

## ORIGINAL PAPER

# Air Pollution in Pristina, Influence on Cardiovascular Hospital Morbidity

Antigona Ukëhaxhaj<sup>1</sup>, Dragan Gjorgjev<sup>2</sup>, Maser Ramadani<sup>1</sup>, Selvete Krasniqi<sup>1</sup>, Tahire Gjergji<sup>1</sup>, Drita Zogaj<sup>1</sup>

National Institute of Public Health Kosovo-Pristina, Prishtina, Republic of Kosova<sup>1</sup>

University "Ciril and Metodij", Skopje, Skopje, Republic of Macedonia<sup>2</sup>

**Introduction:** Numerous studies observed health effects of particulate air pollution. Ambient air quality is particularly bad in Pristina. The principal sources of contaminants are sulfur dioxide (SO<sub>2</sub>), nitrogen oxides NO and NO<sub>2</sub> (NO<sub>x</sub>), ozone (O<sub>3</sub>), lead (Pb), carbon dioxide (CO<sub>2</sub>), particulate matter (PM or dust). **Objective:** to investigate effects of concentrations of pollutants in ambient air on hospital admissions for cardiovascular disease in UCKK- Pristina. **Methods:** Retrospective ecological study. During the three year analytical research predict the potential benefit of decreasing for concentration of PM<sub>2.5</sub>, PM<sub>10</sub> were measured in two station in Pristina. The study population consisted of all hospitalization patient in intern clinic for 2010, 2011 and 2012 year. Air pollution measurements will be used by KHMI data for the year of 2010, 2011 and 2012 for the municipality of Pristina in the measurements point in: KHMI-MESP which is equipped with automatic analyzer- Air Compact Monitoring System (Version 2.2) recordum MESSTECHNIK GmbH. Statistical data processing will be done with SPSS 17.0 statistical package. **Results:** Based on the results obtained during the study period concentrated PM are higher level than standards value. The results showed that the number of hospital admissions for cardiovascular disease are positively correlated with concentration pollutants. Results show clear seasonal variation in the effects of PM on hospital admissions in Kosovo. The study period was short but the mean daily admissions for cardiovascular illnesses were quite large. **Conclusion:** The main source for air pollution was coal-burned power plant and traffic (old vehicles) in Kosovo. **Key word;** hospital admissions, cardiovascular disease, air pollution, airborne particle

Corresponding author: Antigona Ukehaxhaj, MD. National Institute of Public Health Kosovo-Pristina.

## 1. INTRODUCTION

Kosovo is a mountains farm region which at past was in the process of industrialization, because of its reach coal and mineral resources (1).

Pristina is located at the geographical coordinates 42° 40' 0" North and 21° 10' 0" East and covers 572 square kilometers. The population of Pristina: 550,000 citizens (2).

The major contributors to air pollution in Pristina are:

- The largest air polluting source is the coal-burned power plant in Obiliq 5 km near Pristina.
- Air pollution such as CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, Pb, dust, smoke, dioxin

and particulate matter are emitted from the plant and contribute significantly to the bad air in Pristina and surroundings.

- Road transport is another major source of air pollution.
- About 80-85% of all heating in Kosovo come from firewood.
- Dust in the cities from increased traffic and old vehicles are other more recent concern.
- Many people in Kosovo are expose to health risks resulting from environmental pollution (3).
- Kosovo have Law on air protection from pollution, Nr.03/L-160 (4).

Clean air is considered to be a basic requirement of human health and well being (5).

In 2004, the American Heart Association (AHA) publish its first scientific statement regarding air pollution and cardiovascular disease (CVD). The rationale was to provide researchers, healthcare providers, and regulatory agencies with a comprehensive review of the evidence linking air pollution and exposure with cardiovascular morbidity and mortality (6, 7, 8).

There is growing epidemiological evidence on adverse effects of particulate air pollution on cardiovascular health. These effects include increased hospital admissions and mortality (9, 10).

