The impact of outdoor pollution on upper respiratory diseases*

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SUMMARY *We evaluated the prevalence of upper airway diseases among two groups living in areas with different pollution levels. The study was conducted among highschool students living in Bayrampasa (an area polluted by SO_2 and total suspended particulates) and Beykoz (an unpolluted residential area) in Istanbul (n=386). Each subject filled out a standardized zelf-administered questionnaire. Also, anterior active rhinomanometry was performed to objectively evaluate the symptoms in all students. A significantly higher prevalence rate for rhinitis was found in Bayrampaşa, as compared to Beykoz. However, the prevalence rate for pharyngitis was not significantly different between both groups. Smoking was more frequent in the unpolluted area. Exposure to parental smoking in childhood and heating systems in houses were evenly distributed. Household crowding was lower in Beykoz. Rhinomanometric measurements did not show any significant difference between both groups. Multiple logistic regression models estimating the role of each risk factor independently, showed a significant odds ratio associated with residence in Bayrampasa for rhinitis (OR: 2.0; 95% CI: 3.0-1.3). In conclusion, this study indicates that outdoor pollution has adverse effects on the degree of upper airway diseases in Istanbul in the 1990s.*

Key words: rhinitis, air pollution, rhinomanometry, pharyngitis

INTRODUCTION

The epidemiology of respiratory diseases has received wide interest in recent years. Several risk factors, both patient-related (e.g., gender, age, family history, socioeconomic status) and environmental (e.g., indoor and outdoor pollution), have been reported to play a role in the development of respiratory diseases (Forastiere et al., 1994). Many studies have investigated the influence of environmental factors particularly on lower airway diseases, such as asthma and chronic obstructive lung diseases, but have neglected the nose as part of the pulmonary "dead space" (Koo et al., 1990; Rusznak et al., 1994; Ring et al., 1995; Behrendt et al., 1995). However, the nose is both the first target and first defense against airborne hazards (Bascom, 1991a). Recently, research on the effects of air pollution on the upper airways has become more popular. Studies have demonstrated that some air pollutants cause irritation, alter nasal resistance and induce inflammation. Viegi et al. (1991) report that rhinitis seems to be influenced by minor gradients of air pollution, in contrast to coughing and phlegmone. The prevalence rates of respiratory diseases among subjects living in less polluted and more polluted areas have been shown by investigators in various countries (but not asd yet in Turkey), in particular upper respiratory diseases. The present study has been performed in Istanbul, which is densely polluted in certain areas. SO_2 and *total suspended particulates (TSP)* are the main pollutants in Istanbul (Ertürk, 1995). Main sources for SO_2 and TSP are combustion of low-quality coal and fuel for domestic heating and industrial works.

In most of studies, the effects of air pollution on rhinitis have been evaluated by means of standard questionnaires. However, new research methods are needed, particularly to evaluate symptoms objectively. Therefore, rhinomanometry and a standardized respiratory questionnaire to evaluate the symptoms of the patients have been used in this study. The present study was designed to evaluate the effects of air pollution, the so-called "urban factor", on the upper respiratory system of students living in two areas with different levels of air pollution.

MATERIAL AND METHODS

A survey in Istanbul was conducted between November 1996 and January 1997 to study the effects of air pollution on upper respiratory diseases in highschool students. The sample inclu-

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Table 1. Ranges of sulfur dioxide (SO_2) and total suspended particulates (TSP) recorded in the industrialised area (Bayrampaşa) in the period 1994-1996.

variable	levels of pollutants (μg/m^3)					
	1994		1995		1996	
	SO_2	TSP	SO_2	TSP	SO_2	TSP
annual mean	169.0	103.6	157.7	109.5	112.6	148.8
SD	106.3	36.0	82.5	29.1	59.1	42.6
lower 95% CI	97.6	79.4	102.3	89.9	72.9	120.2
upper 95% CI	240.4	127.8	213.2	128.7	152.3	177.4
minimum	66.0	51.0	73.0	74.0	42.0	97.0
maximum	329.0	159.0	301.0	168.0	209.0	221.0

ded 386 students in grades 9 and 10 in two highschools with similar socioeconomic status. These schools were chosen from the areas with different pollution levels: Bayrampaşa (an area polluted mostly by heating systems and industrialization) and Beykoz (a residential area relatively unpolluted, on the Bosporus where there is no industrialization and open to north-northeast and south-southwest winds). The subjects had been living in these areas for more than five years. The rates of pollution in these areas were measured by Refik Saydam Hygiene Centre (Istanbul Regional Institute, Environmental Health Department) with monitors located in the residential sections of Bayrampaşa and Beykoz. The WHO acidimetric method and OECD filter sorling method were used. In Bayrampaşa, in 1996, the mean annual concentration of SO_2 was 112.6 μg/m^3, whereas the mean annual concentration of TSP was 148.8 μg/m^3. Both concentrations are close to the WHO air quality guidelines of 150 μg/m^3 (Table 1). In Beykoz, in 1996, the mean annual concentration of SO_2 was 21 μg/m^3, whereas the mean annual concentration of TSP was 22.7 μg/m^3.

