TAMPERE UNIVERSITY
OF APPLIED SCIENCES

RETROSPECTIVE STUDY OF EFFECTS OF AIR POLLUTION ON HUMAN HEALTH

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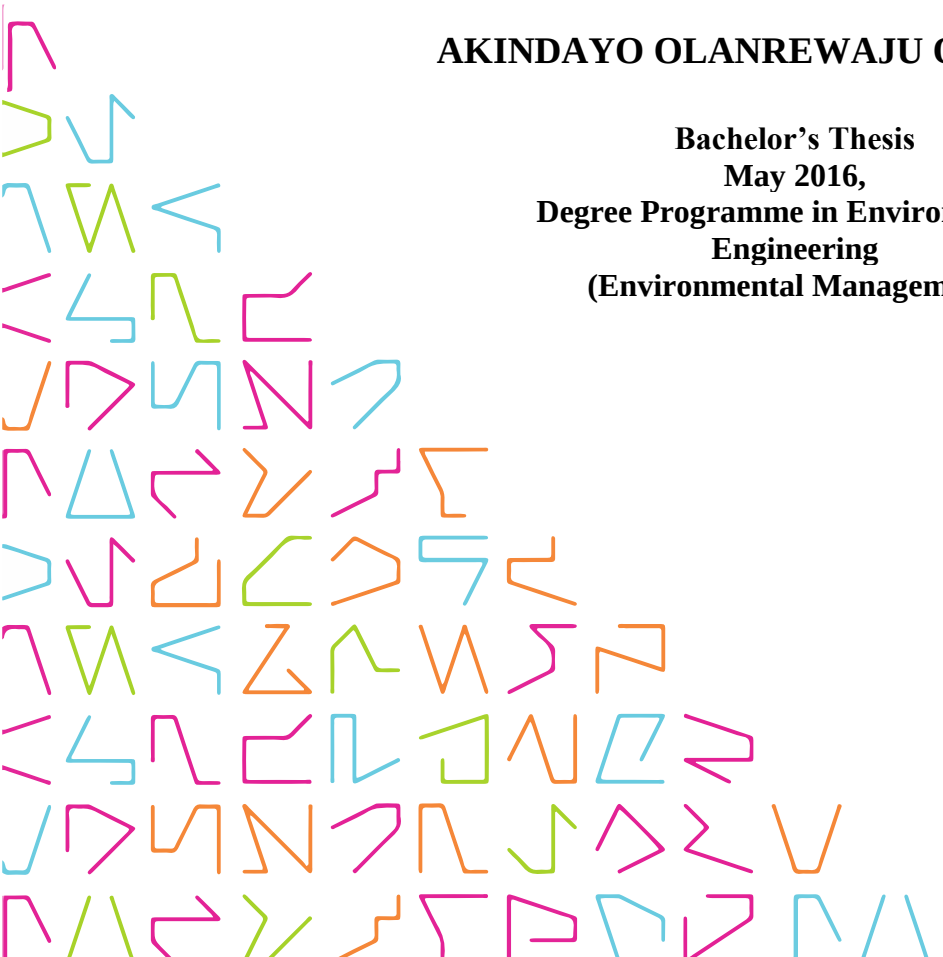
Bachelor's Thesis
May 2016,
Degree Programme in Environmental Engineering
(Environmental Management)



ABSTRACT

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
Degree Programme in Environmental Engineering
Option of Environmental management

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Retrospective Study of Effects of Air Pollution on Human Health

Bachelor's thesis 66 Pages.
May 2016

Environmental air pollution poses serious challenges to human health, the effects which are mostly seen as the respiratory diseases, cardiovascular diseases and cancers. Our health is closely related to our environment.

The aim of this study was to identify the air pollutants that are of health importance to humans and to find their negative impacts on human health, conduct retrospective studies to find out if there is a correlation between exposure to environmental air pollutants and hospital visits due to symptoms of respiratory diseases and to see if exposure to environmental air pollution has significant effects on hospital visits due to the symptoms of respiratory diseases.

Patients' data were collected from respiratory and infectious disease Dr Victor Babes hospital, Timisoara, Romania. Hospital case files of 229 patients that presented at the hospital from 1st February 2016, till 22nd March 2016 were collected and analysed in accordance with rules of the ethical committee. The data collected includes hospital file number, sex, age, diagnosis, comorbidity, month of the last hospital visit, positive family history of the diseases, occupation, working in environment with toxic substances, exposure to toxic substances at workplace, smoking, years of smoking, and number of packets of cigarette per day.

The Pearson correlation coefficients of correlation between the exposures to environmental air pollutants against total hospital visit is 0.99 showing a strong correlation and also the P value of 0.004 ($p<0.05$) using two-tail shows that exposure to environmental air pollutant has a significant effect on the total hospital visits due to symptoms of illness at the confident interval of 95%.

The findings justify that exposure to air pollution has serious effects on human health especially in causing symptoms and diseases.

Keywords: air Pollution, air pollutants, human health, exposure, toxic environment, diseases, retrospective studies, respiratory and infectious.

Acknowledgement

I give all glory to God for seeing me through the journey. Special thanks to my mum, my sister and Engr. & Mrs Salami for their parental, moral and financial support, you are God's sent! My gratitude goes to my former study coordinator and my project supervisor, Dr Eeva-Liisa Viskari for her moral support and encouragement throughout the programme especially when the journey was very rough. My gratitude also goes to the study counsellor Mirja Onduso for her encouragement and support in every ways and to the Study coordinator, Mika Nieminen and to all my teachers at TAMK, I am proud of you all for impacting priceless knowledge into me.

I also want to use this opportunity to thank my teachers at University of Medicine and Pharmacy, "Victor Babes" Timisoara, and Dr. Emanuela Tudorache and the Professor Voicu Tudorache, the head of Pneumology department for their supports during the data collections for this thesis. I also sincerely appreciate my friend, Raluca Eremia for her support in translation during data collection. To all my colleagues at both TAMK and UMFT, wishing you all the very best in your future endeavours.

It wouldn't have been possible to go through this journey without the unconditional love and supports of the Ogunbayos'. Thank you all for being there always.

May 2016,
Akindayo Olanrewaju Ogunbayo

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1 INTRODUCTION

1.1 Study Background

Since the industrial revolution, the rate of pollution of our environment has increased tremendously with the negative impact threatening our existence in terms of climate change, global warming and flooding.

Environmental air pollution poses serious risk to our existence as human, the effects which are underestimated and reported. Several scientists, researchers, international organisations, governmental and non-governmental agencies are relentlessly studying the impacts of environmental pollution on our health. The emerging data from the recent research on the health consequences of environmental air pollution are astonishing and scary. Recently, diabetic diseases have been linked to environmental air pollution (Chen H, 2013), Infertility and pregnancy loss have also been attributed to air pollution (Nazli Hossain & Elizabeth Westerlund Triche, 2007). In 2014, World Health Organization announced the classification of air pollution as class I human carcinogen due to cumulative evidence by the researchers across the world that air pollution is a predisposing factor to nasopharyngeal, lung, head and neck cancer (Wong IC, 2014)

According to the latest report and data released by WHO on 25th March, 2014, about 7 million deaths in 2012 were attributed to air pollution exposure, the data which doubled the previous estimation. This data made WHO to term air pollution as the largest single environmental health risk.

The evidences of involvement of pollutant gases in development of allergic reactions are emerging. Li J and associates from Peking University, Beijing in their recent research found that over 400 unique bacterial species including opportunistic pathogens and those that are capable of eliciting allergic reaction were found in abundance in the dust samples collected from filter of automobile air conditioning (AC) within 5 minutes of powering (Li J, 2013).

1.2 Aims of this study

The aims of my studies are as follows:-

- To identify the air pollutants that of health importance human find their negative impact on human health.

- To identify the previous researches done in the field of environmental health and link the cause to effect of pollutants on human health and profound solutions for prevention against these pollutants.
- To access the European Environment Agency database and generate data on environmental air pollutants which are of health importance among 28 European Union country EU28.
- To make retrospective studies and collect patients' health data at the Respiratory and Infectious disease, Dr Victor Babes hospital, Timisoara.
- To analyse the collected patients' data and find if there is a correlation between exposure to environmental air pollutants and hospital visit due to symptoms of respiratory diseases by the patients using Pearson correlation analysis.
- To find if exposure to environmental air pollutants has significant effect on hospital visit due to symptoms of respiratory diseases.

1.3 Null hypothesis (H0)

1) There is no correlation between the disease cases presented as a result of exposure to environmental air pollution and total hospital visit.
2) Exposure to environmental air pollutant do not have a significant effect on the total hospital visit due to illness.

1.4 Scopes of this study

The effect of environmental air pollution on human health is a well-known topic and of research interest in the field of environmental and public health studies and research. There have been many publications by different health agencies, environmental agencies, and researchers in the field of environmental, public and global health across the globe. The most common studies involve studies of ambient air pollution exposure and their effects on cardiopulmonary diseases (Phung D, 2016), on hospital emergency room visit (Liu P, 2016) and hospital admission of young children for acute lower respiratory infection (Le TG, 2012). Most of these studies focused on indoor or outdoor air pollutant as well as ambient air pollution with little studies on long term exposure to these pollutants. However, none of these studies have tried to study exposure to toxic environmental air pollutants at workplace in addition to exposure to ambient air in relation to hospital visit.

The uniqueness of this studies lies in the fact that it is non biased retrospective epidemiological studies which identified all the major and established diseases (that were presented at the respiratory and infectious disease hospital Dr Victor Babes, Timisoara) associated with environmental air pollution. The identified diseases were analyzed and their presentation were compared among those that were considered to be exposed to considerable long term effects of environmental air pollutants and those considered to be non-exposed (but do not include ambient air pollution).

1.5 Limitation of this study

The limitation of this study lies in the data collection. In the hospital case file, it is usually written if a patient is exposed to toxic environment mostly occupational related exposure. The possible exposed pollutants and the dosage of exposure were not recorded in the hospital case file.

In future studies, data in occupational medicine which includes nature and dosage of exposure should be used. Also, undertaking epidemiological case studies research and cross referencing them with this study (retrospective) will be a valuable research in future studies.

2 MAN AND HIS IMMEDIATE ENVIRONMENT

Man is found constantly interacting with his environment in which his health cannot be separated from his immediate environmental qualities. The air we breathe in, the work we do and the physicochemical and biological factors of the environment has a tremendous effect on our health (Environment Nature and Energy Department, 2014).

According to Business dictionary, Environment is defined as the sum total of all the surroundings of a living organism including, natural forces and other living things which provides living conditions for development and growth as well as of danger and damages. (S.balanarayanan & K.vetrivel, 2012). In relation to health, the world Health Organization (WHO) defined environment as all physical, chemical and biological factors external to person and all related behavior. It is imperative to maintain a healthy environment in order to have a good health.

According to WHO and the most commonly quoted definition, health is "a complete state of physical, mental and social well-being, and not merely the absence of disease or infirmity'' (Jakob, 2005).

Our health is closely related to our environment (Environment Nature and Energy Department, 2014) such that a healthy environment brings healthy living and vice versa. Our health can be traced to our microclimate, the home we live: the type of fencing; roofing, wall colour and landscape orientation. The public health practitioners are at the forefront of preventing diseases and promoting health of the people (Gabriel N. Stover, 2003), increasing quality of life and years of healthy living (Oregon Public health authority, 2014).

According to Professor Cristina Pretrescu of University of Medicine and Pharmacy ''Victor Babes'' Timisoara, in her published book titled Element of Hygiene, she explained how the building we live can affect our health and pointed out some building associated illnesses (non-hazardous). There are 2 categories of building-associated illnesses which are:-

1 Acute short-latency illnesses
2 Potential chronic long-latency illnesses

Examples of short latency illnesses are: - sick building syndrome, mass psychogenic illness, specific illness resulting from identifiable noxious materials, certain infectious and building associated hypersensitivity pneumonitis (Cristina Pretrescu, 2002). The symptoms are of acute onset and closely associated with the duration of staying in the building and the symptoms subside when one leaves the building. In contrast, long-latency illness is associated with long

time low level exposure to contaminant of indoor air which may result into chronic pulmonary diseases or even cancer (Cristina Pretrescu, 2002).

Building associated illness could be specific if it could be proved that the symptoms and illnesses are associated with specific noxious substances in the building for instance Legionnaires' disease, occupational asthma, hypersensitivity pneumonitis, Inhalation fever and humidifier fever (Merck Manuals, 2008). It could be nonspecific if it is difficult to establish the link between building related exposure and illnesses (Merck Manuals, 2008). Such symptoms includes :- Itchy, irritated, dry, or watery eyes, runny nose or nasal congestion, throat soreness or tightness, dry itchy skin or unexplained rashes, headache, lethargy, or difficulty in concentrating.

It has been established that environmental factors are responsible for about 25% of total diseases burden globally and one third among children (World Health Organization, 2006).

2.1 Environmental Air Pollution

'Ever since primitive *Homo sapiens* sat crouched by the warmth of a smoky fire in his Paleolithic cave, human have been undoubtedly been coping with a certain amount of polluted air' (Mengesha Admassu & Mamo Wubeshet, 2006)**.** Since the industrial revolution, the rate of pollution of our environment has increased tremendously with the negative impact threatening our existence in terms of climate change, global warming and flooding. The rapid population growth demands that the technology must meet the demand globalization and subsequently, increase in combustion of fossil fuel. Historically, environmental air pollution could be traced back to city of London which was known for coal mining and exportation. (Mengesha Admassu & Mamo Wubeshet, 2006).The city was well known for 'big smoke', fog and smog. In 1873, over 700 people died as a result of smog and in December 1952, approximately 4000 during Great London Smog (Oosthoek, Jan, 2014).

The same trends which made London headquarter of polluters were seen in United State during 19th and 20th century. However, today, one needs not to travel to either London or United State to feel the environmental and health impact of air pollution as a result of industrialization.

Nowadays, the problem of air pollution is felt mostly in the urban area due to increase in consumption of products which gives bye products as air pollutants. Inadequate pollution control, lack of regulations and proper law enforcements, unregulated vehicular emissions and

increasing desertification among others are seen as factors promoting environmental air pollution (Parivesh Hazardous Air Pollutants, 2009)

2.11 Definition of Air Pollution

World Health Organization in 1999 defines air pollution as 'substances put in by the activities of mankind in concentration sufficient to cause harmful effects to health, properties, crop yield, or to interfere with the enjoyment of property' (Amitava Mukherjee, 2002)**.** The substances either natural or artificial which pollute the environment is termed pollutant.

For air pollution to have effect, the pollutant is first released to the atmosphere and undergoes some mixing or chemical transformation and thereafter, exact it effect on receptors. Receptor as used in this context is referred to human, animals, plant or materials.

2.1.2 Classification of Air Pollution

Air pollution could be classified as

1 Natural or manmade.
2 Stationary or mobile.

Natural pollutants includes: - pollen grain, volcanic eruption, forest fires, dust storm, spores bacteria and other microorganisms (Bibhabasu Mohanty, 2014) and also radon, fog and mist, and ozone.

The State of New Jersey, Department of Environmental Protection divides man-made sources of air pollution into 1) point sources, 2) area sources and 3) line sources.

Point sources are stationary facilities in which during manufacturing processes emit large or significant amounts of pollutants into the environment for instance, power plants; refineries; municipal waste incinerator; toxic waste transfer, storage and disposal facilities(TSDFs) (State of New Jersey Department of Environmental protection, 2014).

Area sources are regarded as small sources of air pollution which fall below threshold but when the multiplicity effects are combined, they account for significant source of air pollution. Example includes:- industrial processes such as metal electroplating companies, chemical manufacturing plants, metal recycling plants, bakeries, residential heating and fuels use,

gasoline stations, institutional and commercial heating (State of New Jersey Department of Environmental protection, 2014).

2.1.3 Classification of Air pollutants.

Air pollutant is a substance dwelling temporarily or permanent in the air which adversely alters the environments by interfering with the health, the comfort or the food chain or by interfering with the property values of the people' (Eran Sher, 1998).

Air Pollutants can be classified into two

1) primary pollutants
2) Secondary pollutants

Primary pollutants are the pollutants which are directly emitted from the source.

The major primary pollutants are: - Particulate matter, Sulphur (IV) oxide, Nitrogen oxides, lead (Pb), Carbon monoxide, and Volatile organic compounds.

