

RESEARCH ARTICLE

Examination of Bronchial Reactivity in Workers Exposed to Microparticles PM_{2.5} and PM₁₀ during Coal Surface Mining in the Bellaqevc Power Plants of Kosovo

Pëllumb Islami ^a, Ali Iljazi ^b, Hilmi Islami ^c 

^a Department of Clinical Toxicology, Hospital of Mitrovica, Kosova.

^b Kosovo Occupationnal Health Institute, Clinical Centre N.N., Gjakova, Kosova.

^c Department of Pharmacology, Faculty of Medicine, University of Prishtina, Clinical Centre, Prishtina, Kosova

ABSTRACT

The impact of air pollution with microparticles (PM_{2.5} and PM₁₀) on the respiratory systems of workers engaged in the surface mining of coal at the Bellaqevc power plants of Kosovo is studied in this paper. The parameters of lung function are defined via body plethysmography. The resistance of the airways (Raw) was recorded, intrathoracic gas volume (ITGV) was measured, and the specific resistance of the airways (SRaw) and specific conductance (SGaw) were calculated. The research was performed within two groups: a control group and an experimental group. The control group consisted of 28 healthy people, whereas the experimental group consisted of 50 workers engaged in the surface mining of coal at the Bellaqevc power plants of Kosovo. The results obtained from this research indicated that the mean specific resistance (SRaw) was significantly increased in the experimental group (p<0.01) compared to the control group (p>0.1). The study also found that smoking favors the adverse effects of air pollution caused by coalsurface mining at the Bellaqevc power plants (p<0.01).

Measurements of the respiratory systems were made prior to and following provocation with histamine–aerosol (1 mg/ml) in the control and experimental groups. Changes between these two groups following this provocation with histamine–aerosol were found to be statistically significant (p<0.01). In order to cause a respiratory pathology from air pollution, it is required a lot of time, such pollution can permanently cause respiratory system disorders. These scientific findings suggest that the long-term exposure of workers to microparticles PM_{2.5} and PM₁₀ during the process of surface mining coal at the Bellaqevc power plants of Kosovo poses a risk to their health by causing increased bronchial reactivity, bronchial asthma, or chronic obstructive pulmonary disease (COPD).

KEYWORDS: Coal Surface Mining at the Bellaqevc Power Plants of Kosovo, Respiratory System, PM_{2.5} and PM₁₀ Microparticles.

Correspondence: Dr Islami Hilmi, Department of Pharmacology, Faculty of Medicine, University of Prishtina, Clinical Centre, Prishtina, Kosova. Email: islamihilmi@hotmail.com

Copyright © 2020 Islami P et al. This is an open access article distributed under the [Creative Commons Attribution 4.0 International](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Air pollution has extensive systemic effects on the human body, affecting both the respiratory system and the cardiovascular system through multiple mechanisms, including oxidative stress, inflammation, and endothelial dysfunction [1]. The correlation between air pollution and cardio-respiratory disease is a global concern [2].

In addition to morbidity and cardio-respiratory mortality, recent studies have found that air pollution is also correlated with health effects, such as dementia, structural changes in children's brains, cognitive impairment, and diabetes [3].

A study conducted in the United States showed that the incidence of lung cancer is related to exposure to PM_{2.5} microparticles [4]. In another study by the American Cancer Society, the incidence of lung cancer increased by 8% with 10 µg × m⁻³ increases in the levels of PM_{2.5} microparticles measured between cities [5]. PM_{2.5} microparticles have also been associated with decreased parathyroid hormone levels in exposed individuals [6]. Regardless of its origin, air pollution is a toxic mixture of microparticles and particulate matter (PM) composed of organic chemicals (polycyclic aromatic hydrocarbons

(PAHs), metals (iron, nickel), gases (ozone), endotoxins, bacteria, and minerals (quartz, asbestos) [7].

Air pollution has become the leading cause of premature death [1]. Global estimates indicate that environmental pollution causes 1.15 million deaths worldwide (corresponding to almost 2% of the total number of deaths) [8]. The risks of air pollution on human health are mainly related to PM microparticle concentrations, especially PM_{2.5} microparticles, which have been classified as carcinogenic by the International Agency for Research on Cancer [9,10]. PM_{2.5} microparticles penetrate deep into the lungs and contribute to respiratory diseases causing lung cancer and cardiovascular disease [11,12]. Such microparticles are the result of thermal power plant release, the burning of coal or wood, vehicles, or directly causing fires in the mountains, and such released microparticles can remain suspended in the air for long periods of time. Based on this, the essential purpose of this study was to compare bronchial reactivity between healthy persons and persons exposed to high levels of PM_{2.5} and PM₁₀ microparticles in the specific work environment of coal surface mining at Bellaqevc thermal power plants in Kosovo. There is no doubt that the most direct type of microparticle air pollution damage is reflected in the human respiratory system; thus, our study is focused within this context.

