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Air Pollutants and Its Effects on Human Health: The Case of the City of Trabzon

Yelda Aydın Türk and Mustafa Kavraz
*Karadeniz Technical University
Turkey*

1. Introduction

Air pollution, both indoors and outdoors, is a major environmental health problem affecting everyone in developed and developing countries alike. Any agent that spoils air quality is called air pollutant. Air pollution can be defined as the presence of pollutants, such as sulphur dioxide (SO₂), particle substances (PM), nitrogen oxides (NO_x) and ozone (O₃) in the air that we inhale at levels which can create some negative effects on the environment and human health (Bayram, 2006). Air pollutants have sources that are both natural and human-based. Now, humans contribute substantially more to the air pollution problem. Though some pollution comes from natural sources, most pollution is the result of human activity. Air pollution is a problem of growing importance. This pollution damages the natural processes in the atmosphere, and affects public health negatively. Currently, several cities stand out as worst cases of air pollution (Kilburn, 1992). It was found that until the 1980s, 1.3 billion people lived in cities where pollution was above the air quality standards (Bayram, 2006). Besides, air pollution is a main threat to the vegetation.

Pollutants such as dust, soot, fog, steam, ash, smoke, etc. are introduced into air naturally and as a result of human activities. The atmosphere can neutralize toxic solid, liquid and gaseous substances by melting them; however, due to the production of excessive amounts of such substances and depending on the meteorological and topographic conditions, the atmosphere is in a continuous process of pollution. (Kaypak and Özdilek, 2008). There are several main types of pollution. Among the main pollutants in the urban atmosphere are primarily the particle substances (PM), sulphur dioxide (SO₂), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and secondarily ozone (O₃) that is created as a result of photochemical reactions. (Özden et al., 2008).

Particles are introduced into the air by burning fuel for energy. The gases produced as a result of burning fuels in automobiles, homes, and industries are a major source of pollution in the air. The exhaust from burning fuels in automobiles, homes, and industries is a major source of pollution in the air. Some believe that even the burning of wood and charcoal in fireplaces and barbecues can release significant quantities of soot into the air. Another type of pollution is the release of **noxious gases**, such as sulfur dioxide, carbon monoxide, nitrogen oxides, and chemical vapors. These can take part in further chemical reactions once they are in the atmosphere, forming smog and acid rain (URL4).

Air pollution was first seen in Turkey as a serious problem in the early 1970s, and in the following years it spread into other cities mainly Istanbul. The reason for this is that lignite

coal which has a high pollution rate was started to be used as a source of energy (Evyapan, 2008). 41% of the energy sources that are consumed in Turkey is used for heating purposes in houses, and in winters air pollution in the residential areas with intense population reaches levels that threaten human and environmental health.

An air pollutant is any substance which may harm humans, animals, vegetation or material (Kampa and Castanas, 2008). Air pollutants cause adverse effects on human health and the environment. A constant finding is that air pollutants contribute to increased mortality and hospital admissions. Human health effects can range from nausea and difficulty in breathing or skin irritation, to cancer (Kampa and Castanas, 2008).

There are studies in literature which report the relationship between respiratory tract diseases and the level of air pollution concentrations (SO₂ and PM). Few scientists found that air pollution is associated with respiratory tract diseases of many sorts, including lung cancer and emphysema. A number of studies have established a qualitative link between air pollution and ill health (Lester and Eugene, 1970). In their study, Sardar et al. (2006) investigated the health records and found that there are statistically significant relationships between respiratory tract diseases and rough particles, and that rough particles constitute an important threat for human health. In addition, epidemiological and toxicological research have focused on the role of particles (PM_{2.5}) on the observed health effects (Anderson, 2000, Brown, Stone, Findlay, Macnee, Donaldson, 2000, 1990). In their study, Lipfert et al. (1995) report that there is a statistically significant relationship between atmospheric particle matter size and admissions to hospitals for respiratory tract infections and mortalities. On average, 5% of daily mortality is associated with air pollution.

As is the case of all environmental problems, the two primary causes of air pollution in Turkey are urbanization which has been rapid since the 1950s, and industrialization. Before industrialization, more than 80% of the population lived in rural areas, but now more than 60% live in cities and industrial complexes. Among the developments contributing to air pollution in the cities are incorrect urbanization, low quality fuel, the high content of sulphur and ash in the fuel used for heating and improper combustion techniques, the shortage of green areas, the increase in the number of motor vehicles, inadequate disposal of wastes and meteorological factors (Özer et al, 1997).

Combustion of coal and various kinds of oil cause excessive air pollution in Istanbul, Ankara, Bursa, Erzurum and Trabzon. In the Marmara Region, after the introduction of natural gas for heating, the levels of pollution caused by heating was reduced in the cities in this region. However, it has been observed that air pollution is increasing in cities like Gaziantep, Erzurum, Bayburt, Trabzon, Niğde, Kütahya, Isparta and Çanakkale where there is no intense industrialization.

Although air pollution is a serious problem in Turkey, the number of studies on the effects of air pollution on health is rather limited. . In a study that investigated the relationship between air pollution and mortality, Şahin (2000) found a statistically significant correlation between the total suspended particulate matter and daily mortality in Istanbul. In a thesis study, Olgun (1996) concluded that in Istanbul there was an 8% increase in the mortality caused by respiratory system diseases in the children of 0-2 age group during the winters when air pollution is the highest. Another study by Olgun (1996) which again focused on the 0-2 age group investigated the 5-year SO₂ and total suspended particulate matter (PM) values and the admissions to hospitals due to respiratory system diseases. The study found that parallel to the increase in the air pollution, there was an increase in the bronchitis,

sinusitis, laryngitis and pneumonia cases and that there was an increase in the average length of stay in hospitals.

In a study, Keleş et al. (1999) investigated the prevalence of allergic rhinitis and atopy in two quarters of Istanbul, where in one air pollution was intense and where in the other low. They found that allergic rhinitis symptoms were significantly higher in the quarter where there was an intense air pollution.

Ünsal et al. (1999) investigated the admissions to the emergency service of the Eskişehir Public Hospital for symptoms of certain diseases, and they found that parallel to the increase in daily SO₂ levels, there was also an increase in the number of admissions due to lower respiratory tract infections, Chronic Obstructive Pulmonary Disease (COPD) and Cor Pulmonale (Ünsal et al., 1999). Another study carried out in Ankara investigated the relationship between the concentrations of particulate matter (PM), one of the air pollution parameters, and asthma. A correlation was found between emergency asthma admissions and SO₂ and PM concentrations (Evyapan, 2008).