The students were asked to complete a self-administered questionnaire adapted from the International Consensus Report on Rhinitis as well as a Turkish version of the American Thoracic Society Questionnaire. The following symptoms were considered for the analysis: (1) pharyngitis: throat irritation apart from common colds; and (2) rhinitis: symptoms of nasal discharge, sneezing or nasal obstruction (two out of three) occurring for more than 1 h on most days (International Rhinitis Management Working Group, 1994).

Non-smokers were defined as those who had never smoked any kind of tobacco regularly. Smokers were those who were currently smoking at least one cigarette per day.

Active anterior rhinomanometry was performed in a warm room in the upright sitting position recommended by the International Standards Committee. The rhinomanometric measurements were performed and evaluated by the same physician with the Rhinotest MP500. The response of the nasal airway to decongestion was used as a parameter to determine mucosal problems. The percentage of increase in flow rate after decongestion was measured.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 6.0. The Chi-square test was used to compare symptom rates among the different areas studied. In order to investigate the role of different risk factors in determining upper airway diseases, we used a multiple logistic regression model, with gender (0: female; 1: male), smoking habit (0: non-smoker; 1: smoker), heating (1: central heating; 2: stove), and household crowding (1: <4 people at home; 2: >4 people at home) as parameters. Rhinomanometric measurements and their relationship to several factors were measured using Spearmen's coefficient of correlation, with the p-value obtained from the one-sample t-test.

RESULTS

The characteristics of the population studied are described in Table 2. Gender, household crowding, heating system, smoking status and parental smoking differed between the areas, whereas no differences were found for age. However, these differences were not statistically significant. With respect to respiratory symptoms, the students living in Bayrampaşa showed a higher prevalence rate for rhinitis, but the prevalence rate for pharyngitis was not significantly different (Table 3).

Table 2. Characteristics of the study population.

variable	Beykoz (n=198) %	Bayrampaşa (n=188) %
sex		
make	42.4	59
female	57.6	41
household crowding		
low	55.5	33.5
high	44.4	66.5
heating		
central heating	18.2	13.8
stove	81.2	86.2
parental smoking		
yes	62.1	66
no	37.9	34
smoking		
smoker	19.7	7.4
nonsmoker	80.3	92.6

Table 3. Comparison of prevalence rates (%) of respiratory symptoms.

symptom	unpolluted area (Beykoz) n=198	polluted area (Bayrampaşa) n=189
rhinitis	34.8	51.6*
pharyngitis	15.2	12.2

*$p<0.001$(by Chi square)

The degree of association of rhinomanometric measurements with several factors among the study population is shown in Table 4. The increase in flow-rate after decongestion in subjects living in Beykoz was only slightly higher than in subjects living in Bayrampaşa. Although rhinitis was found to be significantly higher in the polluted area, there was no significant difference in rhinomanometric measurements between the polluted and unpolluted areas. When the relationship of other factors with rhinomanometric measurements was examined the percentage

Table 4. Association of rhinomanometric measurements with risk factors.

variable	increase in flow-rate %
sex	
male	95.52*
female	74.08
heating	
stove	85.96
central heating	79.38
household crowding	
low	89.93
high	80.87
smokin	
smoker	98.52
non-smoker	82.74
parental smoking	
smoker	84.00
non-smoker	87.61
zone	
polluted	80.91
unpolluted	88.70
rhinitis	
yes	81.71
no	87.32

*p<0.05 Chi-square

Table 5. Effects of risk factors on respiratory symptoms, odds ratio and confidence intervals.

risk factor	rhinitis	pharyngitis
sex	0.7	1.6
	(1.1-0.5)	(2.9-0.9)
smoking	1.0	0.6
	(1.8-0.6)	(1.6-0.2)
parental smoking	1.2	0.4
	(1.8-0.8)	(0.7-0.2)
heating system	1.3	2.6
	(2.3-0.8)	(7.4-0.9)
household crowding	0.8	1.7
	(1.2-0.6)	(83.1-0.9)
zone	2.0	0.8
	(3.0-1-3)	(1.4.-0.4)

*Derived from multiple logistic regression models.
Confidence interval 95%

of increase in flow-rate after decongestion in subjects who were smokers, had stoves for heating and low household crowding was found to be higher, although the differences were not statistically significant. Furthermore, although the increase in flow-rate after decongestion in subjects with rhinitis was higher than in normal subjects, it was not statistically significant. On the other hand, there was an association with gender, which was significant (p=0.02): The percentage of increase in flow-rate after decongestion was higher in males.

