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Thesis

Title: Particulate suspended matter (PM10) and cases of respiratory diseases in Shenyang China

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UMD 7

Summary

Shenyang is one of biggest cities in china with strong economy and convenient transport networks. The economy of this city mainly relies on manufacturing and heavy industries, so during the rapidly development, air pollution become one of the problems of this city. Local government have already done several actions to change the air quality of city. But due to people long term exposure to air pollutants, the health impacts cannot be ignored in this city.

There are many types of air pollutants and many kinds of airborne diseases, this thesis selected suspended particulate matter-- PM10 as an example of air pollutants and chose respiratory disease as an example of airborne disease.

The objective of this research is to investigate the existence of a possible relationship between suspended particulate matter levels and cases of respiratory diseases from a systematic sample of medical and air pollution records in the metropolitan area of Shenyang. There are three research questions: (i) what is the level of PM 10 in the study area and how it varies with the change of winter and summer seasons? (ii) How the number of respiratory diseases varies with the increased of air pollution (PM 10) and the change of winter and summer seasons? (iii) What is perception of local people regard to increase of air pollution and the increased number of respiratory diseases.

The research type in this study is an exploratory research. The research strategy applies was survey and archival analysis. This research collected data from guanbei community which is located next to two heating provision factories and Renji hospital, meanwhile in this research area also has Huanggu Monitoring Station which takes the responsibility to measure the concentration of air pollutants. A purposive sampling technique was used to choose key persons/experts and citizens. Sixty (60) questionnaires and ten (10) interviews were applied. Records of emergency cases of the year 2010(months of January February, June, July, August and December) were collected at Renji hospital and suspended particulate matter--PM10 of the 2010 (months of January February, June, July, August and December)at monitoring station.

The most important finding are : (i) In generally, PM10 concentration (24hours) of six month(January, February, June, July, August and December) in research area is higher than municipal guidelines (150ug/m^{-3} 24hours), and it varies with the change of seasons. Level of PM10 in wintertime is noticeable higher than in summertime. (ii) The number of respiratory cases varies with the increases of air pollution (PM10) and the changes between winter and summer time. The data collected from Renji hospital revealed that cases of respiratory disease appeared more frequently during the winter than summertime with winter having higher concentration of PM10. The data collected from 2005 to 2010 also shows that the increased number of respiratory cases varies with increases in PM10 concentration (iii) Most citizens

(58%) realised the possibility of a relationship between increases in air pollution and the increased number of respiratory cases. Research has shown that citizens also tend to think that long term diseases such as chronic obstructive pulmonary disease (COPD) and Pulmonary edema are the most common illnesses related to air quality.

We can finalize that there is a possible relationship between the increasing of air pollution and the increasing number of respiratory cases.

Key words: Particulate suspended matters; respiratory diseases; air pollution; Shenyang

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Abbreviations

PM10	**: Particulate Matter (<10 um)**
ED	**: emergency department**
COPD	**: chronic obstructive pulmonary disease**
Co_x	**: carbon monoxide**
So_x	**: sulfur dioxide**
NO_x	**: nitrogen dioxide**
O3	**: ozone**
AQGs	**:Air Quality Guidelines**
HMS	**:Huanggu Monitoring Station**
AAQS	**:Ambient Air Quality Standards**

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Chapter 1 Introduction

1.1background of the problem

Clean air is considered to be a basic requirement of human health and well-being. However, air pollution continues to be a significant threat to health around the world. Industrial activities, motor vehicles and even burn coal at home contribute a lot to air pollution. For more than two centuries, severe air pollution incidents in mega cities, such as London, have shown that breathing dirty air can be dangerous and, at times, deadly. But concern about the health effects of air pollution did not effectively coalesce until the late 1940s and early 1950s, when air pollution disasters on two countries --"killer fog" in the small town of Denora, Pennsylvania American and London "fog", which raised an alarm. Although, nowadays, an increasing number of regions and nations pay more attention to improve the quality of air, the bad consequences of air pollution still cannot be ignored.

The polluted air contains many kinds of toxic chemicals ,such as sulfur dioxide, particulate matter, ground-level ozone, nitrogen dioxide, carbon monoxide, these air pollutants have been proved that can cause airborne diseases, such as, asthma, respiratory illness, cardiovascular disease, lung cancer, which can increase the opportunity of death in vulnerable groups. WHO pointed out that air pollution is sixth-leading cause of death, causing over 2.4million premature deaths worldwide (WHO, 2002) . Due to huge amount of health cost and seriously consequences of air pollution, in 2002, WHO made the new Air Quality Guideline(AQG) for the concentration of air pollutants :PM10 </=20 μg/m^{-3};NO2 </=40 μg/m^{-3};SO2 </=20 μg/m^{-3} (Annual) , which can give guidelines for countries or cities to produce air pollutants within certain amount ,therefore can help these countries to minimize health risks for their citizens.

In some industrialized countries have lowered the levels of these pollutants in many cities, which due to they have adopted Ambient Air Quality Standards (AAQS) to safeguard the public against the most common and damaging pollutants, and even invested large amount of money in pollution control, but poor air quality is still a major concern throughout the industrialized world. Meanwhile, urban air pollution has worsened in most large cities in the developing world. This situation driven by population growth, industrialization, and increased vehicle use. Despite pollution control effects, air quality has approached the dangerous levels. Worldwide, WHO estimates that as many as 1.4 billion urban residents breathe air exceeding the WHO air guideline.

The health consequences of exposure to dirty air are considerable. On a global basis, estimates the rate of mortality due to air pollution represents about 0.4 to 1.1 percent of total annual deaths (Health Effects Institute (HEI), 2007) .The health impacts of urban air pollution seem likely to be greater in some of rapidly developing countries, like China, Indian, where pollution levels are higher. The World Bank has estimated that in urban areas of the developing world, roughly 2 to 5 percent of all deaths due to air borne disease.

Among these developing countries, China in particular at high risks in terms of airborne disease, which because of its rapid push to industrialize, large amount fossil fuel and coal combustion, an rapidly increasing number of motor mobiles. Furthermore, China has also experienced increasingly severe dust storms, which are commonly believed to be caused by over-farming, over-grazing, and increasing use of irrigation. Plumes of dust from northern China, mixed with toxic air pollution, now are a major public health concern in China (David, 2009,p2). Therefore, Ghina is experiencing dramatic levels of aerosol pollution over a large portion of the country and outdoor air quality in Chinese cities is among the worst in the world, in some of China's major cities, particulate levels are as much as six times the WHO guidelines .This low air quality situation has become a widespread health hazard to the population of Chinese cities and people's lives are at risk from various kinds of airborne diseases.

According to the tenth five-year plan (2001–05) report, China's emissions of SO2 and soot were respectively 42 percent and 11 percent higher than the target set at the beginning of the plan. In, 2007 "China Human Development Report" pointed that in 2005, China had 60 million people premature died which due to air pollution and 550 million people suffered from chronic bronchitis, 2,000 people suffered from respiratory disease (Xuetao bai, yaojin cao, 2008). Meanwhile, World bank estimated that every year in China about 178,000 deaths which caused by air pollution.

1.2 Problem of statement

One of biggest Chinese cities—Shenyang, also faces air pollution problem. High energy consumption fuelled, by economic growth mainly relies on industry and has caused a remarkable increase in the amount of auto-vehicles. These activities have became the primary contributors to the city's declining air quality.

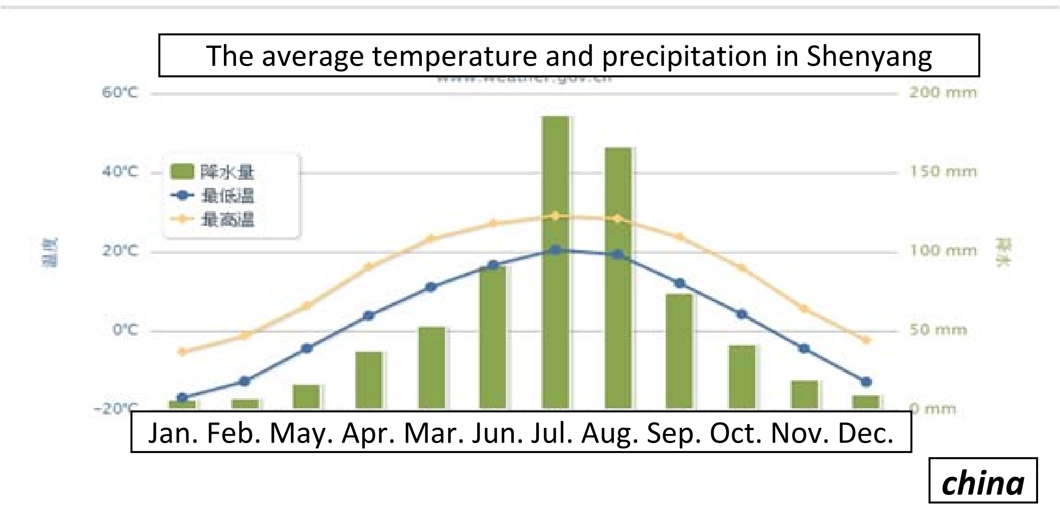
The city of Shenyang, located in north-eastern part of china, is a sub-provincial city, and capital of Liaoning province, Figure 1.1. This city is in the central part of Liaoning Province. The location of Shenyang is in latitude from 41° 11' to 43° 2' N and in longitude from 122° 25' to 123° 48' E, The western parts of the city's administrative area are located on the alluvial plain of the Liao River, while eastern part consists of the hinterlands of the Changbai Mountains which is covered by forests. The highest point in Shenyang is 414metres (1,358ft) and the lowest point only 7metres (23ft). The main urban area is located to the north of Hun River. The urban areas of this city has 5 districts, and suburban area of city has 5 districts as well as 4counties.

This city has distinctive four seasons: spring, summer, fall, winter. The characters of Shenyang's climate is summer is hot and humid whereas winter is cold and dry. The cold period (winter) comprises the months of January, February, December and the temperatures varires from 0 Centigrade to Centigrade. The summer time is from June to August and the temperatures varies from 17Centigrade to 30Centigrade, Figure 1.2.

Figure1.1 Shenyang Geography

sources: http://en.wikipedia.org/wiki/Shenyang

Figure1.2 monthly average temperature Centigrade and average amount of precipitation (mm), 2010, Shenyang



http://tieba.baidu.com/f?kz=797950920

This city is one of biggest city in china which is about 12,980km² and the population (2008) is about 7,200,000. The urban area of this city is 3,495km² and the population is about 5, 090, 000, the density is 1,555.1/sq mi.

As a mega city, Shenyang not only enjoys nation-wide fame as the equipment manufacturing centre of China , but is also famous for the production of heavy-duty mining equipment, heavy motors, and petrochemical engineering worldwide. The scale of the city's equipment manufacturing sector is massive and ranks number one in China.

In addition, Shenyang is the transportation hinge of Northeast China with smooth networks and developed transportation. The total freight of the city is more than 150 million tons and total passenger transport reaches about 100 million people each year. Shenyang's aviation can reach more than 70 cities in China and 11 international cities.

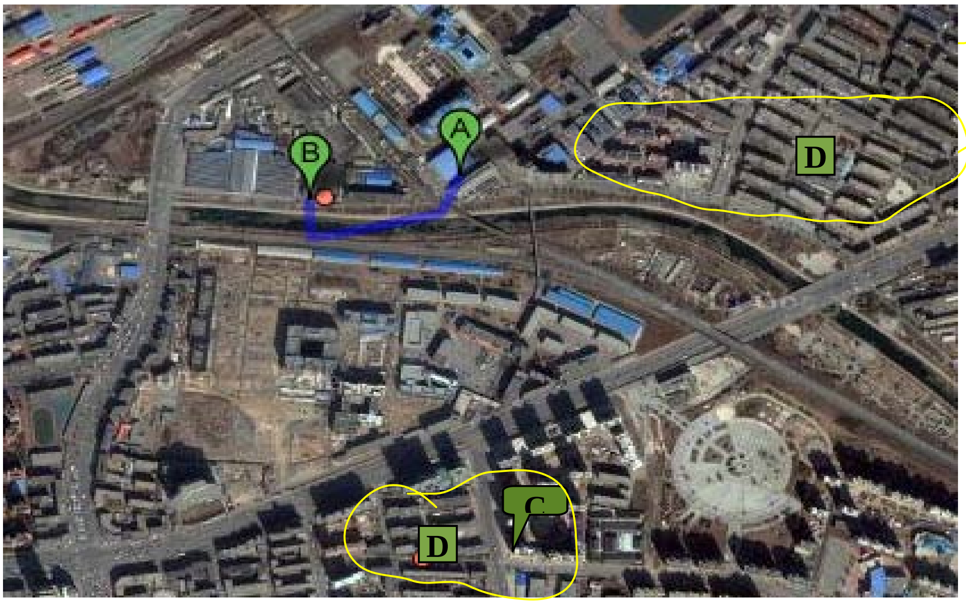
Due to Shenyang is a big city, I will only choose the on community to do my research. This community is called Guanbei Street Community which belongs to Huanggu district. This community has about 30,000 neighbourhoods, most of them work in Tianxu Heating Provision factories as well as in "Gear Factory " Heating Provision factories.

Between the two Heating Provision factories and community, there is Renjing hospital which is mainly built for Guanbei Street Community, Figure 1.3. Furthermore, there is also a

Huanggu Monitoring Station which mainly provides the air quality data for this area, Figure 1.4.

There are several reasons i chose this community as research area. Firstly, this area pollution is very seriously, especially in winters, which due to these two Heating Provison Companies have to use coal to provide heating service for the whole district. In addition, most of inhabitants are workers of these two companies which means they have to work in bad air quality with simple protective measure for the 8hours per day. Last but not least, most of workers are low education level people who do not have awareness of protection themselves in bad working condition.

Figure 1.3 The location of Tianxu Heating Plant , "Gear Factory" Heating Plant, Renji Hospital and Guanbei Street Community



A:

Renji Hospital

B:

Tianxu Heating

provision factory.

C:

"Gear Factory ' Heating Provision factory

D:Guanbei street

community

Source: google map

Fig. 1.4 The location of the monitoring station in Huanggu District

A :

the monitoring station

B :

Renji Hospital

Source: google map

1.3 Justification of Study

The study seeks to find the possible relationship between PM10 and respiratory disease using the PM 10 as the indicator. This study might arise the awareness of public about consequences of bad air quality and help citizens to recognize what kind of diseases are airborne disease. Meanwhile, the study might encourage the municipality to implement several political measures to improve the bad air quality situation put pressures on factories to reduce their emissions. Moreover, this research may arouse conscience of private companies to make efforts on improving their own techniques in order to improving air quality.

1.4 Research objective and research questions

The study seeks to find the possible relationship between the increasing of air pollution and the increasing of respiratory disease using the PM 10 as the indicator.

The research questions are:

- What is the level of PM 10 in the study area and how it varies with the change of winter and summer seasons?
- How the number of respiratory cases varies with the increased of air pollution (PM 10) and the change of winter and summer seasons?
- What is perception of local people regard to the increased of air pollution and the increased number of respiratory diseases?

1.5 Hypothesis

The following is the hypothesis of this study:

The number of people who visit hospital due to respiratory disease increase when the air pollution (PM10 concentration) increases.

Chapter 2 Literature review

2.1 The definition of Air Pollution

Due to industrialization and rapidly economic growth, the environment is depleted fast. Human being through explore nature resources create financial benefits, but also at the mean time put a time bomb in their daily lives. Nowadays, especially people who live in developing countries, are suffering bad air quality, living in smoggy surroundings, breathing hazard air ,some of them even die because of long exposure to air pollutants. Obviously, air pollution is already become one of critical issues around world.

