CHANGES IN AIR QUALITY AND ITS EFFECT ON EMERGENCY ADMISSIONS

Hacer Hicran Mutlu[1] , Kurtulus Aciksari[2]

[1]Family Medicine Department, Istanbul Medeniyet University, Istanbul, Turkey
[2]Emergency Medicine Department, Istanbul Medeniyet University, Istanbul, Turkey

ABSTRACT

INTRODUCTION: Air pollution is an emerging problem in developing countries as well as the world. Effects of air pollution due to short-term exposure may lead to increase in daily mortality, respiratory and cardiovascular hospital admissions, respiratory and cardiovascular emergency room admissions, respiratory and cardiovascular primary care visits and acute respiratory symptoms. The objective of our study was to examine the relationship between air pollution and diagnoses of patients in family medicine outpatient clinic located in emergency room.

MATERIAL AND METHODS: Our study enrolled 17869 patients who were admitted to the family practice outpatient clinic implemented in emergency department. The relationship between patients' diagnosis and air quality was examined.

RESULTS: The genders of the patients were 50.8% female (n = 9077) and 49.2% male (n = 8792). The mean age was 43.9 ± 19.9. Respiratory system diagnosis showed a statistically significant relationship with the air quality measurement of PM10 (p < 0.05). Patients diagnosed with upper respiratory tract disease and fatigue and hypertension on sensitive air days were found to be significantly higher than those with good air quality. There was a statistical significance between air temperature, and fatigue and cough complaints (p < 0.05).

CONCLUSIONS: For human health protection, continuity of life, and environmental sustainability, air pollution should be reduced and brought under control. In our study, with the increase of particulate matter, we observed that patients with respiratory system diseases, fatigue complaints, and hypertension increased. Sharing these results with province-wide authorities may help the settlement and industrial planning in the upcoming years.

KEY WORDS: air pollution, emergency admission, family medicine

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INTRODUCTION

Air pollution is an emerging problem in developing countries as well as the world. Air pollution is related to many factors such as population growth, usage of fossil fuels, industrialization, and increased utilization of vehicles using combustion engines [1]. Air pollution can be defined as the rise of chemical substances above certain limits which threatens the wellbeing of living in form of dust, smoke, gas, and vapour. Particulate Matter (PM) 10, which is particularly responsible for air pollution, is a complex mixture of extremely small particles and liquid droplets consisting of acids, organic chemicals, metals, and soil or dust particles. Normally, particles with a particulate matter size greater than 10 μm cannot reach alveoli. PM10 value indicates the number of ultrafine particles found in the air that are smaller than 10 μm. These particles can especially reach the

ADDRESS FOR CORRESPONDENCE:
Kurtulus Aciksari, Emergency Medicine Department, Istanbul Medeniyet University, Istanbul, Turkey
e-mail: drkurtulus@yahoo.com

alveoli by passing through the airways. The amount of PM10 has been shown to cause cardiovascular and cerebrovascular diseases by activating systemic inflammation and direct and indirect coagulation in the human organism [2].

According to the World Health Organization (WHO) report, outdoor air pollution causes 4.2 million premature deaths annually. 58% of premature deaths are due to ischemic heart disease and stroke; 18% are due to chronic obstructive pulmonary disease and acute lower respiratory tract disease, and 6% are due to lung cancer [3]. Effects of air pollution due to short-term exposure may lead to increase in daily mortality, increase in respiratory and cardiovascular hospital admissions, increase in respiratory and cardiovascular emergency room admissions, increase in respiratory and cardiovascular primary care visits, an increase in acute respiratory symptoms (wheezing, cough, sputum production, respiratory tract infections) [4].

The monitoring of air quality is carried out by both the Ministry of Environment and Urbanization and the weather monitoring stations of some municipalities. At the stations where air quality is monitored, the data of PM10, O_3 (Ozone), SO_2 (Sulfur Dioxide), NO (Nitric Oxide), CO (Carbon Monoxide), air temperature, air pressure, and relative humidity are monitored and presented as hourly and daily data. Based on these data, vehicle traffic is the most important NOx source in Europe and it is the primary source of PM10 and the second most important source of PM2.5. In Turkey, with increasing, fossil fuel consumption, particularly for air pollution PM10 parameter; Kahramanmaras, Istanbul, and Ankara are in the top three among air polluted cities [5].