Another study investigated the relationship between air pollution and admissions to hospitals for acute respiratory tract diseases between June 1994 and June 1995 in Istanbul. A positive relationship was found between the PM levels and admissions to hospitals (Dağlı et al., 1996). Similarly, a thesis study that was carried out in Izmit and that covered the years of 1996 and 1997 investigated the relationship between admissions to hospitals due to asthma and air pollution and meteorological parameters. The study found that there is a positive correlation between year-long weekly average smoke concentrations and admissions to hospitals due to asthma ($r=0,26$; $p=0,000001$). On the other hand, a weak correlation was found between the SO₂ levels and admissions to hospitals due to asthma in summer times ($r=0,22$; $p=0,002$) (Çelikoğlu, 1999). Another study that was carried out in Gaziantep investigated the life quality of asthma patients. The study found an increase in the asthma symptoms in times of intense air pollution (Fişekçi et al., 2000).

In addition, studies that investigated the relationships between air pollution parameters (SO₂ and PM) and such respiratory tract diseases as COPD and asthma were also carried out in such cities as Gaziantep, Denizli and Diyarbakır. The findings of these studies showed an increase in the admissions to emergency services of hospitals especially in times of intense air pollution.

In the framework of the study, the effects of air pollution on human health were investigated in the city of Trabzon that was chosen as the study area. The time interval of the study was determined to be between 2000-2009, and the possible effects of the air pollution on human health during this time interval were recorded and displayed.

This study aims to investigate the relationship between morbidity (number diseases reported /total population) of the diseases and the air pollution parameters (SO₂ and PM concentrations). To this end, the data for diseases caused by air pollutants and air pollution concentrations in the winter months in the city of Trabzon between 2000 and 2009, have been recorded and statistically analyzed.

2. Effects of air pollutants on health

Given the fact that an average person inhales about 13,000-16,000 litres of air daily and 400-500 million litres in his lifetime, then the importance of air quality for human health becomes clearer (Öztürk, 2005). The direct effects of air pollution on human health vary depending on the period of exposure to air pollution, intensity of air pollution, and the

general health condition of the population. Although the negative effects of air pollution can also be seen on healthy people, its effects create more serious problems in groups with higher vulnerability. Children and the elderly, those with respiratory tract diseases and cardiocascular diseases, those who are allergic, and those who do exercises are at more risk (URL 9). It has been reported in such studies that air pollution increases the risk of acute respiratory tract diseases in children and leads to an increase in cardiorespiratory morbidity and mortality (Bayram et al., 2006).

As a result of the negative effects of air pollution on health, the following have been observed:

- An increase in lung cancer cases
- An increase in the frequency of chronic asthma crisis
- An increase in the frequency of asthma cases
- An increase in the frequency of coughing/phlegm
- An increase in the acute disorders of upper respiratory system
- An increase in eye, nose and throat irritation cases
- Reduction in respiratory capacity
- An increase in mortality
- A reduction in productivity and production
- An increase in medical treatment expenses

The relationship between air pollution and lung cancer has also been addressed in several case-control. Studies focusing on morbidity endpoints of long-term exposure have been published as well (Cohen,2000, Katsouyanni et al.,1997). Notably, work from Southern California has shown that lung function growth in children is reduced in areas with high PM concentrations (Gauderman et al.,2000 and Guaderman et al.,2002) and that the lung function growth rate changes in step with relocation of children to areas with higher or lower PM concentrations that before (Avol, E.L. et al. 2001).Pollutants in the air cause health defects ranging from unnoticeable chemical and biological changes to trouble breathing and coughing. The ill effects of air pollution primarily attack the cardiovascular and respiratory systems. The severity of a person's reaction to pollution depends on a number of factors, including the composition of the pollution, degree and length of exposure and genetics(URL3).

Health effects of concern are asthma, bronchitis and similar lung diseases, and there is good evidence relating an increased risk of symptoms of these diseases with increasing concentration of sulphur dioxide (SO₂), ozone(O₃) and other pollutants. Moreover, there is increasing evidence to suggest that pollution from particulate matter (PM₁₀ and black smoke) at levels hitherto considered "safe" is associated with an increased risk of morbidity and mortality (disease and death) from heart disease as well as lung disease. This is likely especially in people with other risk factors (such as old age, or pre-existing heart and lung disease). These concerns are the subject of current research throughout the world(URL-1).

The 2005 *WHO Air quality guidelines* (AQGs) are designed to offer global guidance on reducing the health impacts of air pollution.According to WHO; Air pollution is a major environmental risk to health and is estimated to cause approximately 2 million premature deaths worldwide per year. The *WHO Air quality guidelines* represent the most widely agreed-upon and up-to-date assessment of health effects of air pollution, recommending targets for air quality at which the health risks are significantly reduced. By reducing particulate matter (PM₁₀) pollution from 70 to 20 micrograms per cubic metre can cut air quality-related deaths by around 15% and help countries reduce the global burden of disease from respiratory infections, heart disease, and lung cancer (URL2).

Sulphur dioxide (SO₂) and Particulate Matter (PM) are among the most important air pollutants that affect human health negatively. Sulphur dioxide (SO₂) reacts with the moisture content in the nose, nasal cavity and throat and, in this way, it destroys the nerves in the respiratory system and harms human health. (Öztürk, 2005). When the SO₂ concentration is higher than the World Health Organization (WHO) standards, it negatively affects especially those with asthma, bronchitis, cardiac and lung problems (Öztürk, 2005). The studies have shown that air pollution has an important role on the development and progression of lung cancer (URL 10). It was also found that air pollution increases the risk of acute respiratory tract diseases especially in children and that it causes an increase in cardiorespiratory morbidity and mortality (Bayram et al., 2006). The aim of the "Regulations for the Protection of Air Quality" dated 2 November 1986 (published in the official gazette no 19269) is to take under control the soot, smoke, dust, gas, steam and aerosol emissions created by any kind of human activity; to protect human beings and their environment from the dangers caused by air pollution; to prevent and eradicate the negative effects that occur in the environment and that harm the community and neighborhood relations, and itemize the mandatory short- and long-term limit values for various air pollutants (Table1). (Öztürk, 2005). The negative effects of particulate matter on human health increase as the size of the matter gets smaller. Due to the fact that those who do sports especially in areas with high PM concentrations take deeper breaths and more frequently during the activity than those who do not do sports, such matters reaches the lungs more easily and accumulate there (Öztürk, 2005).