Air pollution from PM 2.5 has also been associated with increased incidence morbidity and mortality from coronary disease, stroke, heart failure (9, 10, 11-15).

Alternatively, it has been hypothesized that an increase in air pollution levels could modify autonomic nervous control of the heart in subjects with existing cardiovascular disease and thus lead to increased morbidity and mortality (13-20). In addition, it has been shown that inhaled ultrafine particles diffuse rapidly into the systemic circulation, and this process could account for extra pulmonary effects of air pollution (10-15).

Positive associations between individual air pollutants and mortality or morbidity have been found in

many American and European studies (13-15).

PM is a widespread air pollutant present wherever people live. The health effects of PM<sub>10</sub> and PM<sub>2.5</sub> are well documented. Most, but not all, epidemiological studies corroborate the evaluated risk for cardiovascular events associated with exposure to fine PM<sub><2.5</sub> in aerodynamic diameter (PM<sub>2.5</sub>) which has been associated with increased risks of myocardial infarction (MI), stroke, arrhythmia and heart failure exacerbation within hours to days of exposure in susceptible individuals (16, 17).

In this context, the assess the lag structure between air pollution exposure and elderly cardiovascular hospital admission shown in many study (19-29).

## 2. GOAL

Aim of the current study was to investigate the relationship between hospital admission and cardiovascular disease in Pristina and exposure to ambient PM for the period 2010-2012. The reduction of the annual PM<sub>10</sub> air pollution level will lead to significant reduction of mortality rates in Pristina population.

## 3. MATERIAL AND METHODS

The research material is presented as eco-media data (the ambient air: air pollution data for PM<sub>2.5</sub>, PM<sub>10</sub> and O<sub>3</sub>) as well as mortality and morbidity data for Pristina as urban area.

The analytical research has predicted the potential benefit of decreasing of daily PM<sub>2.5</sub> and PM<sub>10</sub> and O<sub>3</sub> for long time period in order to carry out the epidemiological description and analyze of main characteristics in the period 2010-2012 and forecasting the future trend as benefit for the Republic of Kosovo.

University Clinical Center (UCCK) is the only referral tertiary care center in Kosovo with 2344 beds and approximately 60.000 admissions per year. It is the main research institution in the field of clinical research.

Hospital admissions for cardiovascular disease in UCCK for 2010-2012 were collected.

Patient data captured age, year of admission and diagnosis on discharge from the ten revision of the Interna-

tional classification of diseases (ICD-10). As well as all hospital admissions, those specific disease for the circulatory system (I 00-I 99).

Air quality data for the study period were obtained from the KHMI which manages two stations for the municipality of Pristina in the measurements point in: KHMI-MESP which is equipped with automatic analyzer sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) carbon monoxide (CO), suspended particle analyzer PM<sub>10</sub> / PM<sub>2.5</sub> with air pointer Automatic Air Compact Monitoring System (Version 2.2) recordum MESSTECHNIK GmbH.

Pristina Rilindja- Second station MESP/IHMK. This station is equipped with optical analyzer three channels (Makeup Model 180) which is configured to measure fractions (particle matter) PM<sub>10</sub>, PM<sub>2.5</sub> and meteorological parameters, wind direction, wind speed, air temperature humidity relative air, atmospheric pressure.

Distance from the source of gases contaminates 1 km as the crow flies, sampling height of 2.3 and 4 m from ground level.

Sampling procedure and semi automatic, automatic aspiration through the air samples. Preparation of samples and their analysis based on standard methods of operation according to Directive 2008/50/EC, for each parameter.

### 3.1. Statistics

Data management was performed with SPSS 17.0. Effects estimates and 95% confidence interval (CI) were calculated per 10 Mg/m<sup>3</sup> increase in PM.

Of statistical parameters to calculate the average Arithmetic, SEM (standard error of the sample), IC (confidence interval) with 95% reliability, minimum and maximum concentration of pollutant and Geometric mean and standard deviation (SD).

