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Effects of Air Pollution on Mortality and Morbidity in Samsun Province of Turkey

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Abstract

Objective: We aimed to evaluate the relationship between hospital admissions and hospitalizations from respiratory system diseases, cardiovascular diseases, neurological and psychiatric diseases with air pollution. The second aim of the study was to calculate the total number of deaths that can be attributed to air pollution with the AIR Q + program.

Methods: The study is a descriptive type of ecological study. As the determinant of air pollution, daily PM10 data from all stations located in the central districts of Samsun were used. The records of all applications and hospitalizations that received any of the ICD-10 diagnostic codes I00-99, J00-99, F00-99, and G00-99 were included in the study. Correlation and regression analysis were conducted to explain the relationships between hospital admissions, hospitalizations, and PM10 and meteorological parameters.

Results: The annual average of PM10 was found to be 50.4±19.3 µg/m3. There were positive and statistically significant correlations between the daily number of admissions of all diseases evaluated with PM10. Positive and statistically significant correlations were found between hospitalizations for only respiratory and cardiovascular system diseases with PM10. Admissions from respiratory system diseases (3%), cardiovascular (2%), neurological (1%), and psychiatric diseases (1%) and hospitalizations from respiratory diseases (%2) increased for every 10 µg / m3 increase in PM10 level. The annual average of PM2.5 was found to be 31.8 µg/m3 using the AIR Q + program. The number of natural deaths that can be attributed to air pollution in 2018 was 835 (12.3%), and the estimated number of deaths attributable to 100,000 people at risk was 111.8 (RR: 1.14).

Conclusion: Hospital admissions and hospitalizations are increasing due to air pollution. Many deaths and adverse health effects can be prevented by reducing the air pollution that increases especially in the winter period to the determined limit values.

Keywords: Air pollution, morbidity, mortality

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INTRODUCTION

Air pollution has become one of the most important environmental health threats worldwide. According to World Health Organization (WHO) data, more than 80% of people living in urban areas are exposed to air pollution above WHO limits (1). It is estimated that air pollution is responsible for 7 million deaths each year worldwide (2). Particulate matter, 10 µm of air pollutants (PM10) is released from various natural and human activities and has been shown to be associated with negative health effects as an indicator of air pollution in many epidemiological research studies.

Health effects of PM exposure; increasing hospital admissions range from hospital admissions and the risk of premature death (3). More and more evidence has been obtained from epidemiological research studies in recent years that it is associated with respiratory diseases, cardiovascular diseases, neurological and psychiatric diseases. While most of them examined hospital admissions and deaths associated with respiratory diseases and cardiovascular diseases, fewer studies have examined potential associations between neurological and psychiatric diseases and air pollution. It is estimated that PM initiates and promotes neurodegeneration by triggering oxidative stress and inflammation processes.

The importance of the relationship between PM10 and morbidity and mortality can differ from region to region due to significant differences in the level of pollution, climatic conditions, and individual sensitivity (4). However, most of the current studies investigating the adverse health effects of air pollution have been conducted in developed countries, and there is still limited evidence from developing countries. There are very few studies examining the effect of air pollution on hospital admissions and hospitalizations in our country. This can undermine the priority of environmental interventions and policy implementation. In a study conducted in Istanbul, it has been shown that the increase in PM10 has a significant effect on hospital admission rates from respiratory diseases (5). More studies are needed, especially at national and regional levels, to better understand the real impact of air pollution on public health.

In this study which is the first study to evaluate respiratory diseases, cardiovascular diseases, neurological and psychiatric hospital admissions, and daily PM levels in Turkey using negative binomial regression (NBR) in a generalized linear model (GLM) was used while controlling the time trends and meteorological factors. The aim of this study is to evaluate the relationship between the admissions made with the diagnosis of respiratory system diseases, cardiovascular diseases, neurological and psychiatric diseases, and hospitalizations to the 2nd and 3rd stage hospitals in the central districts of Samsun province in 2018 with the air quality measurement data and meteorological parameters. In addition, this study, it was aimed to evaluate the relationship of PM10 measurement data with the number of measurements and to calculate the preventable number of deaths with the AIR Q + program.

