Assessment of Air Pollution Impacts on Population Health in Bejaia City, Northern Algeria

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Abstract

Background: To assess the health impact of air pollution on Bejaia population in the north of Algeria, we carried out a descriptive epidemiologic inquiry near the medical establishments of three areas.

Methods: From hospital admissions registers, we collected data on the hospital mortality and admissions relating to the various cardiorespiratory pathologies generated by this type of pollution. In parallel, data on the automobile fleet of Bejaia and other measurements were exploited to show that the pollutants concentrations are strongly correlated with the urban traffic concentration.

Results: This study revealed that the whole of the population is touched, but the sensitivity to pollution can show variations according to the age, the sex and the residence place. Population of Bejaia town marked the most raised death and morbidity rates, followed by that of Kherrata. Weak rates are recorded for the rural population of Feraoun. Stronger correlation (>0.9) is evident amongst CO and deaths due to asthma and COPD in Béjaia city.

Conclusion: This approach enables us to conclude that the population of Béjaia could not escape the urban pollution generated by her old automobile fleet. Installation of a monitoring and measuring site of air pollution in this city could provide a beneficial tool to protect its inhabitants by informing on air quality they breathe and the measures to following order to minimize the impacts on their health and by alerting the authorities during the critical situations.

Keywords: Air pollution, Urban pollution, Health impacts, Algeria

Introduction

This paper presents an epidemiological approach in respiratory diseases produced by air pollutants, with specific attention directed to the automobile pollutants in urban area. Here, the term "respiratory diseases" refers to respiratory disorders like chronic obstructive pulmonary disease COPD, asthma, lung cancer and emphysema. It requires hospital admission of patient and in many cases produces his mortality.

Many studies have shown evidence in the association between air pollution and human health in urban areas (1-10). In the last 30 years, evidence on adverse health effects –both increased hospitalization and mortality – of elevated ambient levels of air pollutants has been accumulating (6,11), more so recently with the use of meta-analyses of single-city time-series analyses (12-14) or multi-city studies (15).

So, various recent approaches were inventing. The most common approach is an intervention study of short-term changes in air pollution and subsequent health responses from a specific and local

event(16-21).They elaborate models to estimate the effects of short-term exposure to ambient air pollution on health such us a Bayesian model used in time series studies (22, 23). Other studies examined long-term action at local, regional or global scale. Here too, they use large statistical methods to estimate the long-term effects of air pollutants (Particle Matter PM, Volatile Organic Components VOC and nitrogen dioxide NO_2) on morbidity and mortality from cardiopulmonary diseases in different parts of the world (24-33).

Few studies have evaluated whether reductions in air pollution on the scale of years are associated with improved population health.

Relatively, little is known about the health state of human living in low income countries. It is well known that the monitoring of air pollution is very important to assess adverse health effects of these environmental stressors in humans. Perhaps, this can explain why in Algeria, where automobile is the principal source of air pollution in urban area, there are no such studies. For instance, in the case of Bejaia, which is one of Algerian littoral wilaya (department) and which saw a very intense vehicle traffic, there is no information about the pollution degree. This intensity is especially getting from its economic activity thanks to its dynamic port.

Moreover it is classified, in 2011, the first at the national level regarding its economy. In addition, in summer, road traffic is most intense because of efflux of tourists visiting the coastal towns of this wilaya. The strong correlation between the pollu-

tion measured and the number of vehicles constituting the traffic confirms that the air pollution of this city is mainly from automobile origin. On the whole, this pollution is not without impacts on the population of this agglomeration. For a population of 912579 inhabitants, like that of Béjaia, with a number of 174847 vehicles in 2009, the study of the medical effects generated by this kind of pollution proved to be necessary.

This paper details the first step towards quantifying the environmental impacts in Béjaia. The study presented addresses the need to assess the health impact of air pollution in Bejaia (Algeria). Here we focus our attention on flows down a rough bottom. First, we will describe the used method. Second, we will present the results data and discuss on the different points getting from these results.

Methods

Bejaia vehicle fleet

During the period (1970-2012) the vehicle fleet has approximately multiplied by 20. So, it passed from 11285vehicles in 1970 to 214189 vehicles in December 2012.The average age of the automobile fleet has increased from about 5.5 to 8.5 years, thus increasing the likelihood of vehicles with poorly functioning emission control systems. Table 1 shows Bejaia's Vehicle fleet in circulation from 1999 to 2012.