SO ₂ (ppm)	Duration of Exposure	Effects
0,037-0,092	Annual Average	With 185 µg m ⁻³ smoke concentration, increase in respiratory track diseases and lung diseases
0,007	Annual Average	With high particulate matter concentration, progression in the respiratory track diseases in children
0,11-0,19	24 hours	In low particle concentration, increase in the respiratory track diseases in the elderly .
0,19	24 hours	Progression in chronic respiratory track diseases in the grown-ups
0,19	24 hours	In low particle concentrations, an increase can be observed in mortality
0,25	24 hours	With 750 µg m ⁻³ smoke concentration, an increase in daily mortality rates may be observed (UK). Sudden increase in morbidity.
0,5	10 minutes	In asthma patients, increase in breathing resistance during exercise (mobility)
5	24 hours	In healthy people, increase in breathing resistance
10	10 minutes	Bronchospasm
20		Eye irritation, coughing

Table 1. Effects of sulphur dioxide (SO₂) on human health (Öztürk, 2005)

SO₂ can affect the respiratory system and the functions of the lungs, and causes irritation of the eyes. Inflammation of the respiratory tract causes coughing, mucus secretion, aggravation of asthma and chronic bronchitis and makes people more prone to infections of the respiratory tract. Hospital admissions for cardiac disease and mortality increase on days with higher SO₂ levels. When SO₂ combines with water, it forms sulfuric acid; this is the main component of acid rain which is a cause of deforestation.

Particulate air pollution is a mixture of solid, liquid or solid and liquid particles suspended in the air. These suspended particles vary in size, composition and origin. It is convenient to classify particles by their aerodynamic properties because: (a) these properties govern the transport and removal of particles from the air; (b) they also govern their deposition within the respiratory system and (c) they are associated with the chemical composition and sources of particles. These properties are conveniently summarized by the aerodynamic diameter, that is the size of a unitEUR/density sphere with the same aerodynamic characteristics. Particles are sampled and described on the basis of their aerodynamic diameter, usually called simply the particle size (URL 11).

The effects of PM on health occur at levels of exposure currently being experienced by most urban and rural populations in both developed and developing countries. Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer. In developing countries, exposure to pollutants from indoor combustion of solid fuels on open fires or traditional stoves increases the risk of acute lower respiratory infections and associated mortality among young children; indoor air pollution from solid fuel use is also a major risk factor for chronic obstructive pulmonary disease and lung cancer among adults. The mortality in cities with high levels of pollution exceeds the mortality observed in relatively cleaner cities by 15–20%. Even in the EU, average life expectancy is 8.6 months lower due to exposure to PM_{2.5} produced by human activities. Specifically, the database on long-term effects of PM on mortality has been expanded by three new cohort studies, an extension of the American Cancer Society (ACS) cohort study, and a thorough re-analysis of the original Six Cities and ACS cohort study papers by the Health Effects Institute (HEI) (URL 11).

In view of the extensive scrutiny that was applied in the HEI reanalysis to the Harvard Six Cities Study and the ACS study, it is reasonable to attach most weight to these two. The HEI re-analysis has largely corroborated the findings of the original two US cohort studies, which both showed an increase in mortality with an increase in fine PM and sulfate. The increase in mortality was mostly related to increased cardiovascular mortality. A major concern remaining was that spatial clustering of air pollution and health data in the ACS study made it difficult to disentangle air pollution effects from those of spatial auto-correlation of health data per se. The extension of the ACS study found for all causes, cardiopulmonary and lung cancer deaths statistically significant increases of relative risks for PM_{2.5}. TSP and coarse particles (PM₁₅ - PM_{2.5}) were not significantly associated with mortality (13). The effect estimates remained largely unchanged even after taking spatial auto-correlation into account (URL 11). Particulate matters can proceed up to the alveoli in the lungs and therefore causes such important problems as asthma and bronchitis (Sloss and Smith,2000).

3. Study area

The City of Trabzon is situated in northeast of Turkey (Figure1), lies on the north sides of the Eastern Black Sea Mountains, between longitudes 38° 30' - 40° 30' E and latitudes 40° 30'

- 41° 30' N (URL 5). The area of Trabzon is about 4.664 km² and total population of the city is about 293.000. The population density is about 5.000 people per km². Trabzon has a typical Black Sea climate, with rainfall throughout the year. Sea climate, with a lot of rainfall throughout the year. Summers are cool and winters are mild and damp. Towards the south, the climate becomes colder. Trabzon has a thick vegetation and receives ample rain [URL 7]. Though, in general, Trabzon has a rainy climate, and rain reaches its peak between September-late June. The average annual rainfall is 800-850 kg/m², and about 152 days of the year are rainy. Starting from the sea level, the elevation reaches up to 3000 m in the south. The annual average temperature in Trabzon is 14.57 °C [URL 5], and the dominant wind directions are south-southwest in December, southwest in April, south in June, and west-north in the other months. April and especially May are rather foggy, and relative humidity reaches its peaks in May (79%) and June (76%), respectively. The humidity starts to decrease in summer months and reaches 67% in December, which is the minimum level. Sometimes, the humidity reaches 99% (URL-6).

As a result of fast urbanization, there has been quite a dense housing in the city. Residential areas are concentrated on the coastal areas of the city especially in the west of the city (Figure 1). In recent years, the number of high-rise buildings is increasing day by day in the valleys stretching towards the south of the city.

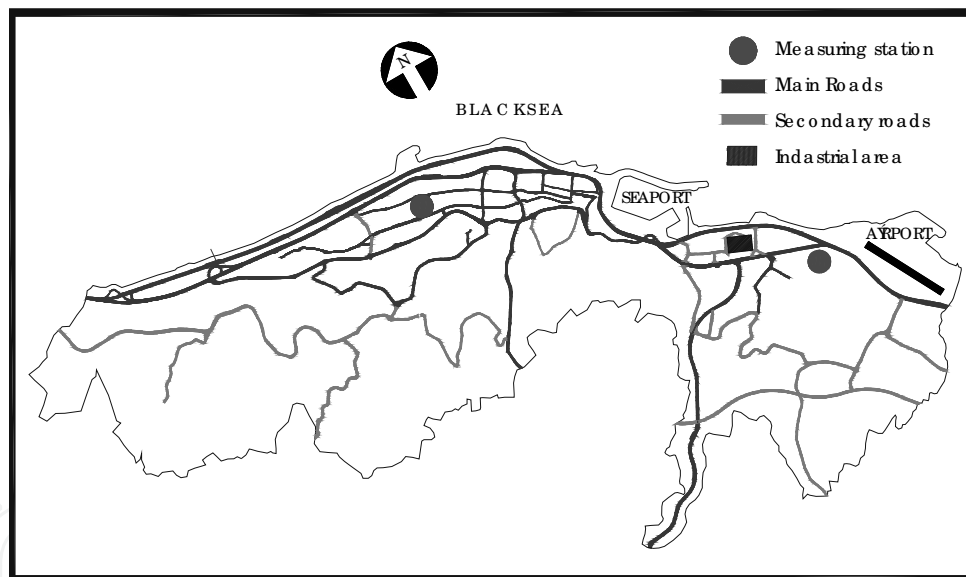


Fig. 1. Trabzon city map.