METHODS

Procedure

This is a descriptive, ecological study, and it was conducted by evaluating the air quality measurements, admissions and hospitalizations in the central districts of Samsun province in 2018.

Study Area

Samsun is a city located in the coastal strip on the northern part of Turkey. Although the climate shows different characteristics in the coastline and inland areas, it generally has a mild climate. It is the most populous and industrialized city of the Black Sea geographical region with a surface area of 9579 km2. Atakum, İlkadim, Canik, Tekkekoy districts, which form the central districts, have a surface area of 661 km2. According to Turkish Statistical Institute (TSI) data for 2019, the total population of Samsun is 1,348,542 and the population of the central districts is 706,331 (6). In addition to the port and copper, fertilizer, and cigarette factories in the city, there are 6 organized industrial zones where large industrial enterprises are located (7). Five air quality measurement stations are located in the central districts of Samsun. Temporary malfunctions in the measurements may occur due to the displacement of the stations due to force majeure, and malfunctions in the measuring device and cabin (7). In Samsun, the main sources of air pollution depend on different emission sources such as motor vehicles, industrial processes, construction activities, residential heating and ship emissions.

PM10 Measurements

Hourly and daily PM10 measurement data between January 1, 2018, and December 31, 2018 were taken from the database of the Ministry of Environment and Urbanization and included in the study. The daily average of hourly measurements taken from 5 air quality monitoring stations was used. The average PM10 values of the days where at least 75% of the 24 measurements that need to be performed daily were analyzed. The days exceeding the 24-hour average limit between these days are considered as "the number of days exceeding the average". Monthly and annual average PM10 values were calculated based on the number of days evaluated. The obtained results were contrasted with the daily and annual PM10 average upper limit values from the WHO, the European Union (EU), and Turkey.

Meteorological Parameters

Daily average temperature, pressure, humidity, wind speed, and direction data for 2018 were obtained from Samsun Meteorology

Directorate. Weather data included 100% of the average daily results in Samsun.

Data for Hospital Admissions

The daily data on outpatient and inpatient treatments of the patients were obtained from the hospital statistics of outpatient clinic applications, emergency room applications, and hospital admissions records in the central districts of Samsun. According to the International Statistical Classification of Diseases and Health Related Problems 2010 Version (ICD-10) system developed by WHO, the patient records made with the diagnosis of cardiovascular diseases (I00-99), respiratory system diseases (J00-99), neurological system diseases (G00-99) and psychiatric diseases (F00-99) were taken as the basis. The population of our study consists of the records of 1.455.943 patients who received any of the relevant ICD-10 diagnostic codes. Informed consent was not required as we are using aggregated data. Patient names, identity information, and full addresses were removed from the information provided for this study in accordance with national confidentiality provisions. The approval of the study was obtained from the ethics committee of Ondokuz Mayis University Medical Faculty.

Statistical Analysis

In this study, modeling was performed using GLM to estimate the relationship between daily air pollutant concentrations and hospital admissions. Daily hospital admissions and hospitalizations show excessive spread (variance > average). This situation violated the assumption of the equality of mean and variance of Poisson regression, which is the preferred modeling technique in census data (8). Therefore, the data; As in many other studies that associate air pollution with health, it has been evaluated using the Negative Binomial regression method, one of the regression models with counting data, which provides the requirement for variance to be greater than the average (9).

Since it was reported in previous studies that meteorological parameters were related to hospital admissions and hospitalizations, its effect on the model was smoothened (10). The days of the week and whether there is a holiday as a categorical factor are also defined as confounding factors (covariates that may be related) in the statistical model, as the pollutant concentrations appear different due to the industry's cessation of work on holidays and the admissions to health institutions are lower than normal. Since there was no strong correlation between independent variables, any variable was not removed from the model.

SPSS (version 20.0) was used for the statistical evaluation of the data and Jamovi statistical package program was used for regression analysis. Whether the data obtained in the study were suitable for normal distribution was analyzed with the Kolmogorov-Smirnov test. While expressing descriptive analyzes, continuous variables fitting for normal distribution were expressed using the arithmetic mean ± standard deviation, and those that did not conform to normal distribution were expressed using median (min-max), and data obtained by counting were expressed using number and percentage (%).