Sources of air pollution can derive from two ways: natural causes and human activities. These two ways are called natural sources and anthropogenic sources. Some of the major natural sources like volcanic emissions, forest fires and sandstorms can produce air pollutants, but here we mainly focus on anthropogenic sources, such as, factories, power stations and motor mobiles. Furthermore, air pollution is usually divided into two categories: outdoor air pollution and indoor air pollution. Although indoor air pollution also affects people's daily lives a lot, this article is mainly discuss outdoor pollution which can be attributed to industrial activities, transportation and fossil fuel or coal combustion.

Throughout human history, most direct human energy needs are derived from combustion. The problem of air pollution was first recognized about 500 years ago when the burning of coal in cities was increasing. About 200 years ago, a large growth was seen in the amount of coal burnt, since the Industrial Revolution took place in European countries then gradually spread to the whole world. Along with the development of technology, cars have been introduced to people’s daily life. Since motor vehicle have invented, the number of cars on roads is constantly increasing around the world. As we know, each car burns fuel, and fumes come out of the exhaust pipe which can pollute the atmosphere. Air pollutants come from these activities no matter industrial activities or various kinds combustion.

In 1949, the American Medical Association's Council of Industrial Health has defined air pollution as the excessive concentration of foreign matter in the air which adversely affects the well-being of the individual or causes damage to property (American Medical Association, 1949). But the typical legal definition of air pollution is in 1956 which defines the air pollution as “The presence in the outdoor atmosphere of substances or contaminants which put there by man, in quantities or concentrations and of a duration as to cause any discomfort to public health, or to human, plant or animal life or property or which interfere with the state or throughout such territories or areas of the state as shall be affected thereby" (Oregon Revised Statutes, 1956). Recently, also have new definition of air pollution emerge. Like in 2000 Sue hare and Laura defined "Air pollution is the term used to describe any harmful gases in the air we breathe, which is composed of many environmental factors. Pollution can be emitted from natural sources such as volcanoes, but humans' activities such as, power generation and using of motor vehicles, are responsible for much of the pollution in our atmosphere"(Sue hare,laura revecca &joe 2000); In 2004, American national environmental research institute "Air pollution is a complicated phenomenon that starts with emission of polluting compounds from a series of sources. Emitted compounds are dispersed, and sometimes also transformed, in the atmosphere, before they are deposited and have unwanted impacts" (American national environmental research institute, 2004).Combine these definitions with nowadays situation, as I understood, air pollution is the procedure that the emission which come from human activities, such as, coal combustion, using motor vehicles, heating; and natural sources, like, volcanoes, which can goes into air, affects human health and cause air-born disease as well as threaten people's life.

2.2 Air-born Disease

There is a trend that nowadays many people move or travel to the suburbs to escape the "illness of the city." They move out of the city to get closer to the countryside air, to provide the fresh and clear air for their kids, or to get away from the smoggy and tangy city. The one cause of this trend is that most people are already aware of the larger amount of health cost due to air pollution.

Exposure to ambient air pollution has been linked to a number of different health outcomes, starting from modest transient changes in the respiratory system and impaired pulmonary function, continuing to restricted activity or reduced performance, then emergency department(ED) visits\ hospital admissions and finally mortality. There is also increasing evidence for adverse effects of air pollution not only on the respiratory system, but also on the cardiovascular system. Nowadays, therefore, there are lots of evidences show that air pollution can affect our health in many ways:(1) aggravation of respiratory and cardiovascular disease; (2) decreased lung function; (3) increased frequency and severity of respiratory symptoms such as difficulty breathing and coughing; (4) increased susceptibility to respiratory infections; (5) effects on the nervous system, including the brain, such as IQ loss and impacts on learning, memory, and behaviour; (6) cancer; (7) premature death (U.S. environmental protection agency,2010).

Meanwhile, WHO pointed out that air pollution is sixth-leading cause of death, causing over 2.4million premature deaths worldwide (WHO, 2002); The long-term effect of studies in several large cities predicts 60,000 deaths each year due to cardiac and respiratory problems which caused by air pollutants (American Heart Association ,2011); The Ontario Medical

Association estimates that over 5,800 people in Ontario will die prematurely in 2012 because of air pollution (Ontario College of Family Physicians,2005).

Furthermore, Some researches also point that vulnerable individuals, such as, those with pre-existing heart and lung diseases, diabetics, older adults, and children, are very sensitive and appear to be at greater risk for air pollution-related health effects.

Table 2.2.1 shows many kinds of disease can be caused by air pollutants. We can easily find that air pollutants can have long-term and short term affects on respiratory systems, Cardiovascular and procreation as well as the growth of young generation. If people exposure to high concentration air pollution for long time, it will cause premature death.

Table 2.2.1Air pollutants impacts on human health

Respiratory effects	Air pollution exacerbates asthma and other respiratory diseases. Smog days are correlated with an increase in visits to physicians, and hospital admissions for breathing problems. Children, people with chronic diseases such as chronic obstructive pulmonary disease (COPD), and people who work or exercise outdoors are particularly vulnerable
Cardiovascular effects	Exposure to particulate matter has been shown to contribute to cardiovascular illness, hospitalization, and mortality. Elderly patients, people with underlying heart or lung disease, lower socioeconomic populations, and diabetics may be at increased risk.
\ Cancer	A study by the American Cancer Society found a link between fine particulate pollution and lung cancer.17 Exposure to vehicle-exhaust has also been linked to ovarian cancer
Reproductive effects	Exposure to carbon monoxide and ozone during the second month of pregnancy has been linked to cardiac and orofacial birth defects. Long term exposure to air pollution is associated with low birth weight, preterm birth, intrauterine growth retardation, and negative pregnancy outcomes such as miscarriages stillbirths and deaths in early infancy

long term exposure	Important recent research has shown that children living in communities with higher pollution exhibit delayed lung development. This developmental delay could contribute to chronic obstructive airway disease in adulthood. Recent research has also shown that exposure to air pollution can both exacerbate asthma in children who are already asthmatic, and cause new cases of asthma.21, 22 These new findings of delayed lung development and new cases of asthma are particularly worrying.

Sources: U.S. environmental protection agency,2010)

In addition, numerous studies indicate that particulate pollution can cause acute changes in lung function and respiratory illness. Long term and short term expose to particulate pollution can result in increased hospital admissions for respiratory disease and heart disease, school and job absences from respiratory infections, or aggravation of chronic conditions such as asthma and bronchitis.

Recently, many of studies have linked short-term increases in particulate levels, such as the ones that occur during pollution episodes, with immediate (within 24 hours) increases in mortality. This pollution-induced spike in the death rate ranges from 2 to 8 percent for every 50-$\mu g/m^{-3}$ increase in particulate levels (Health Effects Institute (HEI), 2005). These basic findings have been replicated on several continents, in cities as widely divergent as Athens, São Paulo, Beijing, and Philadelphia (Bart Ostro, 2003). During major pollution events, such as those involving a 200-µg increase in particulate levels, an expert panel at the World Health Organization (WHO) estimated that daily mortality rates could increase as much as 20 percent (WHO 2006). These estimates should be viewed with caution, however, because some of those who die during a pollution episode were already sick, and the pollution may have hastened the death by only a few days**.**

2.3 Air Pollutant---Particulate Matter 10um (PM10) and related diseases

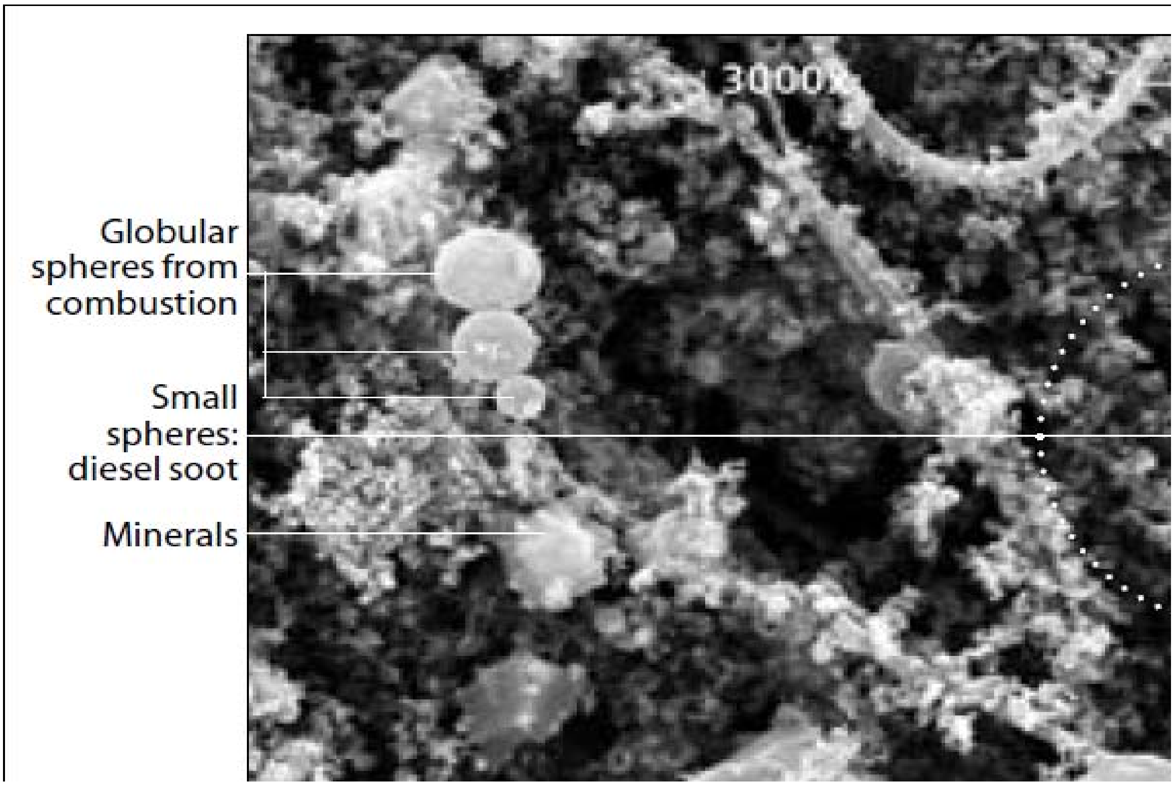
Air pollutants arise from a wide variety of sources (nature sources and anthropogenic sources) , and in generally, they are mainly a result of the combustion process .

Generally, air pollutants are divided into primary pollutants like carbon monoxide (COx), sulfur dioxide (SOx), dust and soot, which are emitted directly by air pollutant sources; secondary pollutants like nitrogen dioxide (NOx), ozone (O3) as well as aerosols, which are created by chemical changes which occur in the atmospheric environment. Physically, they are also divided into gas particles and particulate matter(PM) (U.S.environmental protection agency,2010). These classical air pollutants with high concentrations can contribute to respiratory problems, cardiovascular disease, lung cancer, ect.

Numerous scientific studies show that exposure to these air pollutants may lead to short term effects such as reduced visibility, headaches, allergic reactions, irritation to the eyes, nose and throat, and longer term effects such as breathing difficulties, asthma and various chronic respiratory illnesses such as lung cancer and heart disease.

The term particulate matter (PM) is used to describe airborne solid particles and/or droplets. These particles may vary in size, composition and origin (Fig. 2.3.1) (WHO of Europe, 2004).

Figure 2.3.1 Electron micrograph of PM sampled on a filter near a street; diesel soot (small grey spheres) dominates the samples

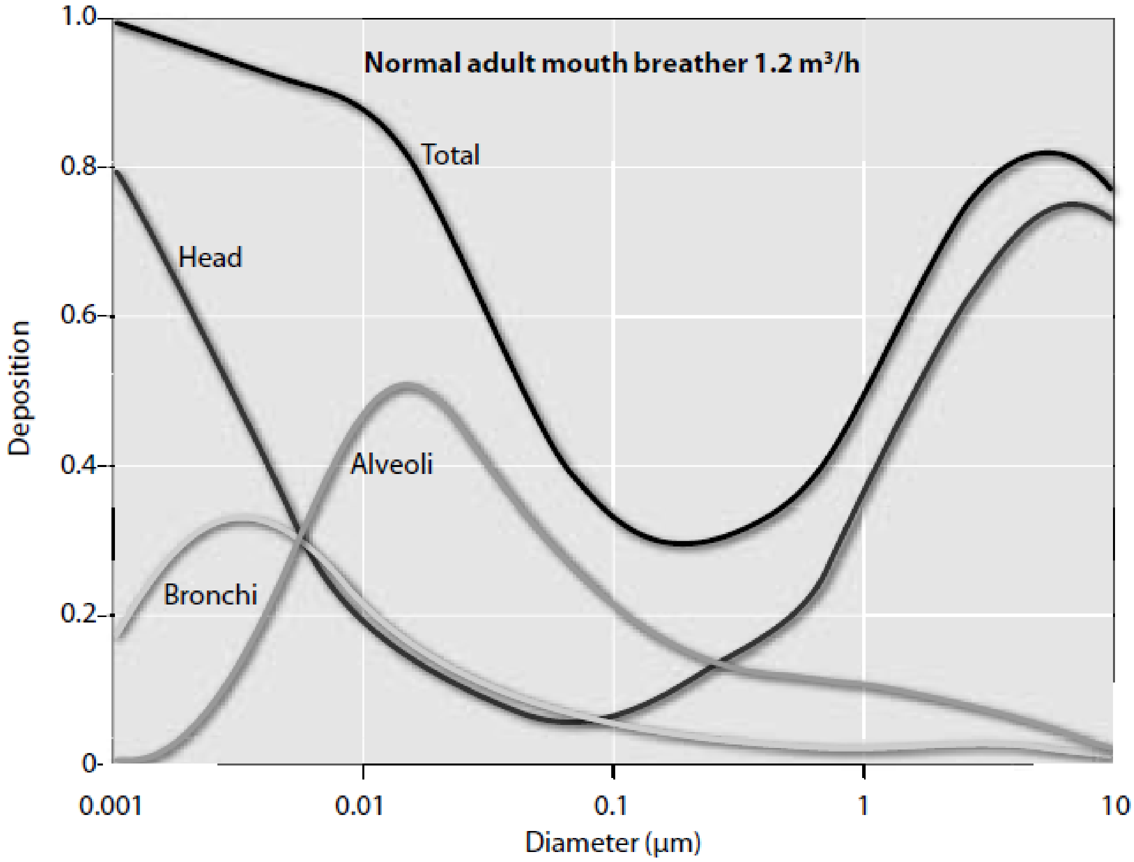


source: C.Trimbacher Umweltbundesamt Wien.2004.

PM is quite common classified by size, because size governs the transport and removal of particles from the air to the deposition within the respirator system. Based on size, urban PM tends to be divided into three principal groups: coarse, fine and ultrafine particles. The smaller PM is, the easier it goes into lungs and deposit in bronchi and alveoli. PM10 is used to describe particles with an aerodynamic diameter smaller than 10 µm. The particles contained in the PM10 size fraction may reach the upper part of the airways and lung. For the quantitative assessment of health effects, normally PM2.5 and PM10 are selected because these exposure metrics have been used in epidemiological studies throughout the world. However, due to the short time-period, here mainly choose PM10 as an example of many kinds of air pollutants.

Fig. 2.3.2 shows depending on their size, where particles are schematically deposited in the respiratory tract. Smaller particles penetrate more deeply into the lung and may reach the alveolar region. As we can find that from figure 2.2, the deposition of PM10 in pulmonary parts is also huge amount which means can have significant impacts on respiratory system, therefore, it is reasonable discuss the relationship between PM10 and related disease.

