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THE CORRELATION OF HIGH AMBIENT SULFUR DIOXIDE CONCENTRATION WITH RELEVANT HOSPITAL ADMISSIONS

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ABSTRACT
Objective: *To determine the correlation of high concentrations of ambient sulfur dioxide (SO_2) in association with the relevant hospital admission of patients divided into age groups in Zenica city (Bosnia and Herzegovina).* ***Methods :*** *The study was descriptive - analytical and retrospective. The effects of high concentrations of ambient sulfur dioxide (SO_2) on the increasing number of hospital admissions seven days before and seven days after high concentrations of ambient sulfur dioxide (SO2) were analyzed. Respondents were divided into five age groups : children 0-7 years and 7-14 years, teenagers 14-19 years, adults 19-65 years and seniors over 65 years in the area of Zenica city during period of 2001- 2011. In this study, we used data obtained from General Hospital in Zenica and Metallurgical Institute "Kemal Kapetanovic" University of Zenica, Bosnia and Herzegovina. For statistical analysis of the data we used the Chi square test and correlation test.* ***Results****: Statistical analysis of the data in the investigated group showed correlation between high concentrations of ambient SO2 and the number of hospital admissions ($p < 0.001$) .* ***Conclusion*** *: Air pollution in the city of Zenica is a risk factor for the increase of the number of hospital admissions, which should be kept in mind during planning and staffing of health care facilities.*
Keywords: air pollution, sulfur dioxide (SO2), hospital admissions

1. INTRODUCTION
Residents of Zenica city, the center of ferrous metallurgy of Bosnia and Herzegovina, are at high risk of developing respiratory diseases, as a result of technological process in plants that are high polluters of the environment[1]. What affects high risk of development of acute respiratory diseases are: high emissions of sulfur dioxide and dust, especially dust with a high content of lead, cadmium and other heavy metals, nitrous gases, carbon monoxide, fluoride, ammoniac, polycyclic aromatic hydrocarbons and other especially harmful organic compounds [1] .The main source of air pollution in Zenica are metallurgy plants whose facilities are causing large amounts of dust and smoke into the urban are stationed practically next to the facilities [1]. Air pollution is a major environmental risk to health and it is estimated that it causes about 2 million cases of premature death worldwide annually [2]. Exposure to air pollutants is largely beyond the control of individuals and requires action by public authorities at national, regional and even international levels [3]. More than half of the cases of the impact of air pollution on human health refer to people in developing countries [4]. Contamination of our environment is one of the most important risk factors in emerging respiratory diseases,

particularly chronic obstructive pulmonary disease (COPD) and lung cancer [4]. Since1930 the impact of pollution on the occurrence of respiratory symptoms has been monitored [4].

2. PURPOSE AND RESEARCH

The main objective of the research was to determine the relationship and impact of increased concentrations of SO_2 on the increase of the number of hospital admissions of the patients suffering from acute and chronic respiratory diseases in Zenica municipality. In order to undergo statistical – analytical process of the obtained results of generally recognized increased number of hospital admissions of patients suffering from acute and chronic nonspecific diseases in Zenica, the comparative sample of eponymous population and area, seven days before the high concentration and 7 days after the high concentration of pollutants was researched (SO_2).Tests carried out in this paper should contribute to an increase of the number of scientific information on the impact of air pollution on the incidence of acute and chronic respiratory diseases. The expected results of the research will be of great importance, not only for acquiring knowledge about the impact of air pollution on the incidence of acute and chronic respiratory diseases, but they should also have an impact on changes in administrative -legal regulations in this field.

3. MATERIAL AND METHODS

In the afore mentioned study, we investigated the effect of the high concentrations of sulfur dioxide (SO_2) on the number of hospital admissions, patients with respiratory illnesses seven days before and seven days after increased concentrations of sulfur dioxide. The study was descriptive – analytical and retrospective. The subjects were divided into five age groups: 0-7 yrs., 7-14 yr., 14-19 yrs., 19-65 yrs.and subjects over 65 years in the area of Zenica city, from 2001 – 2011 year. In this research,we used data obtained from a hospital in Zenica city and Metallurgical Institute "Kemal Kapetanovic" University of Zenica. For statistical analysis of the data we used the Chi square test and correlation test.