Correlation analyzes were conducted to explain the relationships between hospital admissions and hospitalizations and PM10 and meteorological parameters such as temperature, pressure, humidity, and wind speed. Data fitting normal distribution were evaluated with the "Pearson correlation test", and those not fitting normal distribution were evaluated with the "Spearman correlation test". The relative risk (RR) was calculated as the natural exponent of the beta (B) NBR coefficient [RR = exp (B)]. Results are expressed as excess risk. Excess risk

values are multiplied by the coefficient of 0.65 was found for Turkey. By entering PM2.5 values and other necessary information, the number of deaths that could be prevented when the pollution levels were reduced to the WHO limits and the death rates attributable to pollution in a hundred thousand was calculated (12).

RESULT

The annual average of PM10 was found to be 50.4 ± 19.3 µg / m3 and the median was 45.4 µg / m3 (15.0-145.7 µg / m3) in Samsun central districts. The average PM10 values measured at stations in central districts were found to be the

(ER) was calculated as the percentage (%) increase of the dependent variable [(RR-1) x100] for each unit increase of exposure to the independent variable (11). In this way, it is possible to obtain the increased risk of hospital admissions and hospitalizations due to the increased level of PM pollution. After setting the GLM with NBR, the model was tested using the z-test. In the study, p <0.05 was determined as the statistical significance level for all tests.

Air Q+

Using the AIR Q + program developed for the WHO European region, the total number of deaths above the age of 30 that can be attributed to air pollution in a particular region can be calculated with PM2.5 averages. PM2.5 measurements; the program itself did it automatically; PM10 to PM2.5 cycle, the WHO suggests that the average PM2.5

highest in Yuzuncuyil Station (63.5 ± 25.8 µg / m3) and the lowest at Atakum Station (37.6 ± 15.5 µg / m3). The relocation of Ilkadim Hospital station due to compulsory reasons caused long-term data loss in PM10 measurements between 12.07.2018 and 01.12.2018. 48 (15.4%) out of 311 days evaluated in Atakum, 97 (48.0%) out of 202 days at Ilkadım Hospital Station, 100 (34.8%) out of 287 days in Canik, Yuzuncuyil Station 354 days in 228 (64.4%), Tekkekoy in 337 days in 134 (39.8%) yielded daily average values which are above the limit value for the WHO, the EU, and Turkey (Table 1). PM10 limit values from WHO, the EU, and Turkey, and PM10 limit values being implemented in Turkey in 2018 are shown in Table 2. The annual averages at all stations are well above the WHO annual limit value (20 µg / m3).

Looking at the provincial monthly averages of PM10 measurements, the highest month was recorded in March (70.7 µg / m3) and the lowest in September (37.3 µg / m3). It was found that the average monthly hospital admissions of all the diseases evaluated in the study were higher in winter than in summer. Considering the number of days exceeding the 24-hour average, most of the days that pass above the limit values are in the winter period.

In Table 3, the relationship between the daily admissions, hospitalizations and meteorological parameters of the disease groups and daily average PM10 levels are evaluated. respectively. A positive, weak and statistically significant relationship was found between PM10 levels and admissions due to respiratory system diseases, cardiovascular diseases and neurological diseases. A positive, very weak and statistically significant relationship was found between PM10 and psychiatric disease admissions. A positive, very weak and statistically significant correlation was found between PM10 and hospitalizations due to respiratory system diseases and cardiovascular diseases. There was no statistically significant relationship between PM10 and hospitalizations due to neurological and psychiatric diseases. A negative, weak and statistically significant relationship was found between PM10 and average temperature and average wind speed.

GLM models created to determine the effects of air pollution on the number of respiratory system diseases admissions were significant ($p < 0.001$), and the coefficient of indication was found to be ($r2$: 0.69) 69% in the temporal variation of hospital admissions due to respiratory system diseases. In the GLM negative binomial regression model; A positive correlation was observed between each 1 µg / m3 increase in PM10 level and the number of SSH admissions (RR: 1.003, 95% CI: 1.00-1.004; p: 0.001). The coefficient of determination was found to be (r2: 0.92) 92% for hospital admissions due to cardiovascular diseases and in the GLM Negative binomial regression model; A positive correlation was observed between the number of cardiovascular diseases hospital admissions for every 1 µg / m3 increase in PM10 level (RR: 1.002, 95% CI: 1.0001-1.003; $p < 0.05$). The coefficient of determination is (r2: 0.88) 88% for hospital applications due to neurological diseases.