The objective of our study was to examine the relationship between air pollution and diagnoses of patients by studying the relationship between the International Classification of Diseases (ICD)-10 data, where the patients admitted to family practice outpatient polyclinics, especially in emergency rooms are diagnosed, and the PM10 and NO values in air quality.

MATERIAL AND METHODS

Our study enrolled 17869 patients who were admitted to the family practice outpatient clinic implemented in the emergency department of Istanbul Medeniyet University Faculty of Medicine Emergency Department and whose addresses are in Kadıköy district in Istanbul between May 2017–May 2018. The diagnoses of the patients were retrospectively screened using the ICD-10. In this period, PM10 and NO measurement values of Göztepe Station of the Ministry of Environment and Urbanization were evaluated by considering the 24-hour average data. The relationship between patients' ICD-10 diagnosis codes and air quality was examined. In PM10 evaluation, which is one of the air quality parameters, PM10 0–50 μg/m3 was characterized as 'Good', 51–100 μg/m3 as 'Medium', 101–260 μg/m3 as 'Sensitive', 261–400 μg/m3 as 'Unhealthy', 401–520 μg/m3 as 'Bad', and > 520 μg/m3 as 'Dangerous'. In the European Union member states, while the average limit value of PM10 for 24 hours is 50 μg/m3, the average limit value of NO_2 for 24 hours is 200 μg/m3 [6]. For the research, authorization was obtained from Istanbul Medeniyet University Faculty of Medicine Ethics Committee in 2019.

Statistical Analysis

Descriptive values of the data obtained were calculated as mean $\pm$ Standard Deviation (SD), median, number and % frequency. The suitability of air quality parameters to normal distribution was examined with the Kolmogorov-Smirnov test. The differences between PM10 and NO_2 values, which are among the air quality parameters obtained from the measurement stations, and patient diagnoses were evaluated with the Kruskal Wallis test and the posthoc test was used to determine different measurement values. Statistical significance level was p < 0.05 and IBM SPSS (ver. 22.0, Armonk, NY: IBM Corp.) software was used in calculations.

RESULTS

The genders of the patients who participated in our study were 50.8% female (n = 9077) and 49.2% male (n = 8792). The mean age and SD of our patients were calculated as 43.9 $\pm$ 19.9. Descriptive values of patient diagnoses and air quality measurement values were calculated (Tab. 1). The diagnoses of patients who were admitted to emergency family practice were examined in terms of air quality measurements PM10 and NO_2 (Tab. 2) and it was determined that they did not demonstrate normal distribution. Patients diagnosed with a respiratory system diagnoses showed a statistically signifi-

Table 1. Descriptive statistics

	n (days)	Mean ± SD	Median (Min–Max)
Diagnosis J(0–99)	251	38.14 ± 19.89	35 (1–111)
Diagnosis M(0–99)	250	14.41 ± 6.76	14 (1–40)
Diagnosis R53	205	6.69 ± 6.54	4 (1–44)
Diagnosis R05	194	4.87 ± 3.70	4 (1–20)
Diagnosis I10	242	2.66 ± 1.49	2 (1–7)
SO_2	364	3.90 ± 2.38	3 (1–18)
PM10	365	48.37 ± 35.77	37 (8–199)
CO_2	365	607.18 ± 331.15	560 (69–2843)
NO	362	55.21 ± 69	30.5 (0–377)
NO_2	362	64.14 ± 24.09	61 (19–148)
NOX_2	362	119.29 ± 88.38	89.5 (20–485)
O_3	365	19.47 ± 9.56	18 (4–48)
HUMIDITY	365	74.09 ± 11.25	74 (39–98)
HOT WEATHER	365	18.16 ± 6.93	18 (2–33)
AIR PRESSURE	365	1014.66 ± 6.42	1014 (997–1033)