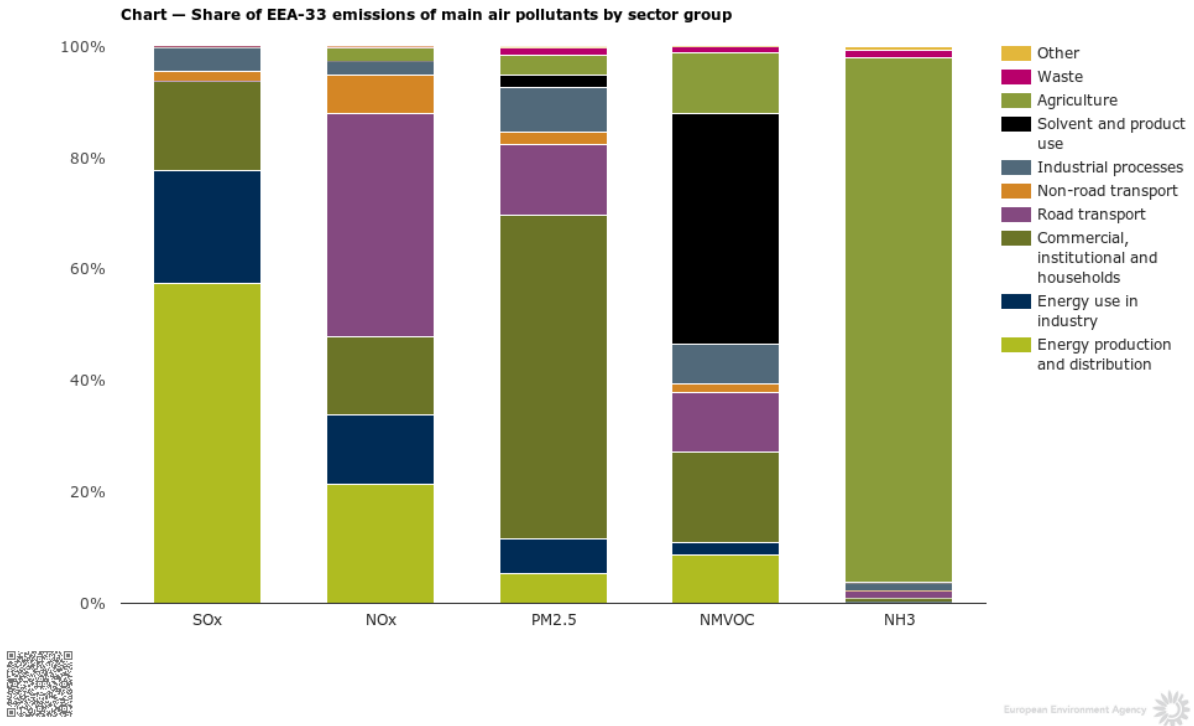


Figure 1: The emission of main pollutants by EEA 33.
The data was generated from the database of European Environment Agency
Source: European Environment Agency

Secondary pollutants are formed in the atmosphere as a result of chemical reaction of primary pollutants. Example includes: - Tetraoxosulphate (IV) acid, nitrous acids which causes acidic rain, Smog

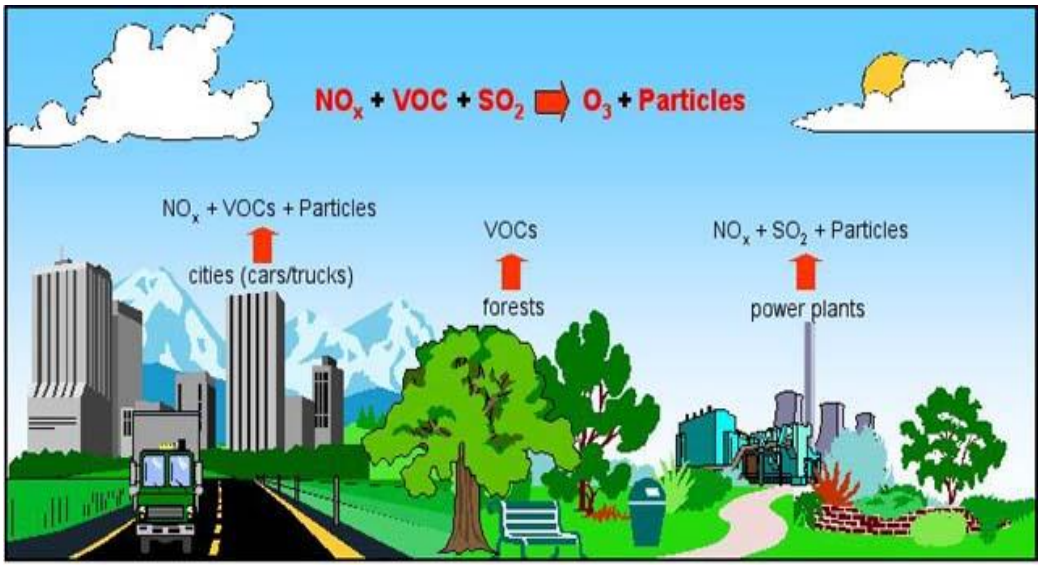


Figure 2 showing how various primary air pollutants could combine together in the atmosphere to give secondary pollutants.
Source: US department of commerce and national oceanic and atmospheric administration.

3 MAJOR ENVIRONMENTAL AIR POLLUTANTS AND THEIR HEALTH EFFECTS

There are many air pollutants which are of public health importance. They have pronounced consequences on human health ranging from causing asthma, respiratory diseases, infections and risk factors for cancer. Depending on the dosage of exposure and accumulation of these pollutants in the body overtime, a serious health threat and death can ensue. These pollutants include: - carbon monoxide, oxides of sulphur and nitrogen, heavy metals and particulate matter.

3.1 Carbon Monoxide

It is a colourless, odourless, tasteless and very poisonous gas. Its occurrence is naturally in volcanoes, natural gas emission and seed germination (Bibhabasu Mohanty, 2014). Artificially, it is formed as a product of incomplete combustion processes of carbon based energy sources such as burning of fuels (Scottish Environmental protection Agency, 2014). People in urban area are constantly exposed to this harmful gas. Furnaces and heater also emit this gas especially when they are not properly maintained

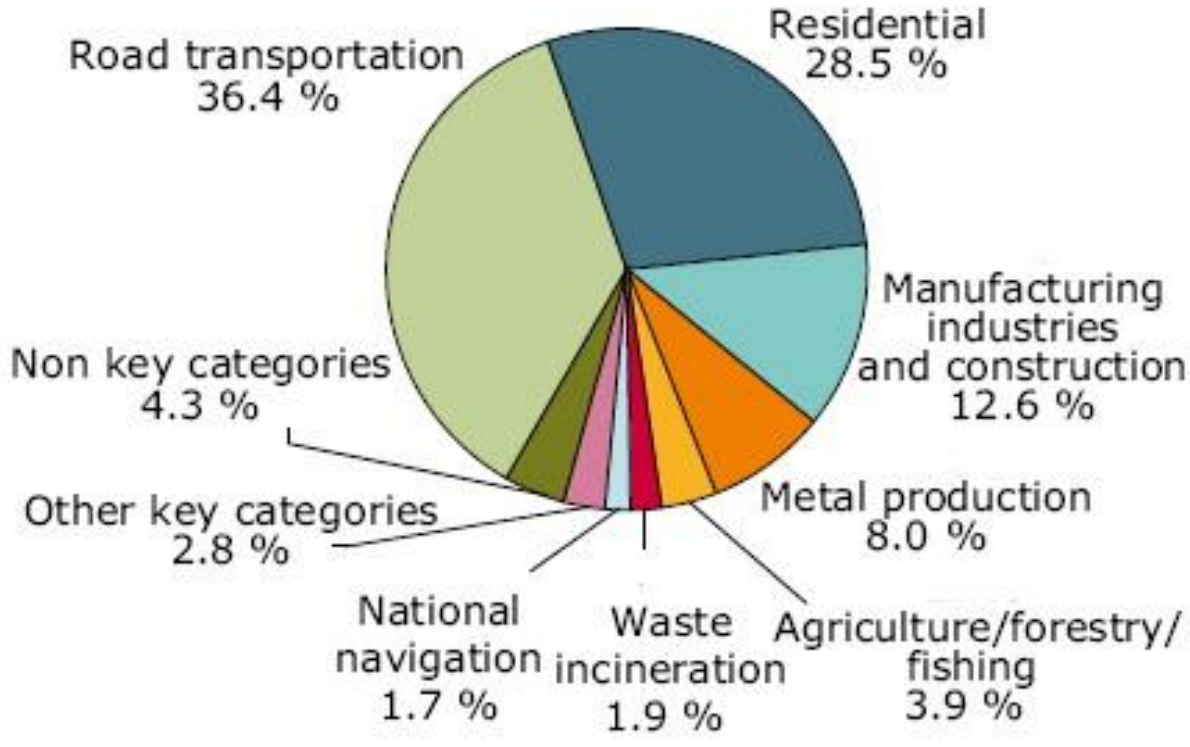


Figure 3 Showing sources of emission of carbon monoxide and contribution of various sectors to the emission.
EU-27 emission of carbon monoxide, 2006 (EEA, 2008**)**

The pie chart above (Figure 3) shows that transportation sector is responsible for the largest contribution to the emission of carbon monoxide followed by manufacturing and construction

industries. Metal production, agricultural/forestry/fishing and waste incineration also have significant contribution to the anthropogenic carbon monoxide emission.

In the European Union territory, notable success is achieved in reducing the carbon monoxide emission from 1990 to 2013. Stricter measures have been put into place in cutting down CO emission for instance, vehicles owners are made to pay for their CO emission. The Figure 4 below shows the total CO emission reduction among the 28 EU member state.

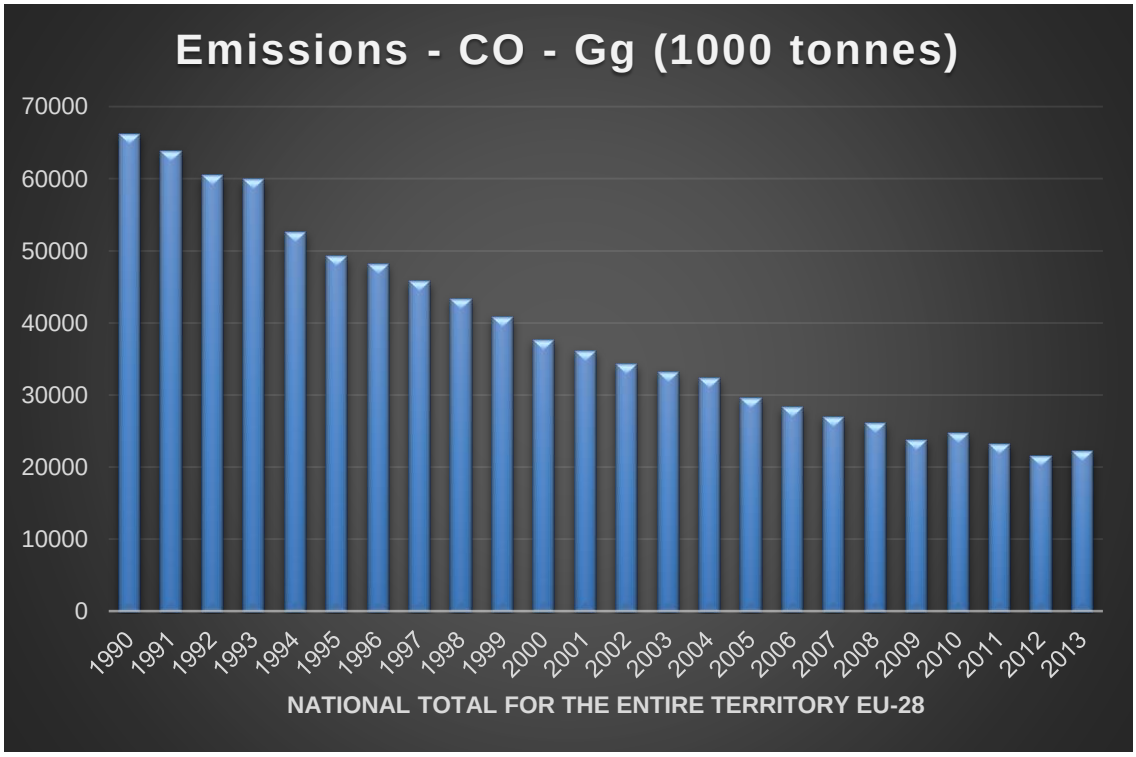


Figure 4: EU-28 Total emission of carbon monoxide in EU between 1990 and 2013.
Data was generated from the European Environment Agency database and exported into excel 2013 for representation.
Source: European Environment Agency

3.1.1 Health effects of CO

When carbon monoxide is inhaled excessively, it could lead to death. This is because, carbon monoxide forms strong bond irreversibly with the haemoglobin in the body which is responsible for oxygen transportation. The resulting effect is the formation of carbonxyl haemoglobin which is a stationary biochemical substances and leading to impairment in transportation of oxygen in the body and depriving vital organs of oxygen. (J Raph, 2004).

$Hb(aq) + 4O_2(g) \leftrightarrow Hb(O_2)_4(aq)$ Normal biochemical reaction of oxygen with haemoglobin

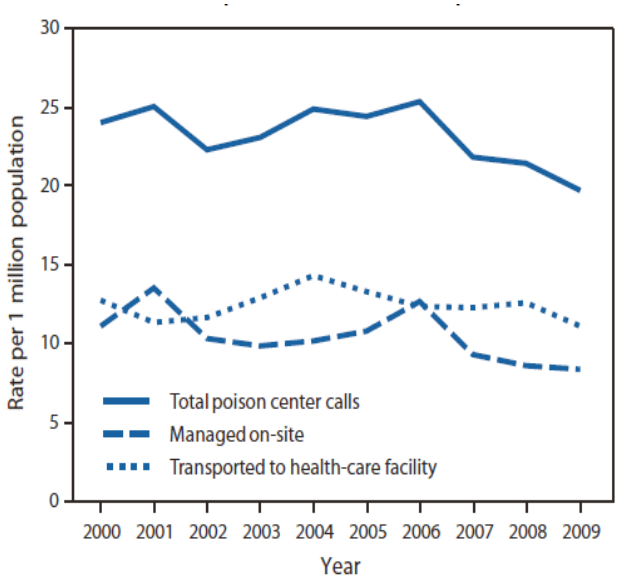
Lung Tissue

Hb(aq) + CO(g) → HbCO (aq) Abnormal biochemical reaction of CO with haemoglobin

Lung Tissue

The affinity of human haemoglobin for carbon monoxide is about 210 times higher than for oxygen which implies that even at high oxygen concentration, carbon monoxide will still bind with haemoglobin (J Raph, 2004), (Ivan Blumenthal, 2001). J Raph also explained further that the problem is even worse for foetus because foetal haemoglobin has higher affinity for carbon monoxide than adult haemoglobin. This implies that unborn babies may die of carbon monoxide poison even when it does not have lethal effect on the mother.

In United States alone, according to data of national poison data system, carbon monoxide poison was responsible for about 20 to 25 people per million population call to poison centre where between 10 to 15 people per million were managed on site and also between 10 to 15 people per million were transported to the health care facility as shown in the figure 5 below.



Source: US Census Bureau. Annual estimates of the resident population for the United States, regions, states, and Puerto Rico: April 1, 2000 to July 1, 2009. Washington, DC: US Census Bureau, Population Division; 2010.

* Per 1 million population.

Figure 5 Annual rate of reported carbon monoxide exposure. National poison data System, united State 2000-2009
Source: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6030a2.htm

The figure 6 below shows the number of death and the age group attributed to carbon monoxide poison in the United States. The data shows that there more death attributed to male especially among the ages of 25 to 64 than to female.

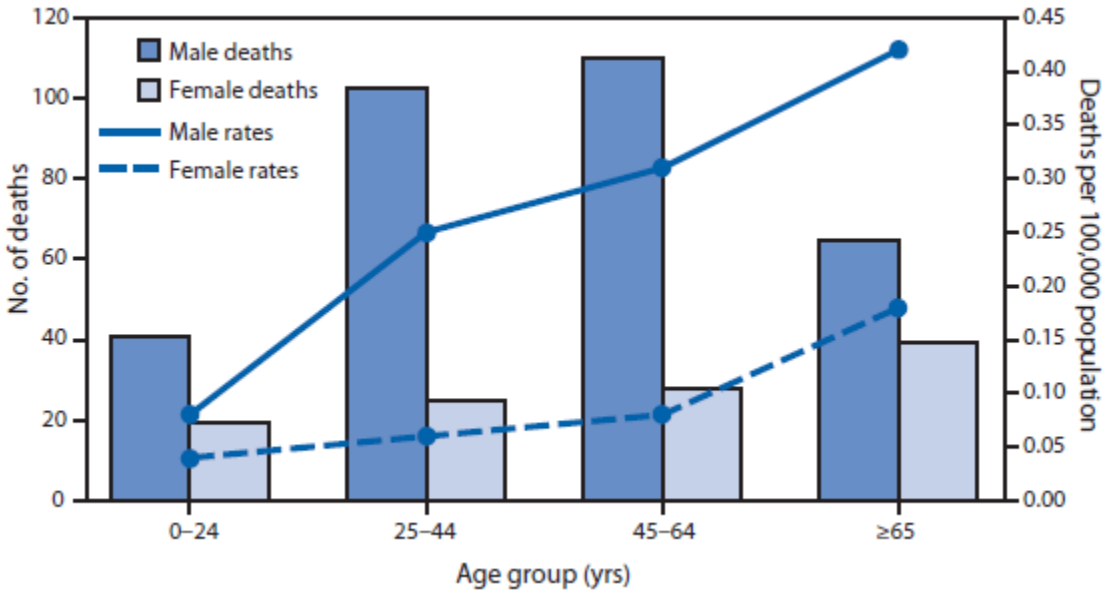


Figure 6:- Average annual number of deaths and death Rates from unintentional, non–fire-related carbon monoxide poisoning, by sex and age group — United States, 1999–2010. Source: Centres for diseases control and prevention

3.2 Oxides of nitrogen (NO_X)

Oxides of nitrogen comprises group of gases due to different combination of nitrogen and oxygen. Two most common oxides of nitrogen of environmental importance are nitrogen dioxide NO_2 and nitric oxide. Nitrogen oxides are emitted naturally during lightening, forest fire and natural ionizing radiation. According to European Environment Agency, the most significant source of nitrogen oxides emission are 'Road transport' (41%), 'Energy production and distribution' (23%), 'Commercial, institutional and household' (13%) sectors, Energy use in industry' (22.5%), 'Industrial processes' (2.4%), 'Non-road transport (2.4%) as represented in figure 7

Nitrogen oxides are precursor of ozone formation which has tremendously harmful to human (The North America Mosaic, 2014). It has been documented that the human impact of nitrogen oxide is associated with ground level concentration and peak level exposure (World bank Group, 1998).