MATERIALS AND METHODS

Our study was focused on research regarding increased bronchial reactivity and chronic obstructive pulmonary disease by applying the Chronic Respiratory Disease Questionnaire by the Medical Research Council (MRC) [13].

In this way, we ascertained the manifestation of increased bronchial reactivity and COPD by measuring objective respiratory system parameters via the body plethysmography of workers working in surface mining in at the Bellaqevc power plants. Research on work performed during the exposure to various microparticles has helped identify the major causes of increased bronchial reactivity and obstructive lung diseases, such as climatic conditions in the workplace, various habits, smoking, working conditions, and workplaces. It is important to note that there are statistically significant differences between non-smokers and smokers. There are also statistically significant differences between people who suffer from chronic obstructive bronchitis and those who do not, which corresponds to the value of the MRC questionnaire [14].

In the present study, the selection of employees was conducted in a randomized manner, and all research participants were informed about the procedures and purpose of the research. All workers taking part in the research were informed not to take any medication for at least 48 hours before the examination so as not to interfere with the results of our tests. So, lung function was determined under resting conditions. Then, the specific resistance of the airways (Raw) and the volume of intrathoracic gas (ITGV) were measured by applying the body plethysmography technique. From the results obtained for the Raw and ITGV, specific airway resistance (SRaw) and specific conduction (SGaw) values were also calculated.

We applied an additional procedure to both the control group and experimental group in order to verify whether the selected individuals were healthy and did not exhibit bronchial reactivity in their airways. We demonstrated this by performing provocation testing for bronchoconstriction using bronchoconstrictor agents, such as histamine-aerosol (1 mg/ml). In our case, we used histamine-aerosol as a constrictive substance of the airways.

The research was conducted in two working groups: The control group included 28 healthy individuals, and the experimental group included 50 workers with permanent work in the surface mining of coal at the Bellaqevc power plants of Kosovo. Plethysmography is a very precise type of equipment, which serves to measure the volume of air inside the chest. This equipment consists of a plastic cabinet that enters the individual to be measured. He/she blows into a turbine, which, like in spirometry, records the volume and flow of air the subject performs. By means of plethysmography, we can record the pressure-pressure curves as well as the pressure-air flow curve. In the case of changes in the respiratory system, increased hyperreactivity or COPD immediately requires the initiation of appropriate therapeutic treatment with the following drugs: adrenergic bronchodilators, anticholinergic substances, or methylxanthines [15-18]. Whereas anti-inflammatory drugs: corticosteroids, antihistamines, and antileukotrienes [19-22].

Since the treatment of these diseases via medicine is limited, the only possibility for truly avoiding respiratory disorders is the taking of preventive measures [23,24].

Since in this study we are dealing with the difference between two research groups, on this basis we have used t-test as a differentiating mechanism regarding the level of significance between the two comparative groups: the control group and the experimental group (workers of the surface mining of coal in Bellaqevc of Kosovo power plants). In the control group and the experimental group, we have two series of values of plethysmography parameters, which are obtained as a result of measurements prior and after provocation with histamine. Statistical processing includes determining the mean value (X), standard deviation (SD) and standard error (SEM), as well as testing statistical differences between workers and the control group. Statistical method - ANOVA was used for analysis. The ANOVA test was used to analyze the variations between the results obtained within the group. The parameters are summarized in the MS-EXCEL software. The results obtained were tested with the help of the Student's t-test, in order to ascertain the significant differences between the experimental group and the control group. The computer software INSTAT-3 and STATISTICA FOR WINDOWS were used for statistical processing.

RESULTS

We could conclude that, in healthy people, there is no presence of bronchial reactivity in the respiratory tract, and thus they can be used as a control group to assess the conditions of the experimental group (see tables 1, 2 and diagram).

Table 1. General characteristics of the researched people.

Group	N	Age (years)	Height (cm)	Weight (kg)	VC (L)	FEV ₁ (L)
Control	28	35.7± 0.8	175±0.22	68.5±1.7	3.80±0.12	3.72±0.15
Experimental	50	55.25±1.33	171±0.14	75.80±1.10	3.75±0.13	3.45±0.28

- Generalized mean values for: Control group n = 28, X ± SEM; Experimental group n = 50, X ± SEM.
- The general starting values for: VC (L) and FEV₁ (L) are also given.
- VC =Vital capacity expressed in liters,
- FEV₁ - Enhanced expiratory volume in the first second, expressed in liters.

Table 2. Body-plethysmography features of the people involved in this study.