Figure 2.3.2 Deposition probability of inhaled particles in the respiratory tract according to particle size



Source: W.G. Kreyling, adapted from International Commission on Radiological Protection.

Many epidemiological studies have already proved that high concentration of PM10 (>20 µg/m^{-3} Annual) has health effects which include mortality, lung cancer, cardiovascular and respiratory disease, Emergency Department visits as well as restrictions in activities. In addition, more specific respiratory symptoms, such as, asthma exacerbation, acute and chronic bronchitis; more specific cardiovascular outcomes, such as, heart attacks, change in blood composition, changes in heart rate and heart rate variability, have been found to be associated with PM10 exposure.

Furthermore, we can measure the impacts of high concentrations of PM10 in long-term exposure and short-term exposure. The long-term effects are higher, in terms of mortality (P.Glorennec, F.Momroux, 2007). For example, the report from WHO shows that from 2002 to 2004, in Italy 13cities, high concentrations (26.3 μg/m-3 to 61.1 μg/m-3) of PM10 with long-term exposure have caused 6848 deaths per year, on average(Marco et al. 2006). In addition, long-term exposure promotes the development of chronic diseases, including lung cancer (Pope et al., 2002). The short-term effects are often described as affecting specific population groups, children or the elderly, often with pre-existing diseases (Filleul et al., 2003; Gouveia and Fletcher, 2000).

2.4 Causes and types of respiratory disease

Respiratory disease is the term for diseases of the respiratory system. This system includes lungs, pleural cavity, bronchial tubes, trachea, upper respiratory tract and of the nerves and muscles of breathing.

Respiratory disease also can be classified in many different ways: by the organ involved by the pattern of symptoms or by the cause of the disease.

Table 2.4.1lists various kinds of respiratory diseases as well as the causes of these kinds of diseases. From the table we can easily find that PM10 is the main cause for some types of respiratory disease, such as, Bronchitis (chronic), Asthma (irritant), and Pulmonary and so on.

Table 2.4.1 The causes and types of respiratory diseases

Type of Respiratory Diseases	Cause with Strong linkage	Cause Medium linkage
Asthma (allergic)	Fibber dust ;plant pollens; wood dust; metal fumes;	PM10 ; ozone
Asthma (irritant)	Cotton dust ;SO2;NOx ;PM10 ;tobacco smoke(both active smoking and second-hand smoking)	Ozone ; pesticides
Bronchitis (chronic)	Fire smoke; PM10; cotton dust; engine exhaust; tobacco smoke(active smoking) soot	Tobacco smoking (second-hand) pesticides
Bronchitis (obliterans)	Chlorine; hydrogen sulphide; Nox; ozone	
Chronic obstructive pulmonary disease (COPD)	Soot ;PM10;tobacco smoke (active smoking);wood dust	Metal fumes ;ozone; tobacco smoke (second-hand)
Lung cancer	Diesel exhaust ;mineral oil;PM10;soot ;tobacco smoke(both kinds)	Copper ; benzene ;lead
Pneumonia	Mercury ;nickel;ozone;PM10	
Pneumoconiosis	Asbestos fibers; ceramic fibers ;mineral dust	Metals; coal dust; PM10
Pulmonary edema	Mercury nickel ; Nox; zinc ;PM10	Ozone
Pulmonary fibrosis	Asbestos fibers;coal dust ;PM10;tobacco smoke (both)	Nickel; copper ozone

Sources:http://www.home-air-purifier-expert.com/lung-disease.html#Asbestosis 2005.

This table also shows the strong or medium linkages between respiratory disease and toxic chemical causes. Strong indicates a clear causal link with the respiratory disease has been verified by the medical community. Medium indicates some evidence of human health effects through epidemiological studies and animal studies

2.5 PM 10 and Respiratory Disease

As I mentioned above, PM or particulate matter is a mix of solid and liquid nitrates, sulfates, and ammonium, it is usually classed as either coarse, fine, or ultra fine, with fine particles meaning those smaller than 10µm.

Generally coarse particles come from environmental and geological sources and except In extremely polluted areas is not due to combustion emissions, whereas much of the finer particles are associated with combustion emissions from cars and industry; for this reason, the studies that I examined have tended to focus more on fine particles, as they are generally more relevant to manmade pollution and its effects on people. Coarse particles are still relevant to the study since they also have an effect on human health, but as an investigation into the effects of man-made pollution, I found that emissions generated fine particles (PM10) were much more relevant.

As well as particulate matter, polluted air is also characterized by ozone, and nitrogen dioxide. PM is the factor with the closest link to emissions, with ozone and NO2 levels being more sensitive to environmental changes such as temperature and location specific factors.

Of all the factors available for analysis of air quality, fine particulate matter is the most closely connected to combustion emissions, so gives us the best perspective on the effects of pollution on human health.

2.5.1 Short term effects

In 2004 the WHO conducted a major study across Europe, which monitoring the effect of fine particles on people health. This study finds a direct connection between rises in PM10 levels and increases in hospital admissions as well as mortality.

Studying data from a wide range of sources around Europe, the WHO found that rises in PM10 levels always precipitated rises in hospital admissions relating to respiratory diseases such as asthma attacks, lung inflammations, allergic reactions, and so on. Based on data from 80 experts, accounting for around 10000 deaths per year in Europe, the report estimated that high PM10 levels caused by emissions were directly responsible for 3% of deaths from respiratory illnesses and 5% from cardiovascular problems, (WHO 2004). A similar study in Coachella Valley, California produced similar results, estimating that notable increases in PM10 caused around 1% of mortality over the course of their study. This study was conducted on a much smaller scale, focusing on a small city in the California desert but finding similar results.

A study of the Pearl River in China by D. Huang showed similar short term effects overall, and with the unprecedented scale of urbanization in the area with Guangzhou, Shenzhen and Hong Kong all growing and industrializing so rapidly, the resulting PM emissions are having a drastic effect on health. Interestingly, this study focused on the economic costs of poor air quality, previous estimates had put the total cost of air pollution to China (missed work, hospitals etc) at between 5 -7% of the nations GDP(D.Huang 2010), and Huang's study estimated that , 1.5 2% could be accounted for by fine particle matter(PM10).

In summary, there is a wealth of studies indicating that PM10 caused by combustion emissions from cars etc. can have serious short term effects on human health. Although I did not go into detail about so many studies, the volume of work all seems to agree with this basic finding.

2.5.2 Long Term effects

The long term effects of exposure to high levels of PM10 are more difficult to measure than the short term effects. Whereas immediate effects can be easily monitored through hospital admissions, mortality rates and other quantifiable data, long term effects such as reduced lung function, restricted activity, effects on lung development in young people, and miscellaneous pain and suffering are much harder to measure. As well, as with any long term study, the increased timeline means play more factors will come into play, both at personal and at city level, making it harder to ascertain a direct link between particulate matter and health.

These effects are often even harder to monitor in the developing world due to the pace of change. Shenzhen in the Pearl River is probably the best and most famous example of this, 30 years ago it was a small village, but now it is a city with over 8 million inhabitants (D.Huang.2010). The fact that population and industry are changing so quickly prevents truly meaningful long term study with such rapidly changing external factors.

Despite the difficulties in collecting data, neglecting the long term effects would prevent us from getting a full picture. With so many well documented cases of respiratory illnesses being contracted in the workplace and not being identified until many years later in jobs, such as, coal mining or building where exposure to particles have emerged as primary causes for dangerous and even fatal illnesses, if the general population of cities are at risk from similar problems then this would make the case for action much more urgent.

The easiest indicator of long term effects is life expectancy. The WHO study in Europe estimated that living in urban areas with a high PM count reduced life expectancy on average by one year across Europe; this was echoed by the multi city study of the USA, which correlated life expectancy and PM10 concentration levels finding that those living in more polluted areas had slightly shorter lives (Mercedes, 2005). However, the data for Chinese coastal cities generally showed higher life expectancies in urban areas despite the higher levels of particle matter, I would imagine that this was due to the disparities in living standards between the developed coast and the interior.

The long term illnesses most clearly associated with PM10 are lung cancer and asthma, both of each causes are still debated in medical circles. Although it is fairly likely that high levels of particle emissions play a part, there are still so many possible causes for these illnesses. How large a part particulate matter plays will be as mere speculation at this time. Some estimates have claimed that up to 8% of lung cancer deaths are caused by particles from combustion emissions in heavily polluted areas(Pope et.al.2002), but some claim the effect is negligible.

A study also indicates that permanent pollution, for instance, may sometimes, in association with such other factors as smoking or occupational risks, cause long-term effects on health which affect particularly groups of sensitive persons: children, the elderly and those suffering from chronic respiratory Insufficiencies. (Brilhante, 2002, p170)

No reliable projections were available about the effects of fine PM10 on lung development. I would hypothesize that since children are more sensitive to the short term effects of high PM10 levels, that this will also be reflected in the long term, with cleaner air allowing their lungs to develop more fully. However, since there are so many other socioeconomic and environmental factors at play in children's development, once again it is difficult to scientifically make any claims.

2.5.3 Affected groups

The American and European emphasized that children were more affected by high levels of PM10 than adults. Related hospital admissions and sick days showed consistent increases in the proportion of young people admitted with respiratory illnesses during high PM10 days (Gauderman et al.2004). One of reason why young people are most vulnerable is that their lungs are generally more active than older people. Because of physiology as well as the fact that they are generally more active and spend more time outside, so it is not surprising that they are more at risk from airborne particles.

In Toronto Canada, a study focusing on children health found that even low levels of coarse or fine particle matter can have noticeable effects on children, with a direct correlation between increases in PM and increased hospital admissions (Mei lin et.al.2002). A combination of higher lung activity and lower immune systems means that young people are the most affected by particle matter regardless of location. Older people also seemed to be more at risk, again hospital admissions and mortality rates reflected a stronger connection to high levels of fine particle matter (Pope et.al.2006). Presumably this may due to their immune systems and general health deteriorating through age and having less resistance to the problems associated with PM10.

People who work in highly polluted environmental also are at risk of getting respiratory diseases. A study in American indicates that ooccupational exposure to certain industrial pollutants also increases the risk for chronic obstructive pulmonary disease COPD. This study found that the fraction of COPD attributed to work was estimated as 19.2% overall and 31.1% among never smokers (Hnizdo E, Sullivan, PA, Bang KM and Wagner G.,2002) .

I could not find any studies with serious evidence of any connection between genders or socioeconomic status and PM10 levels, however, both of the American studies I used emphasized the importance of lifestyle. Findings reflected that being outdoors or indoors without air conditioning had a major effect on susceptibility to PM10; in other words it is far healthier to stay indoors in a polluted environment. It would logically follow that the people who are affected the most are those who spend more time outside, since working out of doors is generally low income work, we can assume that it this group will be more affected by PM10 than others.

2.6 Meteorological Factors

The first statistic that we notice with regards to meteorology is that in all of the studies carried out around the world more extreme weather conditions cause an increase in hospital admissions, including for respiratory illnesses that are connected to PM10. Generally, seasons are treated as a confounding rather than useful element in these studies, the logic being that removing the influence of weather would help to focus on the problems caused by emissions which are preventable. Furthermore, it is also worth remembering that more fires occur in summer, both natural and man-made, releasing coarse and fine particles into the atmosphere (Leah Welty 2005). Finally, weather will affect PM counts as particles released naturally by plants such as pollens will also affect the air quality. Seasonal illnesses such as hay fever and summer colds are caused by allergies to naturally occurring PM and must be accounted for in this study to isolate the illnesses caused by fine particle matter from combustion emissions and so on.

Another major factor that needs to be taken into account is human activity in different seasons. For example, in warmer weather people will spend more time outside, and hence be more exposed to polluted air than if they stayed in, also, in single city studies, research must take into account the increase in people arriving in or leaving the city (increased tourism in warm weather etc). Studies in China, America and Europe all noted that respiratory illnesses both short and long term were affected by the availability of air conditioning with those using air conditioning to stay warm or cool being less at risk than those without. This factor is especially noticeable in China due to the rapid industrialization of the country as more and more people installing air-conditioning into their houses is steadily decreasing vulnerability to admissions, in the short term at least.

A study by Vestenius shows the result that average concentrations of Polycyclic aromatic hydrocarbons (PAH)-compounds in precipitation and PM10-fraction are highest in winter. During winter, there are more PM10sources due to heating. PAH-concentrations in PM10 are approximately inversely proportional to outdoor temperature (M. Vestenius, H. Hellen and H. Hakola, 2009 p1).

A survey in 14 sites of Taiwan proves that a regular pattern of seasonal variation of PM10 concentration were formed both in south-western and southern regions especially in south, which is characterized by high winter (November, December and January) and low summer (June, July and August), modified by a second high peak in March(Kuang-Ling Yang,2002). This study also explain one of reasons why PM10 concentration varies with the change of season is that two meteorological conditions— temperature and precipitation days (Kuang-Ling Yang, 2002).

However, a study by Leah Welty observed that while seasonal factors were accounted for in single city studies, multicity or multinational studies found difficulties taking account of these factors due to varying climates in different regions which become more pronounced the larger the area, and are especially relevant when examining data for a country such as China with such a large area and variety of climates (Leah Welty 2005).

Lastly, not only temperature and precipitation can effects on particulate matter levels, wind direction also can affect the concentration of PM. The study in California for example, focused on a town in the desert, and changes in wind speed or direction have a major effect on health regardless of human activity, as sand and dust were airborne in quantities dangerous to humans. Although both contribute, fine PM (PM10) has been observed as much more likely to trigger respiratory illness.

2.7 Air quality guidelines in China, the EU, and the US

Ambient and occupational guidelines exist for particulate matter. Some guidelines are for total particulate matter (TPM), whereas others are for particular size fractions - usually PM10 or PM2.5.

Different countries have different guidelines for particulate matter that generally classify different levels of PM10 according to their functions. For each of these function a maximum level should be measured in two ways: (i).the average concentration in 24hours ; (ii).the average concentration throughout the whole year. The table below shows the guidelines for selected countries, namely, China, the EU and the US (table 2.7.1).

Table 2.7.1 ambient air quality guidelines for particulate matter

Country/ Institution	**Aerosol**	**Level (ug/m-3)**	**Averaging period**	**Data of implemtation**	**Relevant law**
WHO	PM10	20	24hours	2005	AQG
		50	Annual		
China	PM10	50(i)150(ii)250(iii)	24hours	January 1996	GB 3095-1996
		40(i)100(ii)150(iii)	Annual		
EU	PM10	50	24hours	January 2005	COUNCIL DIRECTIVE1999/30/EC
		40	Annual		
USA	PM10	150	24hours	1990	NAAQS
		50	Annual		

Compared to the guidelines of EU and US, Chinese guideline allows relatively higher PM10 concentration both in 24 hours and through the whole year. Most of the countries that used one of the WHO Air Quality Guidelines (AQGs) documents to set or revise an AQG evaluated the evidence in the document, compared it to their local conditions, and then decided on a guideline. In the case of the PM guidelines, the more recent the WHO publication the more likely a country was to modify the WHO AQG for local conditions (Candace Vahlsing & Kirk R. Smith, 2010, p7). Therefore, it is not surprising to find that different countries have different PM10 guidelines.

China classify the air quality to 3 grades and each grade has its own level of PM10, as we can see from 2.7.1, the first grade allows 50ug/m^{-3}(24hours), the second grade allows

150ug/m^{3}(24hours)and the third grade allows 250ug/m-3(24hours). However, the guidelines in Shenyang municipality use the third grade of air quality allowing 350ug/m-3(24hours) (Shenyang municipality, 2008).

One of reasons that Shenyang government allows higher PM10 concentration is that the city's economy relies heavily on industry, restricting PM10 levels would be very costly. This, of course, has a negative effect on public health.