4. RESULTS

In summed up presentation of the results, we analyzed the average number of residents of Zenica divided into five age groups and observed over a period of ten years. In the above groups the average number of patients with acute and chronic respiratory diseases was monitored and analyzed, as well as the average concentrations of SO_2, in the period from 2001 – 2011 based on the division of the research groups was made . Based on the conducted research, the average rate of subjects with acute and chronic respiratory diseases was analyzed, as well as the incidence rate per 1,000 residents of population ages and the average concentration of SO_2 . The average concentration of SO_2 in the air in the period from 2001 – 2011 amounted to 58.48 g/m^3 , and we analyzed the above mentioned with the average rate of illness of subjects divided grouped into five age groups . Since Zenica city, monitors daily the concentrations of sulfur dioxide, we compared the average rate of subjects with an acute and chronic respiratory diseases in all age groups and the average concentration of sulfur dioxide.

Table 1. Average number of hospital admissions/incidence of patients suffering from acute and chronic respiratory diseases 7 days before and 7 day safter the high concentration of SO_2 in the period from 2001- 2011.

Age group / average hospital admissions	0. – 7. yrs		7. – 14. yrs		14. – 19. yrs		19. – 65. yrs		> 65.yrs.	
	patients	healthy	patients	healty	patients	healthy	patients	healthy	patients	healthy
Not exposed	75	15692	71	14747	49	9251	132	66575	147	18138
Exposed	105	15662	85	14733	58	9242	100	66607	151	18134

Statistical analysis of the obtained correlation was + 0.6753

Tests have shown that there is a linear increase in the number of hospital admissions, patients suffering from acute and chronic respiratory disease in the same time period as compared to a linear increase in the concentration of SO_2.

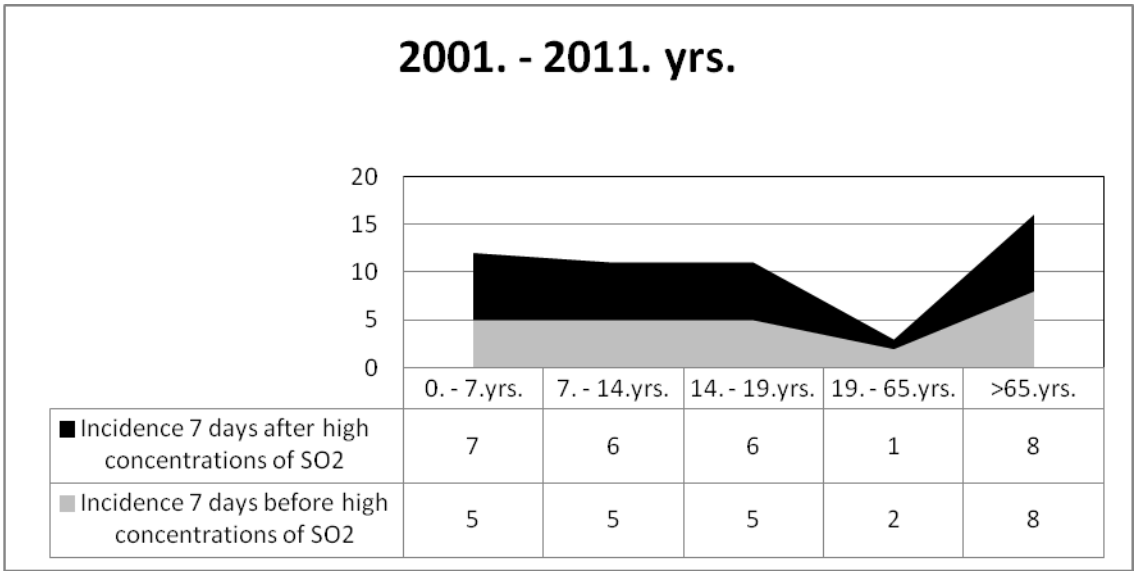

Figure 1. Incidence relationship of subjects from 2001 - 2011 divided into age groups, 7 days before and 7 days after high concentrations of SO_2