Group	N	Raw (kPa×s/L)	ITGV (L)	SRaw (kPa×s)	SGaw (kPa×s)
Control	28	0.12 ± 0.03	2.55 ± 0.4	0.30 ± 0.6	3.33 ± 0.17
Experimental	50	1.29 ± 0.7	3.20 ± 0.6	4.12 ± 0.9	0.24 ± 0.12

- Raw (kPa × S/L); ITGV (L); SRaw = Raw × ITGV;
- SGaw = 1/SRaw.
- Raw - Airway resistance expressed in kilopascal/second/liter,
- ITGV - Volume of intrathoracic gas expressed in liters,
- SRaw - Specific airway resistance which is the relationship between resistance and the volume of intrathoracic gas,
- SGaw - expresses the relationship between 1/specific resistances. SGaw can also be referred to as specific airway passage or conductivity.

All constitutional data of individuals from both groups are given in Tables 1 and 2.

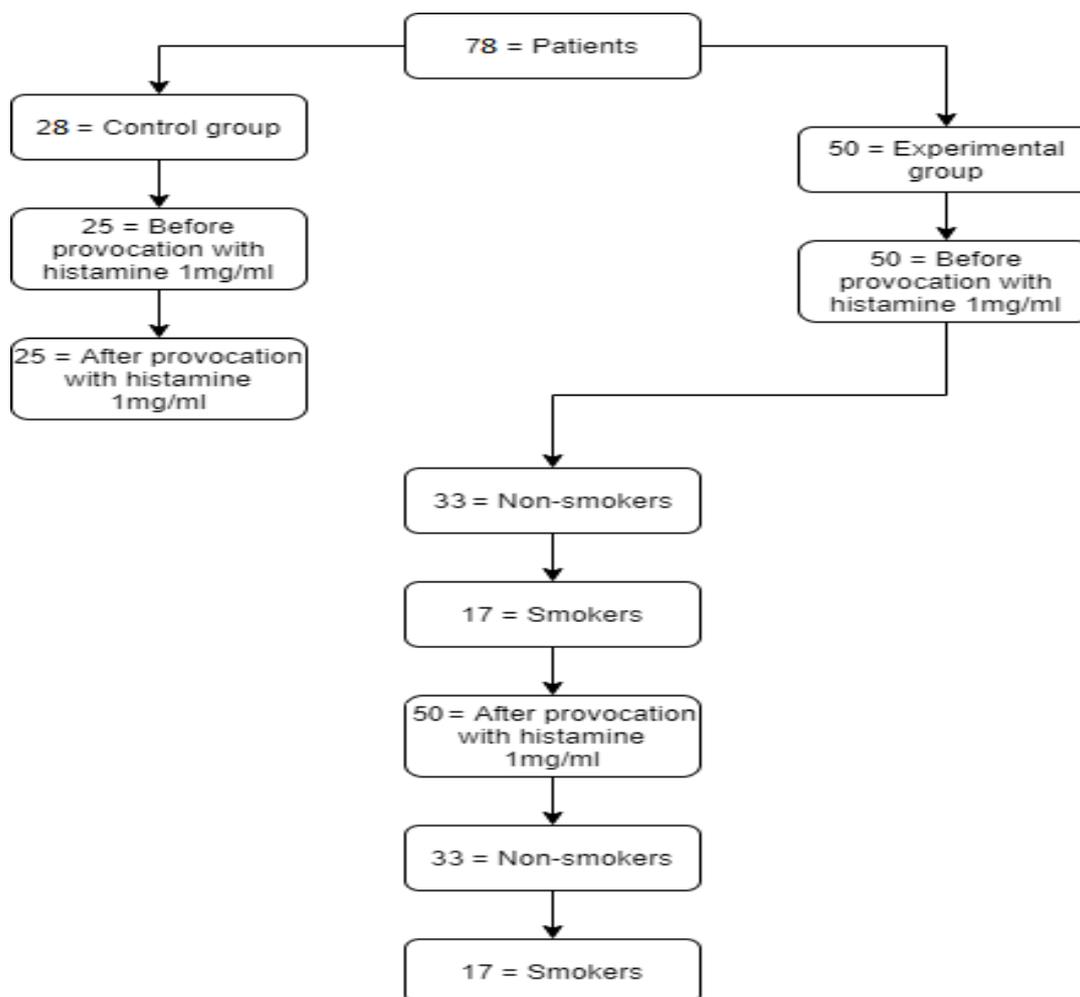


Diagram 1. Frequency of people participating in the research of the control and experimental group.

We will first present the results measured via body plethysmography for the control group, with the aim of eliminating suspicion regarding the presence of bronchial reactivity in this group. So, these results will be expressed in two series: prior to and after provocation with the test

for bronchoconstriction using histamine-aerosol (1mg/ml) (figs. 1 and 3).