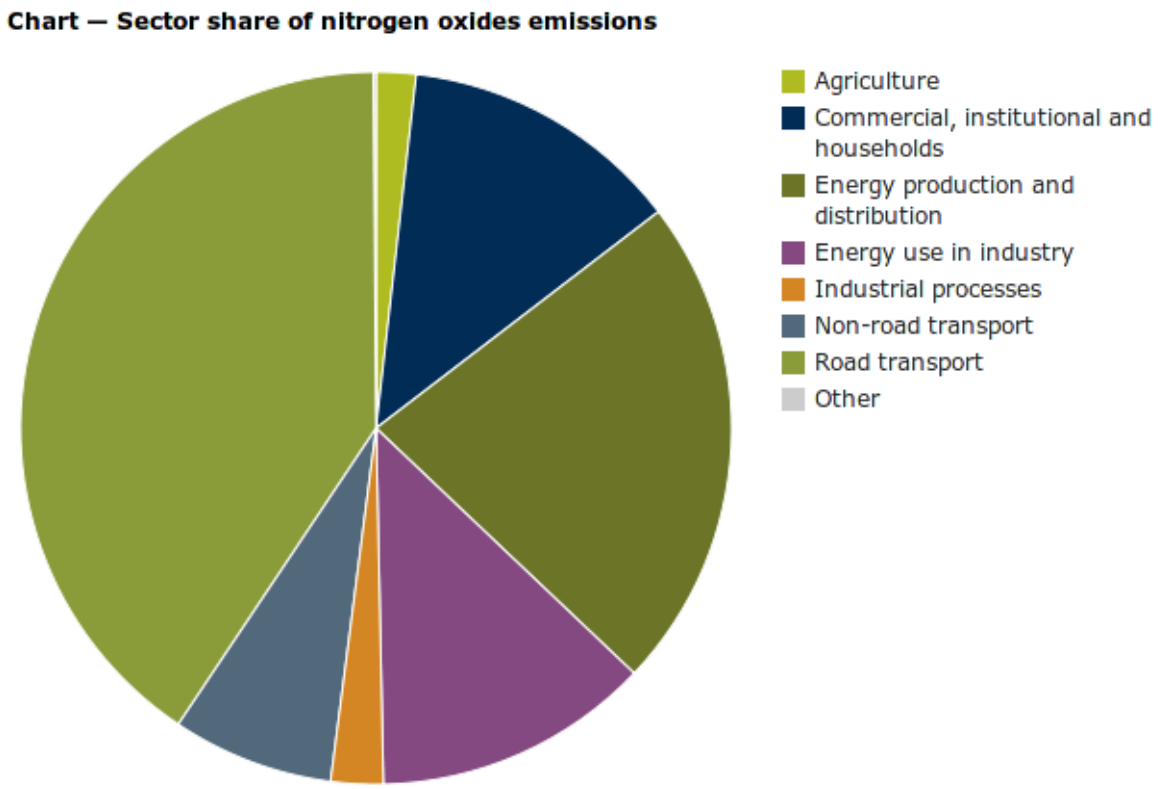


Figure 7.The contribution made by different sectors to emission of nitrogen oxides in 2011. National emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention) provided by European Environment Agency (EEA)
Source: European Environment Agency

Due to the environmental and health impacts of these gases, European Environmental Agency and other environmental institutions have been advocating for member states and countries to reduce their emission level. Figure 8 shows the target path o 2020 Gothenburg emission ceilings for EEA 30 member state

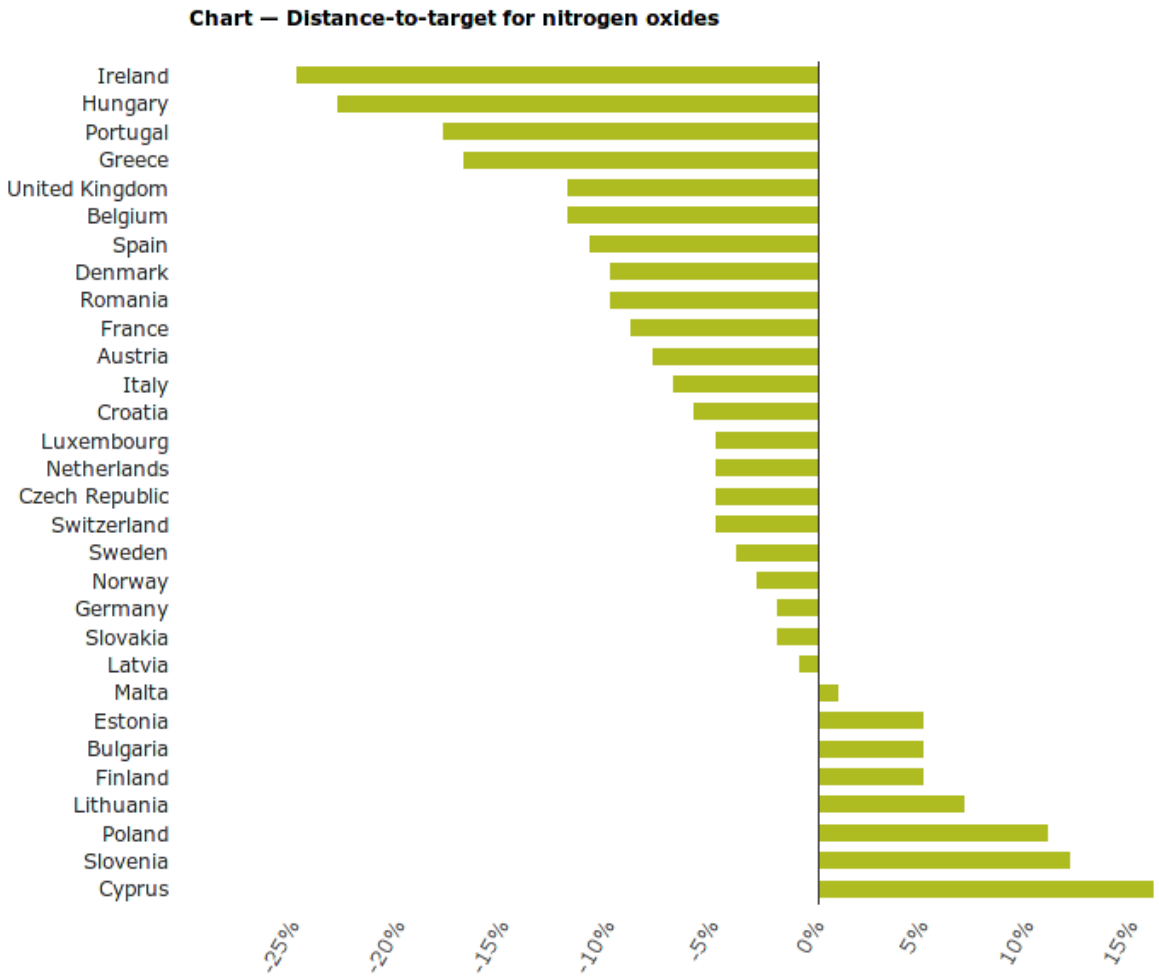


Figure 8: Percentage points below or above linear target path to 2020 emission ceilings.
The distance –to-target indicator shows how current emissions compare to a linear emission reduction 'target-path between 2011 emission levels and 2020 Gothenburg emission ceiling for each country. Negative percentage values indicate the current emission level lie above linear target path to 2020
Source: European Environment Agency

3.2.1 Health effects of NOx

It has been documented that nitrogen oxides are toxic to animals and human being due to its ability to form nitric acid. In the atmosphere, it is involved in acid rain formation together with other gases such as SO_2. In human, it forms nitric acid with water in lung, mucus membrane and skin (New Zealand Ministry of Environment, 2014). Low level exposure to nitrogen dioxide can lead to increased bronchial reactivity, increase in response to allergen in asthma patients and aggravation of chronic respiratory diseases (Hong Kong Center of health protection, 2014).

Long term exposure to nitrogen oxides make human susceptible to respiratory infections, lung irritation and damage in asthmatic patients (New Zealand Ministry of Environment, 2014).

3.3 Sulphur oxides

Sulphur oxides exist in two forms, sulphur (IV) oxide (SO_2) and sulphur trioxide (SO_3). SO_2 is commonly used in bleaching as a reducing agent, as a disinfectant in breweries and food factories, as a fumigatives for grains, grapes and citrus food, in fermentation stage of wine making and also in food preservation. It is a colourless gas with a characteristic choking smell. (Australian Government department of the Environment, 2014).

According to European Environmental Agency, the most significant source of nitrogen oxides emission are 'Energy production and distribution' (58%) 'Commercial, institutional and household sector' (15.2%), Energy use in industry' (20.4%), 'Industrial processes' (3.5%), 'Non-road transport (2.6%).

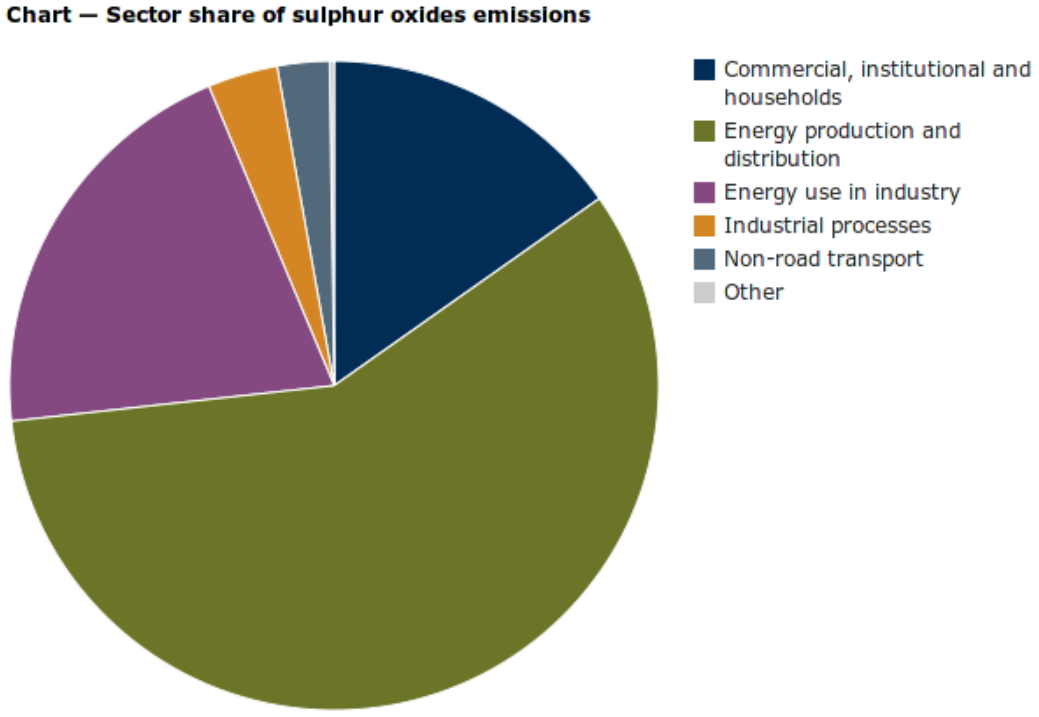


Figure 9: The contribution made by different sectors to emission of nitrogen oxides in 2011. National emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention) provided by European Environment Agency (EEA).
Source: European Environment Agency

Unlike NOx, the contribution of road transportation to emission of SOx is very small (less than 1%). According to the report of sulphur dioxide SO_2 emission assessment by European Environment Agency, there has been a tremendous reduction in SOx emission by EU-28 between 1990 and 2013 where the total emission was reduced from 25000 tonnes in 1990 to less than 5000 tonnes in 2013. This success was as a result of combined measures, including switching from using sulphur containing fuel to liquid fuel and natural gas and with the usage of flue-switching abatement technology (European Environment Agency, 2011).This huge success can illustrated in figure10.

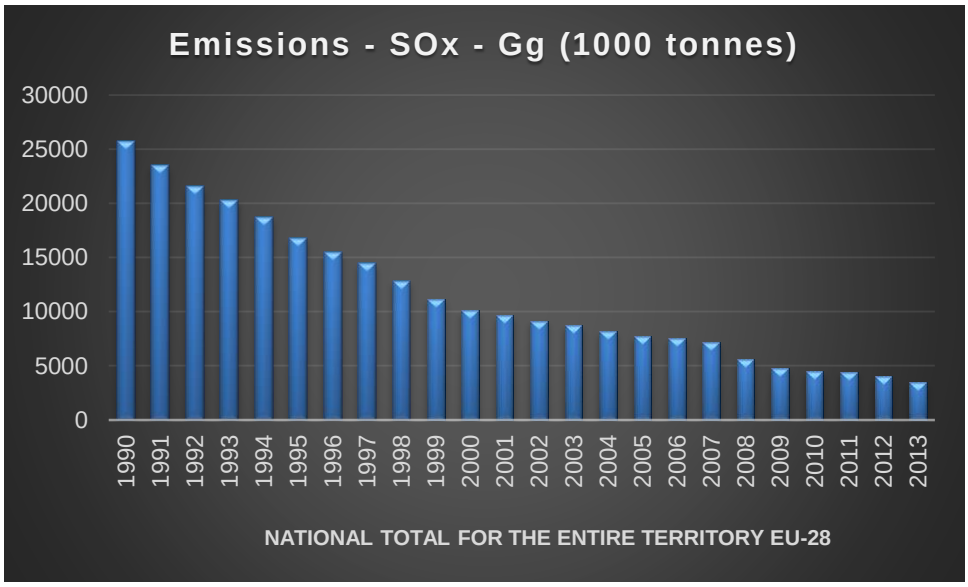


Figure 10 Showing EU-28 Total emission of carbon monoxide in EU between 1990 and 2013. Data was generated from the European Environment Agency database and exported into excel 2013 for representation.
Source: European environment Agency

3.3.1 Health effects of SOx

In the atmosphere, SOx dissolves in water to form acid rain. When breath in, it causes irritation of nose, throat, airways which lead to coughing, wheezing, shortness of breath or tight feeling around the chest. Current studies show that short exposure to SOx ranging from 5 minute to 24 hours gives variety of respiratory symptoms including bronchoconstriction and asthma (United State Environmental Protection Agency, 2014)

3.4 Heavy metals and particulate matter (PM)

3.4.1 Heavy metals

Heavy metal pollution is a big threat to human. Apart from polluting land and water, they are also seen as air pollutants of health importance. For thousands of years, these metals have been in use despite their health consequences. Exposures to these have been increasing in some part of the world especially in developing countries (Lars Järup, 2003). There is no clear definition of heavy metals but in terms of density, they are regarded as electronegative metals of density greater than 5 g/cm$^{3.}$ (S. K. Agarwal, 2009). In the context of this thesis, Cadmium (Cd), lead (Pb) and mercury (Hg) shall be considered.

Cadmium compounds are used in making rechargeable batteries and proper disposal and recycling are required to minimise their pollution. Cigarette smoking, food containing cadmium are other sources of cadmium exposure. Fish absorbs mercury in water and human are exposed to this metal when they consume them. (World Health Organization, 1992). Anthropogenic source of cadmium, lead and mercury are; - industrial processes; energy production and distribution; energy used in industries; transportation; non-transportation; waste; commercial, institutional and household. According to the data released by the European Environment Agency, illustration below (figure.11) was extrapolated to explain the anthropogenic contribution (in %) of different sector to the emission of these heavy metals by the EU28 countries in 2012.

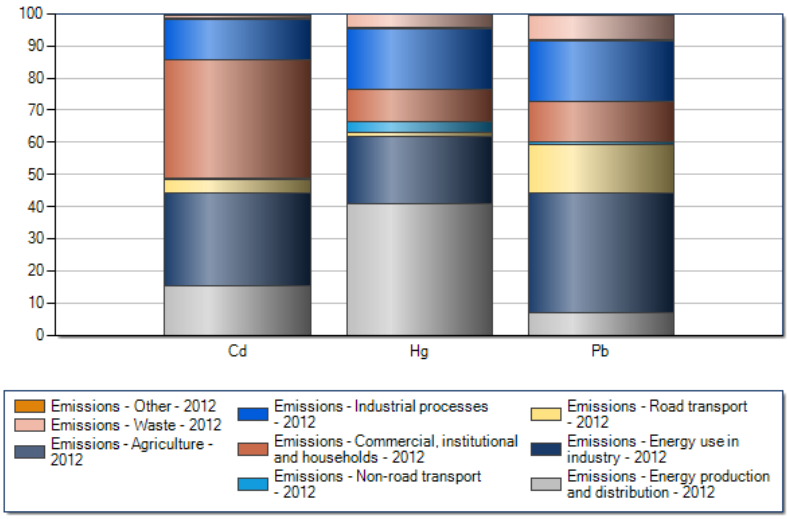


Figure 11: Contribution made by different sectors to emission of cadmium, mercury and lead in 2012. National emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention) provided by European Environment Agency (EEA)
Source: European Environment Agency.

Compared to 1990, the emission of these metals have gone down, although much work is needed to be done to achieve the emission target set for these countries.

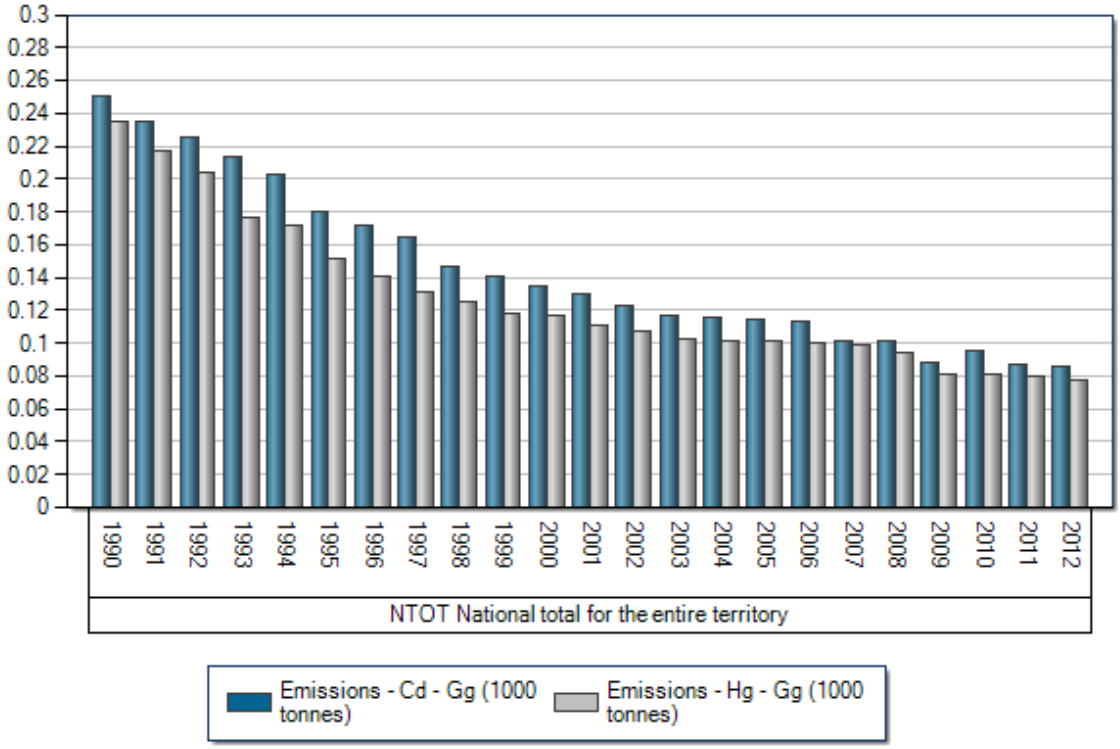


Figure 12: The total emission of cadmium and mercury by the European Union countries EU-28 from 1990 to 2012. The data was generated from the European Environment Agency database and was represented using chat.
Source: European Environment Agency

From figure 13, one would see that the quantity of lead emitted is far more than cadmium and mercury. Such finding is not surprising because lead is used as a petrol additive although this practice has being in tight control in developed counties.

