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Relationship Between Air Pollution Generated by Traffic Emissions and Cardiopulmonary Disease in Annaba (Algeria)

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Abstract: This study is destined to highlight the relationship that may exist between atmospheric pollution from automobile origin and the rate of hospital admissions for cardiovascular causes (ACV) and respiratory (R) in Annaba, Algeria. Health data and parameters related to air pollution are measured during the period from 2004 to 2007. These parameters are studied in terms of climate data in the region. Our results showed that levels of pollutants generated by road traffics increases with the medium temperature. Meanwhile, during the warm days (≥20°C) a clear relationship between NO_2, NOx and stroke and RA. This does not seem to be the case during the cold days (≤ 20°C). This relationship also exists between the increasing number of vehicles, the report NO_2/NOx and total mortality. This study shows that temperature, the number of vehicles and rates from automobile pollutants are indeed responsible for the increasing rate of hospital admissions for cardiovascular and respiratory causes.

Key words: Air pollution · Traffic emissions · Cardiorespiratory disease · NO_2/NO_X estimate

INTRODUCTION

Many epidemiological studies around the world highlight the close association between the daily variations of air pollution and mortality associated with cardiovascular and respiratory diseases [1-3]. However, very little research has been undertaken in Algeria [4].

The automobile is the primary source of air pollution in the cities, especially in urban areas. Recent studies [5, 6] highlight the existence of a high risk of mortality associated with peaks of short term pollution particularly affects people with cardiovascular disease (CV) and respiratory (R).

Thus, if air pollution is responsible for the high mortality rate due to cardiovascular and respiratory diseases in many countries around the world, it becomes important to monitor this phenomenon in the rate of admissions of patients with cardiovascular diseases (CV) and respiratory (R) in hospitals and in this sense that particular attention is given to this aspect and that many studies on the association working mortality/exposure to air pollution. This parameter is expressed by the rate of admission in hospitals; it is currently an important indicator of air pollution [7, 8].

"Hospital admissions" parameter becomes a base data for the impact assessment of air pollution in short term. Thus, the association between air pollution and respiratory and cardiovascular diseases is an area of research particularly important in recent years; the role played by air pollution in the cardiovascular and respiratory diseases genesis was recently other parameter subject of much research in this field [9-16]. This type of research is still low in the third world and especially Algeria.

This study has twofold: first, it analyzes the links between short-term levels of certain air pollutants and hospital admissions for respiratory and cardiovascular causes among residents of the region of Annaba (East-Algeria), ranked 4th largest city in terms of population density and on the other hand, it explores the relationship between exposure to air pollution and road traffic in Annaba. The study period covers 3 years from 2004 to 2007. The study area includes Annaba and the nearby suburbs (El Bouni, Sidi Amar, El Hadjar).

MATERIALS AND METHODS

In our work, we are interested in first hand, to variations in the rates of certain air pollutants related to

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road traffic and on the other hand, the rate of hospital admissions for cardiovascular and respiratory causes at Central Hospital of Annaba and during the period from 2004 to 007.

Study Area: The study area includes the city of Annaba and its inner suburbs to the east of Algeria and whose population is around 600,000 inhabitants which makes it ranked 4th after Algerian town the capital Algiers, Oran and Constantine. Annaba is a city in subhumid to humid climate with an average annual rainfall ranging from 650mm to 1000mm and an average annual temperature of about 20°C (Annaba Monography, 2001).

Community Health: The health data used for this study are hospital admissions. Patients are those admitted at the Central Hospital of Annaba to cardiovascular pathologies (CVP) or respiratory disease (RP). Only admissions of residents in the study area were taken into account. The study focuses on the average rate of admissions and deaths for both types of pathologies.

Climatic Data and Measuring Pollutants: Climate data for the period and area of study have been provided by the meteorological station of Annaba airport "Les Salines", they relate to the rainfall and humidity averages. On pollutants measured namely SO_2, NO_2 and NO_X, rates were provided by the four stations of the monitoring network of air quality Annaba "SAMASAFIA" located at various places in the city and close to axis road where traffic is very dense. Service stations provide daily rates of SO_2, NO_2 and NO_X. The averages of daily, monthly and yearly are determined.