4. Air pollution in trabzon

Air pollution is an important problem during the winters in Trabzon. The level of SO₂ and PM increases during the winter especially between November and April in Trabzon as it does in the other cities in Turkey. There is a dense air pollution in the residential areas along the coast line in the west of the city. These parts of the city are characterized with high buildings. This prevents the removal of the pollution by the dominant winds in the city (URL 7). Because the pollution is not transported out of the city by the air, a cloud of pollutant particles can easily be seen in winter months (Figure 2).

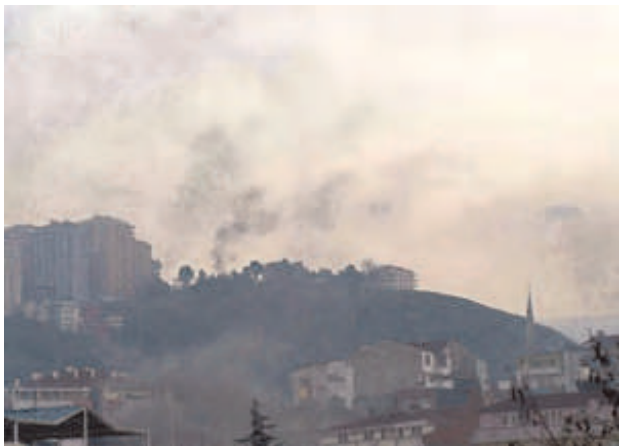




Fig. 2. Air Pollution in Trabzon in Winter Period

According to the data obtained from the Trabzon Local Directorate of Environment and Forest, Trabzon is among the second-level polluted cities in Turkey in terms of air pollution. The geographical and topographical structure of the city, irregular urbanization, and the inadequacy of green areas in the city center are said to be the main causes of air pollution. In addition, the dense housing in the natural air corridors (the valleys) of the city, which would remove air pollution, prevents air circulation especially in winter times, and between 9:00 a.m. and 11:00 a.m., 3:00 p.m. and 6:00 p.m., and 6:00 p.m. and 9:00 p.m. air pollution reaches levels that threatens human health. In addition to dust and gas emissions caused by the burning of solid fuels used for heating purposes, the exhaust gases emitted from motor vehicles at certain times (closing times of schools and shops) increase air pollution.

As in other cities with fast urbanization, many factors such as population growth, irregular and intense urbanization, increase in the number of buildings in the valleys that can be considered as the air corridors of the city, and increase in the number of motor vehicles cause air pollution in Trabzon. The intense air pollution in the city especially between November and April is caused by fuels used for heating purposes in the houses. A study by Uzunalı showed that the main factor that causes air pollution is PM and that this was the result of the use of coal for heating purposes in the residences. When we investigate the annual amounts of coal (Kg) used for the purpose of heating in the city, we see that there is a gradual increase in the amount of the consumption of this type of fuel (Figure 3).

Natural gas is not yet used in the city for heating purposes. However, the necessary infrastructure works for this have been in progress. The active use of natural gas in the future will decrease the PM pollution. In their study, Akkoyunlu and Ertürk (Akkoyunlu and Ertürk,2002) investigated the effect of the increased share of natural gas in residential areas on air pollution levels. The pollution map indicated that the increased use of natural gas in residential areas significantly improved the air quality.

In addition to the aforementioned factors, the light industrial complexes that may contribute to the air pollution in the city are located in the east of the city. Air pollution in this part of the city where there is a cement plant is high but is lower than the pollution in the west. For there is no residential settlement in this area.

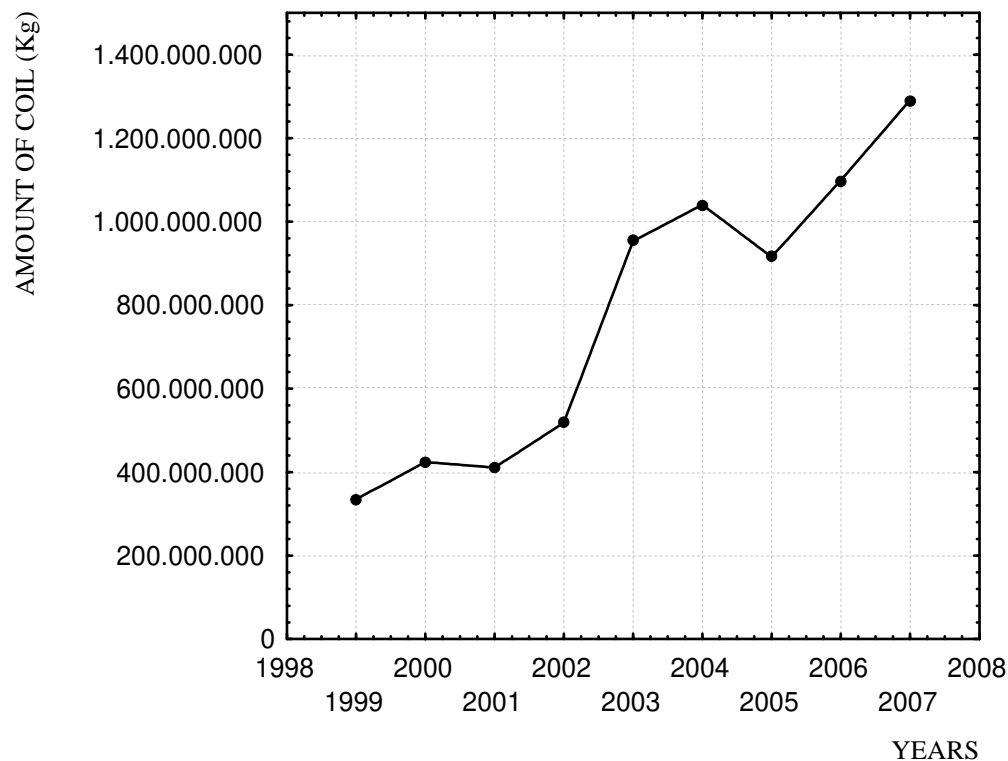


Fig. 3. Annual amounts of coal consumed for the purpose of heating in Trabzon

5. Evaluation of the data(results and discussion)

The air pollution measurements were carried out by the Local Directorate of Environment and Forest in Trabzon for the past 9 years (2000-2009) in the winter months (November-April). Continuous daily observations of SO₂ and PM have

been measured in the city at 2 stationary stations at different places in the city as shown in Figure 1. The monthly average APCs were taken into consideration in this study and are presented in Table 2. Data related to the kinds of diseases in statistic documents have been provided by the Medical Board of Trabzon. Figures 4 and 5 show that, in winter seasons until 2009, the limit of Turkish Air Quality Control Regulation (AQCR) was exceeded significantly both for SO₂ and PM. But the limits in AQCR are less stringent than the standards recommended by the World Health Organization (Table 3). When compared to the WHO standards, the PM values increased especially in December, January, February and March, after 2003. The limits of air pollutant concentrations recommended by the Turkish Standards and WHO Guidelines are plotted as horizontal lines (URL8).