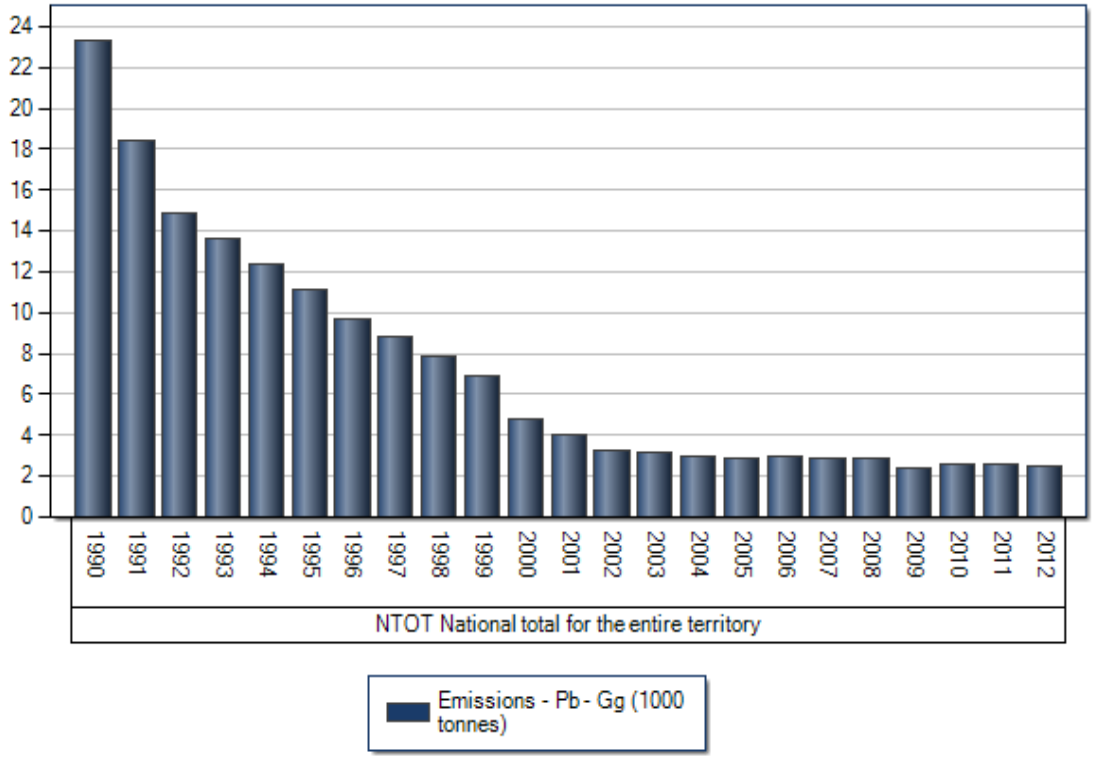


Figure 13: The total emission of lead by the European Union countries EU-28 from 1990 to 2012.
The data was generated from the European Environment Agency database and represented using the above chat.
Source: European Environmental agency;

3.4.2 Particulate Matter (PM)

United state Environmental protection agency defines particulate matter as an air pollution term use in describing mixture of solid particles and liquid droplets found in air. (United State Environmental Protection Agency, 2014). Based on the size of the particles, PM can be divided majorly into 1) coarse particles (PM 2) fine particles (PM 2.5) and ultrafine particles (PM 0.1). PM10 are aerodynamic inhalable particles between 10 μm and 2.5 μm. They are normally found near roadways and dusty industries. They are considered to be of regulatory interest because they may penetrate up to the level of lower respiratory tracts and the gas exchange portion of the lung. (Cristina Pretrescu, 2002).

PM 2.5 are generally found in smoke and emitted from combustion source or formed when gases react with air. The anthropogenic sources of particulate matters in European Union member states are represented in figure 14.

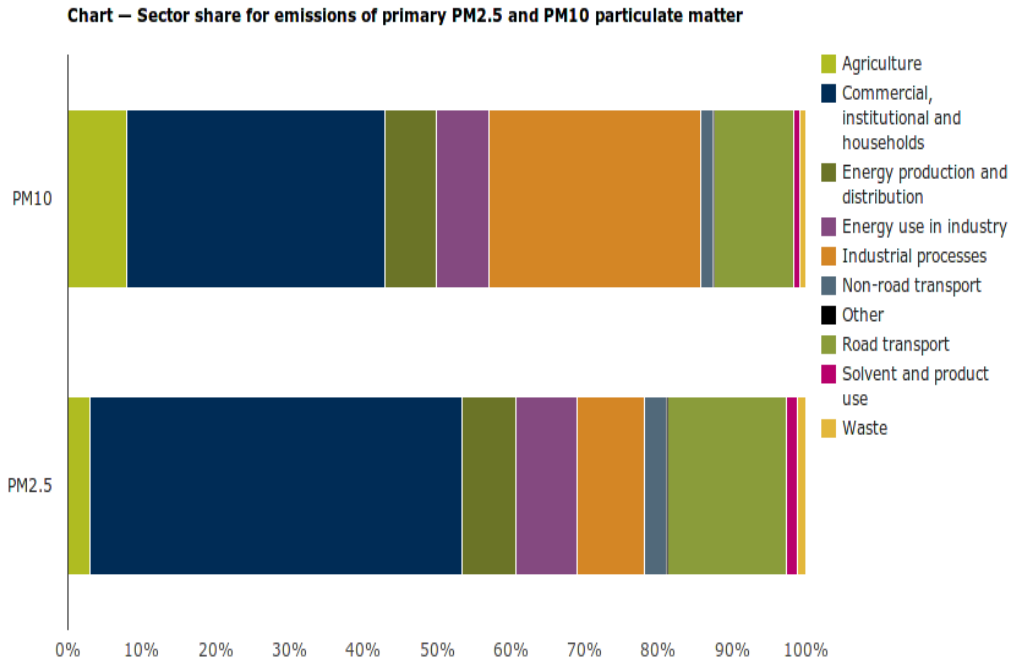


Figure 14 Aggregated and gap-filled air emission dataset, based on 2013 officially reported national total and sectoral emissions to UNECE LRTAP convention.
Source: European Environment Agency

3.4.3 Health Effects of heavy metals and Particulate matter

Cadmium

Cadmium particle inhalation has been documented to cause life threatening pulmonary effect or even death (Seidal K, 1993). Renal tubular damage (Jarup L, 1998); Skeletal demineralisation, bone fragility and fracture (Staessen JA, 1999), (Alfven T, 2000), increase in cardiovascular diseases mortality complicated by renal tubular damage (M Nishijo, 1995). Recent studies have shown that cadmium is carcinogenic in man and chronic exposure could lead to cancer of the bladder; (Feki-Tounsi M, 2014), lung, testicular, prostate and thyroid cancer (Jancic SA, 2014).

Mercury

It has been reported that acute mercury exposure can cause lung damage and chronic exposure may give rise to some psychological symptoms including tremor, restlessness, anxiety, sleep disturbance and depression (Lars Järup, 2003).

Lead

Acute and chronic lead exposure may lead to renal damage (Lars Järup, 2003) It also has neurotoxic effect especially on the children.

Particulate matter

In recent time, there have been many scientific publications on the effect of particulates matter as a pollutant of health importance. PM pollution can be linked to premature death in people with underlying heart or lung disease, such as asthma, airway irritation, nonfatal heart attacks and irregular heartbeat (United State Environmental Protection Agency, 2014).

3.5 Volatile organic compounds

Volatile organic compound are organic compound with one or more carbon atom with very high vapour and pressure which make them readily evaporate into atmosphere at room temperature. Although, there are thousands of compounds that met this criteria but focus shall be made on compound containing two to twelve carbon and non-methane compound. Some examples includes include: acetone, benzene, ethylene glycol, ethylene chloride, perchloroehylene, toluene, xylene, 1, 3, butadiene (Minnesota Department of Health Fact Sheet, 2014). Many of the products we use at home contain these compound. Some researchers have also shown that indoor level of VOC is about two to five times higher than that of outdoor although, room area and ventilation are key factors. Table 1 shows some of the household materials that contain volatile organic materials.

Table 1. Different household sources of VOC

Building Materials	Home and personal care products	Others
Carpets and adhesives	Air fresheners	Cooking
Composite wood products	Air cleaners that produce ozone	Dry cleaning
Paints	Cleaning and disinfecting chemicals	Newspapers
Sealing caulks	Cosmetics	Non-electric space heaters
Solvents	Fuel oil, gasoline	Photocopiers
Upholstery fabrics	Moth balls	Smoking
Varnishes	Vehicle exhaust running a car in an attached garage	Wood burning stoves
Vinyl Floors		Stored paints and chemicals

Source: http://www.health.state.mn.us/divs/eh/indoorair/voc/

Anthropogenic sources of VOCs are: - solvent and product use (43.2%); commercial, institutional and household' (16.7%), 'road transport' (14.6%), 'energy production and distribution' (9.8%), 'industrial processes' (2.4%), agriculture (2.2%), energy use in industry' (2.2%), 'non-road transport (2.2%) and waste (1.3%) as illustrated in the figure 15.

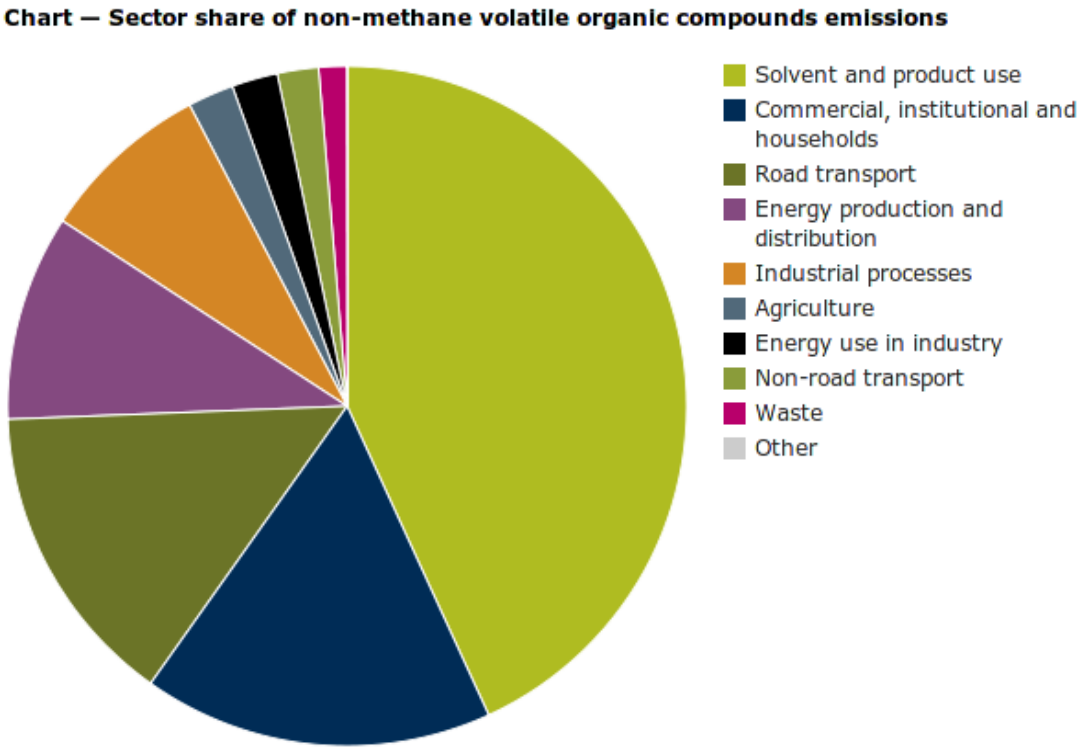


Figure 15: Contribution made by different sectors to emission of non-methane volatile organic compound 2011.
National emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention) provided by European Environment Agency (EEA)
Source: European Environment Agency

Progress has been made since 1990 in European Union member state in reduction of non-methane volatile organic compound as shown in figure 16. The dramatic reduction (about 57%) has been seen in transportation sector due to usage of three-way catalytic converters (in which VOCs are oxidized into CO2 and H2O) and introduction of Euro vehicle emission standard and EU fuel quality Directives (European environment Agency, 2011). Another sector with huge reduction in NMOCs emission is solvents and products use. The report by Netherlands and Denmark also shows about 59% and 50% respectively alone in Solvents and product use as a result of compliance with the solvent directives (European environment Agency, 2011).

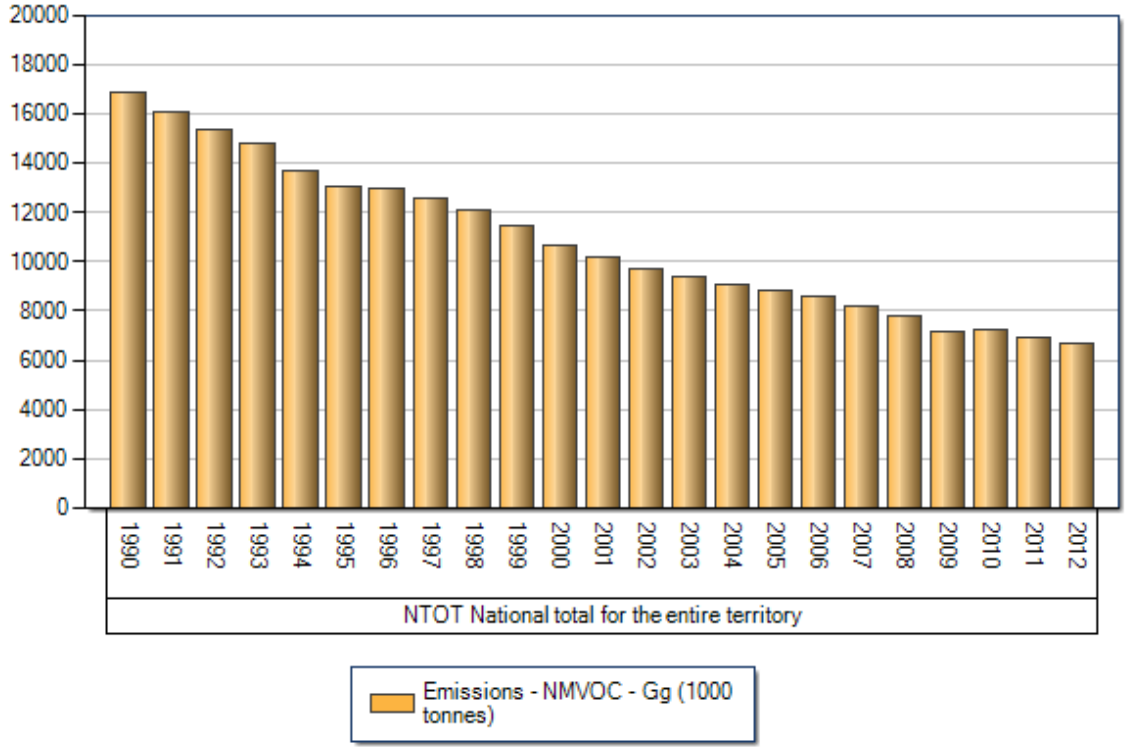


Figure 16: Total Emission of Non-methane Volatile Organic Compound (NMVOC) in EU28. The data was generated from the database of European Environment Agency
Source: European Environment Agency

3.6 Ground level ozone

Ozone is a gas with three atom of oxygen. In the atmosphere, ozone can be found in the stratosphere which helps in absorption of ultraviolent rays and this is termed good ozone. However, ozone can also be found in the troposphere as a secondary pollutant due to NOx and VOCs. Tropospheric ozone is termed bad ozone because of its health consequence. In order to quantify the sectoral anthropogenic emission of ground level ozone; one will need to consider the multiplicity of anthropogenic emission of NOx and VOCs.