Table1: Bejaia's vehicle fleet in circulation

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total	111367	117151	122692	128334	132254	136943	142590	148623	154882	162685	168672	192362	202432	214189
Variation%	-	5.2	4.7	4.6	3.1	3.5	4.1	4.2	4.2	5.1	3.5	14.1	5.2	5.8
Gazoline%	56.1	54.1	52.2	50.6	49.8	49.3	48.9	48.5	48.4	46.9	46.7	46.2	46.4	47
Diesel %	43.9	45,9	47.8	49.4	50.2	50.7	51.1	51.5	51.6	53.1	53.3	53.8	53.6	53

There are several approaches in epidemiological studies of air pollution. The choice of study design is often determined by the research question of interest and by feasibility constraints (34, 35). In our case, the used method is the geographical comparative study. It consists in comparing the

medical risks in polluted zones and weak polluted zones. Generally, it is considered that the exposure is identical for all the inhabitants within the various zones. So it is the ecological type of studies whose comparison is in space. This type of study lends itself well to the analysis long-term

effects of pollution (36). It evaluates the health risks in Bejaia in terms of mortality and morbidity due to air pollution.

Air pollution data

To emphasise the share of the automobile traffic in the air pollution, we measured the concentrations of 3 pollutants (CO, NO and SO_2) and counted the number of vehicles passing by Daouadji square (in Béjaia city).The three-gas analyser IBRID MX6 is placed on the pavement at two meters from the roadway and one meter height. Measurements are raised each five minutes from 7h30 to 18h30.The concentrations of NO and SO_2 are relatively weak, we exploited only CO measurements. There is a good linear regression curve between measured CO concentration in ppm and the vehicle number passing across Daouadji square. The correlation is very significant with 0.78 coefficients. This strong correlation means that measured pollution come principally from automobile traffic. The Variation relation is like equation [1]. CO (ppm) = 0.041 N_{veh} + 0.03 [1].

We can notice that the measured concentrations of CO are comparable with those measured in other European and Asiatic cities and remain less than the recommended limits.

Study population

The study was carried out in three areas in Bejaia (North of Algeria) during the period 2004-2012. The first area is the town center of Bejaia that is an excellent urban city, having a very intense automobile congestion. The second one is Kherrata's area which is crossed by the trunk road number 9 (TRn°9) which passes by the Kherrata tunnel. These two areas were chosen to represent a range of polluted areas with high traffic. The third one is Feraoun which is rural area. It was chosen as reference no polluted area. Characteristics of the study population were gathered in Table 2.

Table 2: Areas characterization

Area	Type	Traffic (vehicle/day)	Sources of Air pollution	Population	Motorization rate (vehicle per persons)	Topography
Bejaia	Urban	>40000	Vehicle fleet	150195	1/5	-
Kherrata	suburban	-	Tunnel, TRn°9	106151	-	basin
Feraoun	Rural	<1893	No source	15563	1/13	-

Health data collection

For each area, daily mortality data for all deaths for the eight-year period from January 2005 to December 2011 were obtained from the annual registers in hospital admissions department. Information recorded includes gender, age, date of death, and cause of death. We report the results only for three causes of mortality: asthma, COPD, Emphysema, CP and lung cancer.

For hospitalization, daily counts of hospital admissions can be analyzed in a similar manner to the assessment of daily counts of mortality. Data for all patients were acquired from the Pneumophtisiology department for the study period. Data for each patient included discharge diagnosis, time of admission, age, sex and address of current residence.

The registered hospital data used in this study were based on discharge diagnoses from January 2005 to December 2011, of the 3 hospitals.

Results

Residence location of patients

There were 1617 patients hospitalized in Kherrata Hospital between January2004 and December 2011.Amongthem, there were 792 patients from Kherrata and Taskriout, which accounted for 49% of total admissions. As shown in Fig.1, the results presented show differences between regions.

Mortality

During the same period, mortality from the studied diseases is particularly high in Béjaia (5-

32/100000) and Kherrata (about 3-17/100000), while the region with the lowest rates is Feraoun, (1-3/100000).
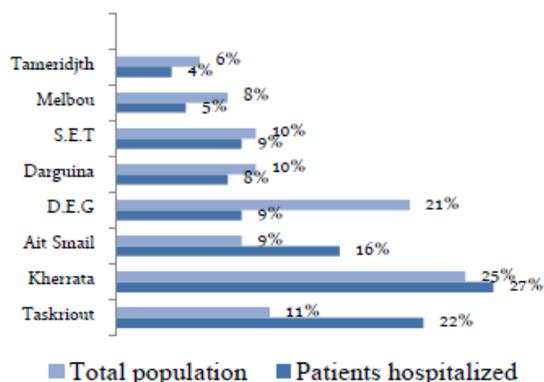
Fig. 1: Proportion of patients hospitalized for respiratory diseases by village in Kherrata compared with proportion of the population of each village regarding total population

In Fig. 2, we present deaths due to respiratory disease by region - Standardized rates per 100 000 people-Years 2005-2012 and the concentration (CO) variation only for Béjaia region. Therefore, the correlation coefficient between deaths and CO concentration, in Béjaia city, was calculated (0, 90849238).