An evaluation of the air pollution data covering the 2000-2009 period showed that the SO₂ and PM concentrations were higher in winter times than in the summer times (Figure 6). In this context, various studies carried out in different years on the air pollution in Trabzon and this study are important in that they show the variations in air pollutants by years. The aforementioned studies (Çuhadaroğlu, 1994-1995; Topbaş et al., 1994-2000) and the present study have shown that the SO₂ and PM values are increasing especially in the winter times. The main reason for this is the use of low quality coal for heating purposes mainly in the residential areas.

Years	APCs	November	December	January	February	March	April
2000-2001	SO2	67	53	63	57	60	41
	PM	38	58	64	58	63	45
2001-2002	SO2	44	63	85	86	72	71
	PM	46	74	93	107	72	71
2002-2003	SO2	79	80	73	59	66	72
	PM	87	90	92	69	74	81
2003-2004	SO2	71	86	109	77	72	67
	PM	90	133	101	73	84	81
2004-2005	SO2	81	98	95	82	88	49
	PM	89	111	79	110	107	58
2005-2006	SO2	79	80	92	64	56	9
	PM	96	127	132	208	119	81
2006-2007	SO2	56	88	100	30	30	19
	PM	77	128	122	100	67	54
2007-2008	SO2	6	8	7	9	4	4
	PM	51	89	80	67	64	58
2008-2009	SO2	20	44	46	26	26	17
	PM	40	94	110	79	66	60

Table 2. The monthly average APCs data in Trabzon.

	Turkish Standards		WHO Standards	
	LTS	STS	Long Term	Short Term
SO2 $\mu\text{g}/\text{m}^3$	150	400	50	125
PM $\mu\text{g}/\text{m}^3$	150	300	50	120

LTS: long-term standarts STS: short-term standarts (maximum daily average)

Table 3. Air quality limits in Turkey and comparison to WHO Standards

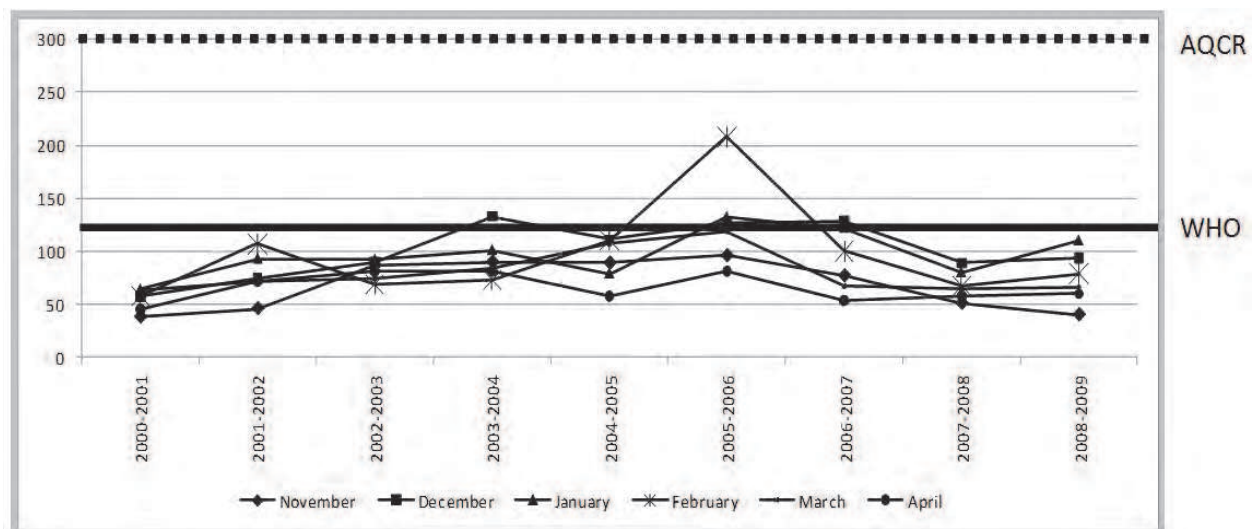


Fig. 4. Measured and calculated monthly mean PM concentrations in winter seasons from 2000 to 2009

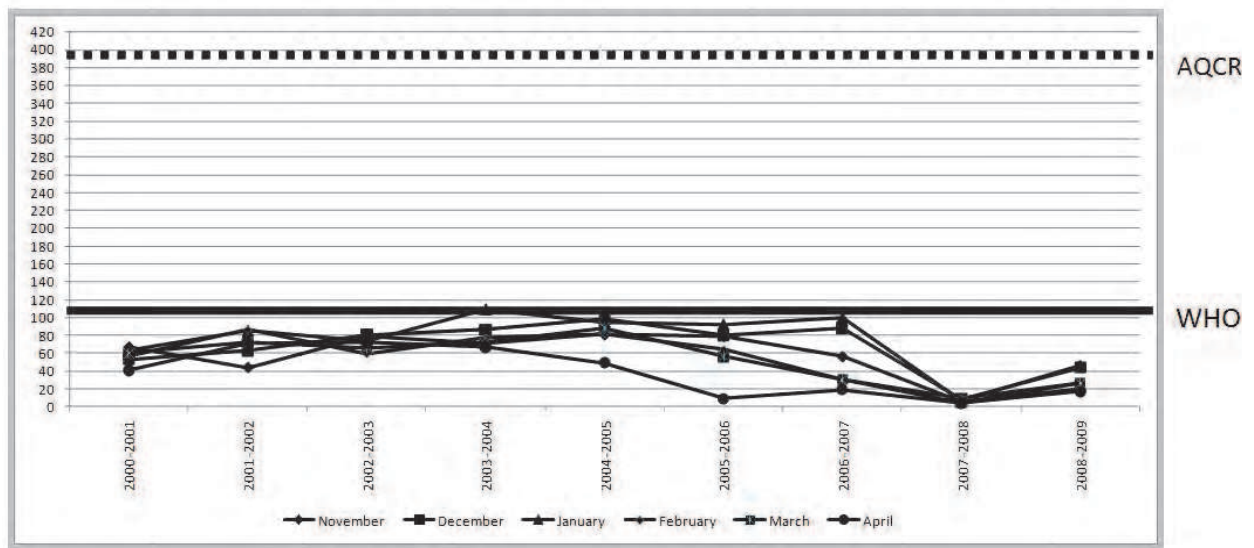


Fig. 5. Measured and calculated monthly mean SO₂ concentrations in winter seasons from 2000 to 2009.