Ground level ozone is responsible for formation of smog which is very difficult to control and may have catastrophic environmental impact on human. In the past, many deaths have been attributed to heavy smog. Figure 17 shows how different. sectors contribute to ground level ozone

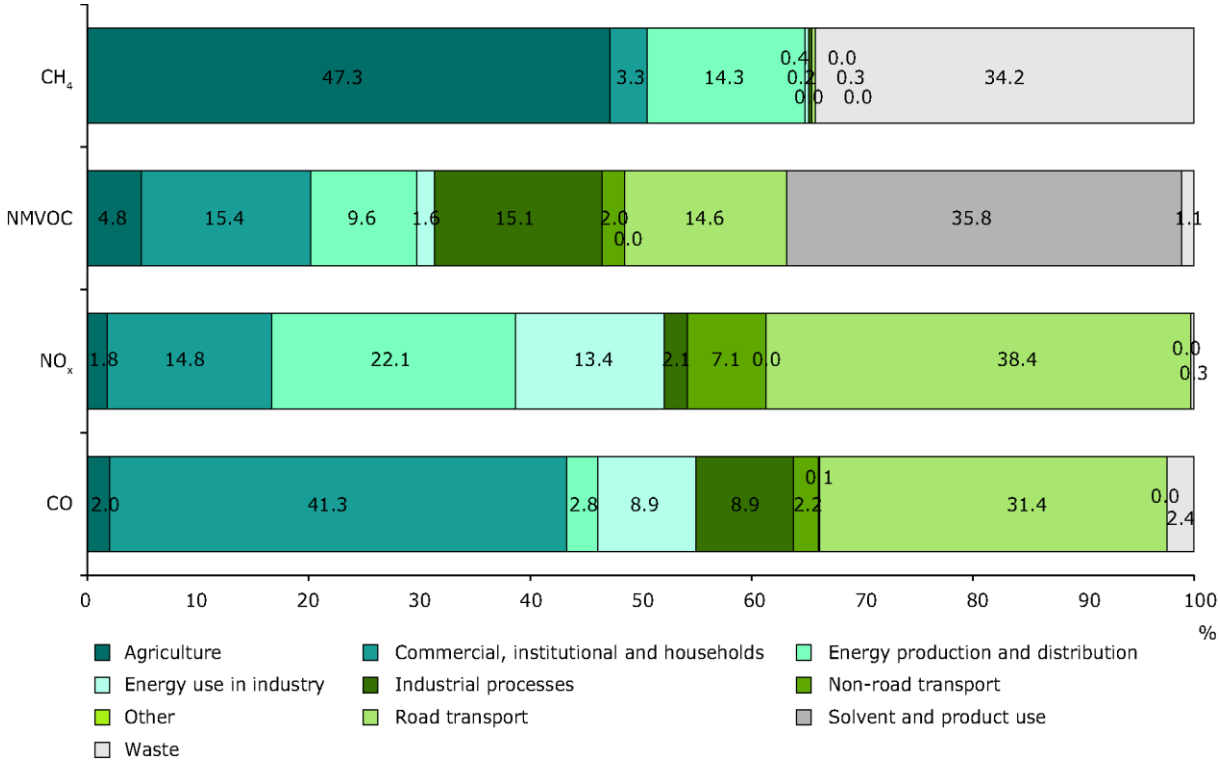


Figure 17: The contribution of different sectors to ground level ozone.
Source: European Environment Agency.

3.6.1 Health effects

In halation of ozone could lead to breathing associated problems, cough, inflammation of the respiratory airways, aggravation of lung diseases such as asthma, chronic bronchitis and progression to lung damage (United State Environmental protection Agency, 2014).

3.7 Biological Air Pollutants

Biological pollutants are living organism which could be plants or animals usually small and enough to contaminate our environments. They may be invisible and can travel far in the air making it easy for their dispersal. Some of these biological air pollutants are found outdoor for instance pollens and some are present indoors for instance mould, animal dander (hair, feather, skin), dust mite, bacteria, viruses. In other word, biological air pollutant could be classified into 1) Outdoor pollutants and 2) Indoor air pollutants.

Apart from the direct effects they have on human, they also play significant roles on actions and transportation of aeroallergens there by making it easy for their penetration into human body (Bartra J, 2007). The evidences of involvement of pollutant gases in development of allergic reactions are emerging. Li J and associates from Peking University, Beijing in their recent research found that over 400 unique bacterial species including opportunistic pathogens

and those that are capable of eliciting allergic reaction were found in abundance in the dust samples collected from filter of automobile air conditioning (AC) within 5 minutes of powering (Li J, 2013). Previously in 2008, researchers from Stockholm published a paper that moderate exposure to air pollution from traffic influence development and sensitization to allergic diseases (Nordling E, 2008). In 2013, researchers also found that children exposed to traffic during infancy have a stronger tendency to develop non allergic asthma (Gruzieva O, 2013).

The Global challenges of climate change are other factors that have impacts on human health. In summer, the weather favour proliferations of Birch and alder pollens in Finland (Hannuksela, 2013) and Ambrosia Pollen in Romania (Florin-Dan Popescu, 2011) which are known environmental allergen. It was recently published that increase in daily temperature favour proliferation of pollen (Biometeorol., 2013) which eventually increases the number of recorded cases for instance at the County Hospital in Timisora, Romania.

Some studies have look into developments and exacerbation of allergic reaction as a results of environmental pollution. There are lots of publications on indoors and outdoors allergens. At the department of Allergology and Immunology at University of Medicine and Pharmacy Victor Babes, Timisoara, Romania, researchers and clinicians from 2010 up to the moments are evaluating patients' sensitivities pattern to inhaled allergens. They concluded that there is a significant rise in number and percentage of patients that are allergic to inhaled allergens which Ambrose pollen was responsible for the majority of the presentations.

3.7.1 Health effects of biological air pollutants

The effect s of biological air pollutants depends on the type and amount of pollutants exposed to. Immunity and immune response plays important role when it comes to the health consequences of these pollutants. One may experience one or more of the following effects after exposure.

1 Allergic reaction
2 Infections
3 Toxic effect

Allergic reaction is an immune response to the foreign body terms allergen. When body is exposed to allergen, immune system is activated to annul the effect. Allergic reaction can range from mild to life threatening situation such as anaphylactic shock. Common allergic response may include watery eyes, runny nose, nasal congestion, itching, wheezing. Some life

threatening case may include bronchospasm and closure of respiratory airways. Example includes asthmatic attack.

Infections occur when body come in contacts with infectious agent such as bacteria, virus, fungi and moulds. The air we breathe may contain some infectious agent capable of causing disease especially those that are airborne.

4 HEALTH CONSEQUENCES OF ENVIRONMENTAL AIR POLLUTION

The adverse effects of air pollution are well established and documented. Several researchers in the field of public health, environmental health, international health and also, international organisation and agency have done tremendous works in the studying and publishing effects of environmental air pollution and human health is several scientific journals. Asides from the respiratory symptoms and allergic reactions that may be associated with the air pollution, some unexpected diseases also manifest which may difficult to trace to air pollution as a causative agent. Some of the diseases can be attributed to Environmental air pollution are as follows

4.1 Respiratory diseases

Respiratory diseases are common manifestation of air pollution. The lesser symptoms include runny nose, sore throat, cough and allergy. (Health Canada, 2014). Serious condition includes asthma, pulmonary emphysema, pneumonia, chronic bronchitis. Chronic obstructive pulmonary disease (COPD) (Faustini A, 2013), pulmonary emphysema, pulmonary fibrosis. At early stage of life, air pollution could predispose chidren to development of childhood asthma. (Loftus A, 2014), (Ding G, 2014). Since the industrial revolution, the rate of pollution of our environment has increased tremendously with the negative impact threatening our existence in terms of climate changes, global warming, flooding. Aside from active and passive smoking, predisposing factors to lung cancer are includes:- exposure to NO_X, coal fumes (Seow WJ1, 2014),exposure to household radon (Milner J1, 201), particulate matter and ozone (Physician for Social responsibility, 2014).

4.2 Cardiovascular diseases

Several research conducted from the last two decades have proved beyond reasonable doubt that air pollution can trigger irregular heart rhythms, strokes, heart attack especially in the people at risk of these conditions. (Diane R. Gold & Jonathan M. Samet, 2013). Researchers have also attributed both short and long time increase in level of the following Pollutants to increase in hospitalisation for cardiac diseases ‘PM10’, ‘PM2.5’ (Wang Y E. M., 2014), Ozone O_3 (Almeida SM, 2014), SO_2, NO_2 (Zhao A, 2014). Recent studies by (Brucker N, 2014) evaluated possible effects of occupational exposure to air pollutants among taxi drivers and they found that exposure to polycyclic Aromatic hydrocarbon (PAH) is an important factors that leads to atherosclerosis among the studied groups.

4.3 Diabetics

Diabetics are of two types, type 1 which is insulin dependent diabetics and it is associated with childhood onset. Type 2 diabetic type 2 in contrast is associated with adult onset. Longitudinal studies in human (Hathout EH, 2002) shows that increased in ozone exposure may be contributory factors to increase in incidence of diabetics type 1 and PM10 may be a specific contributory factor to development of type 1 diabetics before the age of 5. Follow up studies of his research in 2006 conformed to his earlier result but ruled out the possibilities of SO2, NO2 and PM10 as a contributory factor to childhood asthma. However, researcher in Chile published their findings in 2013 that exposure to PM2.5 could be related to peak of diabetics type 1 incidence. In these studies researchers measured the exposure of air pollutant from birth until diagnosis. Moreover, researchers have also shown in series of experiment the relationship between road traffic pollutants to development of type diabetics. Predisposing factors to diabetic type 2 are: - PM2.5 (Chen H, 2013), PM10, NO2 (Eze IC, 2014).

4.4 Infertility

Many reproductive abnormalities have been associated with air pollution. Research carried out by (Hammoud A, 2010) shows that PM2.5 exposure is associated with reduced sperm motility in man. Another studies by (Perin PM, 2010) to find out the effect of preconception exposure to PM10 shows that early pregnancy loss regardless of method of conception. Recently, research by (Nieuwenhuijsen MJ, 2014) studied association between traffic related pollution and fertility rate in Barcelona and found that exposure to particulate matter and NO_2/NOx caused statically significant reduction in fertility among women between age 14 and 45.

4.5 Birth related problems

Scientists have established the detriments of exposure to air pollution during pregnancy, an important studies which all the expected mothers should be aware of. The data obtained in the past has been inconsistence and controversial in associating low birth weight to air pollution. However, in 2014, research by (Akhmat G, 2014) shows that nitrous gas emission is a significant environmental air pollutant causing low birth weight among new born babies. In a state-wide cohort study in North Carolina, (Vinikoor-Imler LC D. J., 2014), their results show that ozone exposure is associated with an increase in the risk of low birth weight. Earlier studies by (Vinikoor-Imler LC D. J., 2013) also suggested that there is a possibility of prenatal exposure to ozone to birth defect such as microtia/anotia, lower limb defect and neural tube defect.

4.6 Cancer

Recently, World Health Organization announced the classification of air pollution as class I human carcinogen due to cumulative evidence by the researchers across the world that air pollution is a predisposing factor to nasopharyngeal, lung, head and neck cancer (Wong IC, 2014). On 17th October 2013, The specialized Cancer Agency for Research on cancer (IARC) monograph programmer reported that outdoor pollution is the leading environmental cause of cancer death (United Nation News centre, 2014**).** CNN news reported that on the same day that WHO reported that 223,000 people worldwide died of lung cancer alone (CNN news, 2013). (Bräuner EV1, 2013) and colleagues from Denmark found that long term residential exposure to radon could be a risk factor for development of brain tumour diseases.

5 GLOBAL BURDEN OF DISEASES ATTRIBUTED TO AIR POLLUTION

This is a measure of global burden of disease (GBD) using disability-adjusted-life-year (DALY) (World Health Organization, 2014). GBD is used to quantify morbidity and mortality due to a given risk factor or disease. With DALY, one can combine years of life lost due to disability and due to death. The concept of DALY measures health gap and not health expectancy. It is the summation of time lived with disability and time loss due to premature mortality. (World Health Organization, 2014)

DALY=YLL + YLD

Where **YLL** is Years of life lost due to premature mortality.

YLD is year of life lived due to disability.

YLL = N x L

Where **N** is the Number of death.

L is standard life expectancy at the age of death.

YLD = I x DW x L

Where **I** is number of incident cases.

DW is disability weight.

L is average duration of disability (years).

According to the latest report and data released by WHO on 25th March, 2014, about 7 million deaths in 2012 was attributed to air pollution exposure, the data which double the previous estimation. This data made WHO to term air pollution as the largest single environmental health risk. In the new data, there is a stronger link between indoor and outdoor air pollution exposure and cardiovascular disease, respiratory diseases and cancer. Recently, WHO has developed improved technology in the assessment of diseases and mortality caused by air pollution.

From the figure 18, about 1.7million death was attributed to household air pollution from South-East Asia while the second largest was seen in Western acific (1.6million). From the illustration, one could extrapolate that the developing nations are more at the risk of death attributed to air pollution

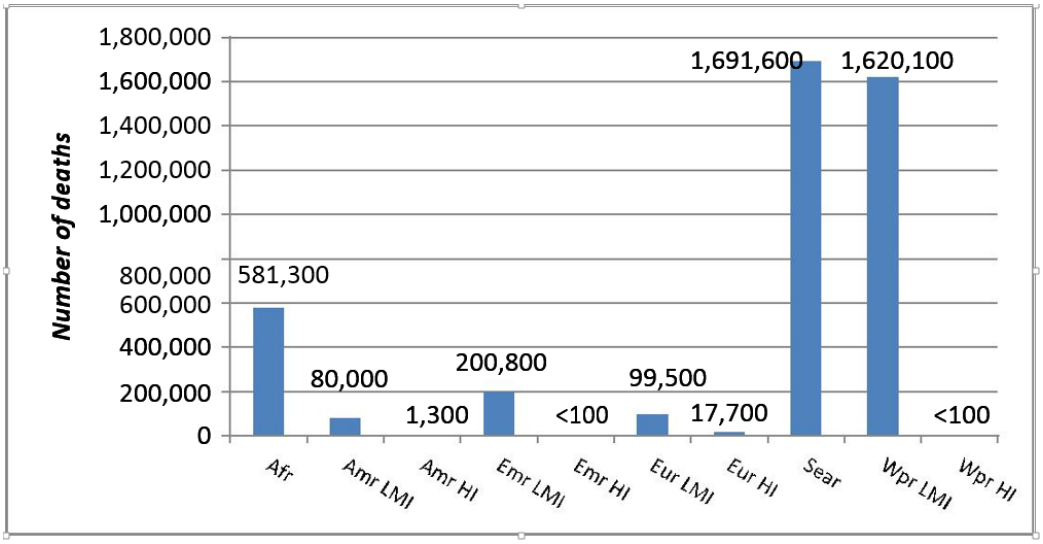


Figure 18 showing HAP: Household air pollution; Amr: America, Afr: Africa; Emr: Eastern Mediterranean, Sear: South-East Asia, Wpr: Western Pacific; LMI: Low- and middle-income; HI: High-income.
Source: WHO 2012

From figure 19, stroke (34%) is the leading cause of death attributed to household air pollution followed by Ischemic heart disease (26%). Chronic Obstructive Pulmonary Diseases is responsible for about 22% while. Acute lower respiratory diseases is responsible for about 12%.

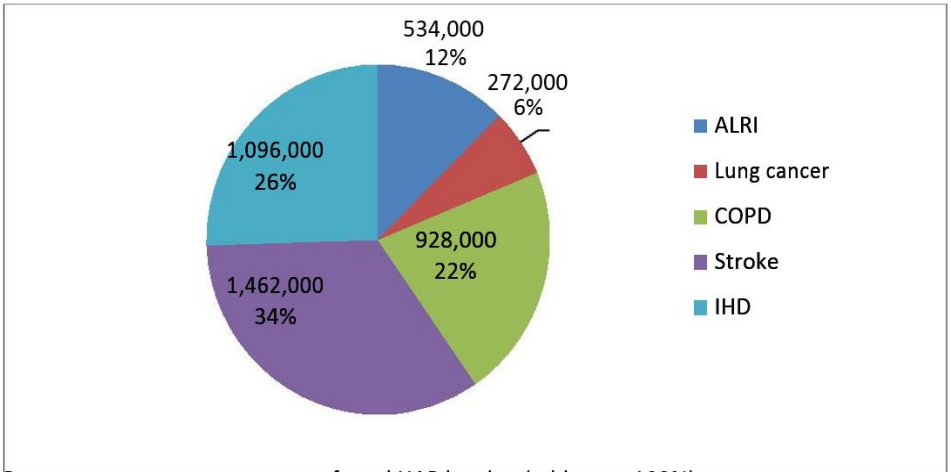


Figure 19 HAP: Household air pollution; ALRI: Acute lower respiratory disease; COPD: Chronic obstructive pulmonary disease; IHD: Ischaemic heart disease.
Source: WHO 2012

Figure 20 shows that death of Men older than 25 years of age are accounted for about 46% of death attributed to Household Air Pollution while Women of age greater than 25 years of age accounted for about 41% the total death.