2.8 International experiences with particulate matters and respiratory diseases

The aim of studies into problems caused by PM10 be should ultimately to find a realistic threshold level to implement for public safety, to find the level of PM10 beyond which public health and safety is seriously compromised, however, this has not been possible due to a number of factors.

The amount of research into this field could be seen as becoming a disadvantage for those looking to put limits on PM levels, with so many studies and different formulate for interpreting the data meaning that no study has yet been able to agree on a universally accepted level of danger. Of course with the difficulty and cost of implementing city or even nationwide regulations on emissions a definite figure is absolutely essential to coordinate any sort of goals.

Geography is also a key factor. The goal of these studies ultimately is to find what constitutes safe air, and thus preventing exposure to unsafe levels of PM. However, the amount of environmental factors aside from combustion related fine particles affecting respiratory health has made this impossible so far.

Although the WHO has set guidelines for recommended levels, despite the amount of studies, the sheer variety of environmental and human factors have meant that no threshold has been successfully implemented as yet. The European Union has set recommended levels, but these are far higher than the level of pollution in European cities, China has proposed targets, but as with much Chinese environmental policy it is implemented and monitored on a provincial rather than national basis. Standards are generally set on an effect basis where the threshold is an immediate danger to citizens, rather than damaging to health.

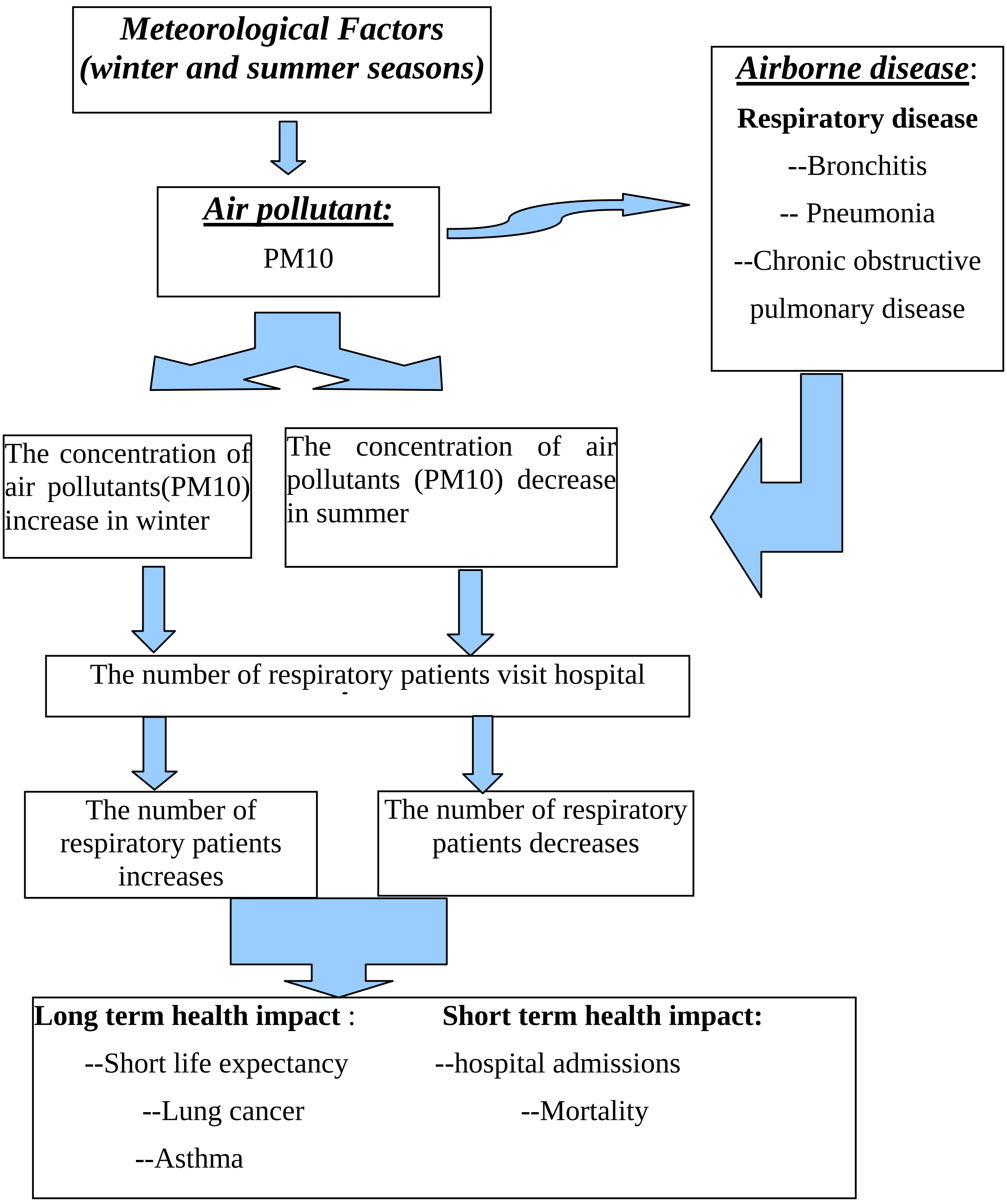
Even though, there are lots of difficulties to do research with the particulate matter and respiratory disease, around the world, there still have some remarketable results. The study in Brazil shows that when compared to summer time, in winter, respiratory disease as a whole increased with the increase in atmospheric pollution. This study also shows that an important relationship exists between the climate factor/pollution and the increase in these injuries (Ogenis 2002). Another survey in Sao Paulo showed that compared to other season of year, the rate of symptoms of respiratory disease are higher in the winter with it's higher pollution levels.

In addition, Health Effects Institution also indicates that pollution-induced spike in the death rate ranges from 2 to 8 percent for every 50-$\mu g/m^{-3}$ increase in particulate levels (Health Effects Institute (HEI), 2005). An expert panel at the World Health Organization (WHO) estimated that ,during major pollution events, such as those involving a 200-μg increase in particulate levels, daily mortality rates could increase as much as 20 percent (WHO 2006)

2.9 Conceptual Framework

the conceptual framework shown in the figure 2.9.1 was developed using the information collected in the literature

Figure 2.9.1 conceptual framework



Chapter 3 Research Methodology

3.1 Types of Research and Research area

The research type of this study is an exploratory research. The research strategy applied was survey and archival analysis.

The research area was Guanbei Street which is located near to Tianxu Heating Provision Factories as well as in "Gear Factory "Heating Provision Factories. Between these two factories, there is Renji hospital. More information on the research area can be found in the section 1.2 of this document.

Guanbei Street Community was chosen because (i) it is one of the most polluted areas of the Shenyang metropolitan area ; (ii) it is near to Renji hospital. This hospital is mainly built for Guanbei Street Community; (iii) there is only monitoring station which is located in the same district with Guanbei community. It would provide environmental conditions in Guanbei Street Community.

Renji Hospital lies in the neighbourhood of Guanbei Street Community and was chosen as the source of health data for this work due to the fact that it has an emergency treatment unit with a good record file organization.

3.2 Data Collection

3.2.1 Literature Study

Relevant secondary data such as reports, textbooks, journals, publications and articles were collected through a literature study from government agencies and a hospital .

3.2.2 Field Work

Primary data was collected through fieldwork from the 2^{nd} July to 1^{st} August 2011 in the city of Shenyang. During this period, two kinds of data were collected: environmental data which used the concentration of PM10 as indicators and the indicator of health data was the cases of respiratory disease which collected from Emergency Department of Renji hospital. These data were collected during 6 months (summer 3 months June, July, August and winter 3 months January, February, December) in the year of 2010, as well as, during 5 years from 2005 to 2010.

The health data was collected from the Emergency Department of the Hospital. The methodology of collecting the cases of respiratory disease includes collection every day for six months (3 months in summer, 3month in winter) of the survey year of 2010 and collection every year from 2005 to 2010.

Environmental data will be collected from Environmental Department and Huangu Monitoring Station. The methodology of collecting particulate matter includes collection every day in six month (3 months in summer , 3 months in winter) of the year of 2010 and collection every year from2005 to 2010

The research instrument used was a combination of an-depth interview and questionnaires.

- Interview

The in-depth interview was applied for groups of organization which are linked with research. Some key respondents were chosen based on a purposive sampling technique. A list of key respondents is shown in table 3.2.2.1.

table 3.2.2.1:list of organizations of key respondents for in-depth interview

No.	Key respondents organization	responsibilities
2	The emergency Department of Renji Hospital	Provides medical support for Guanbei community
2	Huanggu Monitoring Station in Guanbei Community	Monitors the air quality for Huanggu district (Guanbei Community as well as it's neighborhood) provides the concentration of air pollutants of Huanggu district
1	The Environmental Department	Provides the concentration of air pollutants for the whole city of Shenyang monitors the air quality of Shenyang city
2	Health Department	Provide health data for the whole cities educate people to be aware of infection of disease
1	Institution or University	Researches on the impacts of air pollution

- Questionnaire

In order to increase the community's participation, the questionnaire will be designed to be distributed to local people. The copies can be found in the annex 1. Considering that time and finance are the main limitations of the research, 60 persons who take different professions were chosen purposive sampling as responds of questionnaires. Tale 3.2.2.2 shows the list of respondents who will fill in questionnaires.

Table 3.2.2.2:list of respondent to whom questionnaires were applied

Respondents	Number of respondents
housewives	20
Retired people	20
Heating provision company works	20

In order to obtain respiratory disease data, questionnaires will be used for the Emergency Department of Renji Hospital . The expected information will be collected from their digital data base. From this data base, I will collect following information: year, month, day of month, age, sex, address, diagnosis.

- Sample Size

From the information got from Emergency Department, in summer the number of respiratory disease patients will be around 1052case per/month and in winter this number will increase to around 1729 cases per/month a month, therefore the number of hospital visitors will be a huge amount. Due to limited time and budget, I only got the daily cases of respiratory disease for six months (3moths of winter and 3 months of summer) of 2010, and cases of respiratory diseases per year from 2005 to 2010.

3.3 Unit of analysis, variables and indicators

Unit of analysis of this research was PM10 concentration, the number of respiratory cases, respondents who will fill in questionnaires and participants of interview.

From my research questions, I selected several variables and indicators which can be measured. These indicators link to specific questions that was asked through different instruments (in-depth interview, questionnaire and documents ect.), table 3.2.2.1.

Table 3.3.1 variables and indicators

Research Question	Variables	Indicators	Instruments
What is the level of PM 10 in the study area and how it varies with the change of winter and summer seasons?	winter and summer seasons	The concentration of PM10	**Quantitative** **Qualitative** Documents In-depth interview
How the number of respiratory diseases varies with the increase of air pollution (PM 10) and the change of winter and summer seasons?	3.Winter and summer seasons 4.the concentration of PM10	The number of respiratory patients	**Quantitative** **Qualitative** Documents In-depth interview
What is perception of local people regard to increase of air pollution and the increase of the number of respiratory diseases?	Awareness	The number of people realized	**Qualitative** Participant Observation Questionnaire

3.4 Data Analysis

Sample statistical methods like, percentages, frequency distributions, and means, will be used to collected the results. The results will be displayed in tables, matrix and graphics.

3.5 Fieldwork difficulties and changes made related to original proposal

Due to the huge amount of digital data needed to be collected and hospital staff often being uncooperative, I brought my own computer and sat in computer room of Renji hospital every day, typing the data of respiratory cases into my own computer. At the beginning, staff who were in computer room reacted angrily, claiming that I disturbed their daily work. During the period I was working in computer room, they asked me to do some small menial jobs.

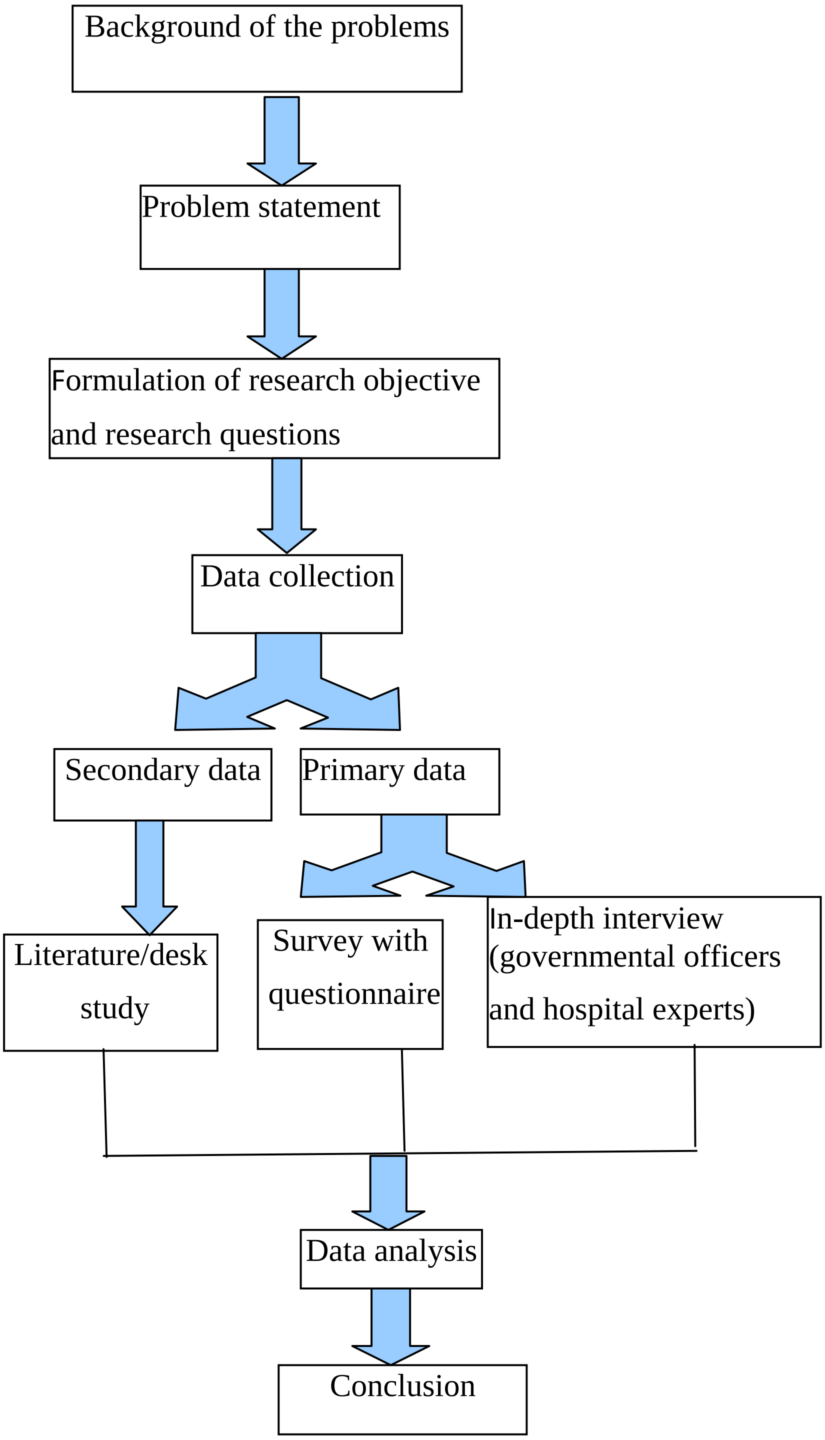
For the interview, my contact who worked for the Environmental Department was not willing to meet me. On the first day, I waited in the waiting room for 2 hours but did not see him.