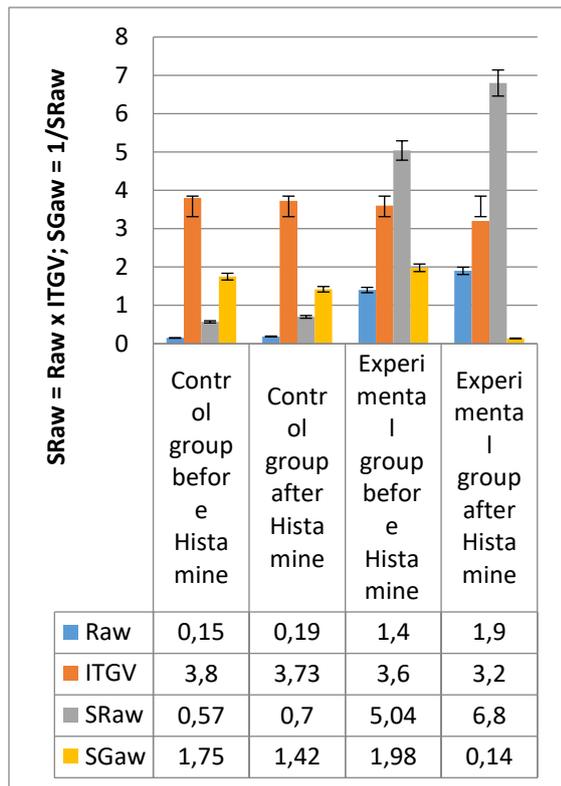


Fig.1. Control and experimental group prior and after provocation with histamine-aerosol 1mg/ml. Comparison of the values of SRaw and SGaw in between the control group ($p>0.1$; $n=28$; $X\pm SEM$) and the experimental group. ($n=50$; $X\pm SEM$; ($p<0.01$).

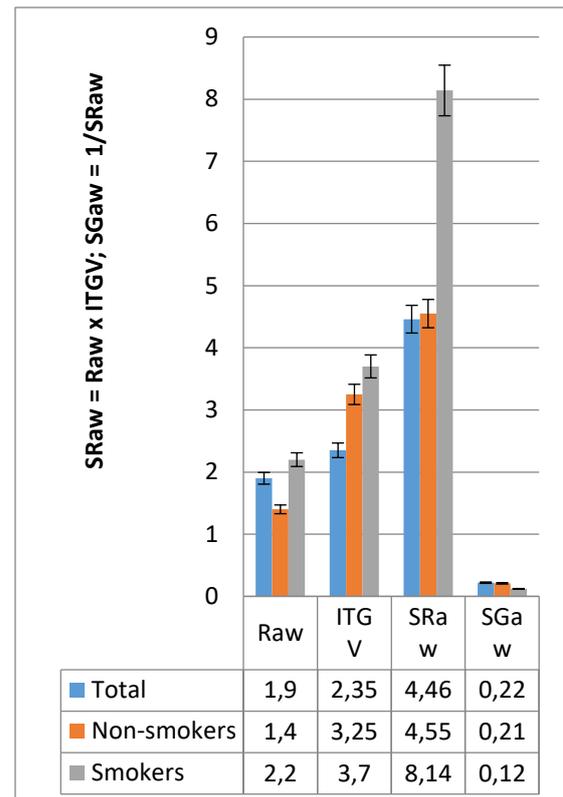


Fig.3. Subject researched as per the smokers and non-smokers categories (after provocation with histamine). Comparison of SRaw and SGaw values in between smokers and non-smokers; after provocation with histamine-aerosol 1 mg/ml. ($n=50$; $X\pm SEM$; ($p<0.01$).

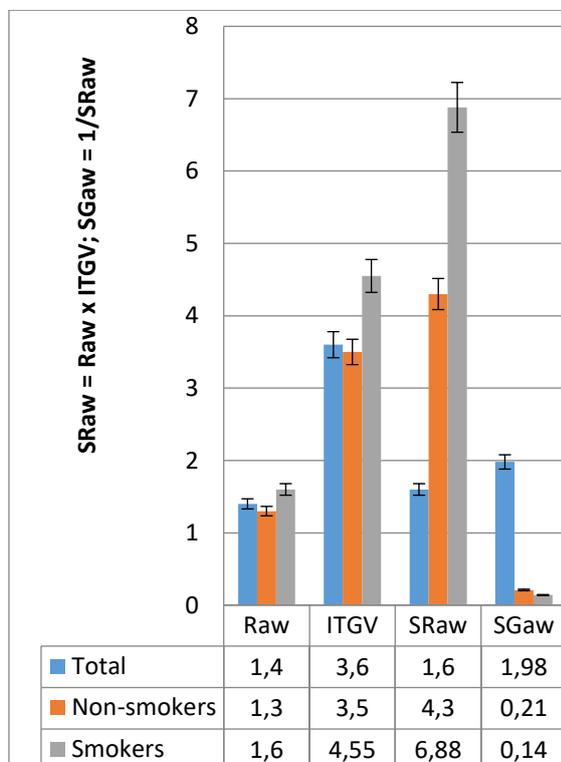


Fig.2. Subject researched as per the smokers and non-smokers categories (prior to provocation with histamine-aerosol). Comparison of SRaw and SGaw values in between smokers and non-smokers categories prior to provocation with histamine-aerosol. ($n=50$; $X\pm SEM$; ($p<0.05$).