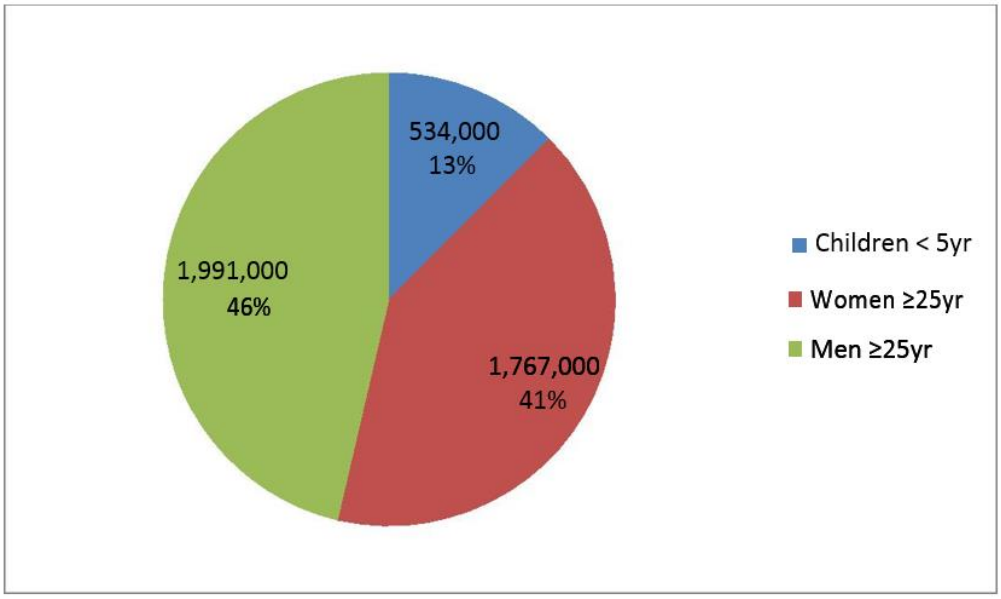


Figure 20. Deaths attributable to Household Air Pollution (HAP) in 2012, by age and sex
Percentage represents percent of total HAP burden (add up to 100%).
HAP: Household air pollution; yr: year.
Source: WHO 2012

Figure 21 shows the total death attributed to ambient air pollution (AAP) in 2012. Unlike what was seen in the death attributed to Household Air Pollution where the number of death in South-East-Asia was the highest, West Pacific Low-Middle-Income was responsible for the highest death attributed to Ambient Air Pollution

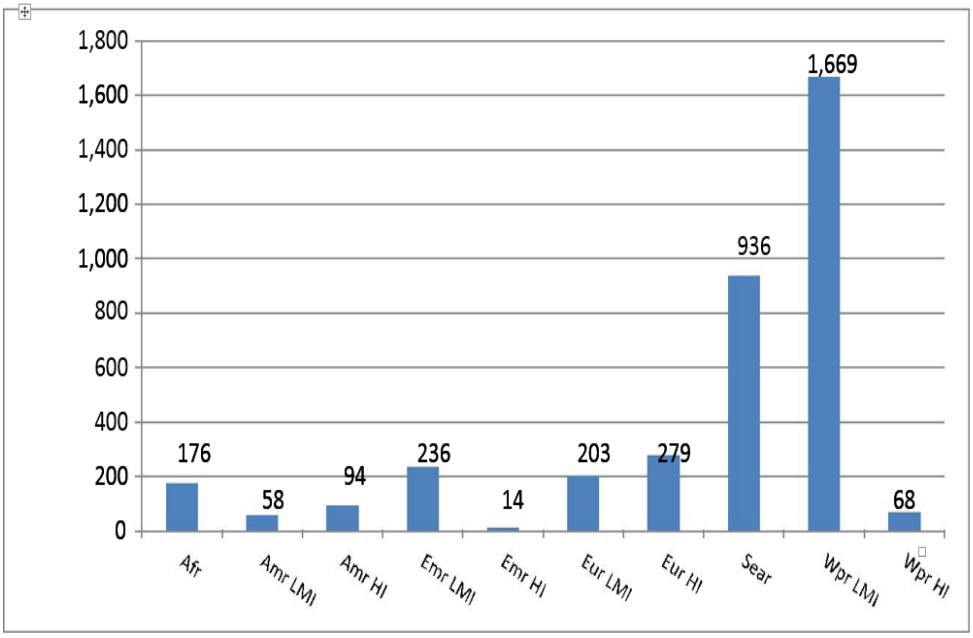


Figure 21. Total deaths (*1000) attributable to Ambient Air pollution (AAP) in 2012, by region
AP: Ambient air pollution; Amr: America, Afr: Africa; Emr: Eastern Mediterranean, Sear: South-East Asia, Wpr: Western Pacific; LMI: Low- and middle-income; HI: High-income.
Source: WHO 2012

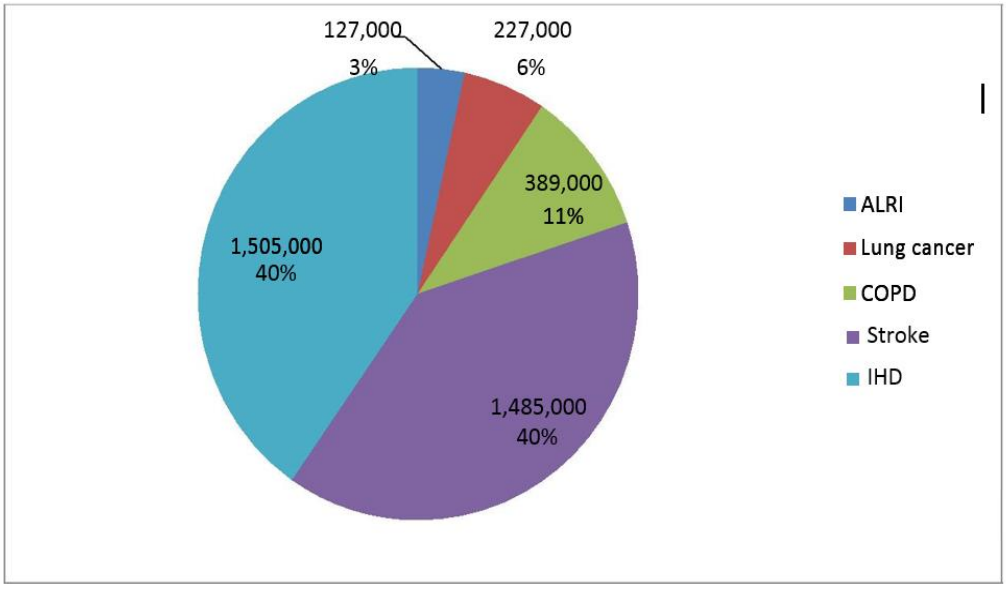


Figure 22. Deaths attributable to Ambient Air Pollution (AA)P in 2012, by disease
Percentage represents percent of total AAP burden (add up to 100%).
AAP: Ambient air pollution; ALRI: Acute lower respiratory disease; COPD: Chronic obstructive pulmonary disease; IHD: Ischaemic heart disease.
Source: WHO 2012.

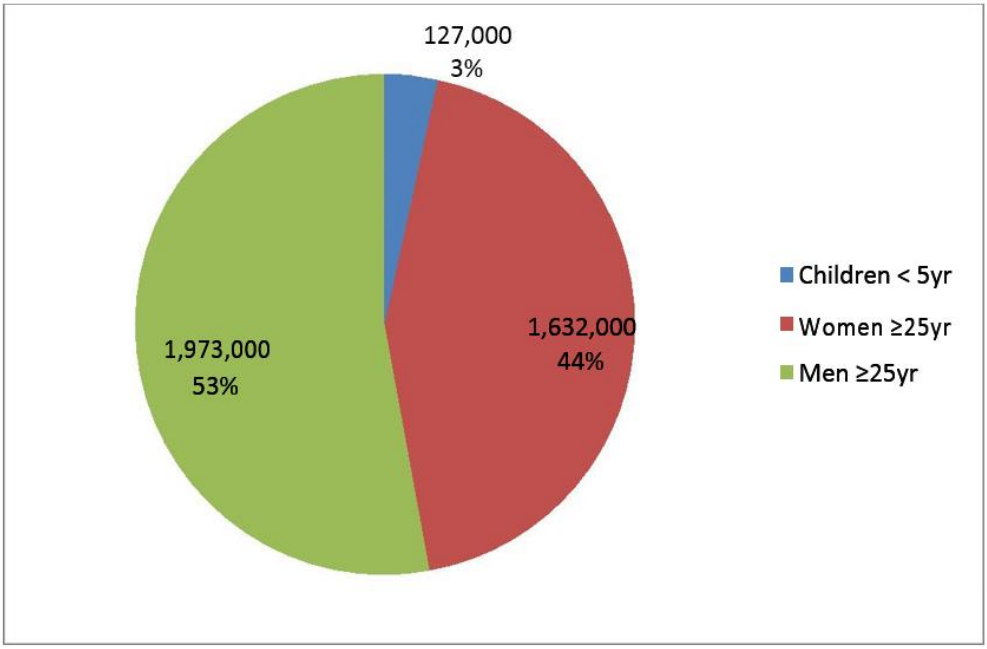


Figure 24 Deaths attributable to Ambient Air Pollution in 2012, by age and sex
Percentage represents percent of total AAP burden (add up to 100%).
AAP: Ambient air pollution; yr: year
Source: WHO 2012

6 DATA COLLECTIONS AND ANALYSIS

6.1 Description of the hospital

The respiratory and infectious disease hospital, Dr Victor Babes is located at the industrial area of Timisoara which is about 5km from the city Centre. This hospital is the city hospital and is responsible for lung related diseases and infections. They receive referrers from private hospitals, policlinics, other tertiary institutions on lung related diseases.

This Hospital was chosen because it is the major hospital in Timisoara County that is responsible for treatment of lung related diseases. It is a tertiary hospital which is also responsible for training of medical students and specialists in respiratory disease. Since most of the environmental air pollutants are introduced into human body through inhalation which implies that lung is the first internal organ that is exposed to these air pollutants, it is not far-fetched to know that the effects of these pollutants will be more pronounced on the lungs. It is therefore considered as a wise decision to choose this hospital for this research and collections of data.

6.2 Method of data collection and representation

This study is a retrospective one where the hospital case files of the patients that presented in this hospital from 1st February 2016, till 22nd March 2016 were collected and analysed. It is important to emphasise that all the patients of this hospital are suffering from respiratory and infectious diseases. The following patients' data were collected and recorded:- hospital file number, sex, age, diagnosis, comorbidity (associative diseases), month of the last hospital visit, positive family history of the diseases, occupation, working in environment with toxic substances, exposure to toxic substances, smoking, years of smoking, number of packets of cigarette per day. The data collection was in accordance with the rules and regulation and of the ethical committee of the hospital without compromising the privacy of the patients' information. The data collected are for research and academic purpose only.

The patients that visited this hospital got referrals from the family doctors, the emergency hospital and some were outwards patients. On presentation at this hospital, the first step involves collection of biodata of the patients and cross reference it with previous hospitalization data or are assigned a hospital file case number if presenting for the first time. The next stage is to take the history of the presenting complains and systematically approach of physical examination, laboratory investigation, x ray, CT scans, MRI, ECG, peak flow meter in order to

arrive at the diagnosis. When the diagnosis is made, the associative diseases known as comorbidity are also taking into the consideration, treated and followed up in the course of the treatment. There is no need for referrer to another hospital for the comorbidity diseases except if there is a complication.

In total, 229 patients' data were collected. These data include present outwards patients, past outwards patients, previously hospitalized patients and excludes currently admitted patients. The data were recorded and analysed using excel 2013. Table, pie chart, histogram were used in data presentation and representation.

7 RESULTS.

In total, 229 patients' data were taken and analysed, 141 male and 88 female as shown in the figure 25 below.

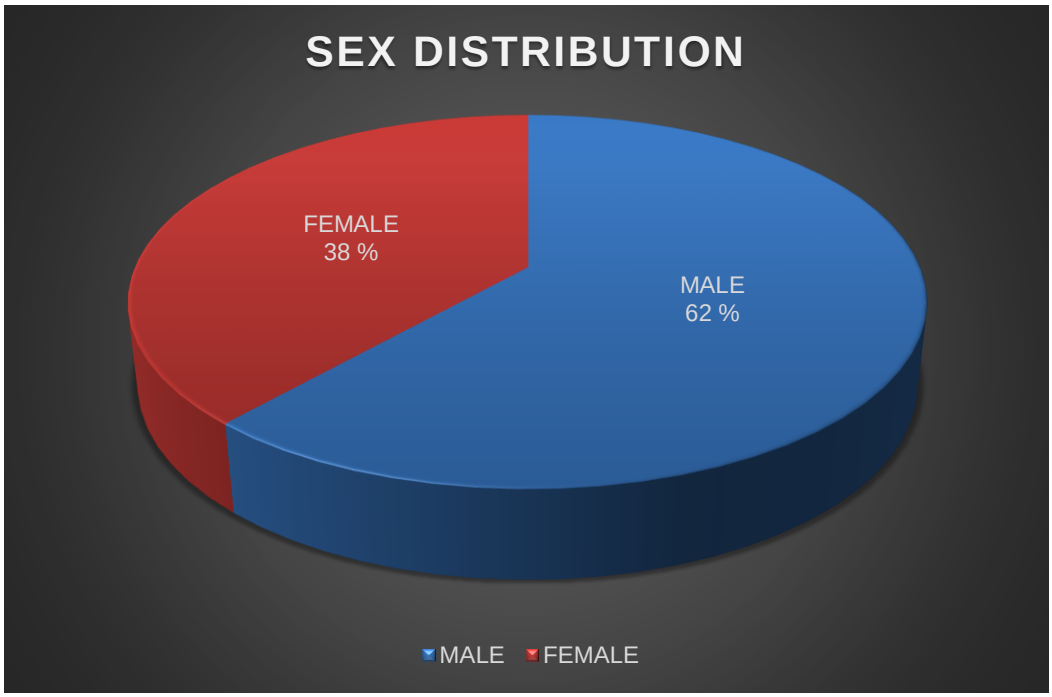


Figure 25: The gender pattern of patients' presentation at the hospital.

It was observed that most of the people presented at this hospital for respiratory related and infectious diseases were majorly elderly. It has been established that the elderly are regarded as vulnerable group of people that are susceptible to disease and disability (WHO, 2016) . Another reason may be due to the fact that environmental pollutants accumulate in the body and manifests there effect later in life. For instance, people that are smoking and exposed to toxic chemical substances may develop illness at a later stage in life.

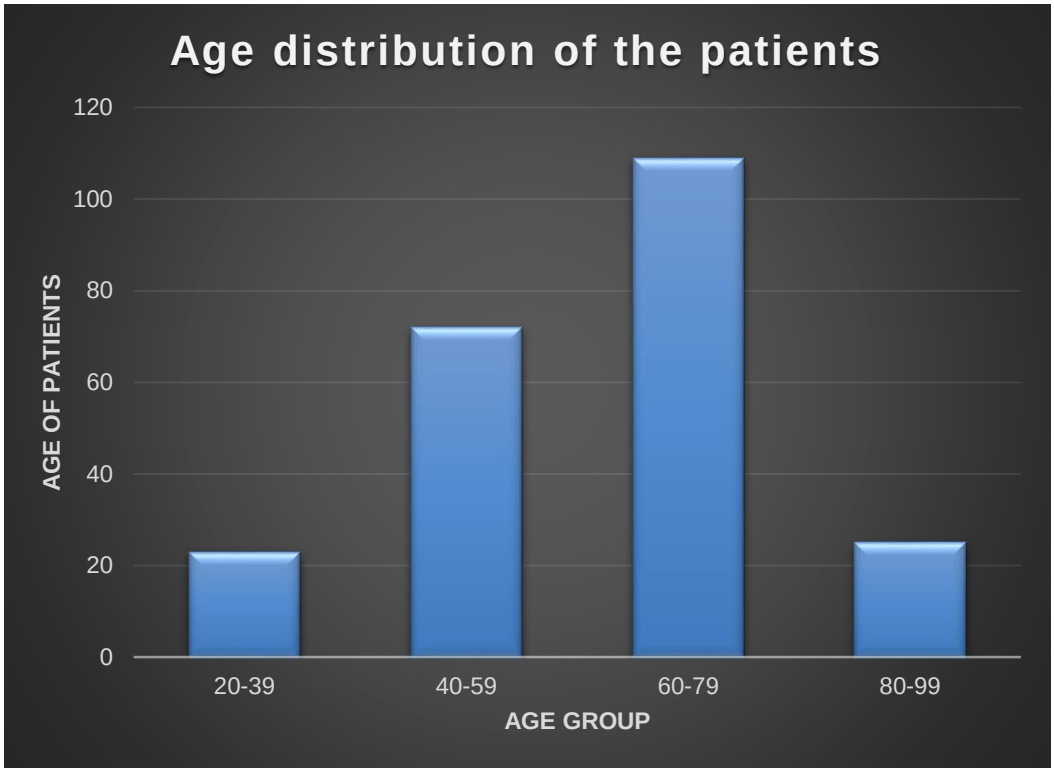


Figure 26: The age distribution of patients presented at the hospital. 23 patients between ages of 20-29, 72 patients between ages of 40-59, 109 patients between the age of 60-79 and 25 patients between the ages of 80-99.

The figure below shows the diseases that the patients presented at this hospital usually have.

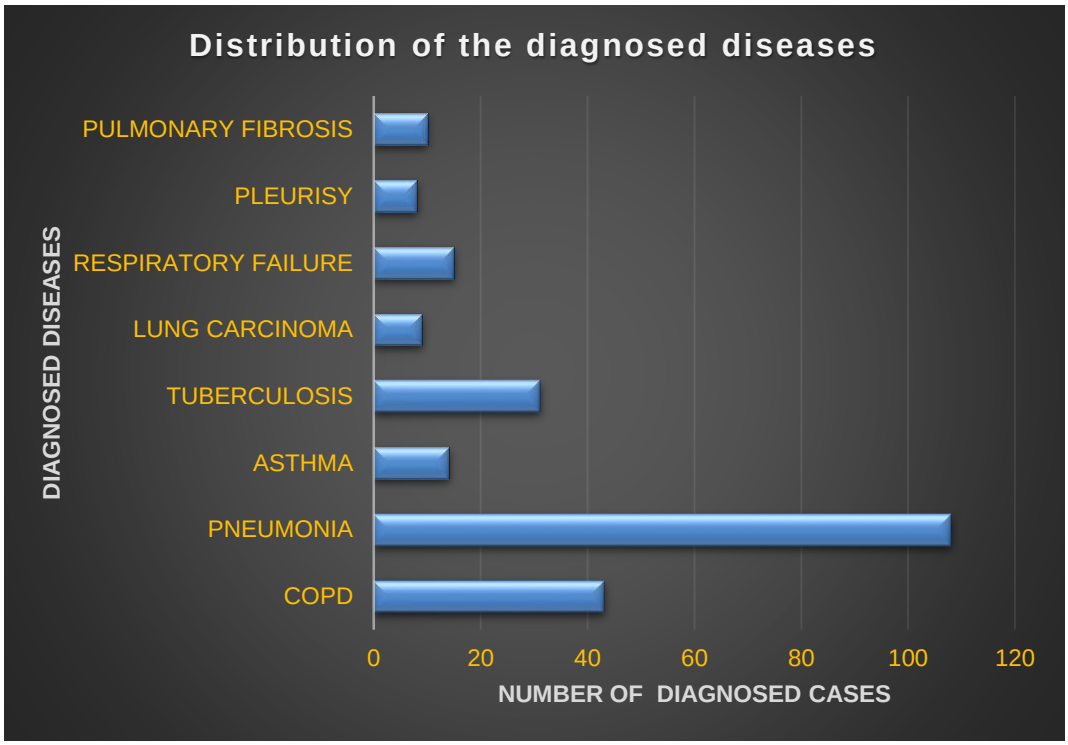


Figure 27: The distributions of diagnosed diseases.

