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Influence of climatic parameters on the distribution of air pollutants and public health in Annaba (East of Algeria)

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ABSTRACT

This study is destined to show the relationship that exists between atmospheric pollution from automobile origins and the cases of hospital admissions for cardiovascular causes (ACV) and pulmonary infections (AP) in Annaba, Algeria. Health data and parameters related to air pollution were measured from 2013 to 2015. These parameters were studied in terms of the climate data in the region. Our results showed that the levels of pollutants generated by road traffics increase with medium temperatures. Meanwhile, during the warm days (≥ 20 °C) a clear relationship between NO2 "Nitrogen dioxide", NOx "Nitrogen oxides", stroke and pulmonary diseases. This does not seem to be the case during the cold days (≤ 20 °C). This study proves that temperatures and rates from automobile pollutants are indeed responsible for the increasing rate of hospital admissions for cardiovascular and respiratory causes.

Key words: Air pollution, Cardio-pulmonary diseases, Climatological parameters.

INTRODUCTION

Many epidemiological studies around the world highlight the close association between the dail variations of air pollution and mortality associated with cardiovascular and respiratory diseases [32-11-16]. However, very little research has been undertaken in Algeria [7-31-45].

Automobiles are the primary source of air pollution in the cities, especially in urban areas. Recent studies [25-37-34] show the existence of a high risk of mortality associated with peaks of short term pollution particularly affect people with cardiovascular disease and pulmonary infections.

Thus, if air pollution is responsible for the high mortality rates due to cardiovascular and respiratory diseases in many countries around the world the phenomenon should be monitored. Cases of patients admitted with cardiovascular diseases and pulmonary infections should be taken into account [3-46].This parameter is expressed by the numbers of admission in hospitals; it is currently an important indicator of air pollution.

"Hospital admissions" parameter becomes a data base for impact assessment of air pollution in short term. Thus, the association between air pollution and respiratory and cardiovascular diseases has been an area of important research particularly in recent years; the role played by air pollution in the cardiovascular and respiratory diseases genesis was recently another parameter subject to much research in this field [28-30-12-35].

Today, only a small number of countries in Africa does not disclose the necessary epidemiological indicators, as well as, the needed tangible and reliable data that can help evaluate the impact of pollution which sometimes prevents the use of classical methods of environmental epidemiology needing measures of indices, collected in a prolonged period of no less than three years [19-9-39-14].

Located in North Africa, Algeria is an example used to illustrate the situation observed currently in developing countries for a whole variety of reasons among which are: the demographic explosion in the country, strong urbanization, and a considerable industrialization especially the one in coastal fringes and highlands that represent

20% of the national territory area where almost more than 80% of the population reside and substantially all the industry is based [26-5-8].

This type of research is still not fully covered in the developing countries and especially in Algeria. This study has two stages. 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) which is the fourth city in the country in terms of population density. Second, it explores the relationship between exposure to air pollution and temperatures in Annaba. The study period covers 2 years from 2013 to 2015 and it includes Annaba and the nearby suburbs (El Bouni, Sidi Amar and El Hadjar).

MATERIALS AND METHODS

Our research project is interested at first hand, with the variations in the numbers of certain air pollutants related to climatic parameters and on the other hand, the cases of hospital admissions for cardiovascular and respiratory causes at the Central Hospital of Annaba between the years 2013/2015. The data presented in this research paper was examined and collected on a monthly basis for a period of 24 months.

Study Area

The study was set up in downtown Annaba as well as in two of the major suburbs of the city, Sidi Amar and El Boubni. Situated in the eastern part of Algeria, between the altitudes 36° 30' North, 37° 30' North and the longitudes 07° 80' East and 08° 40' East.

Annaba extends on an area of 1412 km2 with a population of about 600,000 inhabitants. Despite its touristic aspects the city also has some major industrial infrastructures (Arcelor Metal, Fertial, The Industrial Zone Meboudja and Industrial Zone Pont Boucher), commercials (zone of commercial activities of El Bouni and many other commercial centers and malls located downtown) and universities (University Pole of Sidi Amar, University Pole of Sidi Achour, and University Pole of El Bouni).This entire infrastructure amplifies the city's road traffic and thus threats its environmental quality.

Climatological Parameters

The weather- climate- in Annaba is sub humid with an annual average of precipitation of 650 mm and an average temperature of 20 °C. For the estimation of the various levels of atmospheric pollutants we established some climatic parameters at different target places of the study area. Meteorological data (temperatures and humidity) has been collected for a period of ten years (2005-2015) at the Salines Meteorological Station.