1. relative risk of elevated rates of patients morbidity with acute and chronic respiratory diseases was noticed among age groups up to seven years (1.41), from 7 to 14 years (1.11), from 14 – 19 years. (1.18), group over 65years (1.02), with a statistical probability of 95%.
2. The ratio of probability of exposure or OR (odds ratio) equals (1.40) among the age groups up to the seven years, (1.19) from 7 to 14 years, (1.19) from 14 – 19 years and (1.04) over 65 years. which indicates a positive correlation.
3. There exists a statistical difference between developing acute and chronic respiratory diseases within the two groups of respondents ($P < 0.05$ for the group up to 7 yrs., $p < 0.001$ in case of the remaining four age groups) In the period from 2001- 2011 the average number of participants in other four age groups in Zenica city were exposed to an increased risk of developing an acute and chronic respiratory diseases and the likelihood of exposure ratio (OR) indicates a positive correlation.

5. DISCUSION

It is worrisome that the problems of air pollution have become highly topical in Bosnia and Herzegovina [5]. Problems and negative effects of air pollution are still being investigated [5]. For the study of air pollution fractional approach is used, for example, suspended particles are divided into groups according to the diameter of the particles, and then studied, which is in our conditions difficult to implement [6]. Various studies in the world investigate and indicate the impact of elevated concentrations of sulfur dioxide on human health [7]. Results of parallel studies in London and Hong Kong have shown that increase in the concentration of SO_2 from 10 g/m^3 increases daily hospital admissions of patients with cardiovascular disorders for 1.4 to 2.0% [8]. Previous population studies prove conclusively the connection of adverse health impacts from exposure to air pollution [9,10]. It also shows a retrospective study that we conducted in the period since 2001 – 2011. In the study we found an increased number of hospital admissions of patients with respiratory illnesses seven days after the high concentration of SO_2 in the air. Also, in the study we included patients who are in hospital due to a seriously deteriorated health condition. It was found that patients regardless of age group affiliation were frequently hospitalized. In this study we are not talking only about the negative consequences of $S0_2$ on human health, but also that the impact of this gas, which is being developed in industrial and urban areas, is being associated with the emergence of serious organic diseases,

especially respiratory. In any case, the high concentration of $S0_2$ causes the occurrence of acute and chronic respiratory diseases, and represents a major public health problem .

6. CONCLUSION

Tests have shown the interconnectedness between the increase in SO_2 concentrations and the number of hospital admissions of patients suffering from acute and chronic respiratory diseases, divided into five selected age groups in the municipality of Zenica. Iron and steel industry has always been strongly associated with the environment [1]. Due to the emission of large amounts of sulfur dioxide, particulate matter and other pollutants in the atmosphere, the quality of air in Zenica has negative effect on the health of the population [1]. From the relationship between the incidence of acute and chronic respiratory diseases of the investigated age groups in the period since 2001 - 2011 and the concentration of SO_2 in Zenica, we found that there is a significant statistical correlation between the rate of hospital admissions and the amount of SO_2 concentration. Air pollution is a significant environmental and public health problem in Zenica. This is a significant etiological factor of increase in the number of hospital admissions and patients suffering from acute and chronic respiratory diseases in all age groups in Zenica. In the conducted retrospective study, we showed that this phenomenon can be associated with high concentrations of $S0_2$, as irritants, which affects the airways, but also as a sensitizer, which affects the development process of irritability and hypersensitivity. Based on the indicators found in the literature it is known that health problems are associated with much lower concentrations of SO_2, than previously believed. Therefore in accordance with these findings a higher level of a protection is required, ie reducing SO_2 concentration to a minimum. An implementation of continuous intensive monitoring, with as many of the measured parameters as possible and with sufficient number of measurement points, is highly recommended.

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