The t-test statistical calculation showed that there was no significant difference in the healthy individuals prior to and after provocation with histamine-aerosol 1mg/ml ($p>0.1$). To more clearly understand the differences between these two plethysmography series results in the control group, the same data were presented graphically. The statistical calculations for the SRaw and SGaw for the control and experimental groups indicated that there was an extremely significant difference between these two groups ($p<0.01$). Simply put, these results indicated the presence of pronounced bronchial reactivity in the experimental group. The parameters SRaw and SGaw, analyzed for both groups, are presented graphically in figs. 1, 2, and 3.

DISCUSSION

The literature on the health effects of micro-particulate pollutants in the workplace, including numerous epidemiological and toxicological studies, is extensive. In each separate study, correlations were found between air pollution and microparticles in workplaces and one or more other factors, depending on the level of exposure, health status, and age of the exposed workers [25]. The amount of scientific evidence on the health effects of microparticle pollution in the workplace has been increasing in recent years. Some questions remain unanswered, but many epidemiological studies have indicated that air pollution in the workplace is a risk factor for worker mortality and morbidity [26]. Moreover, the impact of air pollutants on the respiratory tract has been extensively and consistently reported in recent years [27].

Air pollution is one of the leading causes of premature death, strokes, lung diseases, asthma, and various other diseases [28].

In this study, the results measured via body plethysmography in the control group prior to and after the provocation with the bronchoconstriction test with histamine-aerosol 1mg/ml did not indicate a significant difference ($p>0.1$).

The statistical calculations of the SRaw and SGaw for the control group and experimental group indicated that there was an extremely significant difference between these two groups ($p<0.01$). Simply put, these results indicate the significant presence of increased bronchial reactivity in the experimental group.

The difference between the experimental subgroups confirmed the favorable effect of smoking on the aggravation of the negative respiratory effects of air pollution with microparticles PM_{2.5} and PM₁₀ ($p<0.01$).

There is also strong evidence that air pollution with various microparticles in the workplace worsens asthma morbidity and mortality in people with this disease, and there is also some evidence that air pollution with microparticles may affect the prevalence of asthma [29]. Children are at greater risk of developing asthma when exposed to higher concentrations of air pollutants [30].

A study conducted in France found that 9% of total deaths in France are due to PM_{2.5} anthropogenic microparticles [26]. The total mortality calculated for PM_{2.5} microparticles is higher than that due to PM₁₀ microparticles [27].

The American Heart Association published a scientific study stating that 'there is a correlation between PM_{2.5} microparticle exposure and cardio-respiratory mortality-morbidity' [31].

The harmful effects of particulate matters (PM) and respiratory function has been well-verified. In the present study, not only did we find strong epidemiological evidence of a correlation between air pollution with microparticles and asthma, but recent studies, especially in industrial and urban areas, have shown the role of pollutants in the development of asthma and COPD as well [1,32].

Sources of air pollution with microparticles include coal surface mining for exploitation, power plants, and ash depots created by coal burning, coal self-ignition in mines, pollution from local traffic, and heating systems. These sources of pollution mainly emit the following pollutants: SO₂, NO₂, CO, CO₂, airborne microparticles (PM_{2.5}, PM₁₀), and heavy metals (Pb, Zn, Cr, Ni, Cd, Mn).

Thus, from these facts presented above, it can be understood that air pollution is a problem of global proportions. The detrimental effect of poor air quality on health, which is mentioned in most scientific research, is usually attributed to high levels of PM_{2.5} and PM₁₀ microparticles and other gases such as SO₂, NO, and ozone. The same pollution agents have been identified in our country, specifically among the population of the Kastriot region surrounding the generating power plants in Kosovo [33].

Therefore, our findings, in the context of general morbidity, especially respiratory-related morbidity, were very close to those of previous studies conducted throughout the world [34].

In terms of air pollution, tests have been carried out that measure the reduction in its harmful effects on human health after various environmental interventions were made in many countries throughout the world. Laden et al. conducted a study based on the above. According to this research, in six different cities, it was found that the reduction in PM_{2.5} microparticle levels in the atmosphere was associated with a reduction in the risk levels of cardio-pulmonary morbidity and lung cancer. The same beneficial effect of reducing pollution levels was confirmed by work conducted in Hong Kong, in which children of primary-school-age were analyzed as a very sensitive subgroup to air pollution [35].