RESULTS

Data on the distribution of different pollutants measured as well as climate data over the period of study are grouped in Table 1.

We note that the average SO_2 during the year 2004/2005 is highest during the study period and the peak rate increases slightly from 2004 to 2007. Regarding the rate of NO_2, the highest value recorded during the year 2006/2007 with 22.25 mg/m^3, the average rate is the lowest obtained in 2005/2006. The same is true for the average values of NOx where the maximum is obtained for the years 2006/2007 to 28.25 mg/m^3 and the minimum recorded during the year 2005/2006. It is clear from the results that the year 2004/2005 has recorded the lowest rate of SO_2, NO_2 and NOx and the years 2006/2007 is where the highest rates were recorded.

Concerning the average changes in temperature and humidity there is a significant and continuing increase in temperature is observed during the years 2006/2007 with a maximum high of 45.4°C. Meanwhile, the average rate recorded in humidity is high and remains the same throughout the study period. It is clear from the results that all the measured pollutants in our study showed a significant increase with a high and average temperature this is continually increasing.

Table 2 lists the average values of temperature variations, the concentration of pollutants and hospital admissions for cardiovascular diseases (stroke) and respiratory (R) at the Central Hospital of Annaba.

We looked across the table to identify any relationship between the intervals of temperatures ($\geq$ 20°C and $\leq$ 20°C) and levels of recorded pollutants. The results show that variations of SO_2 during the study period do not appear to be associated with variations in temperature and during the 3 years of study. However, recorded variations in NO_2 and NOx show that the average rates of NO_2 increases during the years of study. For temperatures $\geq$ 20°C, the comparison between the two intervals of temperature shows that the obtained values in NO_2 are almost 5 times higher for the year 2004/2005; 12 times in 2005/2006 and 18 times for 2006/2007. For NOx, they are 3 times higher for the year 2004/2005, 6 times for the year 2005/2006 and 9 times for the year 2006/2007.

Table 1: Distribution of pollutants, temperature and average humidity in Annaba city, Algeria (2005-2007)

	Study years								
	2004-2005			2005-2006			2006-2007		
Variables	Min	Max	Mid	Min	Max	Mid	Min	Max	Mid
SO_2 (µg/m^3)	45	117.28	64.43	27.25	83.5	66.5	26.33	79.17	67.08
NO_2(µg/m^3)	4.08	8.91	12.08	4.33	14.86	17.57	4.41	18.58	22.25
NO_X (µg/m^3)	3.83	13	15.71	3.83	10.59	19.83	4.75	12.25	28.25
Temperature (°C)	13.8	31.8	23.28	14.8	32.3	24.2	18.7	45.4	28.08
Humidity (%)	72	83	77.33	72	83	75.83	71	81	76.33

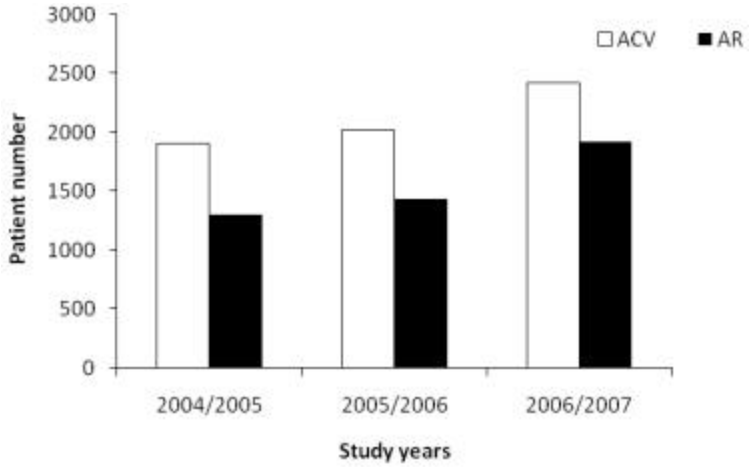

Fig. 1: Average number of patients admitted for cardiovascular diseases (ACV) and pulmonary (AP) at the Central Hospital of Annaba, Algeria (2005-2007).