For questionnaires, I changed my plan and tried to avoid asking housewife and a worker who come from the same family. I did this by dividing Guanbei community into 4 areas: A. B. C. D (fig.3.5.2). For each A and B area , I delivered 5questionnaires to retired people and 10 questionnaires to housewives , and for C and D areas I delivered 5 questionnaires for retired people and 10 questionnaires for workers.

Fig.3.5.2 four areas for delivering questionnaires.

3.6 Research Design

Fig.3.6.1 Research design



Chapter 4 Results and discussion

4.0 Introduction

My fieldwork was conducted from 2nd July to 1st August lasting 1 month. During the fieldwork, I got information about the number of respiratory cases (per day) in wintertime and summertime of 2010, as well as, the number of respiratory cases per year of 2005, 2006, 2007, 2008, 2009,2010 from Renji hospital. meanwhile, in the same period PM10 concentration (24hours) per day from a monitoring station, additionally, through the third person I interviewed people from Huanggu Monitoring Station, Renji hospital, Health Department, Environmental Department and Shenyang university. Furthermore, I also delivered questionnaires to citizens.

The patient's information I got from the hospital. The following information was collected from the hospital data base: year, month, day of month, age, sex, address, diagnosis which was very easy for me to classify.

The PM10 concentration (24hours) was got from Huanggu Monitoring Station. HMS's methodology of collection particulate matter includes collection every day in each month, and measured as the average levels of PM10 over 24hours(see, Annex 4 and 5).

The total number of records sampled at Renji Hospital's emergency room were 1750 in January, 1986 in February, 1468 in December, totally 5,187 in winter and 1006 in June, 1100 in July and 1051 in August, totally 3,157 in summer(see Annex 4 and 5).

In respect of patients' characteristics, the author found that 51.2%were males and 47.8% were females and 0.93‰ had no sex identification. 96.3% patients are residents of Guanbei community whereas only 4.2% are living outside the community. As far as age is concerned, the largest number of records (64.9%) were of persons above 60 years old, followed by young children who made up 14.5%, the adult group (5.45%) occupy the smallest of respiratory cases (see, Annex 8).

Table 4.0.1 and 4.0.2 show that the results as well as the figures of the diagnosis collected from Renji hospital.

Table 4.0.1 Percentage (%) of diagnoses per kind of respiratory disease, percentage(%) of patients' address and gender in wintertime, 2010

Diagnosis	Senis >60	young children 0-5	Children 6-15	Adult 16-59	Total	Guanbei community	Other area	Male	Female	no sex identification
Asthma	1.9 (103)	3.4 (181)	5.1 (267)	0.2 (15)	10.8 (566)	88.7 (4634)	11.2 (588)	51.5% (2692)	47.4% (2475)	1.05% (55)
Bronchitis	1.2 (62)	4.7 (247)	5.2 (274)	1.1 (55)	12.2 (638)					
Chronic obstructive pulmonary disease (COPD)	28.6 (1494)	0	0	0.9 (49)	29.5 (1543)					
Pneumona	0.8 (44)	5.5 (292)	5.5 (288)	0.9 (51)	12.9 (657)					
Pulmonary edema	28.4 (1484)	0	0	1.1 (58)	29.5 (1542)					
Pulmonary fibrosis	1.8 (95)	0	0	3.1 (163)	4.94 (258)					
Total	62.8 (3282)	13.8 (720)	15.9 (829)	7.5 (391)	5222	N=5222				

Table 4.0.2 Percentage (%) of diagnoses per kind of respiratory disease, percentage(%) of patients' address and gender summertime, 2010

Diagnosis	Senis>60	young children(0-5)	childrn (6-15)	Adult (16-59)	Total	Guanbei community	Other area	Male	Female	no sex identification
Asthma	1.2 (37)	6.1 (193)	5.1 (162)	0.2 (5)	12.6 (397)	96.3 (3043)	3.6 (114)	50.1% (1582)	47.9% (1513)	2.0 ‰ (62)
Bronchitis	1.1 (33)	5.9 (188)	5.3 (169)	0.06 (20)	12.4 (392)					
Chronic obstructive pulmonary disease (COPD)	31.9 (1010)	0	0	0.5 (15)	32.5 (1025)					
Pneumonia	0.6 (21)	3.5 (113)	4.3 (136)	0	8.6 (270)					
Pulmonary edema	23.7 (1032)	0	0	0.7 (22)	33.4 (1054)					
Pulmonary fibrosis	0.1 (4)	0	0	0.5 (15)	0.6 (19)					
Total	67.7 (2137)	15.4 (494)	14.8 (467)	1.9 (59)	3157	N=3157				

These tables show that a significantly higher number of respiratory diseases occur in winter time (5222) than in summer (3157).

Regarding the most frequent respiratory disease reported in the hospital. Chronic obstructive pulmonary disease COPD and Pulmonary edema are the most frequent in both periods (winter and summer) (see table 4.0.1 and 4.0.2).

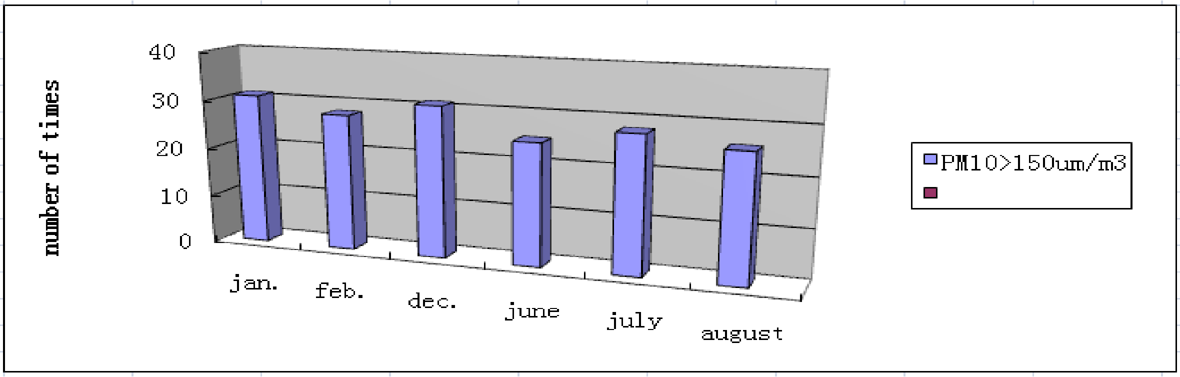
Related to age groups, table 4.0.1 and 4.0.2 show the most vulnerable group is the old people group (>60) in both periods. The Children group is the second most vulnerable, showing a worrying level of complaints. This result also confirmed by Mei (2002, see section 2.5.3). His study was focusing on children health found that even low levels of coarse or fine particle matter can have noticeable effects on children, with a direct correlation between increases in PM and increased hospital admissions.

When we look at the areas where patients come from, table 4.0.1 and 4.0.2 show that most are residents of Guanbei community, 88.7% in winter and 96.3% in summer. From these percentages, we can see that a higher proportion of patients come from Guanbei community in summer than in winter. This may be explained by Spring Festival. In Chinese Spring Festival workers generally visit their hometown causing a massive amount of movement around the country. Therefore, in winter, more people will travel for the celebration, meaning that many residents will leave Guanbei community, while others will arrive from outside.

4.1 Variation of PM10 concentration in winter and summer seasons

Variation of PM10 concentration in wintertime(January, February and December) and summertime (June, July and August) in the research area is showed in figure 4.1.1. As we can see, the PM10 concentration exceeds the prescribed municipal guideline (daily PM10 <150um/m^{-3}) many times through these six months and more times in winter than in ssummer. This indicates that the concentration of PM10 varies with the change of seasons.

Fig.4.1.1 number of times per month that the measured values exceed the municipality guidelines (concentration of PM10 <150um/m^{-3} $_{24hours}$), 2010

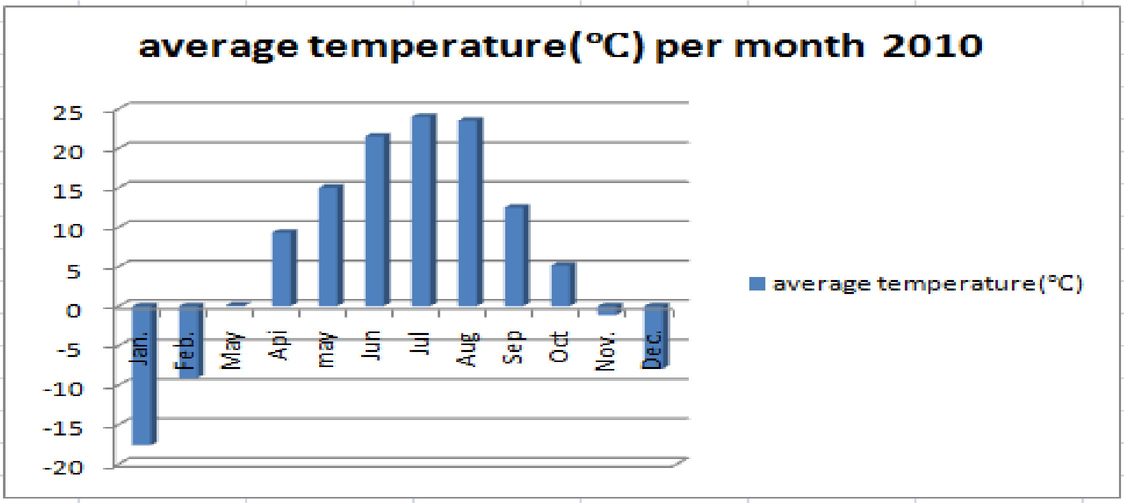


Compared to the summer months, the PM10 concentration exceeds the guideline 31 times and 30 times in January and December respectively. Moreover, through the whole month of February (28days), the daily concentration of PM10 is above the municipal guidelines. Although, there are remarkable differences between winter and summer in terms of PM10 concentration, we cannot ignore that the PM10 concentration exceeds the municipal guidelines (daily PM10 <150um/m^{-3}) more than 20 times in both seasons, indicating that local PM10 concentration (24hours) are constantly relatively high in research area.

One of possible reasons that PM10 concentration in winter is higher than in summer is the increased of human activities that release more fine particles into atmosphere in winter. In Shenyang, winter is fairly cold with temperatures going below freezing (see fig.4.1.2). Therefore, compared to summertime, in winter people have to use more coal for heating. Vestenius (2009 p1, section2.6) also proved that during winter, there are more PM10 resources due to heating. He also indicates that polyclinic aromatic hydrocarbons (PAH) concentrations in PM10 are approximately inversely proportional to outdoor temperature.

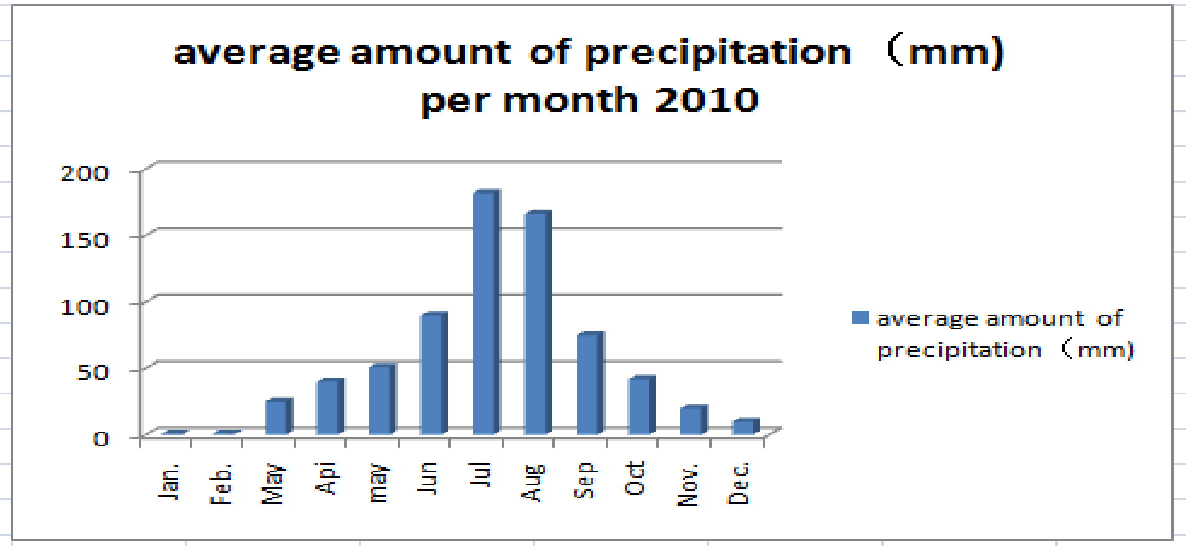
Secondly, usage of large amounts of fireworks also contributes to high PM10 in winter. In China, around January and February is Spring Festival an important part of the celebration is people using huge amounts of fireworks to celebrate.

Fig.4.1.2. monthly average temperature in 2010



Another important fact is the duration of the dry period in winter that is longer than in summer, as we can see from 4.1.3. In winter precipitation is almost 0mm, whereas in summertime, the average amount of precipitation is above 50mm, especially July and August where it goes above 150mm.

Fig.4.1.3monthly average amout of precipitation (mm) per month in 2010



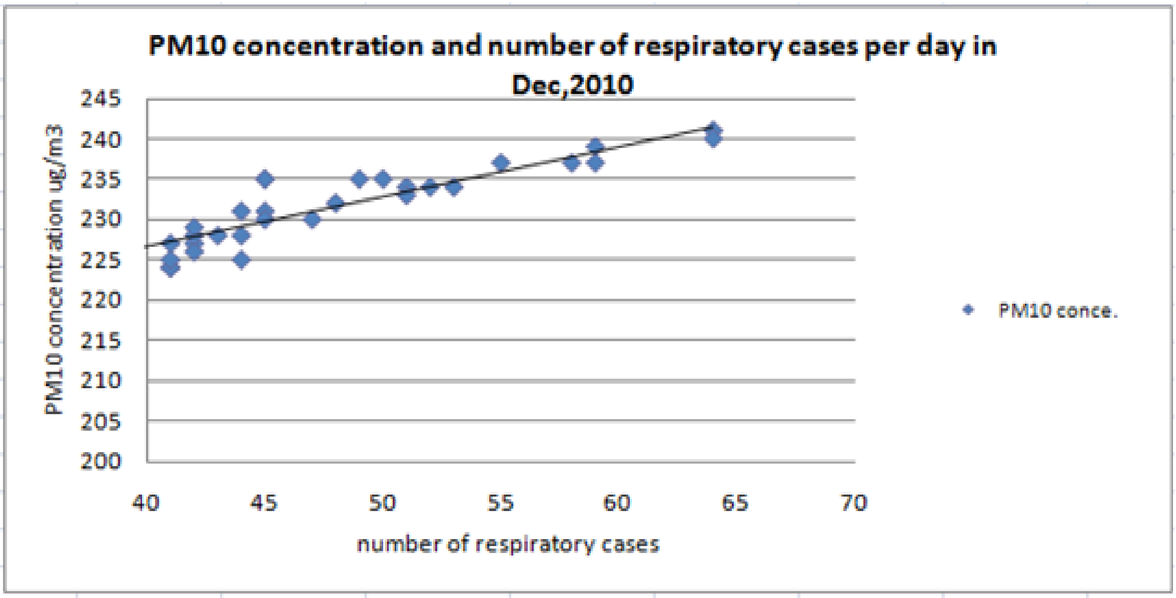
I imagine that the concentration of PM10 is probably also affected by amount of precipitation. Winter has low precipitation with high level of PM10 and summer has high precipitation with low level of PM10.