Acute and inflammatory changes caused by the sudden exposure to high concentrations of microparticles are associated with bronchoconstriction and manifested by dyspnea and chest pain. Respiratory activity is significantly increased and causes exposure to proteolytic enzymes. The inflammatory process associated with COPD is characterized by an increased number of activated alveolar macrophages, neutrophils, cytotoxic CD8 + T lymphocytes, B lymphocytes, CD4 + T lymphocytes, and the release of numerous inflammatory mediators (leukotrienes, cytokines, growth factors, chemokines, and oxidizers). Chronic inflammation leads to the reconfiguration of small airways, producing lumen blockage due to increased mucus production and the thickening of the airway walls due to edema and collagen formation, which causes fibrosis and narrowing [36].

The latest available data, taken from the 2016 Kosovo Energy Corporation Environmental Report (KEK), shows significant pollution within European standards, except for dust deposits. However, those few sampling locations cannot be considered as a complete reflection of the true levels of microparticle air pollution in the region. During public consultations with the community and the surveying of households in this area during the drafting of the questionnaire, numerous respiratory problems and other health symptoms were reported that could be attributed to environmental pollution with microparticles [37,38]. The data from the reports indicated that the allowed criteria had been exceeded several times, from the average values of 300 mg/(m²d) for 3-4 months during the year and the pH according to the WHO, while inorganic and solvent substances are constituents of total dust concentrations for 2016 to 2019 [39,40]. Based on the research and obtained results, it can be concluded that the continuous monitoring of the respiratory tract is necessary, especially in terms of the presence of an inflammatory reaction, which occurs following prolonged exposure to microparticles. Thus, it is necessary for these workers to undergo systematic visits and testing for bronchial reactions to histamine or methacholine, and this is valid for timely therapeutic intervention. Subjects with bronchial hyperreactivity indicated a preference for the rapid onset of permanent changes in their respiratory tracts.

To protect the environment and reduce global climate change, society must make an increased effort to gradually shut down coal-fired power plants and switch to renewable solar power, wind power, hydropower to protect the environment. For example, Germany intends to eliminate coal no later than 2038 and even shorten this period by three years (to 2035) depending on improvement reports that will be conducted in 2026 and 2029 [41,42].

CONCLUSION

In determining the responses to the inhalation of histamine hydrochloride-aerosol (1mg/ml) in the control group and experimental group, a significantly higher percentage of increased bronchial reactivity was found in the workers engaged in the surface mining of coal. This was based on the measurement of airway resistance (Raw, ITGV), specific resistance (SRaw), and specific conductance (SGaw). The differences were found to be significant ($p < 0.01$) when compared with the control group ($p > 0.1$). The experimental group on a whole, as well as the subgroup of smokers, indicated extreme significant changes in specific resistance (SRaw) and specific conductance (SGaw) ($p < 0.01$) compared to the control group ($p < 0.1$). The difference between the experimental subgroups confirmed the favorable effect of smoking on the aggravation of the negative respiratory effects of air pollution.

These studies indicate that the exposure of workers in the surface mining of coal in the Bellaqevc power plants of Kosovo's to microparticles and other pollutants also causes an increase in local mediators and, consequently, an increase in bronchial reactivity. The risks of air pollution on health are entirely related to the concentrations of PM micrograms, especially PM_{2.5}, which has been classified as carcinogenic by the International Agency for Research on Cancer (IARC).

Based on the research and results obtained, it can be concluded that the permanent monitoring of the respiratory tract is more than necessary, especially in terms of the presence of an inflammatory reaction, which occurs after prolonged exposure to environmental pollutants with

microparticles. Those with increased bronchial hyperreactivity exhibit a predisposition to the rapid onset of permanent changes in their respiratory tract, which explains why they should be targeted as subjects at a higher risk. If respiratory changes are observed, appropriate bronchodilator therapy should be initiated immediately to treat lung function disorders, since the progression of the obstructive process complicates later therapeutic treatment.

ACKNOWLEDGMENTS

The authors thank the staff of the Institute of Occupational Medicine in Kastriot, Kosovo and the pedagogical staff of the Institute of Clinical Physiology of the Ministry of Health in Prishtina for providing all the necessary data to the examined patients.

AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the [Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors](#). Indeed, all the authors have actively participated in the redaction, the revision of the manuscript, and provided approval for this final revised version.

COMPETING INTERESTS

The authors declare no competing interests with this case.

FUNDING SOURCES

None.