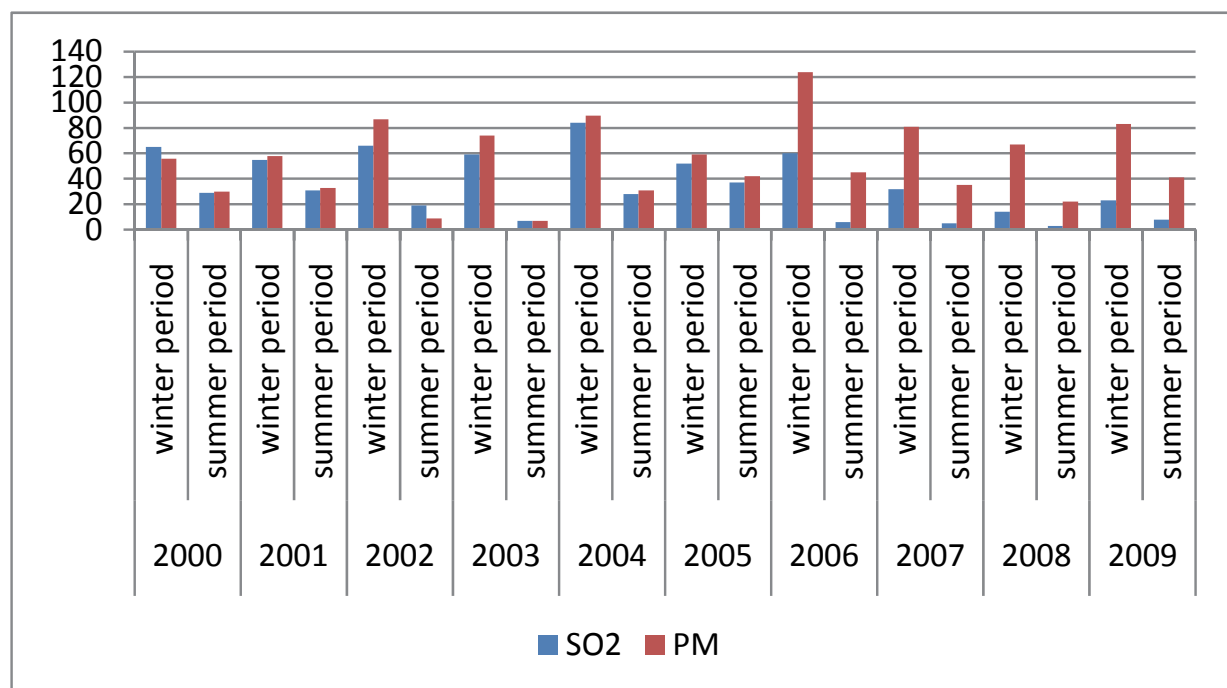


Fig. 6. Distribution in air pollutants in Trabzon in the winter and summer times between 2000 and 2009.

It was found that air pollution in Trabzon has also a serious effect on human health and that there is an increase in the number of air pollution-related diseases. As seen in Figure 7, there is an increase in acute upper respiratory tract infection (URTI), acute tonsillitis, acute bronchitis, and acute pharyngitis in winter times. This increase is a clear indication of the relationship between the air pollutants and respiratory tract infections.

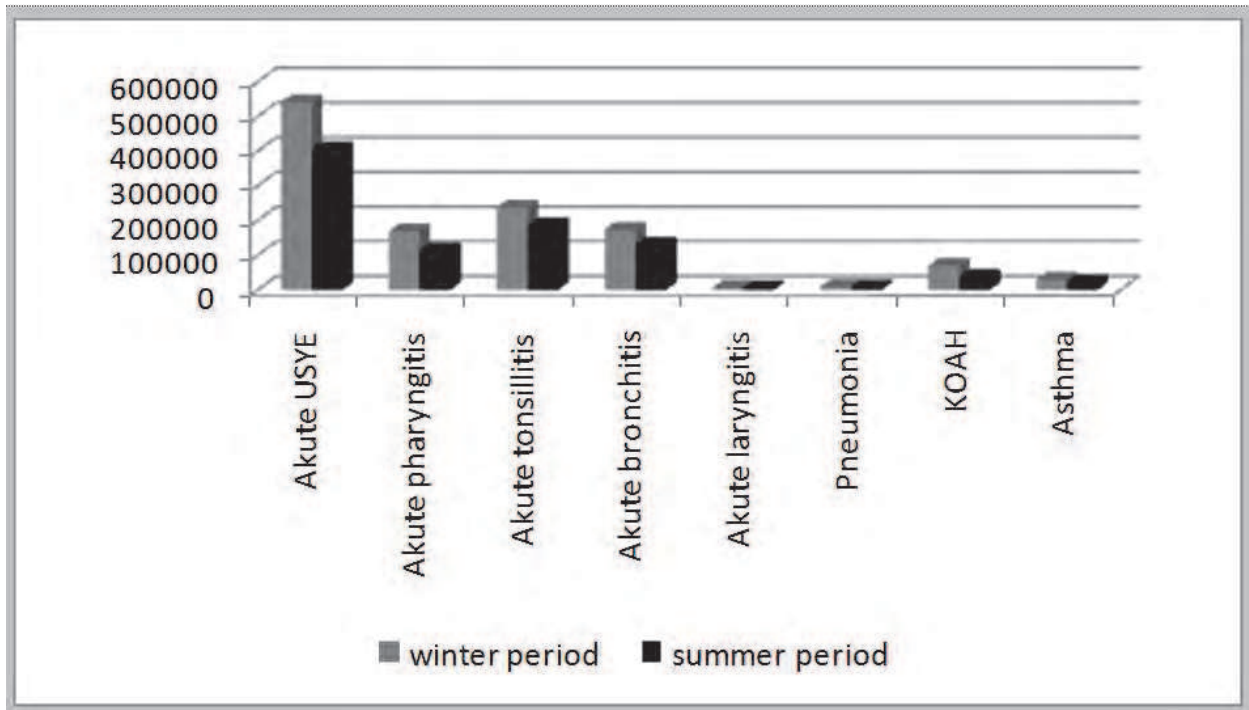


Fig. 7. Distribution in respiratory tract infections in winter and summer times(KOAH:Disease of chronic obstructive lung).

In addition, as seen in Figures 8 and Figure 9, if we examine the distribution of diseases in winter and summer times by years, we see that there is an increase in the number of diseases in the years when the SO₂ and PM values are high (2002-2003, 2004-2005, 2007-2008)).