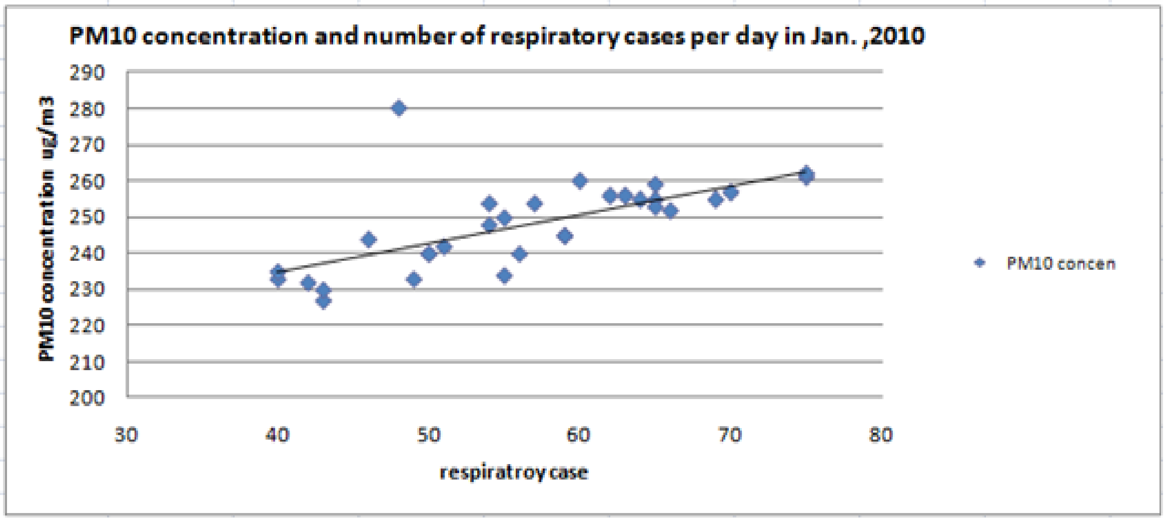
The influence of meteorological conditions is also reported by Kuang-Ling Yang (Kuang-Ling Yang, 2002, see section 2.6). He claimed that PM10 concentration varies with the change of season can also explained by two meteorological conditions— temperature and precipitation days.

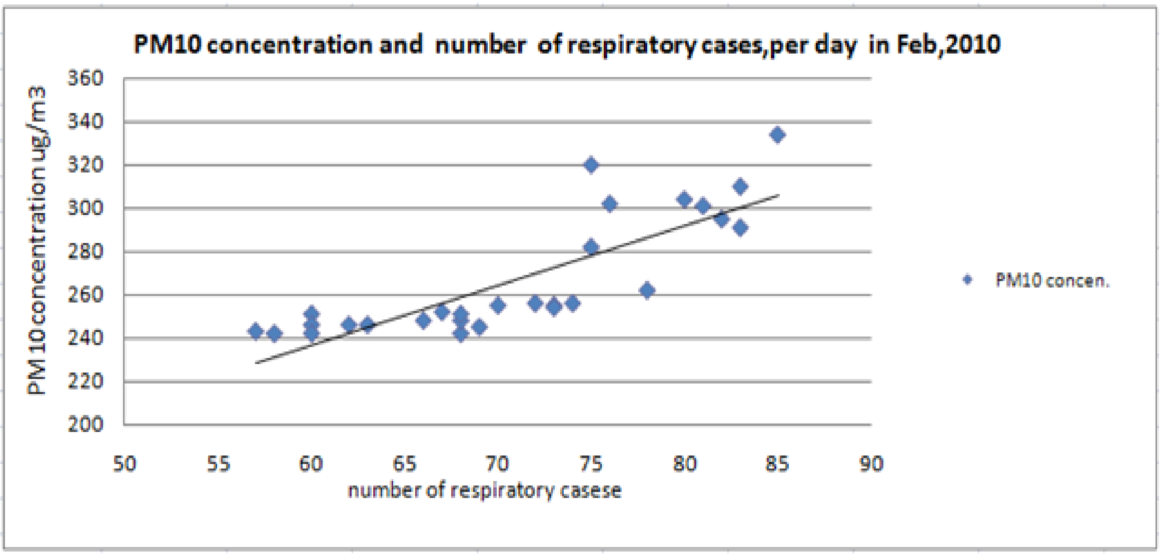
4.2 variation of respiratory disease with the increasing of air pollution in winter and summer

The number of respiratory diseases reported seems to rise in accordance with the increases in PM10 during wintertime (January, February, and December). Fig.4.2.1 shows variations in respiratory disease correspond with PM10 concentration in January, February and December.

Fig.4.2.1. PM10 concentration (24hours) and number of respiratory cases per day in winter (Jan. Feb. And Dec.), 2010







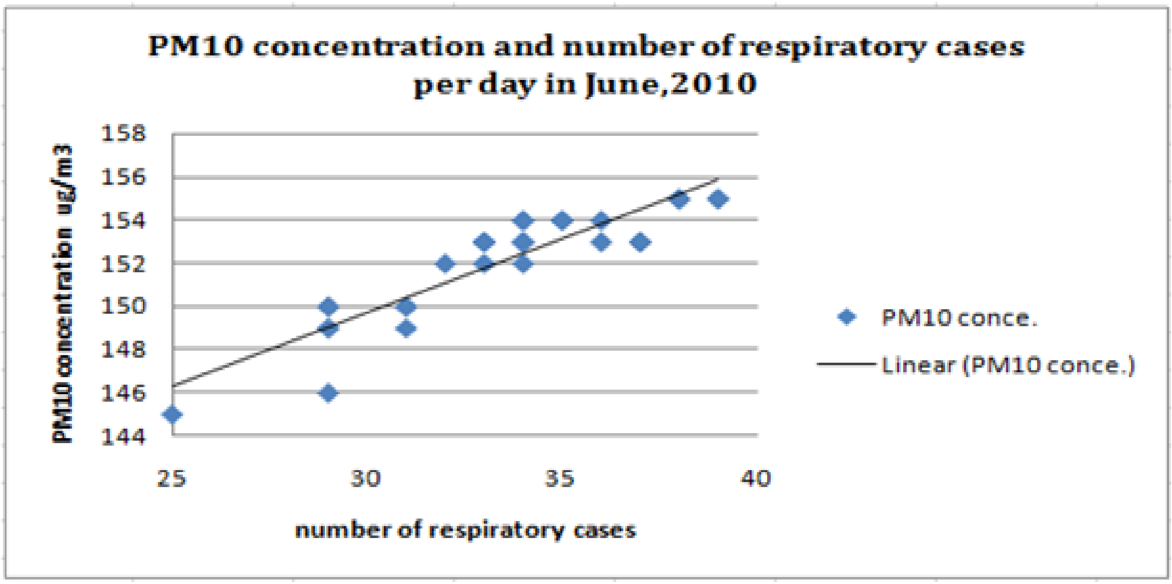
During these three winter months, almost every day PM10 concentration (24hour) is higher than 210ug/m^{-3} and the daily number of respiratory cases is more than 40 patients. One day in February has both the highest daily PM10 concentration (330um/m^{-3}), as well as, the highest number of respiratory cases among these three months (90 patients).

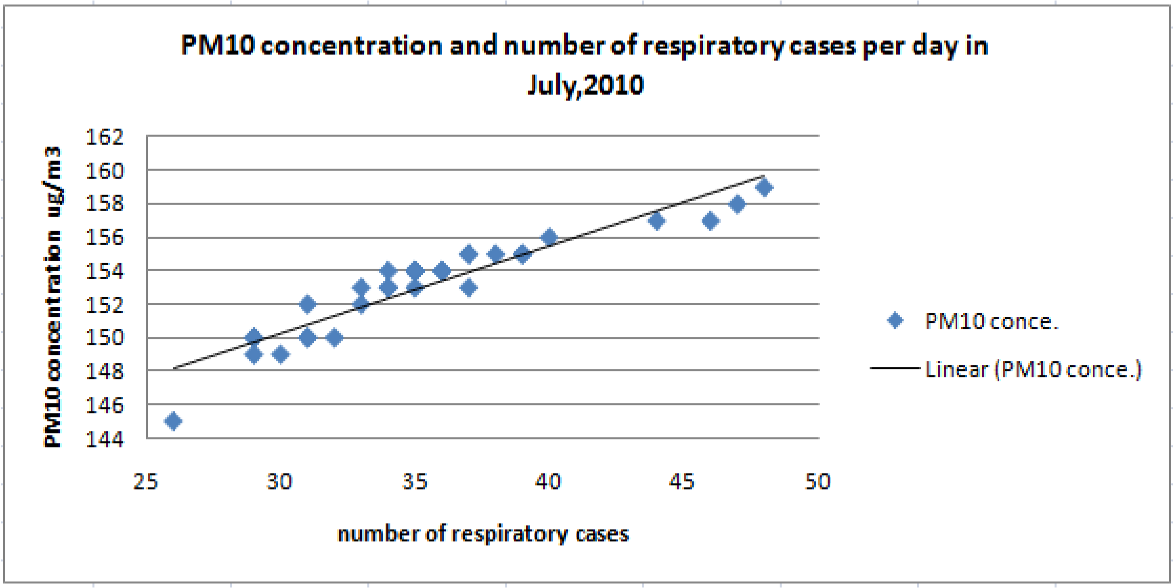
As we can see from figure 4.2.1, February has the highest daily concentration of PM10 which is around 300ug/m^{-3} (24hours), this may be due to Chinese Spring Festival happening at that time, as the huge amount of fireworks could contribute to the high level of air pollutants.

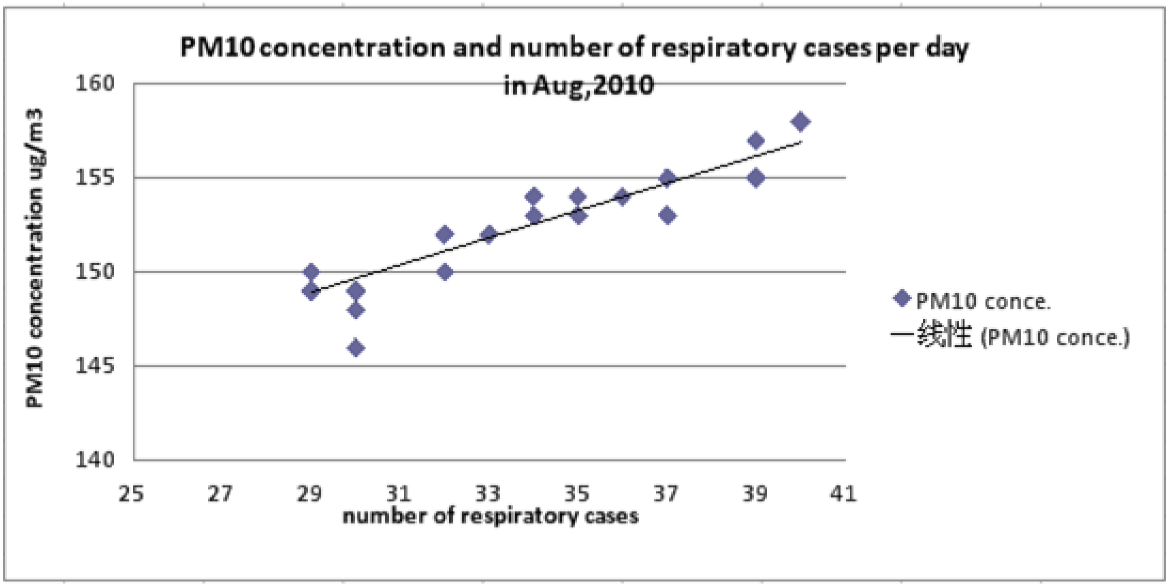
The number of respiratory diseases reported seems to rise in accordance with the increases in PM10 during summertime (June, July, August). Fig.4.2.2. shows that the number of respiratory cases varies in accordance with increasing PM10 concentration in June, July and August.

The highest number of respiratory cases (50 cases) per day happens with the highest daily PM10 concentration (159um/m^{-3}) in July. While, the lowest number of respiratory cases (25cases) per day coincident with the lowest daily PM10 concentration (144um/m^{-3}) in June.

Fig.4.2.2. PM10 concentration (24hours) and number of respiratory cases per day summer (Jun. Jul and Aug), 2010



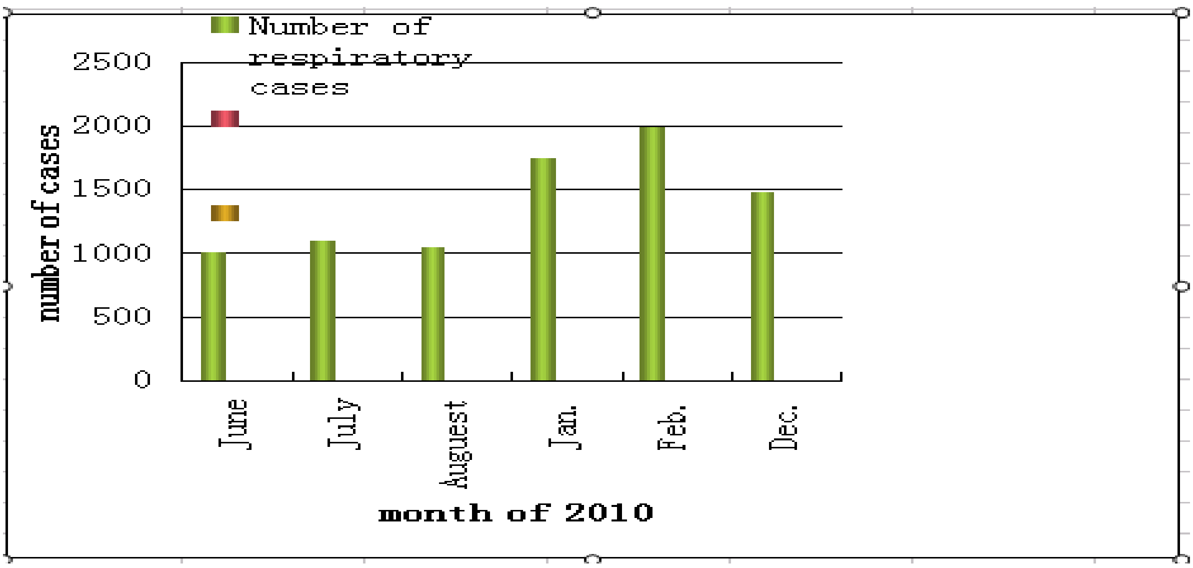




When we compared the average of PM10 between wintertime and summer time (see 4.2.1 and 4.2.2), we can easily find that in winter, the average PM10 concentration is around 250ug/m^{-3} (24hours) which is remarkable high than the average PM10 concentration (150ug/m^{-3} 24hours) in summer.

Compared to summer, winter has a noticeably higher number of respiratory cases. Fig.4.2.3 shows the total number of respiratory case in each month (winter and summer).