CO_2 — Carbon Dioxide; NO_2 — Nitrogen Dioxide; NOX_2 — NADPH oxidase 2; O_3 — Ozone; PM — Particulate Matter; SD — Standard Deviation; SO_2 — Sulphur dioxide

Table 2. Comparison of the diagnoses of the patients and the air quality measurement values

Diagnosis	PM10	n (days)	Median (Min–Max)	p	NO_2	n (days)	Median (Min–Max)	p
J/Diseases of the Respiratory System	0–50	172	35 (4–94)	0.009*	0–100	206	36 (4–111)	0.009*
	51–100	52	42 (13–111)		101–120	23	45 (13–77)	
	101–260	27	46 (23–81)*		> 121	19	49 (23–81)*	
M/Diseases of Musculoskeletal System	0–50	172	14 (2–30)	0.608	0–100	206	14 (2–31)	0.410
	51–100	51	16 (2–40)		101–120	22	17 (3–40)	
	101–260	27	14.5 (12–20)		> 121	19	15 (13–20)	
R53/Fatigue	0–50	140	5 (1–44)	0.005*	0–100	173	4 (1–44)	0.095
	51–100	43	3 (1–18)*		101–120	14	3 (1–18)	
	101–260	22	2.5 (1–23)*		> 121	18	3 (1–23)	
R05/Cough	0–50	135	4.5 (1–18)	0.309	0–100	160	4 (1–18)	0.686
	51–100	36	3 (1–20)		101–120	16	3 (1–12)	
	101–260	23	4 (1–11)		> 121	16	5 (1–20)	
İ10/Hypertension	0–50	164	2 (1–7)	0.033*	0–100	199	3 (1–7)	0.073
	51–100	53	3 (1–7)		101–120	22	2 (1–5)	
	101–260	25	2 (1–3)*		> 121	18	2 (1–3)	

NO_2 — Nitrogen Dioxide; PM — Particulate Matter

cant relationship with the air quality measurement of PM10 ($p < 0.05$). Patients diagnosed with upper respiratory tract disease on sensitive air days were found to be significantly higher than those with good air quality. There was a statistically significant relationship between PM10 and patients diagnosed with fatigue ($p < 0.05$). It was observed that the admissions to the emergency room of the patients diagnosed with fatigue decreased significantly as the weathers quality becomes lower. A statistically significant relationship was found between PM10 and patients diagnosed with hypertension

($p < 0.05$). No statistically significant relationship was found between the patients diagnosed with M(00–99). Diseases of the musculoskeletal system and connective tissue and PM10 ($p > 0.05$). Finally, among the diagnoses that were examined, no significant relationship was found between cough and PM10 ($p > 0.05$). There was a statistical significance between air temperature, and fatigue and cough complaints ($p < 0.05$). There was no statistical significance between humidity and the complaints. When the diagnoses of the patients are examined in terms of NO_2, another parameter used in the evaluation of air quality; a statistically significant relationship was observed in the diagnosis codes of J(00–99) in terms of respiratory system diseases ($p < 0.05$). As the air quality became more sensitive, the number of patients diagnosed with respiratory system diseases increased significantly in the upper J(00–99) diagnostic codes. No statistically significant relationship was found between the patients diagnosed with M(00–99) Diseases of the musculoskeletal system and NO_2 ($p > 0. 0.05$). Patients with diagnosed with pain, fatigue, cough, and hypertension respectively were not found to be significantly related to the NO_2 measurement levels ($p > 0. 0.05$, $p > 0. 0.05$, $p > 0, 0.05$, and $p > 0.05$).

DISCUSSION

With the industrial revolution, air pollution has become one of the biggest problems faced in the 19th century, and due to increasing use of fossil fuels and industrialization in our country, it is increasing day by day. Depending on short-term and long-term exposure to air pollution, its effects on human health may vary. Especially after exposure to particulate matter, air pollution has been shown to cause an average decrease of 1–2 years in life expectancy [7,8]. It has been shown that exposure to pollutants such as PM and ozone in the air is associated with increased mortality and hospitalizations due to respiratory and cardiovascular diseases [9].