In the GLM negative binomial regression model, a positive correlation was observed between each 1 µg / m3 increase in PM10 level and the number of neurological disease admissions (RR: 1,001, 95% CI: 1,0001-1,003; $p < 0.05$). The coefficient of determination for hospital admissions due to psychiatric diseases

Table 1. Descriptive indices of the PM10 values (μg/m³) in the central districts of Samsun, Turkey

Variables	The number of days evaluated	The number of days exceeding the average	PM10 Mean ± SD
Atakum	311	48	37.6±15.5
Ilkadim Hospital	202	97	54.0±19.6
Canik	287	100	48.1±21.2
Yuzuncuyil	354	228	63.5±25.8
Tekkekoy	337	134	48.3±24.8

PM10: 10 μg/m³ particulate matter

Table 2. PM10 limit values from WHO, the EU and Turkey (μg/m³)

		Limit Values			
		WHO	**EU**	**TR(2019)**	**TR(2018)**
PM10	**24 h average**	50	50	50	60
	Annual average	20	40	40	44

WHO: World Health Organization; EU: European Union; TR: Turkey; PM10: 10 μg/m³ particulate matter

Table 3. Bivariate correlation analysis

Variables	**PM10, μg/m³**
RHA	rs = 0.372, p < 0.001
CHA	rs = 0.243, p < 0.001
NHA	rs = -0.236, p < 0.001
HA	rs = -0.178, p < 0.05
HRD	rs = -0.176, p < 0.05
HCD	rs = 0.199, p < 0.05
HND	rs = 0.030, p > 0.05
HPD	rs = 0.025, p > 0.05
Meteorologic measures (24-h average)	
Temperature (◦C)	rs = -0.283, p < 0.001
Wind Speed (m / sec)	rs = -0.219, p < 0.001
Humidity (%)	rs = 0.019, p > 0.05
Air pressure (hPa)	rs = -0.020, p > 0.05

RHA: Respiratory hospital admissions; CHA: Cardivascular hospital admissions; NHA: Neurological hospital admissions; PHA: Psyhiatric hospital admissions; HRD: Hospitalization for respiratory diseases; HCD: Hospitalization for cardivascular diseases; HND: Hospitalization for neurological diseases; HPD: Hospitalization for psyhiatric diseases; rs: indicates Spearman correlation coefficient

Table 4. Relative risk (RR), confidence interval (CI) for significant variables.

Variables	**RR**	**CI (95%)**	**p value**
RHA	1.003	(1.001-1.004)	0.001
CHA	1.002	(1.0001-1.003)	0.021
NHA	1.001	(1.0001-1.003)	0.03
PHA	1.001	(1.0001-1.002)	0.027
HRD	1.002	(1.0001-1.003)	0.01
HCD	1.001	(1.000-1.003)	0.069
HND	1.001	(0.999-1.002)	0.204
HPD	1.000	(0.997-1.002)	0.998

RHA: Respiratory hospital admissions; CHA: Cardivascular hospital admissions; NHA: Neurological hospital admissions; PHA: Psyhiatric hospital admissions; HRD: Hospitalization for respiratory diseases; HCD: Hospitalization for cardivascular diseases; HND: Hospitalization for neurological diseases; HPD: Hospitalization for psyhiatric diseases

Is (r2: 0.93) 93%, and in the GLM Negative binomial regression model; a positive correlation was observed between each 1 μg / m3 increase in PM10 level and the number of psychiatric diseases (RR: 1,001, 95% CI: 1,0001-1,003; p < 0.05). In the models created for hospitalizations, only GLM models created to determine the effects on hospitalizations due to respiratory diseases were found to be significant (p < 0.001). The coefficient of determination is (r2: 0.70) 70%, and in the GLM Negative binomial regression model; a positive correlation was observed between each 1 µg/m3 increase in PM10 level and the number of hospitalizations for respiratory diseases (RR: 1.002, 95% CI: 1.0001-1.003; p <0.05). No statistically significant results were obtained in the regression analysis for hospital admissions of other diseases (p> 0.05) (Table 4).

