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TENDENCIES OF THE DYNAMIC AMBIENT POLLUTION AND RESULTING HOSPITALIZATION DUE TO ACUTE CARDIO-VASCULAR DISEASES IN VARNA REGION

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SUMMARY:

The purpose of the research is to analyze the dynamics of the basic atmosphere pollutants in the city of Varna and the relation to pollution of atmosphere air with ozone, sulfuric dioxide and nitrogen oxides as a risk factor, affecting the frequency of hospitalizations with regards to acute cardiovascular diseases in the city of Varna. A seasonal dynamics of the average diurnal concentration of basic atmosphere pollutants was established. The relative risk of acute myocardial infarct (AMI) increases to a statistically significant value in the days of increasing of ozone concentration with 5 and more μg/m^3 , while concentration increase of nitrogen oxides does not increase the risk of AMI and ischemic cardiac disease - unstable angina pectoris (IHD – unstable AP). The researched data indicates the early effect of the ozone exposition and is related to the increased frequency of AMI-related hospitalizations for the same day. The significantly low content of nitrogen oxides and sulfuric dioxide are a likely reason for not establishing a statistically significant relation of the early effects of its effect to the acute coronary incidents.

Key words: ambient air pollution, acute cardio-vascular disease, hospitalization rates

INTRODUCTION:

Series of researches establish a relation between the early and remote effects of pollution of atmosphere air in the town of high concentration of urbanization and increased risk of cardiovascular pathology /3-7, 9-13/. Our authors indicate hydrogen sulfide, lead and nitrogen dioxide / 2-4/ as cardiac-toxic atmosphere pollutants. The most recent researches are focused on the content of carbon oxide, nitrogen oxides, sulfur dioxide, ozone, lead aerosols and dust – inhalable and respirable fraction in the atmosphere air as an effective factor for the frequency of hospitalizations and mortality rate due to acute myocardial infarct. /7, 10, 12, 13/. The combined effect of these substances, as well as their combination with the meteo-parameters, results in an alteration of the heart effect and only the ozone effect is described as relatively independent to the remaining toxic substances in case of a combined action. /8/

PURPOSE:

Analysis of the dynamics of the basic atmosphere pollutants in the city of Varna; Research of the relation of pollution of atmosphere air with ozone, sulfuric dioxide and nitrogen oxides as a risk factor, affecting the frequency of hospitalizations with regards to the acute cardiovascular diseased in the city of Varna

MATERIAL:

Data from the Regional Inspection of Environment and Waters (RIEW) in the city of Varna had been analyzed with regards to the average daily values of concentrations of the atmosphere pollutants and data of Intensive Clinic of Cardiology, St. Marina University Hospital of the registered recently admitted patients as per days. A summer period ranging from 01.07 to 31.08 and a winter period ranging from 01.11 to 31.12 in 2005 had been examined. The probing collection had been conducted at two stationary points in the territory of the city of Varna as a part of a system of monitoring of air quality. The analysis includes hospitalization solely of residents of the city of Varna.

METHODS:

A variation analysis had been used in the statistical processing of data upon research of seasonality in the dynamics of concentrations of atmosphere pollutants. Using a correlation and regression analysis the connection of the atmosphere pollutants and the intensity of hospitalization of acute myocardial infarct /AMI/, ischemic cardiac disease /IHD/, rhythmic and conductive disturbances, chronic intensified sinister cardiovascular insufficiency /CISCI/ has been monitored. A logarithmic regressive model of description of the influence of ozone over the frequency of the AMI cases has been used.

RESULTS:

The cases of hospitalization of residents of the city of Varna with regards to acute cardiovascular diseases for the period of research are a total of 489, as 127 of them (25,97%) have an AMI diagnosis, 129 (26,38%) unstable AP and 77 (15,74%) heart failure.

Table 1 indicates the basic characterizations of atmosphere pollutants and meteo-parameters of the research period. The concentrations of all substances do not exceed the active quotas.