In research studies examining the effects of air pollution on hospital admissions in Europe and the United States of America (USA), it has been shown that, depending on the increase in PM10 levels, the rates of admission to hospital emergency rooms and mortality due to asthma and chronic obstructive pulmonary disease (COPD) in patients aged 65 years and older have increased [10, 11]. In a study conducted in Seattle, USA, it is shown that every 10 μg/m3 increase in PM10 caused an increase of 13–3.7% in COPD and asthma patients. In the study conducted in Zonguldak province, a positive and weak relationship was detected between all respiratory diseases and SO_2 and PM10 [12]. In another study conducted in Balikesir province, no relation was found between PM10 levels and respiratory diseases [13]. In our study, we detected that more patients diagnosed with respiratory system diseases were admitted on days when air pollution was intense compared to other days.

In a study conducted in Switzerland, every 10 μg/m3 increase in PM10 caused an increase in symptoms of chronic cough, sputum, and daytime shortness of breath in individuals between the ages of 18 and 60. In our study, we observed that as the PM10 value increased, more patients diagnosed with R 05 'Cough' were not admitted to the emergency service. We consider these patients are evaluated primarily in the emergency higher priority areas and/or have different diagnoses.

In a study conducted in Hong Kong, the effects of air pollutants on COPD exacerbations were investigated, and a significant direct relationship was detected between the hospitalization due to COPD acute exacerbations and increased air content of SO_2, NO_2, PM10, and PM2.5. High levels of air pollutants increase both the hospitalizations and emergency admissions due to acute exacerbation of COPD [11]. It has been shown that, at times of air pollution, the number of consultations to family physicians for asthma and lower respiratory tract diseases, although not specific for COPD, increased [14].

It has been shown that particulate matter levels are associated with increased systemic inflammation. Especially with increasing PM values, the average values of C reactive Protein (CRP), IL-6, and White Blood Count (WBC) increase and this increase has been shown to adversely affect the prognosis of patients with diabetes, obesity, and hypertension [15]. In animal experiments on the effects of air pollution, dogs exposed to particulate matter have been shown to have increased systolic blood pressure, diastolic blood pressure, mean arterial pressure, and increased heart rate [16]. In addition, it has been shown that particulate matter levels are associated with acute peripheral artery narrowing and arterial reactivity by disrupting endothelial function [17, 18]. In a study conducted in the Republic of China, it was

shown that every 10 μg/m3 increase in PM values caused an increase in the number of admissions to emergency rooms due to hypertension [19]. In our study, consistently with the literature, we also found that the admissions to green areas of the emergency room due to hypertension increased on days when PM10 was high in the air.

The effect of temperature on human health has been investigated, but the studies on the effect of humidity are somewhat more limited. As a rule of thumb, the adverse effects of relative humidity on human health can be reduced to a minimum level by keeping the humidity between 40% and 60%; in case of relative humidity above and below these levels, physical discomfort can be encountered. In a study, it was observed that admissions to family practice polyclinics due to respiratory infections increased with increasing humidity levels [20]. In our study, no relationship was found between humidity and the complaints. This may be because patients are climatized due to the constant high humidity in Istanbul.

In the study of Makinen et al. [21], it was stated that low temperature was the cause of recurrent respiratory tract infections. In a retrospective study conducted by Danielides et al. [22], it was shown that cold temperatures increased the incidence of acute laryngitis. In another study, [23] it was shown that in every 1.8 Celsius temperature increase exceeding the seasonal threshold, admissions to the hospital with complaints about respiratory tract diseases increased by 4.5%. In our study, in parallel with the literature, it was observed that with temperature drops, cough and fatigue complaints increased.

RESULTS

For human health protection, continuity of life, and environmental sustainability, air pollution should be reduced and brought under control. In our study, with the increase of particulate matter, which is one of the air pollution parameters, we observed that patients with respiratory system diseases, fatigue complaints, and hypertension increased. Since NO$_2$ values were much lower than the limit values in the region where we conducted our study, we have only seen an increase in the admissions for respiratory diseases. Sharing these results with province-wide authorities may help the settlement and industrial planning in the upcoming years.

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