Table 5. Demographic data and death rates in Samsun, Turkey

Number of deaths	8562
Crude death rate	0.65 %
>30 age population	746.656
>30 age number of natural deaths	6830
>30 age natural death rate	0.91 %

Table 6. Estimated attributable proportion (AP) of mortality in a year due to short-term exposure above 10µg/m^3 for PM, in Samsun, Turkey.

Estimated number of attributable deaths (lower-upper)	835 (557-1084)
Estimated AP (lower-upper)	12.3 % (8.2-16)
Estimated number of attributable deaths per 100.000 people at risk (lower-upper)	111.8 (74.6-145.2)
Relative risk (lower-upper)	1.14 (1.08-1.18)

AIR Q+ Calculations

According to the Turkish Statistical Institute data, crude death rate of Samsun province in 2018 was calculated to be 6.5%. Frequently used in calculations; The natural mortality rate over the age of 30, which occurs except for reasons such as murder, suicide, accident and injury, was calculated as 9.1% in Samsun. (Table 5). Considering the number of deaths by month; The month with the highest number of deaths in 2018 in Samsun is January with 808 (9.4%) deaths, and the month with the lowest is June with 607 (7.1%) deaths.

The average of PM2.5 in Samsun province in 2018 was found to be 31.8 µg/m3. Based on this value, if the annual average of PM2.5 throughout the province is reduced to 10 µg / m3, which is the WHO's PM2.5 limit value, with the AIR Q + program, the number and rates of preventable deaths over the age of 30 and the estimated number of attributable deaths per 100,000 people at risk are calculated. In 2018, the number of natural deaths above the age of 30 attributable to air pollution was 835 (12.3%) and the estimated number of deaths attributable to 100,000 people under risk was 111.8 (RR: 1.14) (Table 6).

DISCUSSION

The annual averages of PM10 values measured in the study are above the WHO limit values at all stations. It was also observed that the limit was exceeded in terms of the number of days exceeding the daily average limit, which should be less than 35 times a year at all stations (13). In 2017, the annual average of all cities in our country is above the WHO upper limit (14). The main sources of air pollution in Turkey are motor vehicles, fuel use for domestic heating, and industry emissions (15). Intensive and wrong urbanization, the increasing number of motor vehicles can be counted among the reasons for the increase in air pollution in Samsun. In addition to these, the dominant meteorological conditions of the industry and the region and the extremely rugged topographic structure increase pollution levels. Due to the mountainous structure, residences and industrial facilities were established intertwined in places that allow settlement and industrial sites remained in the center of the city.

In our study, in addition to the fact that monthly PM10 averages are higher in the winter period, the days that exceed the 24-hour average limit values are mostly in the winter period. In different studies carried out in Turkey and in the world's different regions it has been shown that the highest average PM10 values and limit exceedances occurred mostly during the winter (15-18). It is thought that the increase in air pollution during the winter period is mainly due to the increase in the use of fossil fuels for domestic heating as the temperatures decrease.

Our Samsun average wind speed of operation (1.8 m/sec), and the average of Turkey (for the years 2010-2017 to 1.9 m/sec) were lower (19). Yearly average relative humidity in Samsun (68.2%) was calculated to be respectively higher than the one in Turkey in general (62.4% for the period from 2009 to 2018) (20). In addition, while the monthly average pressure values were low in the summer period in the city, the average pressure was higher in the winter period. In our study, negative, weak, and statistically significant relationships were found between PM10 and mean temperature and wind. In studies evaluating the effect of meteorological parameters on air pollution in the literature, generally negative and significant relationships were found between PM10 and average temperature and humidity (5,21). A negative relationship between PM10 and wind speed is an expected situation, supporting that the wind causes the removal of pollutants from settlements and dilution, and the pollutant concentrations decrease during the periods when the speed increases (16).

When the pressure is low, it reduces air pollution by causing rising air movements (22). In addition, meteorological parameters greatly affect air pollution due to the suspending of air pollutants in the atmosphere and mixing with each other in the air. These values determined in the province of Samsun may have a negative effect on the air pollution of the region.