Data testing would be done with appropriate statistical tests like t-test and analysis of Varians for para-

metric data, whereas for non-parametric data Kruskal-Wallis test would be use to compare differences in concentration of air pollutants in different months. The difference would be significant if P < 0.05 and P < 0.01.

## 4. RESULT

This is the first study to investigate the effects of ambient air pollution on population health in Republic of Kosovo. Using health outcomes, air quality, visibility and meteorological data, the association of particulate air pollution with cardiovascular morbidity was investigated using multivariable pollutant models in a case-cross-over analysis.

Results show clear seasonal variation in the effects of PM on hospital admissions in Kosovo. The study period was short but the mean daily admissions for cardiovascular illnesses were quite large. From all number of hospitalization 1789, biggest number of hospitalization was in 2010 with 634 (35.4%), from which 1003 (56.1%) male and 786 (43.9%) female.

Age group	Gender				Total	
	F		M		N	%
	N	%	N	%		
100-102	1	0.1	-	-	1	0.1
105-109	4	0.5	6	0.6	10	0.6
110-115	55	7.0	64	6.4	119	6.7
120-125	428	54.5	607	60.5	1035	57.9
126-128	2	0.3	2	0.2	4	0.2
130-152	292	37.2	317	31.6	609	34.0
160-169	3	0.4	6	0.6	9	0.5
180-189	1	0.1	-	-	1	0.1
195-199	-	-	1	0.1	1	0.1
<b>Total</b>	<b>786</b>	<b>100.0</b>	<b>1003</b>	<b>100.0</b>	<b>1789</b>	<b>100.0</b>

Table 1. Hospital admission about gender and diagnosis

Age group	Gender				Total	
	F		M		N	%
	N	%	N	%		
20-29	9	1.1	13	1.3	22	1.2
30-39	14	1.8	36	3.6	50	2.8
40-49	60	7.6	95	9.5	155	8.7
50-59	150	19.1	195	19.4	345	19.3
60-69	246	31.3	336	33.5	582	32.5
70+	307	39.1	328	32.7	635	35.5
<b>Total</b>	<b>786</b>	<b>100.0</b>	<b>1003</b>	<b>100.0</b>	<b>1789</b>	<b>100.0</b>
Mean ± SD	65.4 ± 12.3		63.0 ± 12.3		64.1 ± 12.4	
Rank	20 - 108		20 - 99		20 - 108	
Unpaired T-test	T=4.1, P<0.0001					

Table 2. Number of hospital admission about gender and age group

Positive association between male and female had found in study Antonela Zarobeti et al. (20).

Based on diagnosis when looking across all seasons I 20-I25 had the highest number hospital admissions and diagnosis I30-I52 in both gender. Ischemic heart disease and cerebrovascular diseases were not significantly associated with any of pollutants.

This findings is in accordance with the results from 1996-1997 in Helsinki, Erfurt and Alkmaar (Ruuskanen et al, 2001).

Relative risk among those ages > 69 years were higher than in other age groups for all pollutants except PM 10.

Number of hospital admission was for women between 20 year and 108 year old, and men from 20 to 99 year old. Based on this we can say that men in Kosovo has biggest possible to be attack from myocardial infarct than women (Table 2).

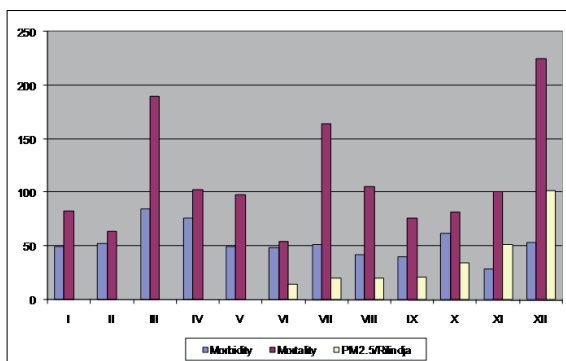
Positive associations were seen in each age group expect those ages 69 years and over. Elevated concentrations of fine particles PM 2.5 were associated with a transient risk of acute miocardi (15, 16).