REFERENCES

- [1] Kelly FJ, Fussell JC. (2015) Air pollution and public health: emerging hazards and improved understanding of risk. *Environ Geochem Health* 37:631-49.
- [2] Weeberb J, Requia, Matthew D. Adams, Altaf Arain, Stefania Papatheodorou, Petros Koutrakis, Moataz Mahmoud. (2018) Global Association of Air Pollution and Cardiorespiratory Diseases: A Systematic Review, Meta-Analysis, and Investigation of Modifier Variables. *Am J Public Health* 108:S123-S130.
- [3] Greven FE, Vonk JM, Fischer P, Duijm F, Vink NM, Brunekreef B. (2019) Air pollution during New Year's fireworks and daily mortality in the Netherlands. *Sci Rep* 9:5735.
- [4] Kevin R. Cromar, Laura A. Gladson, Gary Ewart. (2019) Trends in Excess Morbidity and Mortality Associated with Air Pollution above American Thoracic Society-Recommended Standards, 2008-2017. *Annals of the American Thoracic Society* 16: 836-845.
- [5] Perez L, Rappa R, Künzli N. (2010) The Year of the Lung: outdoor air pollution and lung health. *Swiss Med Wkly* 140: w13129.
- [6] David B. Peden. (2018) The Unexpected Health Effects of Air Pollution. *North Carolina Medical Journal* 79:309-311.
- [7] Traboulsi H, Guerrina N, Iu M, Maysinger D, Ariya P, Baglolle CJ. (2017) Inhaled Pollutants: The Molecular Scene behind Respiratory and Systemic Diseases Associated with Ultrafine Particulate Matter. *Int J Mol Sci* 18(2): 243.
- [8] Marcos Abdo Arbex; Ubiratan de Paula Santos; Lourdes Conceição Martins; Paulo Hilário Nascimento Saldiva; Luiz Alberto Amador Pereira; Alféio Luis Ferreira Braga. (2012) Air pollution and the respiratory system. *J. bras. Pneumol* 38:1806-3713.
- [9] American Tort Lawyers and IARC. (2019) A Toxic Mutual Interest. *European Seed* 6: Issue 2. 456.
- [10] IARC Monographs- Classifications. (2019) Monographs.iarc.fr. International Agency for Research on Cancer; World Health Organization; Book and Report Series.
- [11] Shreosi Sanyal, Thierry Rochereau, Cara Nichole Maesano, Laure Com-Ruelle, Isabella AnnesiMaesano. (2018) Long-Term Effect of Outdoor Air Pollution on Mortality and Morbidity: A 12-Year FollowUp Study for Metropolitan France. *International Journal of Environmental Research and Public Health*, MDPI 15: 2487.
- [12] Samek L. (2016) Overall human mortality and morbidity due to exposure to air pollution. *Int J Occup Med Environ Health* 29: 417-26.
- [13] MRC Asthma UK. (2018) Centre in Allergic Mechanisms of Asthma. Medical Research Council (MRC), UK.
- [14] Austoker Joan, and Linda Bryder, eds. (1989) Historical perspectives on the role of the MRC: essays in the history of the Medical Research Council of the United Kingdom and its predecessor, the Medical Research Committee, Oxford UP.
- [15] Islami H, Veseli H, Behluli E, Morina N. (2012) Importance of the Adrenergic Nerve System in the Response of Gases in the Arterial Blood Following the Provoked Bronchospasm. *Medical Archives* 66:292.
- [16] Islami H, Ilazi A, Gashi N, Mustafa L, Maloku H, Jashanica A. (2014) Response of the adrenergic system after provoked bronchoconstriction in patients with bronchial asthma. *Acta Informatica Medica* 2:107.
- [17] Islami P, Ilazi A, Jakupi A, Bexheti S, Islami H. (2014) Importance of Alpha-adrenergic Receptor Subtypes in