The findings obtained in our study regarding the relationship between PM10 and hospital admissions were compared with different studies, and it was found to be compatible with the literature. There are many studies in the current literature that reveal the relationship between hospital admissions due to respiratory system diseases and cardiovascular diseases and air pollution (5,23-25). Although the mechanism of the effect of air pollution on human health is not known yet, the pathophysiology of particulate matter is blamed for initiating inflammatory processes in the respiratory system or in circulation (26). In the correlation analyses performed in our study, a positive and significant relationship was found between PM10 and hospitalizations due to respiratory system diseases and cardiovascular diseases, while no significant relationship was found between PM10 and hospitalizations due to neurological and psychiatric diseases.

Similar to the literature, the findings show that there is an increased risk in terms of hospitalizations due to respiratory system diseases and cardiovascular diseases due to the increase in air pollution (27-29). A positive correlation was found between PM10 and hospitalizations due to respiratory system diseases between 2000-2005 in Balıkesir (30).

Few studies have examined potential correlations between neurological and psychiatric illnesses and air pollution. Although studies on this subject have increased in recent years, inconsistent results have been reported. Few studies in the literature have examined neurological disease subtypes such as multiple sclerosis, migraine headache, Alzheimer's, Parkinson's disease (PD), and psychiatric disease subtypes such as depression and anxiety disorders (31,32). Although the effects of particulate matter on mortality have been described more broadly in the literature, the evidence for its effect on morbidity is limited, and there are even fewer studies investigating the relationship between particulate substances and hospitalizations. In some studies, in the literature, it has been observed that different subgroups of diseases have been examined. In addition, it is known that the geographical and climatic characteristics of the studied region influence the results. For these reasons, differences in the strength of the relationship may be determined.

According to the results of the regression analysis performed in our study, it was determined that the number of applications for respiratory system diseases increased by 3%, and the number of hospitalizations for respiratory diseases increased by 2% for every 10 µg / m3 increase in PM10 level. In a meta-analysis conducted in 2014, it was observed that there was an increase of 1% in China, 2% in the United States, and 1% in the EU in hospital admissions made for COPD for every 10 µg / m3 increase in PM10 (33). According to the study conducted in Lebanon, it has been determined that every 10 µg / m3 increase in PM10 increases the risk of admission to the emergency department due to respiratory diseases by 1.6% (34). Between 2013 and 2015 in Istanbul, Çapraz et al. (5) found that applications due to respiratory system diseases increased by 0.61% for every 10 µg / m3 increase in PM10. In Bangkok, it has been determined that the risk of hospitalization from respiratory system diseases increases 1.2% for every 10 µg / m3 increase of PM10 (35).

In our study, the risk increase for cardiovascular disease admissions was found to be 2%, but no significant relationship was found in the regression analysis between PM10 and cardiovascular disease hospitalizations. In the study of Feng et al. (36), the increase rate in both respiratory system diseases and cardiovascular diseases was found to be 3% with each ten-unit increase in PM10 levels. In another study conducted in China due to respiratory system disease and cardiovascular disease, it was found that the application rates increased by 2.8% and 0.8%, respectively, for each 10 µg / m3 increase of PM10 (37). In the study conducted by Nascimento et al. (24) in Brazil, it was found that hospital admissions due to hypertension increased by 1-2% with a 10 µg / m3 increase in PM concentration. In another study conducted in 2019, it was determined that the risk of emergency service admission due to atrial fibrillation increased 1.4% for each 10-unit increase for PM10 (38).

According to the results of a meta-analysis, it was determined that every 10 µg / m3 increase in PM10 increases the risk of hospitalization due to cardiovascular disease by approximately 1.1-2.7% (28). Although the findings of our study are similar to the findings in the literature in general, the absence of an increase in the risk for hospitalizations due to cardiovascular diseases may be due to the hospitalization and transfer of patients from outside the province with the health facility capacity and coronary care units in Samsun.

In our study, it was determined that hospital admissions for neurological and psychiatric reasons also increased by 1% for every 10 µg / m3 increase in PM10 level. No significant relationship was found in regression analysis between PM10 and hospitalizations for neurological and psychiatric reasons.