Parameters of Pollution indicators

The collection of information related to atmospheric pollution is done near by the network monitoring the quality of air SAMA SAFIA. This network located in different points of dense road traffic. It functions automatically in a continuous manner using methods of detections by chemiluminescent recognized by the international standards [18-1-49-2-13]. The installation of that network allowed us to set up a regular monitoring of NO2, NOx, and SO2 emissions for a period of two years (2013-2015) this monitorial aimed to undertake a study of the spatiotemporal variations of these pollutants.

Health Community

The health data used for this study were hospital admissions. Patients were those admitted at the Central Hospital of Annaba to cardiovascular pathologies (CVP) or pulmonary diseases (DP). Only admissions of residents in the study area were taken into account. The study focused on the average rate of admissions and deaths for both types of pathologies.

RESULTS

The Evolution of atmospheric pollutants and the climatic data during the study period are regrouped in table 1.

Table 1. Evolution of the average annual atmospheric pollutants during the study period 2013-2015.

Study years	2013-2014	2014-2015	Norms
SO_2 ($\mu g/m^3$)	64,75	61,15	20 ($\mu g/m^3$)
NO_x ($\mu g/m^3$)	28,43	31,16	30 ($\mu g/m^3$)
NO_2 ($\mu g/m^3$)	22,47	25 ,74	40 ($\mu g/m^3$)
Average Temperatures °C	24,2	28,08	-
Average of Humidity (%)	75,83	76,33	-

We notice that the rates of SO_2 since 2013 and until 2015, have lowered respectively from 64,75 to 61m15 µg\m^3 though the rates are still higher than those set by the W.H.O (20 µg\m^3) (Tab.1). As for the rates of NO_x, a successive raise was observed during the study period when it went from 28,43 µ g\m^3 in 2013-2014 to 31,16 in 2014-2015 and they came inferior to those standards of the W.H.O.

The figures (1) and (2) prove evidence the effects of temperatures on the number of deaths and admissions registered in Annaba between the years 2013-2015.

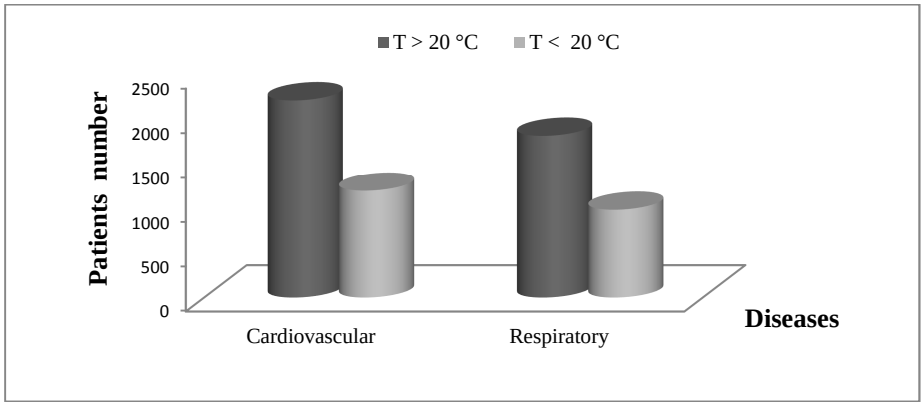

Fig 1. The influence of temperatures and the annual average of admissions caused by respiratory and cardiovascular diseases in Annaba, Algeria (2013-2015).

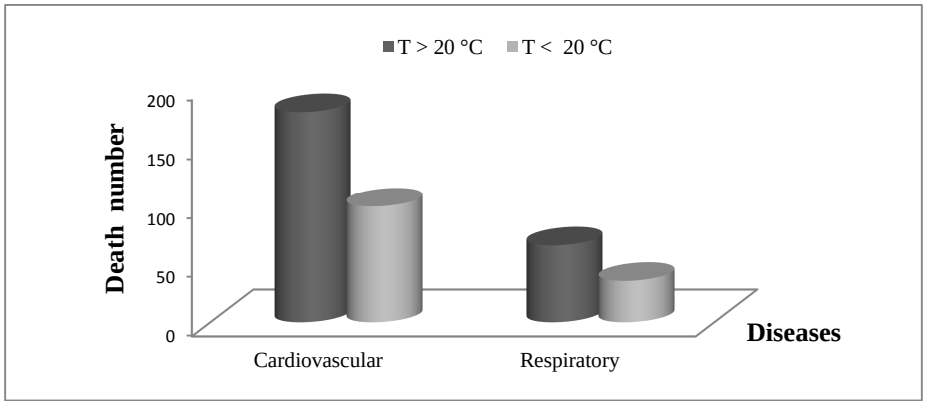

Fig 2. The influence of temperatures and the annual average of deaths caused by respiratory and cardiovascular diseases in Annaba, Algeria (2013-2015).

Table 2: Relationship between the average changes in temperature, the concentration of pollutants and cardiopulmonary admission at Annaba, Algeria (2010-2013).