43 patients were diagnosed with chronic obstructive pulmonary disease (COPD), 108 patients, 14 patients with asthma, 31 patients with tuberculosis, 9 patients with lung carcinoma, 15 patients with respiratory failure, 8 patients with pleurisy and 10 patients with pulmonary fibrosis.

The term “diagnosed cases” was preferred to the use of number of patients in this context because, few patients were diagnosed with more than one disease at the point of presentation and this makes the number of primary diagnosed cases (238) excluding comorbidity slightly higher than the number of patients (229).

The clustered chat above shows that pneumonia is the most diagnosed disease at this hospital followed by COPD, tuberculosis and respiratory failure respectively. Respiratory failure is a complication which arises as a results of other respiratory diseases which can be diagnosed alongside with the primary disease or as a comorbidity. All the above mentioned diseases are related to environmental air pollution as pointed out in the literature review earlier in this paper.

7.1 Comorbidity

Comorbidity occurs when two disorder occur in the same patient sequentially or simultaneously (National institute of drug abuse, 2016). Comorbidity also means interaction between two illness and it affects the course and prognosis of both diseases.

In this hospital, the doctors also take note of the comorbidity of the disease and special attention is given to such patients. From Table 2, it is clearly shown that the most common comorbidity is hypertension which is highly common among the elderly patients followed by COPD, asthma and diabetics respectively all which may be associated with the environmental air pollution as previously described in this paper.

When compared the age different age groups with the diseases cases, it was observed that the patients within the age group of 60-79 have the highest number of disease cases when compares with other age group except in tuberculosis the patients within the age group of 40-59 have the highest disease cases (21 cases) followed by age group of 20-29 (17 cases), age group of 60-79 (16 cases) and age group of 80-99 (2 cases).

Table 2: Comorbidity diagnosed among the patients

COMORBIDITY	NUMBER OF CASES
COPD	26
PNEUMONIA	2
ASTHMA	20
TUBERCULOSIS	15
LUNG CARCINOMA	3
RESPIRATORY FAILURE	12
PLEURISY	1
PULMONARY FIBROSIS	5
PULMONARY ABSCESS	2
HYPERTENSION	91
CARDIOPATHY	9
CARDIOMYOPATHY	2
ANGINA	4
ATRIAL FIBRILLATION	8
MYOCARDIAL INFARCTION	2
DIABETICS	19
PULMONARY HYPERTENSION	2
ALLERGIC REACTION	1
OTHER FORM OF CARCINOMA	5
TOTAL	229

From the table 2, 91 cases of hypertension exist alongside with the diagnosed disease, 26 cases of COPD, 20 cases of asthma, 19 cases of diabetics and 15 cases of tuberculosis.

Table 3: Age group of disease case

	AGE GROUP			
DISEASES CASES (Primary diagnoses plus comorbidity)	**20-39**	**40-59**	**60-79**	**80-99**
COPD	0	24	33	13
PNEUMONIA	7	39	55	8
ASTHMA	6	12	22	4
TUBERCULOSIS	17	21	16	2
PULMONARY ABSCESS	0	2	0	0
RESPIRATORY FAILURE	2	10	17	1
CARDIAC FAILURE	0	1	7	4
PULMONARY FIBROSIS	0	2	7	3
LUNG CARCINOMA	0	3	9	0
HYPRTENSION	1	24	58	11
CARDIOPATHY	0	4	3	2
CARDIOMYOPATHY	0	1	2	0
ANGINA	0	2	4	1
DIABETICS	0	6	13	2
PULMONARY EMPHYSEMA	0	1	1	0
SINUSITIS	0	1	0	0
ATRIAL FIBRILATION	0	2	4	3
OTHER FORM OF CARCINOMA	0	5	0	0
PLEURISY	1	2	7	0

7.2 Exposure to environmental air pollutants

When analysing the lifestyle pattern and work life of the patients, smoking and working in the toxic environment are important associated with the development of theses environmental air pollution related diseases. As earlier mentioned, cigarettes contain a harmful substances called radon. Radon is a known environmental air pollutant and chronic exposure to radon has serious health consequence. It has been established by many researchers and it is a known fact that smoking is a risk factors to many diseases including COPD, asthma, Tuberculosis, (Mayor Clinc, 2016) respiratory failure, and many more diseases.

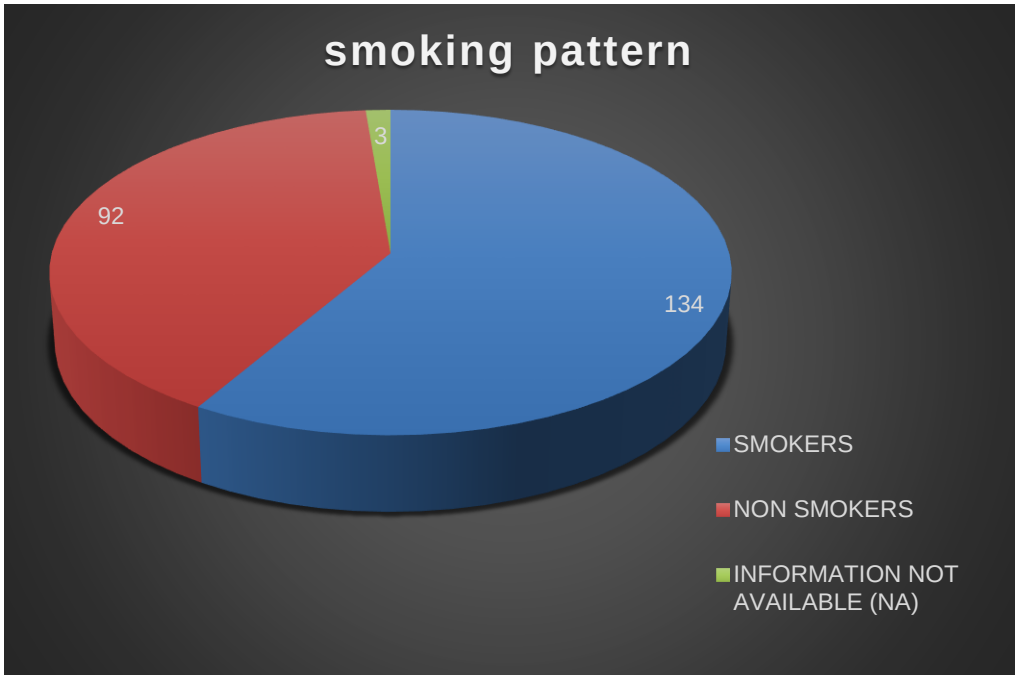


Figure 28: Showing the smoking habits of the patients. 134 patients were smokers and 92 patients were non-smokers and information on smoking habit of 3 patients were not available.

Among 138 patients that are smoking, 12% are within the age group of 20-30, 36.9% are within age group of 40-59, 44.9% are within the age group of 60-79 while 5.8% are within the age group of 80-89 as shown in figure 29.

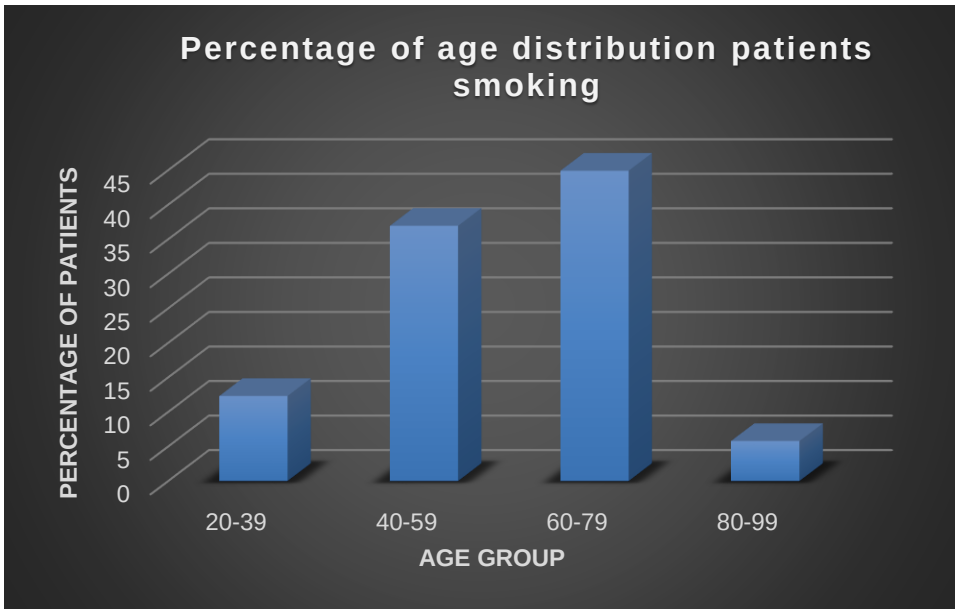


Figure 29: Percentage of patients that are smoking and their age group.

From the analysis, it was observed that certain diseases are common among smokers who did not work in the toxic environment. When looking at the 306 total diagnosis cases among 134

patients who were smokers involving 19 diseases, such common diseases in the descending orders are COPD, hypertension, pneumonia, asthma, tuberculosis, Respiratory failure, lung carcinoma and diabetics. This is shown in figure 30.

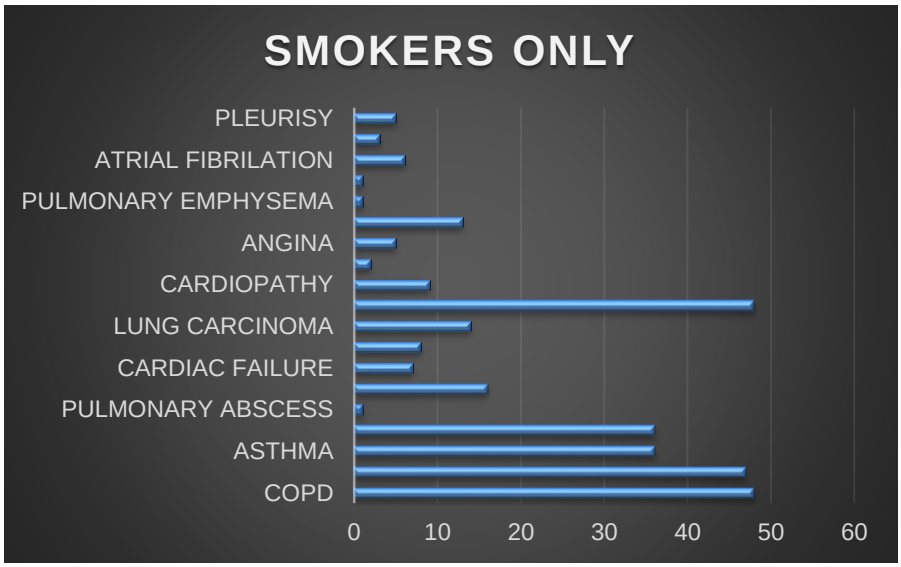


Figure 30 Chart showing 306 diagnosed cases of different diseases among 130 patients who were smokers who do not work in the toxic environment.

On the other hand, among 92 non-smoking patients, 131 total number of diseases were seen. The common diseases among non-smokers who were resented at this hospital in descending orders were pneumonia, hypertension, asthma, COPD and Diabetics

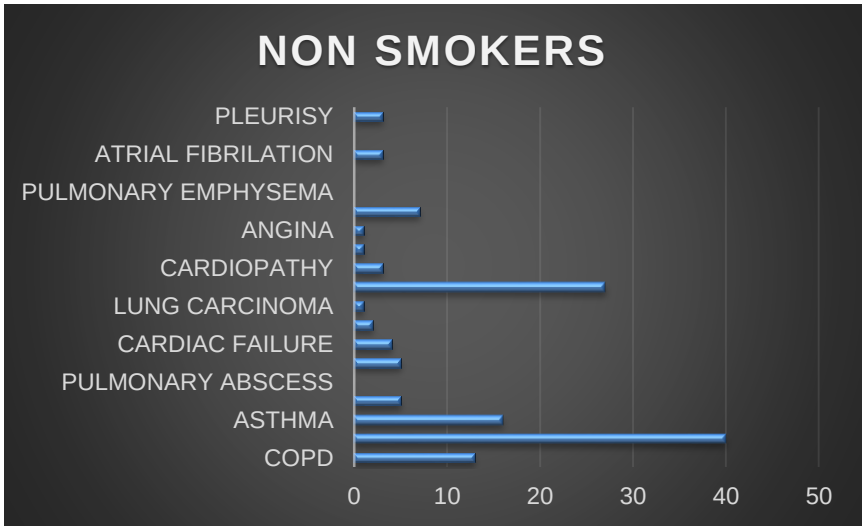


Figure 31: Chart showing 131 diagnosed cases of different diseases among 92 patients who were smokers who do not work in the toxic environment.

In addition to smoking, the work life information is very vital in the course of taking the history of the patients. Some patients work in a toxic environment where the risk of exposure to environmental air pollutants of health consequence is high which put them at the higher risk of

developing certain diseases than the counterpart which are not working in toxic environment. From the data obtained, the nature of the toxic substances which are likely to be exposed to were not provided in the patients hospital case file, instead, they were only denoted with toxic environment workplace. The chart below (figure 31) shows the result of exposure and non-exposure to toxic substances.

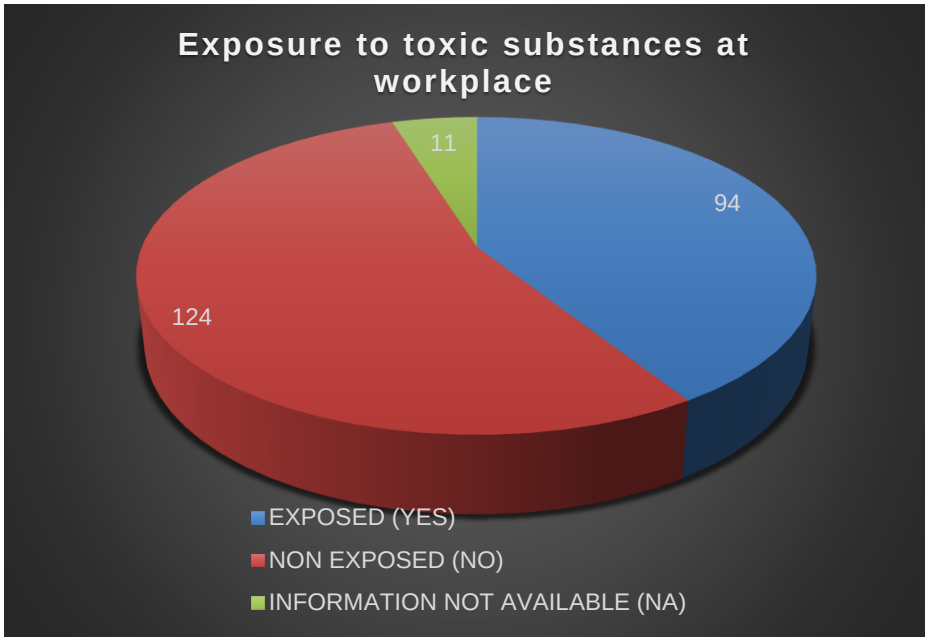


Figure 32: Pie chart showing exposure of patients to toxic substances also termed environmental air pollutants at the work place. 94 patients are exposed, 124 patients were not exposed while information about workplace exposure to toxic substances were not available for on the hospital case file of 11 patients.

Among 94 patients who were exposed to toxic environment due to workplace, 39 total number of diseases were seen. The common diseases among these patients who were presented at the hospital in descending orders were pneumonia, tuberculosis, COPD, respiratory failure and pleurisy

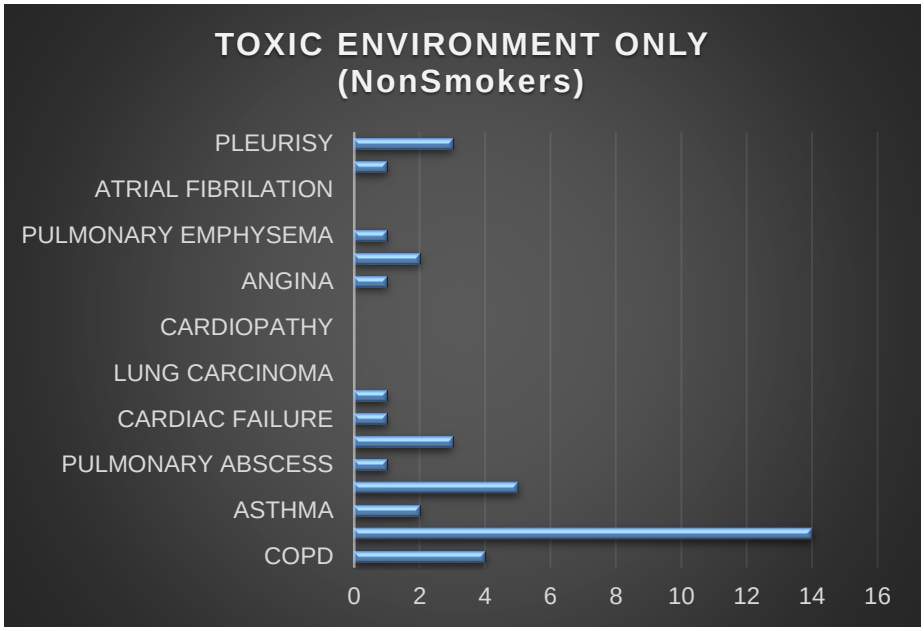


Figure 33: Chart showing 34 diagnosed cases of different diseases among 94 patients who were exposed to toxic environment at workplace and were non-smokers

It is not surprising to see that only respiratory diseases were majorly observed among these patient because the respiratory system is the first internal organ than is exposed to these toxic pollutants as a result of inhalation of toxic gases. Unlike, other group patients, hypertension is not common among these patients.

Interestingly, on analysis, there are 156 total number of patients who were either smokers or/and exposed to toxic environment at working place. Among this group of patients, 358 total number of diseases were recorded. In descending other, the common diseases are pneumonia, hypertension, tuberculosis, asthma, respiratory failure, diabetic, lung carcinoma and pulmonary fibrosis.