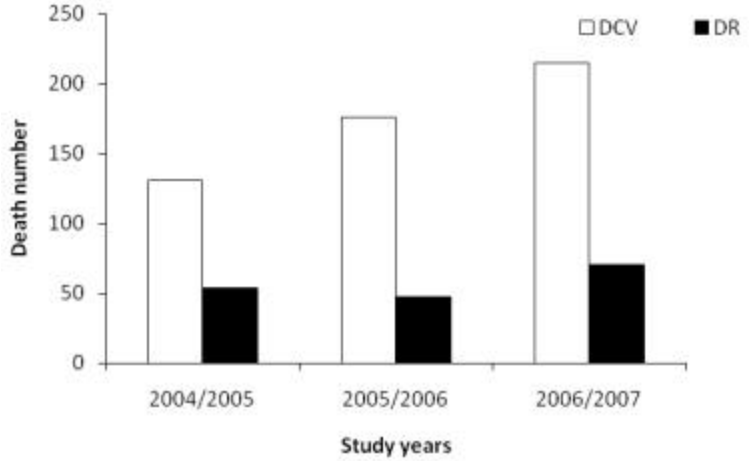

Fig. 2: Average number of deaths for cardiovascular diseases (DCV) and pulmonary (PD) at the Central Hospital of Annaba, Algeria (2005-2007).

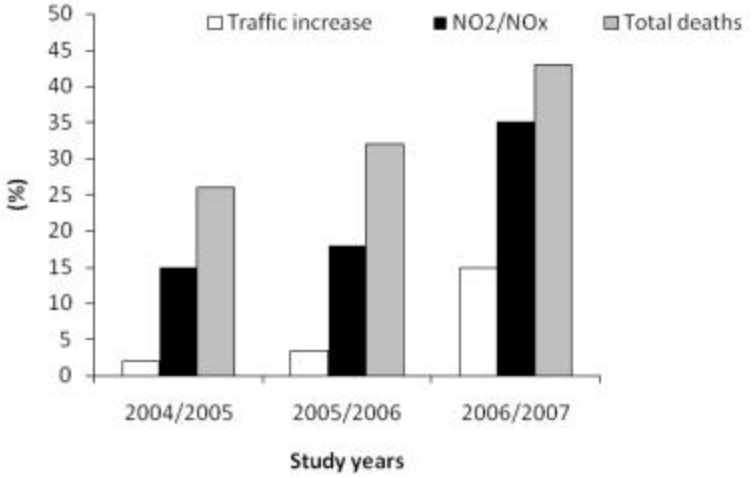

Fig. 3: Relationship between the percentage increase in vehicles, the report NO_2/NO_X, reports Deaths from cardiovascular disease (DCV)/admissions for cardiovascular diseases (ACV) and reports Deaths from Pulmonary disease (PD)/Admissions for Pulmonary pathologies (AP) in Annaba, Algeria (2005-2007)

Table 2: Relationship between the average changes in temperature, the concentration of pollutants and cardiopulmonary admissions at Annaba, Algeria (2005-2007)

Temperature (°C)	Pollutants ($\mu g/m^3$)	Study years 2005	2006	2007
≥ 20°C	SO_2	96,7	63	64
	NO_2	6,9	15,4	21
	NO_X	1,1	1,9	6,96
	ACV	1377	1451	1688
	RA	995	1063	1436
	Deaths CV	110	146	178
	Deaths R	37	34	49
	Deaths (t)	147	180	227
≤ 20°C	SO_2	15,7	4,9	6,3
	NO_2	1,37	1,33	1,2
	NO_X	0,33	0,31	0,8
	ACV	525	566	729
	RA	306	375	490
	Deaths CV	21	30	37
	Deaths R	17	13	22
	Deaths (t)	38	43	59