*ppm
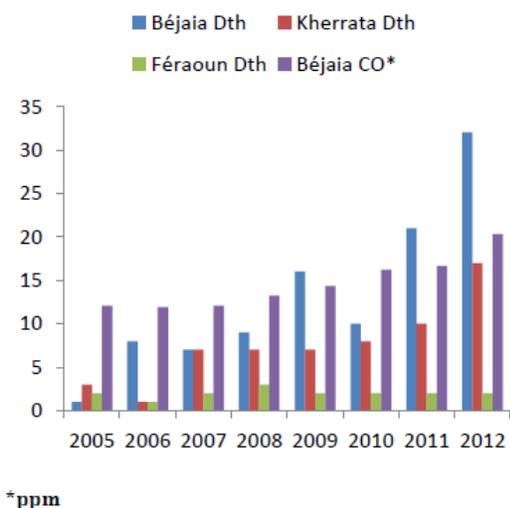
Fig. 2: Deaths due to respiratory disease by region - Standardized rates per 100 000 people-Years 2005-2012 and concentration (CO) variation

Frequencies of the respiratory problems

With regard to morbidity, in the follow-up period, asthma was the 1st leading cause pulmonary disease in the three regions (Fig.3).
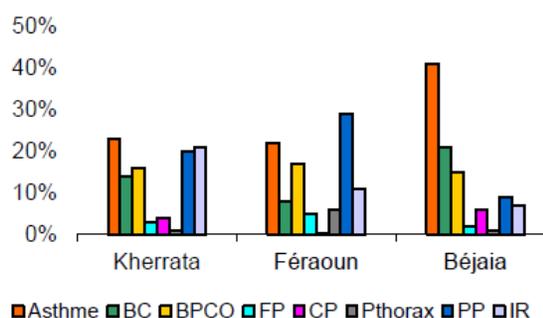

**Fig. 3:** Comparison of prevalence rates of respiratory symptoms/diseases in three subpopulations

Moreover, COPD and asthma levels were higher in Bejaia and Kherrata.

The results suggested that population living in a rural area (Feraoun) was associated with a lower prevalence of asthma and COPD.

As shown in Fig. 4, the morbidity (hospital admission) cases due to COPD and asthma present a similar pattern to that of mortality (Fig.2). Bejaia and Kherrata lead the rankings, having excess cases from 62 to 123 and from 95 to 125 respectively [62-123], [94-125], whereas Feraoun cases are from 8 to 16 [8-16] is at the low end of considered regions. The results showed an increase of morbidity for COPD and asthma associated to increase of air pollutants concentration calculated by Alkama et al. (37-38).
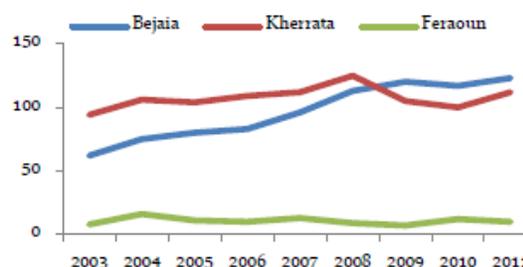
Fig. 4: Daily emergency admissions for chronic obstructive pulmonary disease (COPD) and asthma
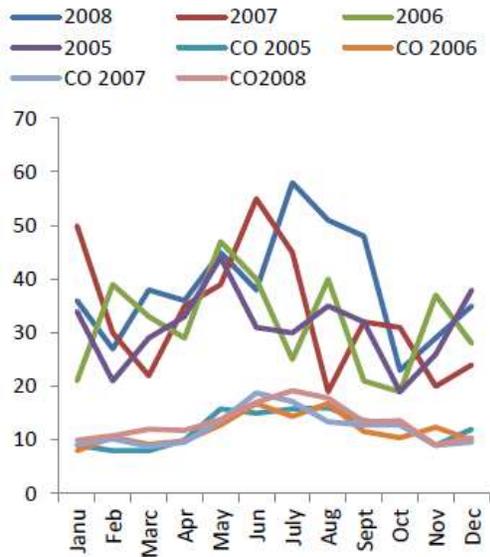
Fig. 5: Morbidity rate of respiratory infection admissions in Bejaia hospital and concentration (CO) variation

Seasonal variations

Respiratory admissions rates showed seasonal pattern with higher admissions in summer.