Fig.4.2.3. number of respiratory cases in winter and summer season



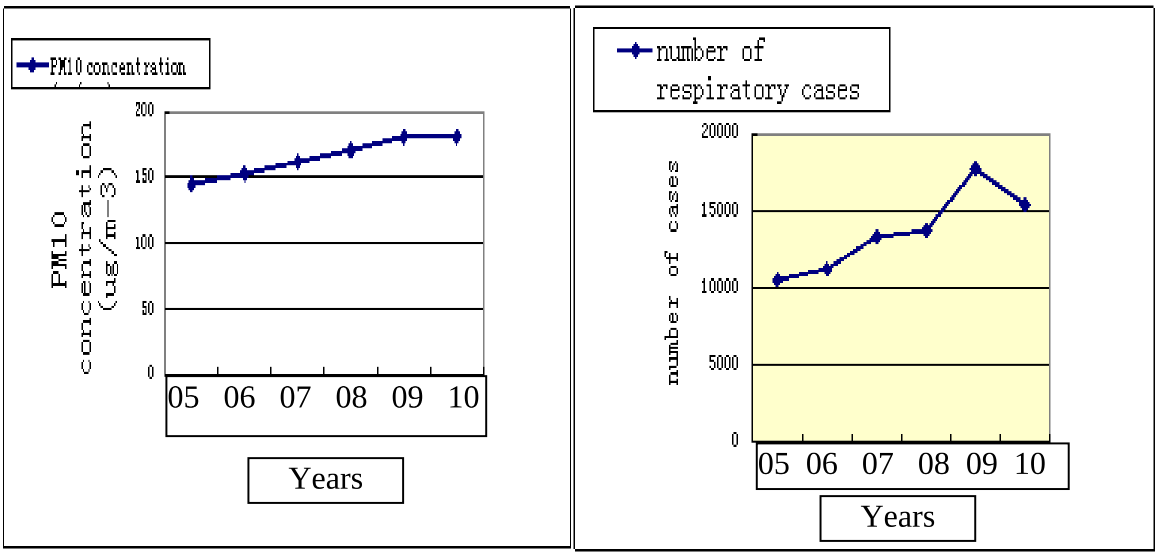
In summertime (June, July and August) the monthly maximum number of respiratory cases is 1100, whereas in wintertime, this number increased up to a minimum 1500cases per month, and almost reaches 2000cases in February. This result also can match the result that the total number of respiratory cases in winter (5222cases) is much higher than in summer (3157) (see table 4.0.1 and 4.0.2 in section 4.0).

Moreover, this result coincidence with the results shown in figure 4.1.1 (see section 4.1) that the PM10 concentration (24hours) is much higher in wintertime than in summer.

Therefore, we can draw conclusion that there is a possible relationship between the increased number of air pollution and the increased number of respiratory cases. This possible relationship is also confirmed by a study of Brihante (2002, section 2.7), which shows there is an important relationship exists between the particulate matter and the increase in respiratory cases. In addition, in 2004 the WHO (section 2.5.1) also finds that there is a direct connection between rises in PM10 levels and increases in hospital admissions as well as mortality

Figure 4.2.4 shows the total number of respiratory cases per year and the average PM10 concentration (24hours) during 5 years (2005 to 2010).

Figure 4.2.4 total number of respiratory cases per year and the average concentration of PM10 24hours, from2005 to 2010



These results seem to confirm the results obtained from the winter and summer periods of 2010. From the years 2005 to 2010, the concentration of PM10 rises from 149ug/m^{-3} to 180ug/m^{-3}, and the number of respiratory cases increases rapidly from about 10,000cases to approximately 18,000 cases, although the number of respiratory cases in 2010 decreased to 15,000, possibly due to the local government's measures to prevent respiratory disease. In general, the increased number of respiratory cases has risen in conjunction with the increase of air pollution.

The concentration of PM10 kept increasing for 5 years, which may be due to increasing energy consumption and an increasing number of private cars. Like Sue(2000, section 2.3) said ppollution can be emitted from natural sources such as volcanoes, but humans' activities such as, power generation and using of motor vehicles, are responsible for much of the pollution in our atmosphere.

4.3 Perceptions of government officers and medical practitioners with regards to variation of respiratory disease and PM10 concentration

In order to get perception of medical practitioners and experts, with regards to the issue about respiratory cases and air pollution. I interviewed 4 people who work in medical field and 4 people whose jobs are related to air pollution issue. All the answers were analyzed by frequency.

- Perception from Renji Hospital staff and Health Department staff

The perception from Renji Hospital and City Health Department staff is showed in table 4.5.1. It reveals the general opinion of medical practitioners with regards to respiratory disease and the variation between respiratory cases and air pollution.

Table 4.3.1The perception of Renji Hospital staff and Health Department staff form interviews

Question	Answer	Frequency
Do you think, the number of respiratory disease patients vary with the change of seasons?	Cases of respiratory diseases varies with the change of season	**3**
	Not sure	**1**
Do you think there is possible relationship between air pollution and respiratory disease?	might have this relationship	**4**
	Might not have this relationship	**1**
Which age group occupies the largest percentage of respiratory disease patients?	Retired people	**2**
	Young children	**2**
Which gender is relative visit hospital more frequently due to respiratory disease?	Male patients more than females	**4**

N=4

3 out of 4 respondents think that the number of respiratory cases varies with the change of season. 2 out of 4 respondents pointed that young children are the most vulnerable to respiratory disease, at the meantime, 2 respondents from Renji hospital believe old people to be also the most vulnerable group.

This perception matches the digital data got from Renji hospital that in both winter and summer season, the majority of respiratory disease happened in old people as well as in young children (see, table 4.0.1 and 4.0.2). Meanwhile, it is also confirmed by Pope (2006 see section 2.5.3) who shows young people to be the most affected by particle matter regardless of location; Older people also seemed to be more at risk, again hospital admissions and mortality rates reflected a stronger connection to high levels of fine particle matter.

Most respondents also claim that the number of male respiratory patients is higher than females. This perception can coincidence with the data got from Renji hospital that more male patients has respiratory disease (see, Annex 8) I imagine that this is because of differences in working class male and female lifestyle with more men smoking, drinking etc. as well as more men working in industrial labour.

When asked if there was a possible relationship between the increasing of air pollution and the increased number of respiratory disease, 100% answer yes which also conform the result from Renji hospital and monitoring station that the number of respiratory cases varies with the increasing PM10 concentration (see, section 4.2) .

- Perception from Hunggu Monitoring Station and Environment Department and University expert

The perception I got from Hunggu Monitoring Station and Environment Department and a University expert is showed in table 4.3.2. It reveals the general opinion of people who are working with air quality issues.

Table 4.3.2 Perception from Environmental Department officer, monitoring station officer and University expert form interviews

Question	Summary of Answers	Frequency
Does the concentration of PM10 varies with the change of seasons?	Generally, PM10 level varies with change of seasons	**4**
which season has lowest concentration of PM10 and which season has highest concentration of PM10?	Generally winter has highest concentration winter has lowest	**4**
Does the concentrations of air pollutants(24hours) are below municipal guidelines	most of time higher than standards	**3**
	Sometimes higher sometimes lower than standards	**1**
Do you think good air quality can help to reduce the chance of getting respiratory disease	yes	**2**
	Not sure	**2**
		N=4

The expert from local university and officers from Environmental Department and monitoring station believe the level of air quality varies with the change of season. They also claim that winter has the worst air quality, whereas, summer has the best air quality. Most of them also admit that most of time concentration of air pollutants (24hours) exceeds municipal guidelines. These perceptions agree with the digital data I got from Hungu monitoring station that daily PM10 concentration is above municipal guidelines(see, Annex 4 and 5). The level of PM10 varies with the change of summer and winter time, meanwhile, PM10 concentration in winter is noticeable higher than in summer (see, fig.4.1.1).

The expert and officers in the monitoring station are worried about bad air quality in Shenyang and its impact on human health, but the officer from Environmental Department did not want to claim that Shenyang has problems with air quality, denying a relationship between respiratory diseases and air quality.

4.4 Perception of citizens with regards to a possible relationship between the increasing of air pollution and the increasing number of respiratory diseases

Questionnaires were delivered to 60 respondents in order to gauge their perception of variations between an increasing number of respiratory cases and the increase of air pollution (PM10). Answers from these 60 respondents are analysed by percentage.

- Kinds of respiratory disease respondents suffered

The number of respondents with respiratory disease (Asthma, COPD, Pulmonary edema, pulmonary fibrosis) is showed in table4.4.1. This table classified respondents according 3 groups: old people, housewives and workers.

Old people seem to be the most vulnerable group to airborne disease, with the largest percentage of respiratory patients (33.3%). Compared to housewives (females 8.3%), workers (males) have more respiratory cases (16.6%) (see, table 4.4.1).

The result from questionnaires also correspond with the result from hospital digital data (see annex 8) and the perception of Renji Hospital and Health Department staff (table 4.3.1) that old people occupy the largest amount of respiratory patients, males seems to be more at risk from respiratory disease than females

Table 4.4.1 Kinds of respiratory diseases citizens are suffering

Answer from respondents	Old people (%)	Housewives (%)	Workers (%)
Asthma	0	8.3	1.6
Chronic obstructive pulmonary disease(COPD)	15	0	0
Pulmonary edema	13	0	0
Pulmonary fibrosis	5	0	15
Total number of patients	33.3	8.3	16.6
No any respiratory disease	0	25	16.6

N=60

When we look at the table 4.4.1, we can find that the most popular respiratory disease are Chronic obstructive pulmonary disease (COPD) and Pulmonary edema in old people's group. This result also match the digital data got from hospital that huge percentage of old people has Chronic obstructive pulmonary disease(COPD) and Pulmonary edema (see, Annex 8) .

One of reasons why Chronic obstructive pulmonary disease (COPD) and Pulmonary edema is popular among elders is that most of the old people are retried workers from two heating provision factories having worked in polluted atmosphere and lived in low air quality area for a long time, their illnesses are often related to long term exposure rather than solely their immediate environment. It can match a study of Hnizdo (2002, see section2.5.3) that ooccupational exposure to certain industrial pollutants also increases the risk for COPD. Another study by Brilhante (2002. See section 2.5.2) also indicates that ppermanent pollution, for instance, may sometimes, in association with such other factors as smoking or occupational risks, cause long-term effects on health which affect particularly groups of sensitive persons: children, the elderly and those suffering from chronic respiratory Insufficiencies.

- The perception of respondents with regards to highly polluted season and more frequently hospital visit season

The perception of respondents regarding which season has the worst air quality and which season they visit hospital more often is showed in table 4.4.2 and table 4.4.3, separately. Answers are analysed by percentage (%) and the total number of respondents is 60 people.

Table 4.4.2 The season has the worst air quality from citizen's perception

Answer	Percentage (%)
Spring	16.7
summer	1.7
Fall	13.3
winter	68.3
Total	100

N=60

As we can see, 68.3% of 60 respondents think winter is the season which has the worst air quality. They complain that in winter due to cold weather they need to provide heating by burning coal, this activity pollutes air a lot. This perception coincides with the perception of monitoring station; Environmental Department officers and University expert (see table .4.3.2). It also agrees with the digital data I collected from the monitoring station showing that concentration of air pollutant is higher in winter (see. Fig.4.1.1).

However, I notice that 16.7% claim spring has the worst air quality. I think this may because of dust-storms. Because there is a study by David (2009, section 1.1) indicates that plumes of dust from northern China, mixed with toxic air pollution, now are a major public health concern in China.

Table 4.4.3 The season has more respiratory cases from citizen's perception

Answers	Percentage (%)
Spring	8.3
summer	3.3
Fall	6.6
winter	78.3
Total	100

N=60

As we can see from table 4.4.3, most of citizens (78.3%) claim that they visit hospital more in wintertime due to respiratory disease, on the contrary, only 3.3% say that they visit hospital more in summertime. This perception is similar with the perception of Renji Hospital staff and Health Department staff (table 4.3.1) as well as coinciding with the digital data I collected from Renji hospital that the number of respiratory cases in winter is markedly higher than in summer(see, fig. 4.2.3).

- Perception of citizens with regards to an increasing number of respiratory cases and increased of air pollution

A high level of awareness with the majority of respondents responding affirmatively, although a significant proportion are unsure, those who disagreed represented a tiny percentage of the small study group as can be seen in table 4.4.4.

Table 4.4.4 Citizen Awareness with regards to an increasing number of respiratory diseases and increase of air pollution

do you think you visit hospital more in winter which due to air quality in winter is worst than any other seasons ?	**Answer from respondents**	**Percentage (%)**
	Yes	58
	No	3.3
	Not sure	38
	Total	100

N=60

Most of citizens (58%) think there is a possible relationship between an increasing number of respiratory cases and increasing air pollution. But 38% of citizens are not sure, suspecting that other factors not relating to air quality also contribute the seasonal changes. Only 3.3% think that there is no relationship between seasons and hospital visits, perhaps due to the low education level.

Chapter 5 : Conclusion

From the discussion in the previous chapter, we can draw conclusion about the possible relationship between PM10 concentration and number of respiratory cases as well as the seasonal factors.

The concentration of PM10 (24hours) was higher than municipal guidelines (<150um/m^{-3} 24hours) throughout the two seasons (winter and summer) of 2010. The PM10 concentration varies with the change of seasons. Furthermore, temperature and amount of precipitation also contribute to this difference.

The frequency of PM10 concentration (24hours) exceeds municipal guidelines (150ug/m^{-3}) in winter by 30 times, whereas in summer it does so 26 times. Meanwhile, the temperature in winter below 0°c with very low precipitation (almost 0 mm), whereas the temperature in summer is around 20° centigrade with 150mm precipitation. The temperature and precipitation levels may contribute to the higher PM10 concentration in winter.

The information from Renji hospital and Huanggu Monitoring Station show that the number of respiratory cases coincides with the levels of air pollution during summer and winter time in 2010. Winter has higher levels of PM10 with higher numbers of respiratory cases, than summer.

In summer time the number of respiratory cases collected in the hospital varies between 30 to 50 cases, whereas in winter this number varies from 40 to 85 cases. The level of PM10 in winter time 250um/m^{-3} (January, February, December) is noticeably higher than it is in summer 150um/m^{-3} (June, July, August).

When we look at the period from 2005 to 2010, the number of respiratory cases seems to rise and fall in conjunction with the PM10 concentration. This pattern is also reflected in the data that I collected from 2010

Regarding the public perception about the relationship between increases in air pollution and the number of respiratory cases, Most citizens (58%) think that there might be a possible relationship. 38% of citizens are not sure, and 3.3% deny this possible relationship. Citizens also tend to show that long term diseases such as chronic obstructive pulmonary disease (COPD) and Pulmonary edema are the most common illnesses related to air quality

From what we discussed above, we can draw the conclusion that there is a possible relationship between the increases in air pollution and the increasing number of respiratory cases. The number of respiratory diseases as a whole increases coinciding with the increase in atmospheric pollution (suspended particulate matter which measure as PM10 24hours) which took place in the months of 2010.

Overall, the result seems to match my hypothesis showing people visit hospital more often due to respiratory disease when the air pollution (PM10 concentration) increases.

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ANNEX 1 Questionnaires for citizens

I. Respondent's Data:

1.Address :_______Shenyang

2.Age :_________Years

3.Gender :_________

4.occupation :____________

5.education(highest) :______________

II. perception of local people regard to increase of air pollution and the increase of the number of respiratory diseases.

KNOWLEAGE OF CITIZENS ABOUT REPIRATORY DISEASE

1.What respiratory disease do you know ?(can be many answers)

a. Asthma (irritant)

b. Bronchitis (chronic)

c. Chronic obstructive pulmonary disease (COPD)

d. Pneumonia

e. Pulmonary edema

f. Pulmonary fibrosis

g. Others_______(please specified)

2. In your opinion what kind of elements can have an affect on respiratory diseases?(can be many answers)

A. temperature b.humidity c. Ari movement d. Air pollutants

3. What the sources of air pollution do you know?(can be many answers)

a. Sources of incomplete combustion of coal and wood

b. Occurrence ash and dust

c. Motor vehicles

d. Natural impact (wind)

e. Tobacco smoking

f. Others ____________(please specify)

PERSONAL INFORMATION

1. How do you cook at home?

a. Burn coal for cooking food

b. Use nature gas

c. Others _______(please specify)

2. How do you get heating service in winter?

a. Provide heating by burning fossil fuel at home

b. Get heating service from the heating provision companies

c. Use electricity

d. Others ________(please specify)

3. Do you smoke?

(YES__/NO___)

4. Do you have any respiratory illnesses?

(YES__/NO___)

5. If yes, what kind of respiratory illness do you have ?

a. Asthma (irritant)

b. Bronchitis (chronic)

c. Chronic obstructive pulmonary disease (COPD)

d. Pneumonia

e. Pulmonary edema

f. Pulmonary fibrosis

g. Others_______(please specified)

6.Are you satisfied with air quality in your living area?

a.Yes

b.No

7.Which season you think has worst air quality ?

a. Spring

b. Summer

c. Fall

d. Winter

e. Don't know

8. Which season you visit hospital due to respiratory illness more frequently ?

a. spring

b. Summer

c. Fall

d. Winter

e. Don't know

8. If more in Winter , do you think this due to air quality in Winter is worst than any other seasons ?

a. Yes

b. No

c. Don't know

9. do you think local government have done any effort to improve air quality?

a. Nob. Yesc. Don't know

ANNEX 2 Questions for hospital staff and Health Department

1.Does the number of respiratory disease patients vary with the change of seasons?