High levels of dust (particles) in urban air and smoke caused the average value of PM 2.5 in Pristina Rilindja measuring point was 49.7 (SD ± 31.0). The lowest value was in 2010 with average 43.0 (SD ± 32.0) and the highest average in 2011 to 57.3 (SD ± 36.2), which corresponds to the number of patients per year. Yaer level PM10=83.1 (SD ± (33.8) /Rilindja, 2012 and 74.3(SD ±50.4) /KHMI.

The trend of the ratio, percentage between the two fractions in the sampling points that measures the urban / traffic pollution, reflects to be comparable between the three years for the months with available measurements, with a quite stable trend, with no major changes from year to year. In the study of air pollution, measurement of fractions smaller that PM2.5, in the content of PM10 particles is of consid-

Year hospitalization	PM 2.5/Rilindja	PM 10/Rilindja	PM 10/HMK
	Mean ± SD	Mean ± SD	Mean ± SD
2010	43.0 ± 32.0	80.2 ± 30.2	50.4 ± 15.1
2011	57.3 ± 36.2	84.5 ± 35.3	49.1 ± 12.5
2012	44.6 ± 20.6	-	116.1 ± 61.4
<b>Total</b>	<b>49.7 ± 31.0</b>	<b>83.1 ± 33.8</b>	<b>74.3 ± 50.4</b>

Table 3. Measurements point and value for PM 2.5 and PM 10 in Pristina



Graph 1. Number of hospital admission, number mortality and PM concentration

Month	Year hospitalization								
	2010			2011			2012		
	Morbidity	Mortality	PM 10/HMK	Morbidity	Mortality	PM 10/HMK	Morbidity	Mortality	PM 10/HMK
I	49	82	72.3	43	107	-	48	127	-
II	52	63	-	42	129	-	53	119	-
III	84	189	44.5	43	166	56	81	127	-
IV	76	102	37.2	39	99	45.2	57	138	91.5
V	49	98	36.2	46	132	37.2	48	118	79.1
VI	48	54	43.3	48	153	38.9	48	130	56.3
VII	51	164	47.1	32	99	78.6	36	113	86.0
VIII	42	105	44.9	45	64	41.7	48	94	104.0
IX	40	76	40.5	49	60	52.3	40	117	74.4
X	62	81	42.7	44	193	-	49	121	71.2
XI	28	100	78.8	46	222	-	44	121	-
XII	53	224	-	61	148	-	65	148	213.6
<b>Total</b>	<b>634</b>	<b>1338</b>	<b>50.4</b>	<b>538</b>	<b>1572</b>	<b>49.1</b>	<b>617</b>	<b>1473</b>	<b>116.1</b>

Table 4. Number of hospital admission, mortality about particulate matter PM 10

erable importance, due to the impact on health. The pollutant concentration for particles PM 2.5 and hospital admissions during the study period was higher. The mean numbers of admissions were slightly higher in month with the cold weather.

The correlation between different measures of particulate air pollution were also clearly higher in Pristina, than in suburban area, suggesting a difference in the air pollution mixture or meteorological conditions. Based on year hospitalization about month we found highest number in 2010, mortality on year 2011. PM10 concentration was in 2012, 116.1 highest and lower in 2011 with 49.1.

The air-quality data from KHMI show that PM, notably, exceeds the EC limit value of an average annual con-

centration of 40 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) for  $\text{PM}_{10}$ , both in the city center and in the suburban area and often exceeds the one-day limit value (not to be exceeded more than 35 times a year) of  $50 \mu\text{g}/\text{m}^3$ . Similar study was founding De Hartog et al. (25).

## 5. DISCUSSION

Air pollution and effect on human health is clearly evident on Pristina city. Association with mean monthly hospital admissions for cardiovascular disease were highest on month during the cool season and days with dust.