- Regulating of Airways Tonus at Patients with Bronchial Asthma. *Acta Informatica Medica* 22:174.
- [18] Hyseini K, Iljazi A, Morina N, Iljazi F, Islami H. (2017) Comparison of methylxanthines (doxofylline and diprophylline) effect in patients with bronchial hyperreactivity and bronchial asthma. *RJPBCS* 5:500-09.
- [19] Lajqi N, Ilazi A, Kastrati B, Islami H. (2015) Comparison of glucocorticoid (budesonide) and antileukotriene (montelukast) effect in patients with bronchial asthma determined with body plethysmography. *Acta Informatica Medical* 23:347.
- [20] Shabani D, Mustafa I, Islami P, Iljazi A, Dauti A, Islami H. (2020) Effect of glucocorticoids following application of adenosine receptor blockers in patients with chronic obstructive bronchitis and bronchial asthma. *OAMJMS* 225:20-25.
- [21] Morina N, Iljazi A, Iljazi F, Hyseini K, Bozalija A, Islami H. (2017) Effect of antileukotriene (zileuton) in patients with bronchial asthma (emphasized reactors, moderate reactors, and non-reactors). *RJPBCS* 8:334-42.
- [22] Morina N, Iljazi A, Iljazi F, Gashi L, Bozalija A, Rustemi F, Islami H. (2018) Effect Antileukotriene Substances (Montelukast) In Patients with Changed Bronchial Reactivity (Non-Reactors, Moderate Reactors and Emphasized Reactors). *RJPBCS* 8:1092-99.
- [23] Haxhiu MA, Islami H, Mandura I, Krasniqi A. (1980) The protective effect of Oxatomide (R 35 443) on exercise-induced asthma. *Plucne bolesti i tuberkuloza* 32: 122.
- [24] Morina N, Haliti A, Iljazi A, Islami D, Bexheti S, Bozalija A, Islami H. (2018) Comparison of Effect of Leukotriene Biosynthesis Blockers and Inhibitors of Phosphodiesterase Enzyme in Patients with Bronchial Hyperreactivity. *Maced J Med Sci* 187:1-5.
- [25] Tord E Kjellstrom, Anne Neller and Rod W Simpson. (2002) Air pollution and its health impacts: the changing panorama *Med J Aust* 177:604-608.
- [26] Annunziata Faustini, Massimo Stafoggia, Paola Colais, Giovanna Berti, Luigi Bisanti, Ennio Cadum, Achille Cernigliaro, Sandra Mallone, Corrado Scarnato, Francesco Forastiere. (2013) Air pollution and multiple acute respiratory outcomes. *European Respiratory Journal* 42: 304-313.
- [27] Martuzzi M, Krzyzanowski M, Bertollini R. (2003) Health impact assessment of air pollution: providing further evidence for public health action. *European Respiratory Journal* 21: 86s-91s.
- [28] Pope CA III, Dockery DW. (2006) Health effects of fine particulate air pollution: lines that connect. *J Air Waste Manag Assoc* 56:709-742.
- [29] Austin M. Williams, Daniel J. Phaneuf, Meredith A. Barrett, Jason G. Su. (2019) Short-term impact of PM2.5 on contemporaneous asthma medication use: Behavior and the value of pollution reductions *Proceedings of the National Academy of Sciences* 116:5246-5253.
- [30] Mary Prunicki, Laurel Stell, Deendayal Dinakarpanian, Mariangels de Planell-Saguer, Richard W. Lucas, S. Katharine Hammond, John R. Balmes, Xiaoying Zhou, Tara Paglino, Chiara Sabatti, Rachel L. Miller, Kari C. Nadeau. (2018) Exposure to NO2, CO, and PM2.5 is linked to regional DNA methylation differences in asthma. *Clinical Epigenetics* 10:2.
- [31] Frederick W. Lipfert. (2018) Long-term associations of morbidity with air pollution: A catalog and synthesis. *Journal of the Air & Waste Management Association* 68:12-28.
- [32] Kelly FJ, Fussell JC. (2011) Air pollution and airway disease. *Clin Exp Allergy* 41:1059-71.
- [33] Haliti A, Islami P, Mustafa L, Dauti A, Bozalija A, Islami H. (2018) Effect of Air Pollutants on the Manifestation of Bronchial Reactivity in a Population Living in Proximity to a Power Plant. *Toxicology International* 25:1-9.
- [34] Laden F, Schwartz J, Speizer F, Dockery D. (2006) Reduction in fine particulate air pollution and mortality-extended follow-up of the Harvard six cities study. *Am J Of Respir and Crit Care Med* 5:173.
- [35] Wong CM, Lam TH, Peters J, Hedley AJ, Ong SG, Tam A, Liu J, Spiegelhalter DJ. (1998) Comparison between two districts of the effects of an air pollution intervention on bronchial responsiveness in primary school children in Hong Kong. *J. Epidemiol. Community Health* 52:571-78.
- [36] Saetta M, Di SA, Turato G, Facchini F M, Corbino L, Mapp CE, Maestrelli P, Ciaccia A, Fabbri, LM. (1998) CD8+ T-lymphocytes in peripheral airways of smokers with chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 157:822-6.
- [37] Air Quality Strategy and Action Plan. (2019) [www.km.net/repository/docs/ Air Quality Strategy and Action Plan](http://www.km.net/repository/docs/Air%20Quality%20Strategy%20and%20Action%20Plan) – Prishtina.
- [38] Provisional Institutions of self Government. (2003) Ministry of Environment and Spatial Planning. Kosovo State of the Environment Report 14:81-84.
- [39] United Nations Environment Programme, UNEP. (2003) Office for the coordination of the humanitarian Affairs, OCHA, Assessment Mission Kosovo-Serbia. Report Industrial Complex in Obilić-Power Plant 3.2: 9-10.
- [40] Institute for Spatial Planning. Spatial plan. (2010) Area of Special Economic Interest " "New surface mining of the coal" Prishtina 2010–2020.
- [41] German Energy Blog Government Adopts Energy. Concept Archived (2015).
- [42] Federal Ministry of Justice and Consumer Protection. "§2 of the "Energy-Taxation-Law" (EnergieStrG)" 2019.