Deaths (t): total deaths, ACV: Admissions cardiovascular PA: Pulmonary Admissions. Death P: Pulmonary Death, Death CV: cardiovascular death; Deaths (t): total deaths

As for hospital admissions for cardiovascular diseases (stroke) and respiratory (RA), a significant increase for temperatures ≥ 20°C, which is always much higher than that observed at temperatures ≤ 20°C and both for (ACV) than for (RA) but with a significant difference for stroke. Regarding the average rate of death for stroke and AR, there is also where the highest rates are recorded for the intervals of temperatures ≥ 20°C with a difference reaching values 5 times higher compared to values obtained always with intervals temperatures ≤ 20°C.

Changes in the average number of admissions for VCP and PR during the study period is illustrated in Figure 1.

There is an increase in ACV average and AR during the study period with higher values obtained for the ACV. It should be noted that the highest increase is observed during the years 2006/2007.

Figure 2 shows the variations in the average number of deaths for CV and AR during the study period.

In this figure, we have postponed the changes in average values of deaths recorded for VTC and DR during the study period. Here we observe that the average number of deaths recorded for DR is much lower than that obtained for DCV where actually there is a difference of 1/3 for the year 2004/2005 which is 1/4 for the year 2006/2007 with always a marked net increase during the year 2006/2007.

The relationship between the percentage increase in the number of vehicles during the period of study and the report NO_2/NOx on the first hand and the percentage of total deaths (DCV and DR) on the other hand is showed in Figure 3.

We note that the percentage of the vehicles number increases with the study period especially during the years 2006/2007 when it reached almost 15%, which represents more than 3 times that recorded in the years 2004/2005 and 2005/2006. It is also noted that the report NO_2/NOx increases in the percentage with the average number of vehicles. Indeed, the increases have a maximum of 35% representing double of the value in 2004/2005. Concerning changes in the average percentage of deaths is observed that it varies so identical and proportional with time, the number of vehicle and report NO_2/NOx. This value reaches 43% which is 2 times the value obtained during the year 2004/2005.

DISCUSSION

Our work is one of the first studies on short-term effects of air pollution related to traffic using the parameters "Hospital admissions" for cardiovascular and respiratory causes. Our results showed that the evolution of average SO_2 does not seem to vary in proportion with the increase in the number of vehicles during the period of study and even less with the observed augmentation in the average temperature during this period. This result is against the meaning of that reported by Chang et al. 2005 [5] where he is showed that this parameter increases in proportion with the environmental parameters. The evolution of two other pollutants, namely NO_2 and NOx showed a marked increase directly related to the temperature, number of vehicles and especially the rate of ACV and AR. It is however important to note that ACV is significantly higher than the AR throughout the study period. This result confirms those obtained by [18-22, 5].

The association between NO2, Nox and stroke and AR supports the results of Wong *et al.* [12] where a close relationship between plasma fibrinogen and NO_2 [23, 24]. Other authors explained this by the disturbances caused by NO_2 in the ventricular rate (arrhythmia) or tachycardia in patients with cardiac defibrillators [25].

Meanwhile our results show that increasing the number of vehicles during the period of study is followed by an increase in the NO_2/NOx, itself linked to a very

high number of ACV and AR. This result confirms those obtained by Kessler and *al*., [26], where he is reported that the parameter NO_2/NOx is a key component in the method of Carslaw and Beevers [27], used for evaluating the density of road traffic. Thus, in the case of our study, the report NO_2/NOx is 15% in 2004/2005; it increases continuously to reach 35% by the end of the year 2006/2007 which reflects the density of the number of vehicles.

In conclusion, our study has revealed significant links between the density of vehicles, air pollution levels that it generates and hospital admissions due to ACV and AR. The introduction of new parameters in the evaluation of the impact of atmospheric pollution automobile offer interesting perspectives to improve the estimation of the risks related to air pollution and hospitalization.

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