Our findings were broadly consistent with those in European and American country (23-29).

Hospital admissions by gender in UCKK on Intern hospital in Pristina for the years 2010-2012 were hospitalized patients total 1789, of whom 786 women (43.97%) and 1003 men (56.1%).

Those ages > 69 years were at higher risk. Elevated concentrations of fine particles PM 2.5 were associated with a transient risk of acute myocardial.

High levels of dust (particles) in urban air and smoke caused the average value of PM 2.5 in Pristina Rilindja measuring point was 49.7 (SD ± 31.0). The lowest value was in 2010 with average 43.0 (SD ± 32.0) and the highest average in 2011 to 57.3 (SD ± 36.2), which corresponds to the number of patients per year. Yaer level PM10=83.1 (SD ± (33.8) /Rilindja, 2012 and 74.3(SD ±50.4) /KHMI.

Mean monthly hospital admissions for cardiovascular disease were highest on month during the cool season and days with dust. The present study is the largest study conducted until today on the effects of particulate air pollu-



tion and CVD. In many study we found a significant associations between PM 2.5, PM 10 and Cardiovascular hospital admissions. In Pristina Ischemic heart disease is the first most common cause of cardiovascular disease, and second most common cause of all hospital admissions.

## 6. CONCLUSION

Adoption and complete transposition of legislation on air, in accordance with European Union legislation, the World Health Organization and other international organizations; Implement the strategy and action plan on air protection from pollution and other national programs and projects for improving the air quality; Reduction number old car on traffic; Adding green surface in urban areas. Using renewable energy. cycling and increased community by public transport.