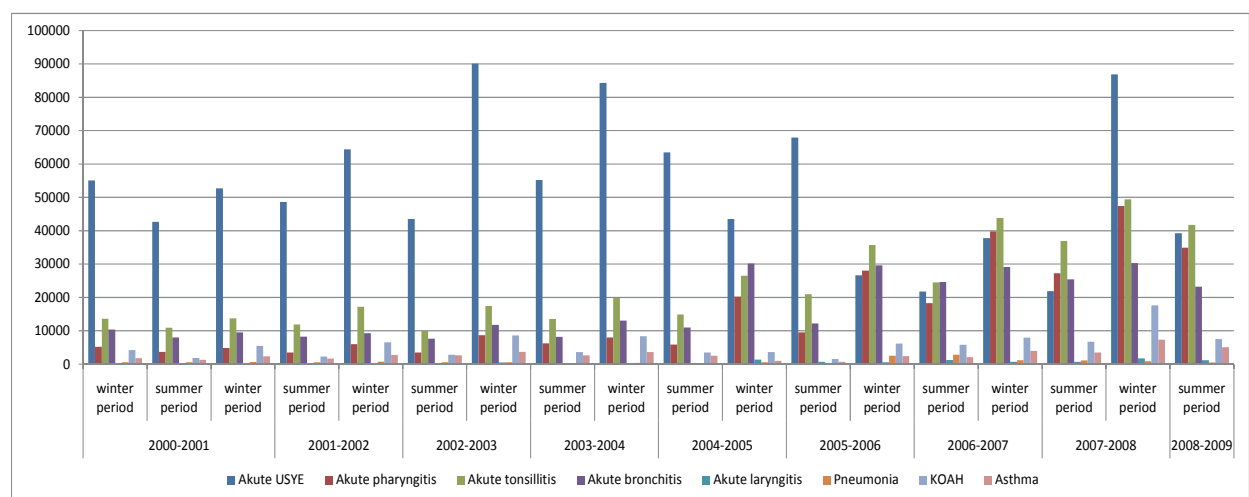


Fig. 8. Distribution in the respiratory tract infections in the 2000-2009 period(KOAH:Disease of chronic obstructive lung).

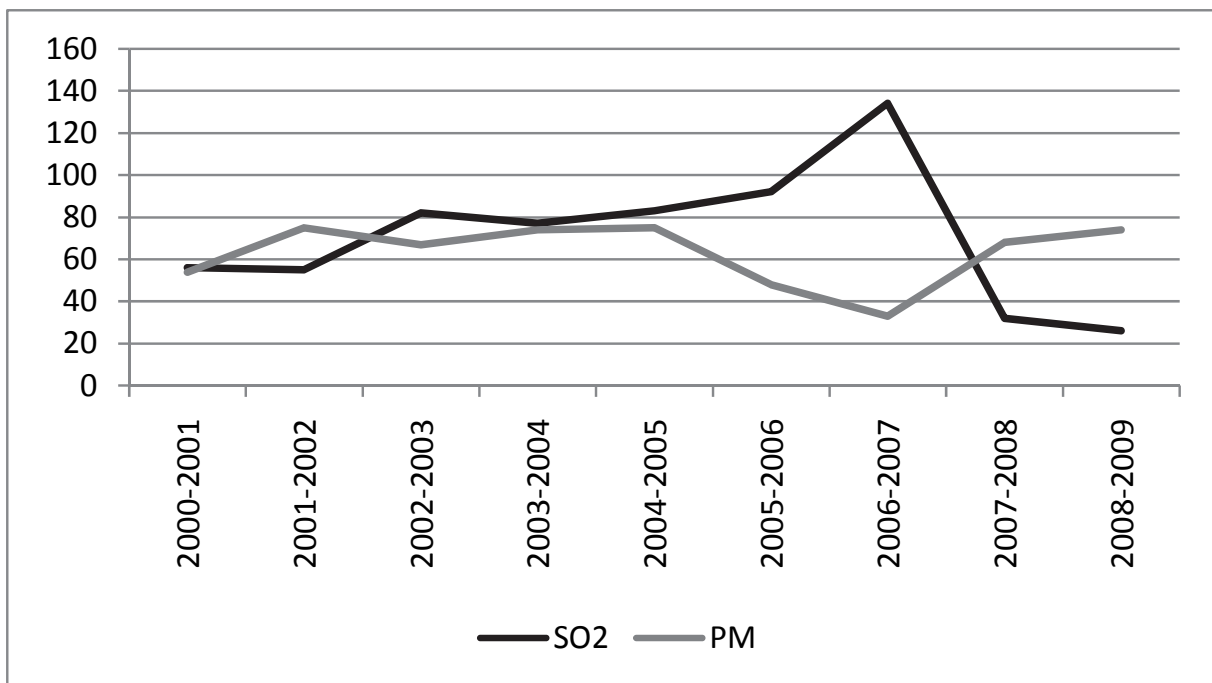


Fig. 9. Distribution in SO₂ and PM values in the 2000-2009 period.

The increase in morbidity that stands out in Figure 10 can be associated with the higher uses of fuels in the years when there was an increase and with the consequent increase in the values of air pollutants (SO₂ and PM).

The increase in the morbidity values of Acute URTI, acute tonsillitis, acute bronchitis, and acute pharyngitis (Figure 11) can be associated with the increasing air pollution in the same years.

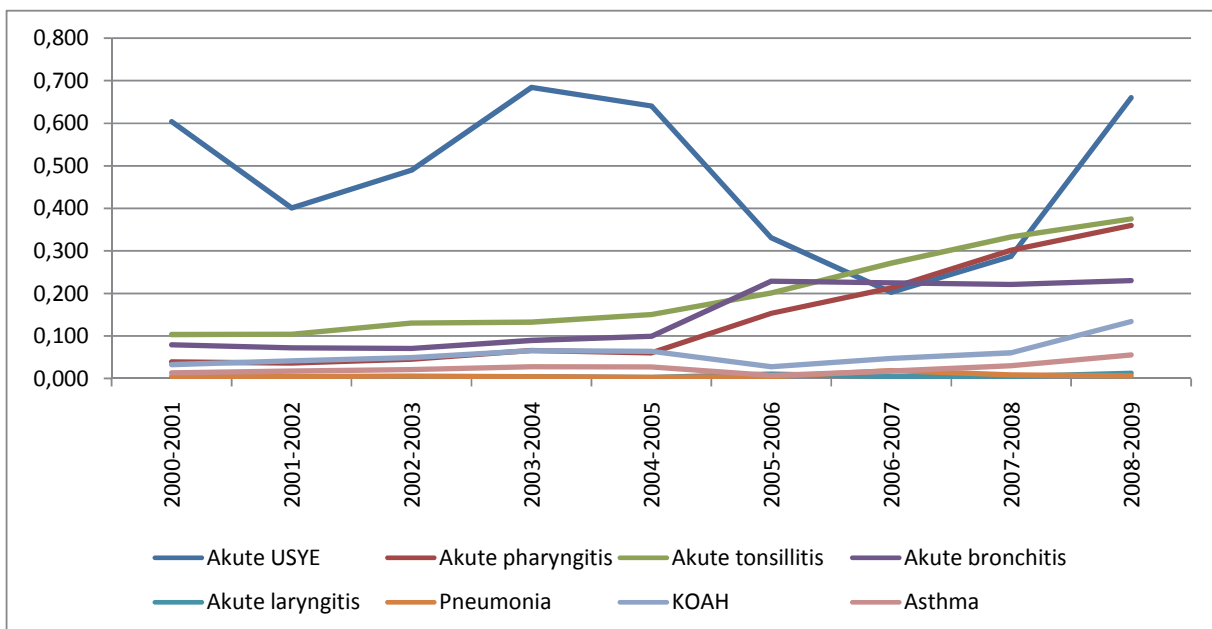


Fig. 10. Distribution in the morbidity values of respiratory tract infections between 2000 and 2009 (KOAHDisease of chronic obstructive lung).