The results obtained with multiple logistic regression models are shown in Table 5. Gender was associated with the risk of pharyngitis in males and with rhinitis in females. Smoking status and parental smoking were found to be negatively associated with pharyngitis. On the other hand, smoking status was not related to rhinitis. The use of stoves was positively associated with both rhinitis and pharyngitis: The odds ratio for pharyngitis was the highest. Finally, residence in the polluted area was significantly associated with rhinitis (odds ratio: 2.0; 95%-confidence interval: 3.0-1.3). However, residence in the unpolluted area was negatively associated with pharyngitis.

DISCUSSION

In this study, students living in Bayrampaşa showed higher rates of upper respiratory system symptoms when compared to those living in Beykoz. These findings indicate that outdoor pollution is a factor in the prevalence of upper respiratory system symptoms, particularly in rhinitis, and this is consistent with the results of other authors (Bascom, 1991a; Viegi et al., 1991; Behrendt et al., 1995).

The prevalence of rhinitis varies from 7% to 21% as reported by several epidemiological studies (Jones, 1997). In our study, the prevalence of rhinitis in both areas is above this range, even in Beykoz – which had been chosen as a relatively unpolluted area. The high prevalence rate for rhinitis in the polluted area is to be expected when considering the adverse effects of SO_2 and TSP on the nasal mucosa (Bascom, 1991a). On the other hand, the high prevalence rate in the unpolluted area in our study is not usual. It is likely that the epidemiological studies were performed in less polluted areas or in areas with negligible pollution levels. Another factor that could explain the variation in prevalence rates is that different definitions have been used in the questionnaires. Moreover, in most studies, only allergic rhinitis has been evaluated. However, we have included all types of rhinitis, apart from common colds.

Our findings support the hypothesis that outdoor pollution has an adverse effect on rhinitis. On the other hand, we found that pharyngitis is not affected by outdoor pollution. Multiple logistic regression models, which estimate the independent effect of each risk factor, confirm the role of a polluted area residence as a risk factor for rhinitis. Furthermore, the differences between both areas with regard to rhinitis are not likely to be due to other risk factors. In fact, there is no difference in age, since students were chosen from the same grades. In Beykoz, there is a higher proportion of smokers than in Bayrampaşa. In fact, smoking is not related to a high odds-ratio for rhinitis, which has also been suggested by other authors (Schumacher and Pain, 1979). Actually, both stoves and central heating with fuels are risk factors for air pollution. On the other hand, there is not a significant difference in heating systems, and the effect of this risk factor has been found to be modest for rhinitis. However, exposure to stoves is a risk factor for pharyngitis.

More objective tools for the assessment of nasal inflammation due to outdoor pollution are necessary. Techniques of nasal challenge and analysis of cell mediators in nasal lavage fluids have been reported to be useful in assessing rhinitis caused by antigens, cold air and viruses (Schumacher and Pain, 1979; Naclerio et al., 1985). Also, measurement of nasal resistance has been used to demonstrate sensitivity to environmental tobacco smoke (Muramatsu et al., 1983). Nevertheless, nasal rhinomanometry has been reported to provide only modest correlations with symptoms of nasal congestion (Bascom, 1991b). In our study, the results of rhinomanometric measurements do not show significant differences between areas with different pollution levels. However, according to the questionnaires, there was a significant difference for rhinitis between these groups. On the other hand, the results of rhinomanometric evaluation between subjects with rhinitis and normal subjects do not show significant variation. The increase in flow-rate after decongestion is slightly higher in rhinitic patients than in normal subjects. This may be due to the mucosal inflammation in rhinitic patients. Cole et al. (1980) have found no change in variability of total nasal resistance in normal subjects and in patients with rhinitis after exposure to ozone, SO_2 or cigarette smoke. However, a correlation between nasal resistance and the degree of nasal obstruction has been demonstrated in symptomatic patients (Rusznak et al., 1994), although not in all studies (Kumlien and Schiratzke, 1979). So, although it is considered to be an objective tool for the assessment of nasal symptoms, rhinomanometry alone does not provide sufficient data. It can be used as a supplementary examination to combine history and physical findings. Finally, the relationship between pollutant exposure and chronic nasal disease is still poorly understood. There is a continuing need to understand pollution effects and to develop practical ways to identify and to treat susceptible individuals.

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