Temperature (°C)	Pollutants (µg/m^3)	Study Period (in years)		Norms
		2013-2014	2014-2015	
≥ 20°C	SO_2	96.7	63	20 (µg/m^3)
	NO_2	23	32.4	40 (µg/m^3)
	NO_x	32	35,2	30 (µg/m^3)
	ACV	1310	1262	-
	AP	1063	1024	-
	DCV	114	110	-
	DP	37	34	-
	D T	151	144	-
≤ 20°C	SO_2	55.7	46.9	20 (µg/m^3)
	NO_2	11,5	10.8	40 (µg/m^3)
	NO_x	10.6	8.87	30 (µg/m^3)
	ACV	459	377	-
	AP	374	336	-
	DCV	26	24	-
	DP	17	12	-
	DT	43	36	-

NB : (DT): Total deaths, ACV: Cardiovascular Admission, AP: Pulmonary Admission, DP: Death Pulmonary, DCV: Death Cardiovascular.

This last shows a clear and close relationship between the raise of temperatures higher than 20 °C and the rates of admissions. In other words, whenever the temperature exceeds 20 °C, it influences with avery important way (**three times higher**) the rates of admissions and deaths.

Table two is a comparison of the average values of temperature variations, the concentration of pollutants and hospital admissions for cardiovascular diseases (stroke) and Pulmonary infections (P) at the Central Hospital of Annaba.

From the table above, we can identify a relationship between the intervals of temperatures (≥ 20 °C and ≤ 20 °C) and the levels of recorded pollutants. The results show that variations of SO2, during the study period do not appear to be associated whit variations in temperature and during 2 years of study. However, recorded variations in NO2 and NOx show that the average rates of NO2, increases during the years of study.

For temperatures ≥ 20 °C, the comparison between the two intervals of temperature, shows that the obtained values in NO_2 were almost two times higher in 2013/2014, as for the years 2014/2015 they were three times higher . As for the values obtained for NOx the results came as follows: 2013/2014 three times higher.2014/2015 four times higher.

As for hospital admissions for cardiovascular diseases (stroke) and pulmonary (AP), 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 (AP) but with a significant difference for stroke. Regarding the average rate of death for stroke and AP, there is also where the highest rates are recorded for the intervals of temperatures ≥ 20 °C with a difference reaching values 3 times higher compared to values obtained always with intervals temperatures ≤ 20 °C.

DISCUSSION

Our research project is one of the first studies on short-term effects of air pollution related to climatic parameters, using the parameters “hospital admissions” for cardiovascular and respiratory causes.

Our results show that the numbers of NOx registered in Annaba match those set by the World Health Organization (30 µg/m3). As for the rates of NO2 they remain inferior _ lower_ to those set by the W.H.O (40 µg/m3). Yet, the numbers of SO2 registered in the study area are literally four times higher than those of the W.H.O (20 µg/m3).We have also noted that during the two years (2013/2015) where atmospheric pollution was high, were the only ones that coincided with the best parameters in terms of accumulation of pollutants (humidity 77, 33%) which confirms the results linked to [33-21].

The results have also shown that pollutants were influenced and affected by climatic parameters especially, temperatures and humidity [38-4-29].

The rates of SO2 registered are alarming and much higher than those recorded at work. These high rates are associate with those generated by big complexes located in Annaba Arcelor Metal and Fertial and engendered new varieties of pollutants that can be more aggressive and more dangerous. In effect, a previous work showed that the two complexes mentioned above, emit a high range of pollutants that exceeds, largely, the rates set by the W.H.O [6-48-27].

As for the slightest reduction of values in SO2 during a period of two years was probably linked to the demolition of the phosphates unit and the installation of catalyst at the complex of Fertial, thus the stoppage of the coking -oven-plant and the high furnaces of the iron and steel complex Arcelor Metal, Annaba [43- 44 –20 -40]. Thus, the density of road traffic in Annaba is inevitably the primary source of air pollution particularly nitrogen oxides and particular combinations (NOx, NO2, PM 2,5 and 10). That last makes it hard for Annaba to prevent the pollution and joins the other Algerian cities, like Algiers, Oran, and Constantine [15-24-8-45].

Concerning the study of the effects of pollution on public health, our epidemiological investigations clearly show with evidence a close relationship between the raise in numbers of vehicles and pollutants which generate temperatures (higher than - superior- 20) and the number of admissions of patients at both services of Cardiology and Pneumonology strongly support the observations linked to [36-10-22] and confirm the work realized through [17-23-41-47-42], which has showed the existence of a relationship between climatic parameters, atmospheric pollutants generated by exhaust pipe gases (SO2, NOx, NO2 and the particle in suspension) and the cardio respiratory diseases especially pneumonia.

CONCLUSION

Our study shows the different combinations that exist between pollutants of diverse origins and their dangerous and deep Impacts on the environment as well as on public health.

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