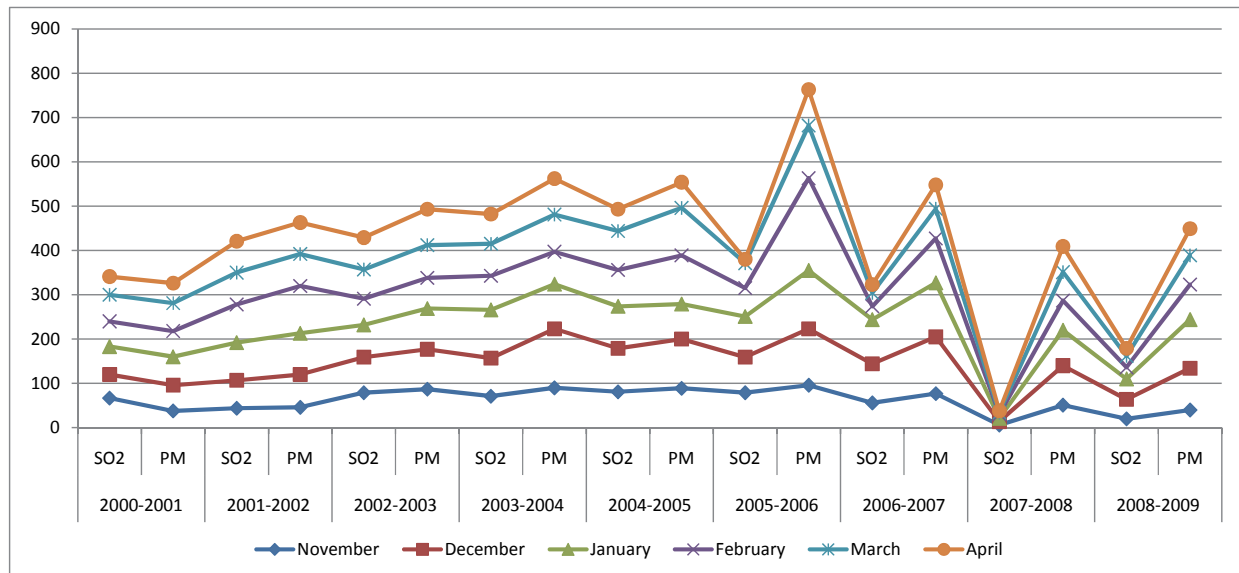


Fig. 11. Distribution in SO₂ and PM values in the winter months between 2000 and 2009.

6. Conclusions

As known, in general, respiratory tract diseases increase with an increase in APCs. According to the results of 9 years obtained from data analysis, as the APCs (SO₂ and PM) increase, so does the morbidity and number of respiratory tract diseases.

The results of this study show that there is a relationship between APCs and respiratory tract diseases. Furthermore, in a study carried out by Topbaş et al. (2004) between 1994-2000, it was found that the SO₂ levels in Trabzon increased especially in the winter months. The other two studies carried out in Trabzon at different times and this study can be considered to be complementary, and are important due to the fact that they show the variations in air pollutants in Trabzon. The aforementioned studies and our study show that the SO₂ and PM values increase especially in winter months. Because of the use of low quality coal for the heating of residences, Trabzon has a high level of air pollution in winter months. and APCs in the problem of air pollution can be solved with a multidisciplinary approach. The use of natural gas for the heating, and a reduction in coal particles, should be encouraged by the Official Institutions in Trabzon. For a short-term solution, high quality coal and fuel oil can be used for heating of residences and for energy. In addition, the direction of wind throughout the winter months should be taken into consideration in the urban structure plan. To improve the wind circulation in the city, buildings, streets and heights of buildings should be thoroughly planned, and designed by taking into consideration the direction of the prevailing winds. In this way air pollution can be reduced.

According to the findings of this study, there are relationships between the respiratory tract infections and SO₂ and PM concentrations in Trabzon. Therefore, because those who do exercises take deep breaths and more frequently, sports activities should not be done in the city especially in the streets, roads and squares where pollution is dense. In this way, more pollutant intake into the body can be prevented. Furthermore, the values regarding the pollutants in the "Air Quality Control Regulation" must be reevaluated and must be gradually aligned with the EU standards. Air pollution has a serious effect especially on the health of the elderly with respiratory problems and children. To this end, the public must

continuously be informed of air pollution values. For everyone living in a city has the right to know about the quality of the air that they breathe.

The increases in the diseases associated with the air quality requires more detailed studies on the air quality of the city. If such studies are planned by being based on the already efficient health statistics, they will make significant contributions to the solution of the problem. In this context, it is important from country level in general to city level in particular to adopt sustainable approaches by taking into consideration the total environmental quality.

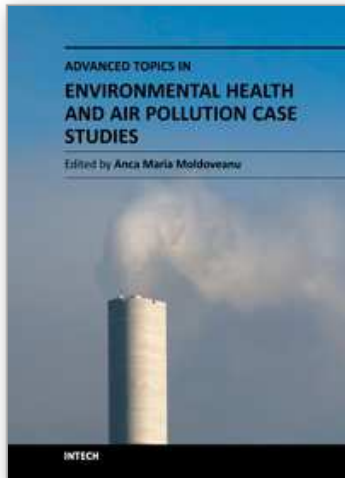
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The book describes the effects of air pollutants, from the indoor and outdoor spaces, on the human physiology. Air pollutants can influence inflammation biomarkers, can influence the pathogenesis of chronic cough, can influence reactive oxygen species (ROS) and can induce autonomic nervous system interactions that modulate cardiac oxidative stress and cardiac electrophysiological changes, can participate in the onset and exacerbation of upper respiratory and cardio-vascular diseases, can lead to the exacerbation of asthma and allergic diseases. The book also presents how the urban environment can influence and modify the impact of various pollutants on human health.

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51000 Rijeka, Croatia
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Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
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