proved that the living conditions, the way of heating, smoking, atopic constitution, etc., have a great influence on the outcome of the mentioned diseases. The investigated population sample shows hommogenity with regard to these factors, so it can be considered that the oscillations in the concentrations of air pollutants can play a significant role in the frequency of allergic diseases in the investigated group.

In accordance with the obtained results it can be concluded that a long term exposure to air pollutants unfavorably influences the health of population and is a risk factor for development and aggravation of certains deseases and symptoms.

The incidence of allergic rhinitis and asthma is significantly higher in the exposed group compared to the non-exposed one.

Results obtained by this research can contribute to forming the basis for controlling and management of the health risk caused by contaminants in the air in the exposed population.

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IZLOŽENOST ZAGAĐENOM VAZDUHU I POJAVA ALERGIJSKOG RINITISA I ASTME

Slavica Stevanović[1], Dragana Nikić[2]

[1]JKP "Naissus", Niš
[2]Institut za zaštitu zdravlja, Niš
E-mail: sslavica@ptt.yu

Kratak sadržaj: *Alergijske bolesti u relaciji sa ekspozicijom atmosfeskim polutantima, upućuju da aerozagađenje može biti jedan od faktora u povećanju prevalence alergijskog rinitisa i astme.Cilj istraživanja bio je utvrđivanje eventualne međuzavisnosti između dugogodišnje izloženosti aerozagađenju i prevalence alergijskog rinitisa i astme u Nišu (zona sa visokim koncentracijama zagađujućih materija u vazduhu) i Niškoj Banji (zona sa niskim koncentracijama zagađujućih materija u vazduhu). Istraživanje je urađeno u Institutu za zaštitu zdravlja u Nišu u periodu između 1999. i 2005. god. Uzorak od 500 ispitanika iz Niša i Niške Banje bio je podeljen u tri uzrastne grupe: do 25, između 26 i 50 i iznad 51 god. Postojanje statistički signifikantne razlike u oboljevanju od alergijskog rinitisa i astme između*

ispitivane i kontrolne grupe i to u svim uzrastnim kategorijama testirano je Mantel-Hanszel-ovim χ^2 testom. Utvrđen je unakrsni i relativni rizik.Kod stanovnika ispitivane i kontrolne grupe izvršeno je anketiranje po modifikovanoj anketi WHO, British MRC i American Thoracis.Statistička značajnost između izmerenih koncentracija polutanata u vazduhu na ispitanim mernim mestima utvrđena je Studentovim T-testom. Od statističkih parametara korišćeni su: aritmetička sredina, madijana, standardna devijacija. Istraživanje je dokazalo da je incidenca allergijske astme signifikantno veća ($p < 0,05$) u Nišu (ispitvana grupa) i to u svim uzrastnim kategorijama. Najveće vrednosti χ^2 testa utvrđene su u uzrastnoj grupi od 26 - 50 god (RR = 2,18, OR = 2,69), dok je u grupi do 25 godina RR = 1,93, OR = 2,46, a u grupi iznad 51 god RR = 1,88, OR = 2,37. Najveće vrednosti χ^2 testa za alergijski rinitis utvrđene su u uzrastnoj grupi od 26-50 god (RR = 13,00, OR = 22,18), dok je u grupi do 25 godina RR = 5,80, OR = 8,53, a u grupi iznad 51 god RR = 1,26, OR = 1,38. Dobijeni rezultati ukazuju da je incidenca alergijskog rinitisa i astme značajno veća kod eksponirane populacije u odnosu na neeksponiranu.

Ključne reči: *aerozagađenje, alergijski rinitis, alergijska astma*