2.If it does, which season has the smallest number of respiratory disease patients and which season has the largest number of respiratory disease patients?

3. What are the most common respiratory diseases? Which kind of respiratory disease occupies the largest percentage?

4. Where do most of respiratory disease patients live?

5.Which age group occupies the largest percentage of respiratory disease patients?

6.Which gender is relative visit hospital more frequently due to respiratory disease?

7. do you think there is a possible relationship between air pollution and respiratory disease?

ANNEX 3 Questions for environmental officers and Environmental Institutions

1. Does the concentration of PM10 vary with the change of seasons?

- If it does, which season has lowest concentration of PM10 and which season has highest concentration of PM10?

2.How do you monitor the concentration of air pollutants?

4.What about local air quality? Do the concentrations of air pollutants are below the standards?

5. Have you received the complaints from citizens about air pollution?

6. Do you think good air quality can help to reduce the chance of getting respiratory disease?

7. What has happened with air quality among 2000 and 2010, have the air quality been improved?

8. What efforts has government made towards improving air quality?

ANNEX 4 daily PM10 concentration and number of respiratory case and monthly number of diagnose of per respiratory disease in different age group in wintertime(Jan, Feb and Dec) in 2010

A	B	C	D	E	F	G	H
Jan. 2010	PM10 concer	Seniors(60-74;75-89	young children(0-	children(6-15)	middle aged people(45-5	adult(16-26;26-44	total
1	0.227	35	3	2	2	1	43
2	0.25	39	5	7	3	1	55
3	0.244	35	8		2	1	46
4	0.254	41	10	1	2		54
5	0.233	33	2	1	1	3	40
6	0.235	35	2	1	2		40
7	0.259	40	11	9	3	2	65
8	0.248	38	6	5	3	2	54
9	0.255	46	8	6	3	2	65
10	0.233	35	5	7	2		49
11	0.24	37	7	8	2	2	56
12	0.242	36	5	6	2	2	51
13	0.232	33	1	5	2	1	42
14	0.252	42	10	8	3	3	66
15	0.255	40	9	8	4	3	64
16	0.256	39	8	12	3		62
17	0.28	34	2	8	2	2	48
18	0.23	35	3	2	2	1	43
19	0.254	39	6	10	2	0	57
20	0.256	41	8	10	3	1	63
21	0.24	35	6	7	2	0	50
22	0.24	36	5	6	3	0	50
23	0.26	38	7	10	3	2	60
24	0.261	44	11	14	4	2	75
25	0.253	40	9	11	2	3	65
26	0.245	37	5	13	2	2	59
27	0.234	34	7	10	2	2	55
28	0.255	40	12	12	4	1	69
29	0.262	45	10	15	4	1	75
30	0.245	38	9	10	2		59
31	0.257	42	10	12	3	3	70
0.24796774	**7.687**	**1182**	**210**	**236**	**79**	**43**	**1750**

Jan. 2010		Seniors(60-74;75-89	young children(0-	children(6-15)	middle aged people(45-5	adult(16-26;26-44	总计
Asthma		34	51	79	3	1	168
Bronchitis		20	69	82	3	5	179
obstructive pulmonary disease		549	0	0	15	3	567
Pneumonia		16	90	75	4	4	189
Pulmonary edema		531	0	0	20	5	556
Pulmonary fibrosis		32	0	0	34	25	91
total		***1182***	***210***	***236***	***79***	***43***	***1750***

A	B	C	D	E	F	G	H
Feb.2010	PM10 concen.	seniors(60-89)	young children(0-5)	children(6-15	middle aged people(45-5	adult(16-44	total
1	0.251	35	10	9	2	4	60
2	0.246	35	8	11	3	3	60
3	0.246	38	9	11	2	2	62
4	0.242	39	11	10	2	6	68
5	0.242	36	5	11	3	3	58
6	0.243	35	7	11	2	2	57
7	0.246	39	8	11	3	2	63
8	0.252	38	10	12	3	4	67
9	0.248	37	13	13	2	3	68
10	0.245	39	12	12	2	4	69
11	0.304	42	17	15	2	4	80
12	0.295	44	15	18		5	82
13	0.301	43	13	19	3	3	81
14	0.334	45	15	21	1	3	85
15	0.32	40	14	17	1	3	75
16	0.302	39	13	18	2	4	76
17	0.31	47	13	15	3	5	83
18	0.282	41	10	17	2	5	75
19	0.251	35	11	16	2	4	68
20	0.255	41	11	14	3	4	73
21	0.242	35	9	10	2	4	60
22	0.256	43	10	15	3	3	74
23	0.262	42	12	15	5	4	78
24	0.255	41	9	14	2	4	70
25	0.254	40	12	14	2	5	73
26	0.248	37	11	13	2	3	66
27	0.256	42	13	14	2	1	72
28	0.291	40	17	19	4	3	83
total	***7.479***	***1108***	***318***	***395***	***65***	***100***	***1986***

Feb.2010		seniors	young children	children	middle aged people	adult	**total**
diganoses		***1108***	***318***	***395***	***65***	***100***	**1986**
Asthma		40	82	127	2	7	**258**
Bronchitis		27	115	123	5	36	**306**
obstructive pulmonary disea		483	0	0	11	3	**497**
Pneumonia		10	121	145	1	34	**311**
Pulmonary edema		520	0	0	13	2	**535**
Pulmonary fibrosis		28	0	0	33	18	**79**
total		***1108***	***318***	***395***	***65***	***100***	***1986***

A	B	C	D	E	F	G	H
Dec.2010	PM10 conce.	seniors	young children	children	middle aged people	adult	**total**
1	0.227	31	4	6	1		42
2	0.224	30	5	6			41
3	0.224	29	6	3	2	1	41
4	0.234	34	5	8	4		51
5	0.23	32	8	4		3	47
6	0.226	29	6	6	1		42
7	0.233	34	7	7	3		51
8	0.235	32	4	8	3	2	49
9	0.239	37	5	9	4	4	59
10	0.228	32	4	4	3		43
11	0.231	31	4	7	1	1	44
12	0.237	36	8	9	4	2	59
13	0.241	36	10	11	5	2	64
14	0.232	34	7	7			48
15	**0.227**	**29**	**5**	**4**	**3**		**41**
16	0.225	30	6	5	2	1	44
17	0.225	27	5	6	3		41
18	0.231	32	5	4	2	2	45
19	0.235	31	8	6	2	3	50
20	0.228	28	6	5	2	3	44
21	0.228	27	5	8	1	1	42
22	0.234	35	8	5	3	1	52
23	0.237	34	8	7	3	3	55
24	0.24	37	12	10	5		64
25	0.227	28	3	4		4	39
26	0.23	33	6	5	1		45
27	0.237	36	8	8	3	3	58
28	0.235	32	5	7		1	45
29	0.235	33	4	6	2		45
30	0.229	30	6	6			42
31	0.234	33	9	7	3	1	53
total	7.178	***992***	***192***	***198***	***66***	***38***	***1486***

diganoses/Dec.2010		seniors	young children	children	middle aged people	adult	**total**
Asthma		29	48	61	1	1	140
Bronchiti		15	63	69	2	4	153
obstructive pulmonary		462	0	0	14	3	479
Pneumonia		18	81	68	4	4	175
Pulmonary edema		433	0	0	13	5	451
Pulmonary fibrosis		35	0	0	32	21	88
total		***992***	***192***	***198***	***66***	***38***	***1486***

ANNEX 5. Daily PM10 concentration and number of respiratory cases and monthly number of diagnose of per respiratory disease in different age group in summertime (June, July and August) in2010

A	B	C	D	E	F	G	H
June2010	PM10 conce.	seniors	young childre	children	middle aged peopl	adult	total
1	0.15	21	4	4			29
2	0.154	23	5	5	1		34
3	0.154	23	6	6	1		36
4	0.153	24	5	4		1	34
5	0.153	26	6	5			37
6	0.149	21	4	4			29
7	0.153	24	4	6			34
8	0.152	20	7	4	1		32
9	0.155	24	6	7	1		38
10	0.15	21	4	4			29
11	0.154	23	5	5	1		34
12	0.146	18	4	6	1		29
13	0.155	26	6	6			38
14	0.152	24	5	5			34
15	0.153	26	6	5			37
16	0.149	21	4	4			29
17	0.145	20	2	3			25
18	0.153	23	5	5			33
19	0.155	26	6	6	1		39
20	0.15	22	3	4	2		31
21	0.152	24	5	4			33
22	0.153	25	6	5			36
23	0.149	21	5	4	1		31
24	0.154	24	6	5			35
25	0.155	24	7	6		1	38
26	0.153	23	5	5		1	34
27	0.155	26	6	6	1		39
28	0.15	22	4	4	1		31
29	0.154	23	6	5	1		35
30	0.153	24	5	4			33
total	4.409	***692***	***152***	***146***	***13***	***3***	***1006***

diganose	/june 2010	seniors	young childre	children	middle aged peopl	adult	total
Asthma		5	56	52	1	0	114
Bronchitis		4	60	54	1	0	119
obstructive pulmonar		327	0	0	3	2	332
Pneumonia		5	36	40	0	0	81
Pulmonary edema		351	0	0	5	1	357
Pulmonary fibrosis		0	0	0	3	0	3
total		***692***	***152***	***146***	***13***	***3***	***1006***

A	B	C	D	E	F	G	H
July2010	PM10 conce.	seniors	young childrer	children	middle aged peopl	adult	total
1	0.154	24	6	5			35
2	0.153	24	5	6			35
3	0.155	25	6	6	2		39
4	0.15	21	4	4			29
5	0.15	22	5	4			31
6	0.152	22	5	4			31
7	0.153	24	4	6			34
8	0.157	27	9	9	1		46
9	0.155	24	6	6	1		37
10	0.15	21	4	4			29
11	0.154	23	5	5	1		34
12	0.158	25	10	8	3	1	47
13	0.149	21	4	5			30
14	0.154	24	5	5		1	35
15	0.145	17	3	4	2		26
16	0.154	24	6	6			36
17	0.153	24	5	5			34
18	0.155	26	6	6	1		39
19	0.157	25	10	9			44
20	0.15	22	4	4	2		32
21	0.152	24	5	4			33
22	0.153	26	6	5			37
23	0.149	21	4	4			29
24	0.155	25	6	6	1		38
25	0.15	21	4	4	2		31
26	0.154	24	6	5		1	36
27	0.159	27	11	9		1	48
28	0.156	26	8	6			40
29	0.154	23	6	5	1		35
30	0.153	24	4	4		1	33
31	0.155	24	7	6			37
total	4.748	730	179	169	17	5	1100

diganose/junly 2010		seniors	young childrer	children	middle aged peopl	adult	total
Asthma		20	76	59	1	1	157
Bronchitis		17	59	58	1	0	135
obstructive pulmonary d		352	0	0	5	1	358
Pneumonia		11	44	52	0	0	107
Pulmonary edema		327	0	0	5	2	334
Pulmonary fibrosis		3	0	0	5	1	9
total		730	179	169	17	5	1100

A	B	C	D	E	F	G	H
Aug. 2010	PM10 conce.	seniors	young children	children	middle aged people	adult	**total**
1	0.15	21	4	4			29
2	0.154	23	5	5	1		34
3	0.155	25	6	6	2		39
4	0.152	24	5	4			33
5	0.153	26	6	5			37
6	0.149	21	4	4			29
7	0.153	24	4	6			34
8	0.152	20	7	4	1		32
9	0.155	24	6	6	1		37
10	0.15	21	4	4			29
11	0.154	23	5	5	1		34
12	0.146	18	4	6	1	1	30
13	0.149	21	3	5			29
14	0.154	24	6	5		1	36
15	0.154	23	6	5	1		35
16	0.153	24	6	4		1	35
17	0.155	24	7	6			37
18	0.153	23	5	5		1	34
19	0.155	26	6	6	1		39
20	0.15	22	4	4	2		32
21	0.152	24	5	4			33
22	0.153	26	6	5			37
23	0.149	21	5	4			30
24	0.154	24	6	5			35
25	0.153	24	5	6			35
26	0.157	25	6	6	2		39
27	0.15	21	4	4			29
28	0.158	26	8	4	1	1	40
29	0.154	23	6	5	1		35
30	0.153	24	5	4		1	34
31	0.148	20	4	6			30
total	4.727	***715***	***163***	***152***	***15***	***6***	***1051***

diganose	Aug. 2010	seniors	young children	children	middle aged people	adult	**total**
Asthma		12	61	51	0	2	126
Bronchitis		12	69	57	0	0	138
obstructive pulmonar		331	0	0	3	1	335
Pneumonia		5	33	44	0	0	82
Pulmonary edema		354	0	0	7	2	363
Pulmonary fibrosis		1	0	0	5	1	7
total		***715***	***163***	***152***	***15***	***6***	***1051***

Annex 6.monthly number of male and female patients in 2010

month of 2010	number of male patients	number of female patients	no sex identification
january	902	825	23
february	1024	942	20
june	509	483	14
july	552	525	23
august	521	505	25
december	766	708	12
total	4274	3988	117

Annex 7. Average temperature and average amount of precipitation per month in 2010

Month of 2010	Jan.	Feb.	May	Api	may	Jun	Jul	Aug	Sep	Oct	Nov.	Dec.
average temperature(℃)	-17.6	-9.1	0.1	9.3	15	21.5	24	23.5	12.5	5.15	-1.1	-7.9
average amount of precipitation (mm)	0.8	1	25	40	51	90	182	166	75	42	20	10

Annex 8. Frequency(%) of diagnoses per kind of respiratory disease, frequency(%) of patients' address in wintertime and summertime, 2010

Diganoses	**Senis> 60**	**young children(0-5)**	**childrn(6-15)**	**Adult (16-59)**	**Total**	**adress of patients**		Gender	
ashthma	1.6 (140)	4.4 (374)	5.1 (429)	0.2 (20)	11.5 (963)	Guanbei community	Other area	Male	Female
Bronchitis	1.1 (95)	5.1 (435)	5.2 (443)	0.6 (57)	12.3 (1030)	96.3 (8027)	4.2 (352)	51.2% (4274)	47.8% (3988)
obstructive pulmonary disease	29.8 (2504)	0	0	0.7 (64)	30.7 (2568)			no sex identification	
Pneumonia	0.7 (65)	4.8 (405)	5.0 (424)	0.6 (51)	11.3 (945)			9.3‰ (117)	
Pulmonary edema	30.0 (2516)	0	0	0.9 (80)	30.9 (2596)				
Pulmonary fibrosis	1.2 (99)	0	0	2.1 (178)	3.3 (277)				
Total	64.7 (5419)	14.5 (1214)	15.5 (1296)	5.4 (450)	8379	N=8379			