**CONFLICT OF INTEREST: NONE DECLARED.**

## REFERENCES

1. Veliu A, Sylva A. Air pollution with particulate matter and heavy metals of Kosovo Thermal Power Plant. *J Int Environmental Application & Science*. 2008; 3(4): 280-287.
2. Statistics of Social Welfare in Kosovo 2007, Series 5: Social Statistics. Statistical Office of Kosovo, Kosovo Government, 2007: 12-37.
3. Kosovo environmental and climate analysis-School of business, Economics and Law-University of Gotthenburg. Draft March 11: 2008.
4. Draft Strategy for air protection from pollutions. MMPH, 2011;
5. WHO air quality guidelines for particulate matter, ozone, nitrogen and sulfur dioxide global update, 2005.
6. Brook RD, Rajagopalan S, Pope CA, Brook JR, Bhatnagar A, Diaz-Roux AV, Holguin F, Hong Y, Luepker RV, Mittleman MA, Petera A, Siskovic D, Smith SC Jr, Whitzel L, Kaufman JD. American Heart Association Council on the kidney in Cardiovascular Disease and Council on Nutrition, Physical Activity and Metabolism. Particulate matter air pollution and cardiovascular disease. 2010; 121: 2331-2378.
7. C. Arden Pope III. The expanding Role of Air pollution in Cardiovascular disease: Does Air pollution contribute to risk of deep vein thrombosis? *Circulation*. 2009; 119: 3050-3052.
8. Yun-Chul Hong, Jong-Tae Lee, Ho Kim, Ho-Jang Know. Air pollution: A New Risk Factor in Ischemic Stroke Mortality. *Stroke*. 2002; 33: 2165-2169.
9. Timonen KL, Vanninen E, De Hartog J, Ibaldo-Mulli A, Brunekreef B. et al. Effects of ultrafine and fine particulate and gaseous air pollution on cardiac autonomic control in subjects with coronary artery disease: The ULTRA study. *Journal of Exposure Science and Environmental Epidemiology*. 2006; 16: 332-341.
10. Brunekreef B, Holgate ST. Air pollution and health. *Lancet*. 2002; 360: 1233-1242.
11. Davidson CI, Phalen RF, Solomon PA. Airborne Particulate Matter and Human Health. A Review. *Aerosol Science and Technology*. 2007; 39(8): 737-749.
12. Wong TW, Lau TS, Yu TS. et al. Air pollution and Cardiovascular disease and hospital admissions for respiratory and cardiovascular diseases in Hong Kong. *Occup Environ Med*. 1999; 56: 679-683.
13. Lie Hong Chen. Coronary heart disease mortality and long-term exposure to ambient particulate air pollutants in elderly nonsmoking. California resident. 2010: 1-12.
14. Forastiere F. Particulate air pollution, host susceptibility, and daily mortality. Italy European Respiratory Society, 2007.
15. European Commission Environmental and Health. Health effects of air pollution on susceptible subpopulations. Traditional air pollutants, ultrafine particles and myocardial infarction. Database and Health Assessment. HEAPSS.
16. Peters A, Dockery D, Muller J, Mittelman MA. Increased Particulate Air pollution and the Triggering of Myocardial Infarction. *Circulation*. 2001; 103: 2810-2815.
17. Dominici F, Peng RD, Bellg ML. et al. Fine Particulate air pollution and hospital admission for cardiovascular and respiratory diseases. *JAMA*. 2006; 295: 1127-1134.
18. Brook RD, Franklin B, Cascio W, Hong Y, Howard G. et al. Air pollution and cardiovascular disease. A statement for healthcare Professionals from the expert panel on population and prevention science of the American Heart Association. *Circulation*. 2004; 109: 2655-2671.
19. Atkinson RW, Anderson HR, Sunyer J, Ayres J, Baccini M, Vonk JM, Boumghar A, Forastiere F, Forsberg B, Touloumi G, Schwartz J, Katsouyanni K. Acute effects of particulate air pollution on respiratory admissions: results from APHEA 2 project. *Air Pollution and Health: a European Approach*. American journal of respiratory and critical care medicine. 2001; 164: 1860-1866.
20. Zanobetti A, Franklin M, Koutrakis P, Schwartz J. Fine particulate air pollution and its components in association with cause-specific emergency admissions. *Environmental Health*. 2009: 1-12.
21. Wong TW, Lau TS, Yu TS. et al. Air pollution and CVD and hospital admissions for respiratory and cardiovascular diseases in Hong Kong. *Occup Environ Med*. 1999; 56: 679-683.
22. Dockery DW, Pope CA III, Xu X. et al. An Association between air pollution and mortality in six US cities. *N Eng J Med*. 1993; 329: 1753-1759.
23. Dockery DW, Pope CA III. Acute respiratory effects of particulate air pollution. *Annu Rev Public Health*. 1994; 15: 107-132.
24. Martins LC, Pereira LA, Lin CA, Santos UP, Prioli G, do Carmo Luiz O, Saldiva PHN, Alfesio Luiz Ferreira Braga. The effects of air pollution on cardiovascular disease: lag structure. *Rev Saude Publica*. 2006; 40(4): 677-683.
25. De Hartog JJ. et al. Size distribution on particulate matter in three European cities. *J Environ Monit*. 2005; 4: 302-310.
26. Schwartz J. Air pollution and hospital admissions for heart disease in eight US counties. *Epidemiology*. 1999; 10: 17-22.
27. Bhaskar A. Environmental Exposures and Cardiovascular Morbidity in Scotland: A Study of the Effects of Air Pollution on Health. 2009; 189-135.
28. Piver JF, Ando WT, Portier CJ. Effects of Temperature and Air Pollutants on Cardiovascular and Respiratory Diseases for Males and Females Older than 65 Years of Age in Tokyo, July and August 1980-1995. *Environmental Health Perspectives*. 2001; 109: 355-359.
29. Peters A, Frohlich M, Doring A, Immervoll T, Wichmann HE, Hutchinson WL, Pepys MB, Koenig W. Particulate air pollution is associated with an acute phase response in men. *European Heart Journal*. 2001; 22: 1198-1204.