Table 1. Characteristics of Pollutants and Meteorology Over the Study Period

					Percentiles				
	Mean	SD	Minimum	Maximum	10th	25th	50th	75th	90th
O_3, µg/m^3	21.15	10.8	4.76	45.07	7.6	11.1	19.9	30.4	34.7
NO, µg/m^3	22.3	19.9	0.03	95.15	4.5	11.2	15.5	27.4	50.9
NO_x, ppm	26.2	17	4.9	94.04	11	16.2	21	29.4	50.9
NO_2, µg/m^3	31.4	13.7	6.8	81.8	15.5	21.0	29.3	40.1	49.8
SO_2, µg/m^3	40.3	5.5	31.9	58.5	34.3	36.6	39.4	42.1	48.5
NMHC, mg/m^3	1.9	1.9	0	8.12	0	0	1.6	3.3	4.9
CH_4, µg-C/m^3	1.9	0.5	0.5	2.6	1.2	1.5	1.9	2.4	2.6
THC, mg/m^3	4.5	1.4	1.6	8.6	2.6	3.5	4.3	5.6	6.3
CO, mg/m^3	1.13	0.4	0.5	2.2	0.6	0.8	1.1	1.4	1.5
Benzol, µg/m^3	1.5	1.4	0	5.1	0	0.03	1.4	2.6	3.6
PM_{10}, µg/m^3	0.09	0.03	0.01	0.18	0.05	0.07	0.09	0.1	0.15
Max. temperature, °C	23.5	1.8	20	27.3	21	22.2	23.5	24.4	26.8
Min. temperature, °C	6.39	4.2	-2.2	13.9	-0.26	2.6	8	9.7	10.9
Humidity, %	76.5	8.9	50.8	96	64.5	71	77	83.3	87.5
Pressure, mbar	1009.5	7.2	992	1030	1001.4	1005	1008	1014	1021
GSRadiation, W/m^2	324.1	280	63.5	713	82.5	92.1	113.8	669.4	698
Study period include July, August, November and December 2005.									

A statistically significant seasonal dynamics of pollution with regards to almost all conducted indications with the exception of carbon oxide, sulfuric dioxide and total hydrocarbons had been established.

TABLE 2. Variables with seasonal dynamic

Variables	Mean Summer	Mean Winter	P
O_3	29.5	12.2	0.000
NMHC	4.02	0.73	0.000
H_2S	0.006	0.001	0.000
NH_3	0.04	0.03	0.000
Temperature	23.5	6.4	0.000
NO	10.2	34.9	0.000
NO_2	18.1	21.1	0.015
NO_x	16.5	36.3	0.000
PM	0.08	0.1	0.003
PM_{10}	49.8	65.0	0.000

Variables	Mean Summer	Mean Winter	P
CO	1.18	1.00	0.075
SO_2	40.78	39.8	0.314
Humidity	70.9	82.4	0.000
Pressure	1006	1013	0.000
AMI	1.27	0.82	0.018
IHD	0.84	1.23	0.049

We found a tendency of the frequency of hospitalizations with regards to AMI of increasing in the summer months, when the concentration of ozone, non-methane hydrocarbons, ammonia and hydrogen sulfide had been increased. As far as the ozone dynamics are concerned, correlation connections with the meteo-parameters (temperature Spearman's Rank Coefficient 0,746) and excessively negative correlation with nitrogen oxides had been established. (Table 3.)

Table 3. Spearman's Rank Coefficients Between Mean Daily Meteorological and Air Pollutant Variables

Variables	Spearman's Rank Coefficients
O_3 – NOx / CH_4 / PM_{10} /	-0,775(**) / -0,417(*) / -0,360(**)
O_3 – NMHC / H_2S	0,597(**) / 0,623(**)
O_3 - Humidity/ WS / Temp / Pressure	-0,458(**) / 0,461(**) / 0,746(**) / -0,344(**)
NO_x – O_3 / NMHC / H_2S	-0,775(**) / -0,433(**) / -0,457(**)
NO_x – CH_4 / THC / PM_{10}	0,726(**) / 0,397(**) / 0,428(**)
NO_x - Humidity/ WS / Temp / Pressure	0,318(**) / -0,540(**) / -0,529(**) / 0,325(**)
SO_2 – CH_4 / NMHC / THC	0,480(**) / 0,453(**) / 0,646(**)
SO_2 – GS Radiation/ WS / Temp / Pressure	0,336(**) / -0,195(*) / 0,366(**) / -0,192(*)

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

The chemical and physical air parameters in the city of Varna correlate with the frequency of some acute cardiovascular diseases and establish a risk for the population health.(Table 4.) AMI correlates to its fullest extent to the level of fine particulates in the winter months, non-methane hydrocarbons and nitrogen oxides, as well as air temperature and humidity.