In Canada, the relationship between daily emergency room admissions for headaches and air pollution has been examined and an increase in the risk of up to 4.2% has been found (39). In the study conducted by Gao et al. (32), it was found that total mental disorder admissions increased by 0.3% for every 10 µg / m3 increase for PM10.

There are also studies in the literature showing that neurological and psychiatric hospitalizations increase with the increase of air pollution. However, it is noteworthy that these studies are generally conducted with smaller subgroups of the diseases. In the study of Angelici et al. (31), it has been shown that there is a relationship between exposure to PM10 and hospitalizations associated with multiple sclerosis. In a study examining the relationship between PM10 and PM2.5 levels and the number of hospitalizations for depressive disorders in China, air pollution was associated with depressive disorders (HR: 1.44 for an increase of 10 µg / m3) (40). It is thought that the differences observed in the epidemiological studies conducted may be due to the geographical and climatic differences of the region as well as the characteristics of person, place, and time.

While 835 deaths were attributed to air pollution with the AIR Q + program, it was shown that if the average PM2.5 was at the level of 10 µg / m3, approximately 112 people could be protected from death for a hundred thousand people over the age of 30 (RR: 1.14). According to the calculation methods of the AIR Q + program, where the average PM is high, the risk of death due to natural causes (RR) over the age of 30 is higher. However, the demographic characteristics of the researched region and the high population of the elderly may affect the results by increasing the mortality rate above the age of 30 used in calculations. According to a report prepared by Clean Air Rights Platform Turkey, in 2017 the overall number of deaths over the age of 30 attributed to air pollution was calculated as 51,574 (13%) of 399,025 deaths via the AIRQ+ program. In the report, the highest mortality rate attributed to air pollution per 100,000 people was found to be in the provinces Afyon (235.2) and Sinop (223.2) (14). In a study conducted in Macedonia, the natural mortality risk over 30 years old was found as RR: 1.3, which is attributed to air pollution in two different regions with a 5-year PM2.5 average of 41.8 and 45.9 µg / m3 (41). According to the research conducted by Lehtomaki et al. (42) in Finland, whose annual average, PM2.5 is 5.8 µg / m3, approximately 2000 people died in 2015 due to air pollution.

In the study conducted by Jirik et al. (43) in 2016, the mortality risk of over 30 years of age attributed to PM2.5 pollution for 2 different regions using AIR Q + was 44 RR: 1.09- 1.15 and 44 RR: 1.13-1.22 for the region of 31-45 µg / m3. In the research conducted in Tehran, using the AIR Q + program, 6710 deaths (13.0%) over the age of 30 and 128 deaths per 100,000 people in a 1-year period between March 2017 and March 2018 were attributed to air pollution from PM2.5 (44).

Limitations

Since many variables are considered in the study, it is one of the limitations of the study to examine only particulate matter measurements as a determinant of air pollution in order to reduce complexity. In addition, since the study is in ecological design, it does not provide information about the causality of the relationship, although a relationship has been determined between admissions, hospitalizations and deaths, and PM10 pollution. The arrival of patients from other districts of the province and even from neighboring provinces to hospitals in Samsun City Center may have affected our research results. In the PM10 measurements taken between the research dates, data was lost due to the days when there were not enough measurements. At the İlkadım Hospital station, the location of the measuring device was changed due to the risk of collapse of the construction wall, and data was lost for 4 months between August and November. Due to the absence of PM2.5 data in all the centers where air pollution measurements were taken in 2018, the PM2.5 averages for the calculations to be made in the AIR Q + program were calculated using the PM10 conversion method and it was assumed to reflect the real world.

CONCLUSION

As a result, it has been shown that air pollution has negative effects on hospital admissions, hospitalizations, and deaths worldwide. Although the increase in the risk of morbidity and mortality due to air pollution seems small when considered for a single individual, its total impact on the general population emerges as a serious public health problem due to the billions of people affected.

Our findings can support awareness raising and air pollution control measures by identifying problems at the local level. Although the results of our study cannot be generalized to the whole society, it is thought that our findings will contribute to other studies in the field.

Ethics Committee Approval: Ondokuz Mayis University Medical Faculty Ethic Committee (OMÜ KAEK-2019/531)

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