Figure 5 shows the morbidity rate of respiratory infection admissions in Bejaia hospital and concentration (CO) variation.

The correlation coefficient between the CO and daily emergency admissions for COPD and asthma calculated from 2005 to 2008 was greater than 0.90.

Gender and age

Overall, females have higher current asthma prevalence than males, although among children aged 0–15years, boys have a higher prevalence (11.3%) than girls (7.9%).Children have higher current asthma prevalence than adults (Fig.6).

Discussion

We conducted a descriptive statistics approach to investigate whether COPD and asthma rates increases on urban Bejaia's population. We found that people who live in areas with high traffic density present high levels in asthma and COPD mortality and morbidity.
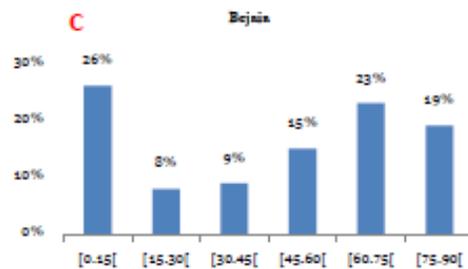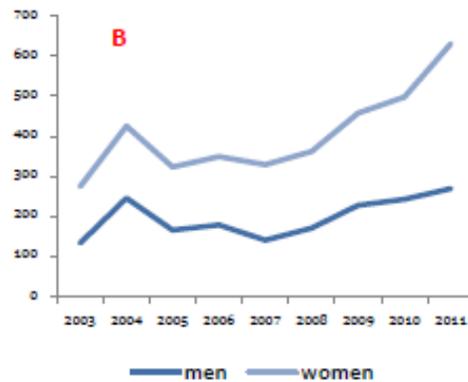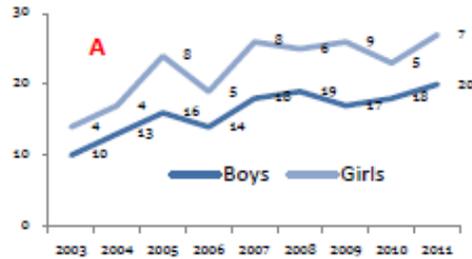
Fig.6: Gender (A, B) and Age (C) dependent variation in hospital admissions

Our findings are consistent with those of previous epidemiologic studies on traffic exposures that reported associations with respiratory diseases (4, 6, 20, 24, 25). In their study, Beelen et al. (24) found that background concentrations estimated for the periods 1976–1985 and 1987–1996 were highly correlated (> 0.9) for each pollutant. Their results show the associations between overall air pollution concentrations and mortality in the full cohort and case–cohort analyses, the relative risk for cardiopulmonary mortality was 1.07 (95% CI,

0.98–1.15) for 10-µg/m3 increase in pollutant concentration. Katanoda K, et al. (6) observed a significant association between mortality from respiratory diseases and the concentrations of all studied pollutants. This association was observed in both sexes, and in male current smokers and female never smokers.

Among the many diseases that are associated with air pollution, asthma is the first cause of hospital admission in Bejaia City (41%).

The present study observed that population living in a rural area (Feraoun) was associated with a lower prevalence of asthma and COPD. By comparison, in 2004 COPD was the 4th leading cause of chronic disease in Italy (39).

We noted that females have higher current asthma prevalence than males, although among children aged 0–15years, boys have a higher prevalence (11.3%) than girls (7.9%).Children have higher current asthma prevalence than adults. Children and elderly age, specifically in the age group (+60) are more vulnerable to air pollution.

We also noted stronger effects in summer compared with winter months regarding the respiratory admissions.

With regard to air pollutants, the correlation coefficient between the CO and daily emergency admissions for COPD and asthma calculated between 2005–2008 was greater than 0.90.

These observations highlight the health state in relation with air pollution fact that susceptibility to the harmful effects of ambient air pollution could be determined by genetic factors as well. More work needs to be done in this area to confirm these observations and further study the impact of air pollution in general population health.

Further studies are needed to explore the findings illustrated in this study, and to explore what contributes to differences among children in rural and urban areas in preventing asthma episodes and utilizing emergency care.

Conclusion

The constantly increasing number of vehicles, their age and the tendency to dieselization are rea-

son make Bejaia vehicle fleet a major source of air pollution.

In this paper we have presented a descriptive statistical study of the impact of air pollution on Bejaia population. We have shown that population exposed to automobile air pollution is a cause of the increased prevalence of respiratory diseases. We have confirmed that population ageing and young population are most affecting by respiratory diseases. Our investigations into this area are still in progress to confirm our hypothesis.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

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