Table 4. Spearman's Rank Coefficients Between Mean Air Pollutant Variables and Hospital Rates

Variables	Spearman's Rank Coefficients
AMI – NMHC	0,230(*)
AMI – NO / NO_X	-0,226(*) / -0,207(*)
AMI – Humidity / Temperature	-0,217(*) / 0,184(*)
AMI – NO (Month of July)	-0,437(*)
AMI – $PM_{2,5}$ (November / December)	0,467(*) / -0,621(**)
AMI – Humidity (Winter)	-0,263(*)
IHD – Temperature / GSRadiation (Summer)	0,258(*) / 0,252(*)

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

The association of Main Gas Pollutants (ozone, nitrogen oxides and sulfuric dioxide) with AMI and ischemic cardiovascular disease – unstable angina pectoris (unstable AP) had been presented in Table 5. As per the details of the logarithmic regression model, the concentration of ozone and nitrogen oxides indicate a relation with those diseases, but the concentration of sulfuric dioxides does not indicate a statistical signification.

Table 5. Correlation and Logarithmic Regression Coefficients on Association between Concentration of Air Pollutants and Occurrence of AMI and Ischemic Heart Disease

Pollutant / Disease	Spearman's RC	Sig SRC	R	ANOVA F	ANOVA Sig	B	Beta	T	Sig
O3 / AMI	0,167	0,068	0,183	4,101	0,045	0,334	0,183	2,025	0,045
O3 / IHD	0,218	0,017	0,180	3,934	0,050	0,339	0,180	1,983	0,050
NOx / AMI	0,207	0,023	0,267	9,113	0,003	0,498	0,267	3,019	0,003
NOx / IHD	0,146	0,109	0,156	2,955	0,088	0,290	0,156	1,719	0,088
SO2 / AMI	0,056	0,536	0,081	0,804	0,372	0,677	0,081	0,897	0,372
SO2 / IHD	0,017	0,859	0,042	0,218	0,641	0,363	0,042	0,467	0,641

The relative risk of AMI increases its statistic significance in the days of increasing of ozone concentrations with 5 and more μg/m^3, while increase of nitrogen oxides concentration does not increase the risk of AMI and unstable AP. (TABLE 6)

The concentration of nitrogen or sulfuric oxides in our research does not indicate increase of the risk of AMI, which is most probably due to the low, below the quota values of the pollutants.

DISCUSSION:

The established lack of seasonality in the dynamics of average daily concentrations of sulfuric dioxide contradicts to results from 10 years ago, when this pollutant indicated a seasonal dynamics of high values through the winter months. /1, 5/ One of the probable reasons for this is change of technology of heating of residential buildings.

The concentrations of nitrogen oxides are similar to the levels from the period 1989 – 1991 and 3-4 times lower than the values of the interval 1992-1994. /1/ The seasonal dynamics in 1999 had indicated a reliable increase of levels throughout the mild period /5/, while our results indicate winter peaks.

The correlation factors between the nitrogen oxides and the AMI frequency we have established are relatively low. Our researches do not find correlation between myocardial infarcts and IHD and a combined activity of SO2 + NOx with R 0.79 and R 0,76, as well as of IHD with the simultaneous activity of SO2+H2S and SO2+HF respectively with R 0,81 and R 0,74. Concentrations of pollutants, quoted in the researches, however exceed the norms 6,3 to 9,2 times. Besides, those authors research the morbidity of population of an industrially developed region, which does not exclude professional exposition of the researched contingent./9/

Our results once again prove the fact atmosphere pollution is only one of the numerous risk factors, participating in formation of cardiovascular morbidity. The significance of this risk factor is determined by the overall influence on the population, resulting in a significant population effect.

The relation we presented between AMI and unstable AP to the ozone pollution levels and lack of relation to the levels of nitrogen and sulfuric oxides had been established by French authors /11/, although they quote significantly higher concentrations of ozone 74,8 μg/m^3, as well as nitrogen oxides 31,4 μg/m^3.

The lack of relation of the concentrations of nitrogen or sulfuric oxides to AMI in our research is most likely due to the content way below the norms of the pollutants. Examinations, establishing a significant relation, quote indices increased 2 to 3 times. (Rome: NO_2=86.0 μg/m^3; Hong Kong: NO_2=53.5 μg/m^3, SO_2=14.5 μg/m^3; London: NO_2=61.2 μg/m^3, SO_2=20.6 μg/m^3; Denver: SO_2=15.2 μg/m^3)./10/

CONCLUSIONS:

A seasonal dynamics of the concentrations of the basic atmosphere pollutants had been established.

The researched data indicates that the early effect of the ozone exposition is related to the increased hospitalization frequency with regards to AMI for the same date.

The relatively low content of nitrogen oxides and sulfuric dioxides is probably the reason not to find statistically significant relation between the short-term effects and the acute coronary incidents.

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