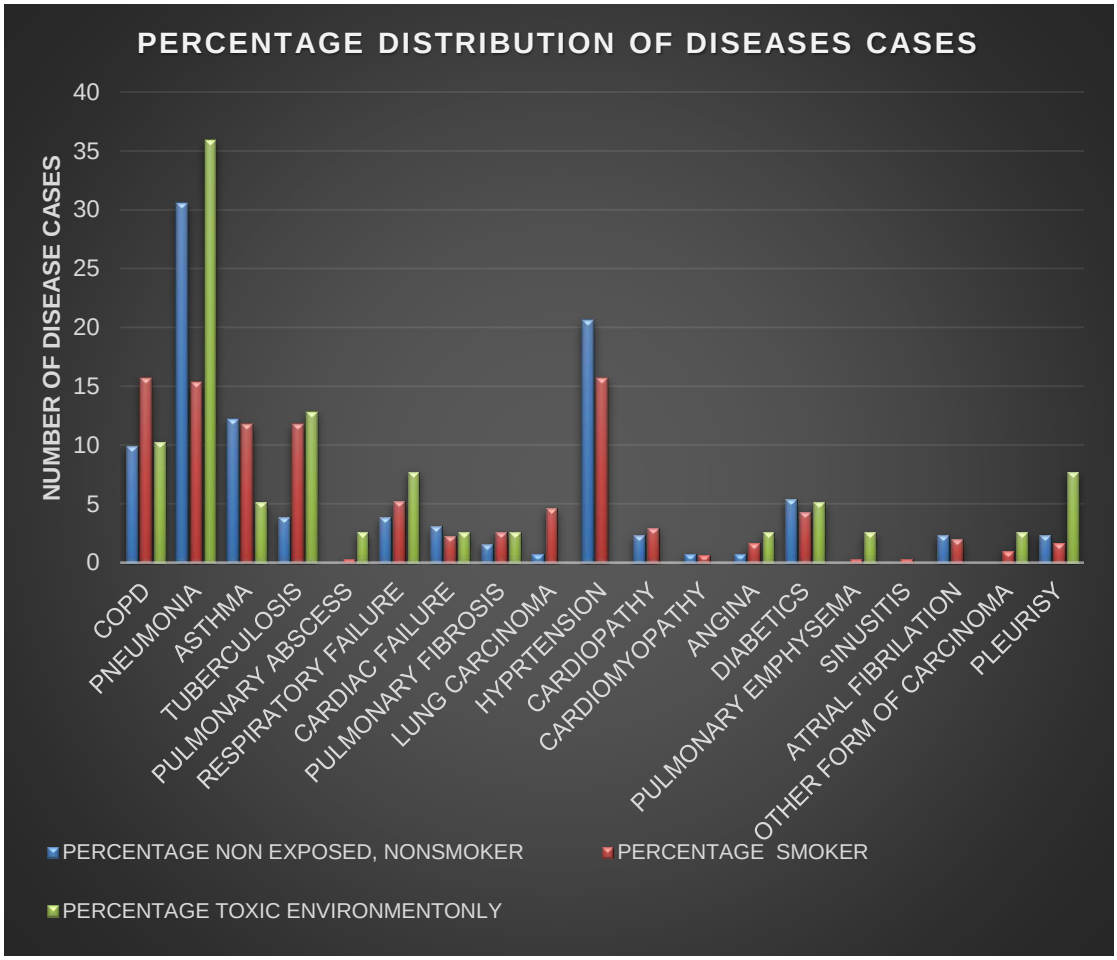


Figure 34: Percentage distribution of disease cases among non-smokers, smokers and patients exposed to environmental air pollutant.

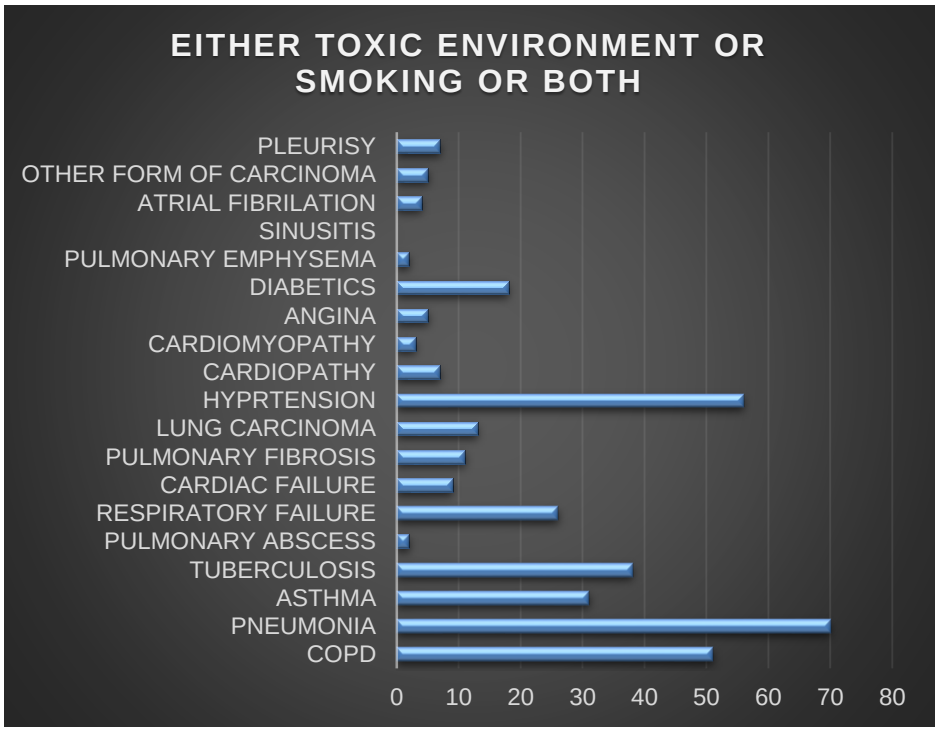


Figure 35 showing 358 diagnosed cases of different diseases among 156 patients who were exposed to environmental air pollutant which could be either or both of toxic environmental working place or as a result of smoking.

When compared, the patients that were not exposed to air pollution (i.e. non-smokers who were not working in the toxic environments) to exposed patients (i.e. patient either smoking or working in toxic environments or both), it was observed in all cases, the number of disease cases presented by the exposed group of patients were more than the number of cases presented by the group of non-exposed patients except in atrial fibrillation disease where non-exposed group of patients has five cases while exposed group of patients has four cases as shown in Table 4.

Table 4: Comparison of disease cases exposed and non-exposed to air pollution groups of patients

DISEASES CASES	NUMBER OF PATIENTS	
	NON-EXPOSED	EXPOSED
COPD	20	51
PNEUMONIA	44	70
ASTHMA	21	31
TUBERCULOSIS	7	38
PULMONARY ABSCESS	0	2
RESPIRATORY FAILURE	5	26
CARDIAC FAILURE	5	9
PULMONARY FIBROSIS	4	11
LUNG CARCINOMA	3	13
HYPRTENSION	35	56
CARDIOPATHY	3	7
CARDIOMYOPATHY	1	3
ANGINA	2	5
DIABETICS	9	18
PULMONARY EMPHYSEMA	0	2
SINUSITIS	1	0
ATRIAL FIBRILATION	5	4
OTHER FORM OF CARCINOMA	0	5
PLEURISY	4	7
TOTAL CASES	169	358

For the comparison purpose and to get a better understanding of the above data, the data was normalized to percentages and plotted as shown in the figure 35. The normalized chart (figure

35) showed that COPD, tuberculosis, respiratory failure, pulmonary fibrosis, cardiomyopathy, angina are more common in exposed than non-exposed patients while pulmonary abscess, pulmonary emphysema and other form of carcinoma are only seen in exposure patients and non were seen among the non-exposed patients as illustrated in

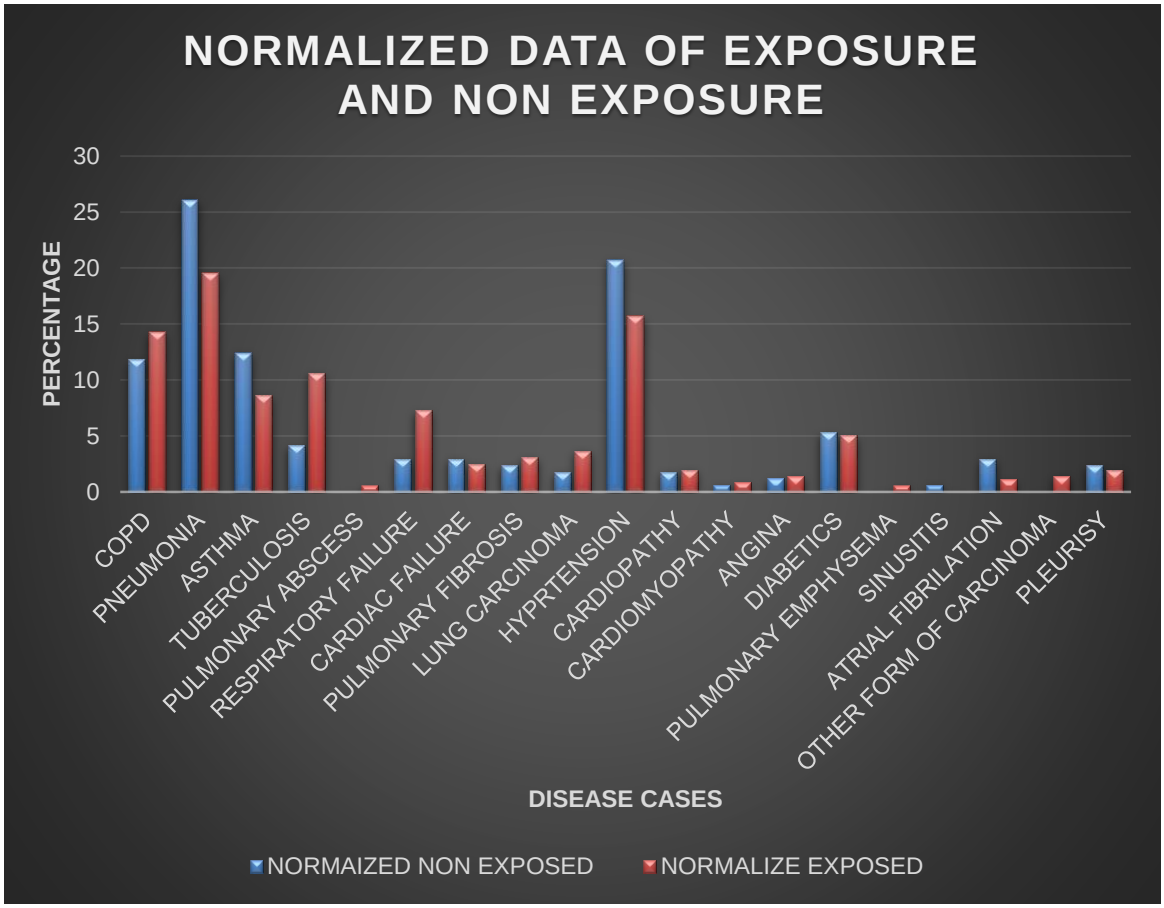


Figure 35: Normalised chat of disease cases presented by exposed and non-exposed groups of patients.

In order to get a clearer picture of the data obtained in this research and to use comparative analysis purpose to assist us in making an informed conclusion, it is necessary to visualize the data in an informative table as shown in Table 4.

Table 4: Categories of patients and disease cases presented

DISEASES CASES	CATEGORIES OF PATIENTS						
	NON-SMOKERS	SMOKERS ONLY	TOXIC ENVIRONMENT ONLY	(smokers + Toxic workplace)	NON-EXPOSURE	EXPOSURE	TOTAL HOSPITAL CASES
COPD	13	48	4	29	20	51	71
PNEUMONIA	40	47	14	23	44	70	114
ASTHMA	16	36	2	7	21	31	52
TUBERCULOSIS	5	36	5	18	7	38	45
PULMONARY ABSCESS	0	1	1	1	0	2	2
RESPIRATORY FAILURE	5	16	3	8	5	26	31
CARDIAC FAILURE	4	7	1	5	5	9	14
PULMONARY FIBROSIS	2	8	1	7	4	11	15
LUNG CARCINOMA	1	14	0	5	3	13	16
HYPRTENSION	27	48	0	28	35	56	91
CARDIOPATHY	3	9	0	1	3	7	10
CARDIOMYOPATHY	1	2	0	2	1	3	4
ANGINA	1	5	1	3	2	5	7
DIABETICS	7	13	2	5	9	18	27
PULMONARY EMPHYSEMA	0	1	1	1	0	2	2
SINUSITIS	0	1	0	0	1	0	1
ATRIAL FIBRILATION	3	6	0	4	5	4	9
OTHER FORMS OF CARCINOMA	0	3	1	3	0	5	5
PLEURISY	3	5	3	4	4	7	11
TOTAL CASES	131	306	39	154	169	358	527

7.3 STATISTICAL ANALYSIS.

Correlation analysis was performed using Pearson correlation coefficient on the above data to see if there is a correlation between the exposure to environmental air pollutants (either smoking or toxic exposure at work place or both) represented by number of cases seen as a result of exposure against total hospital cases seen or recorded. The scattered diagram below shows the relationship exposure to environmental air pollution against hospital case

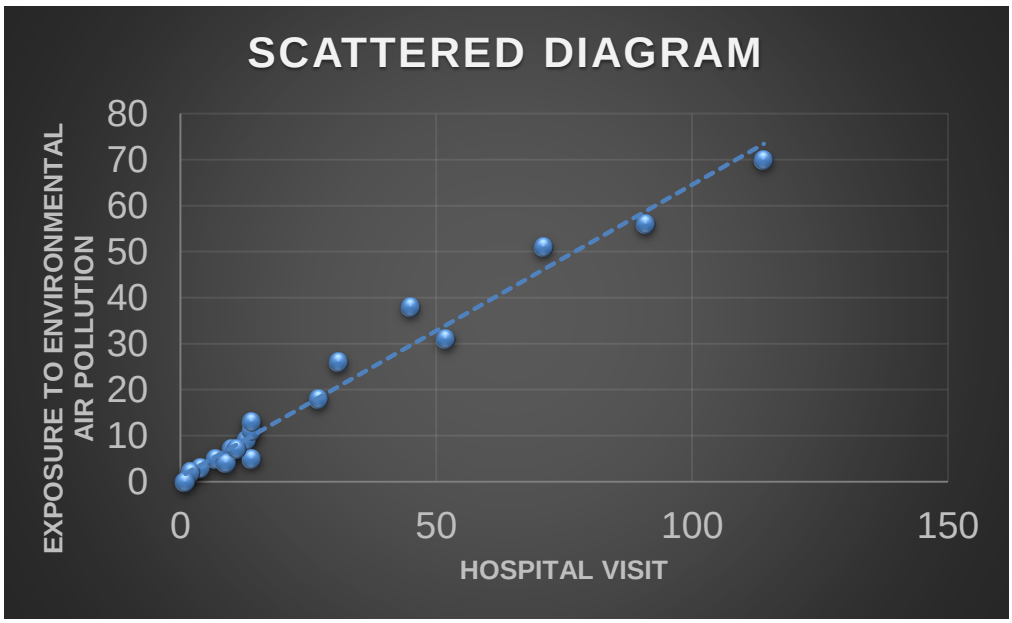


Figure 36: scatter diagram showing relationship between exposure to environmental air pollution and hospital visits due to respiratory illness.

The null hypothesis which state that there is no significant effect of exposure to environmental air pollutant exposure on hospital visit due to illness (total cases diagnosed) was tested using 95% confident interval using two tailed test.

From the Table 5, the Pearson correlation coefficients of correlation between the exposure to environmental air pollutants against total hospital visit (represented by total cases seen or recorded) is 0.987 which shows a strong correlation. This reject the null hypothesis (H0)

The P value of 0.004 ($p< 0.05$) using two-tail shows that exposure to environmental air pollutant has a significant effect on the total hospital visit due to illness at the confident interval of 95%.

Table 5: Pearson's correlation test results

t-Test: Paired Two Sample for Means		
	Exposure to environmental air pollution	**Hospital visits due respiratory disease**
Mean	28	18.842
Variance	1054.111	436.029
Observations	19	19
Pearson Correlation	0.987	
Hypothesized Mean Difference	0	
df	18	
t Stat	3.243	
P(T<=t) one-tail	0.002	
t Critical one-tail	1.734	
P(T<=t) two-tail	0.004	
t Critical two-tail	2.100	

8 DISCUSSION

From the analysis of the result, when looking at the sex distribution of the patients that presented at the respiratory and Infectious diseases hospital, Victor Babes, Timisoara, it was seen that 62% of the patients were male while 38% were female. Although, there is no clear association between environmental air pollution and gender but stronger association is seen in occupational health where respiratory diseases were associated more with women (Clougherty, 2009)**.** It was observed that most of the people presented at this hospital for respiratory related and infectious diseases were majorly elderly where the largest numbers of patients were within 60-79 age group followed by 40-59 age group. It has been established that the elderly are regarded as vulnerable group of people (World Health Organization, 2005) and hence ability to fight against diseases are limited due to aging immune system (Medscape, 2016) Another reason may be due to the fact that environmental pollutants accumulate in the body especially when the rate of metabolism and excretion is less than uptake (Pawel Migula & Migula, 2003) and manifests their effects later in life. For instance, people that are smoking and exposed to toxic chemical substances may develop illness at a later stage in life. The result clearly showed that pneumonia is the most presented disease at this hospital followed by COPD and tuberculosis and respiratory failure.

Pneumonia which could be community acquired (caused by virus, bacteria, bacteria-like organism, fungi), hospital-acquired, health care acquired and aspiration pneumonia (Mayor Clinic, 2016). Another reason for high rate of pneumonia infection could be due to the fact that older age above 65 is considered to be a major risk factor. Other risk factors for pneumonia are smoking, hospitalisation, chronic diseases which include COPD, asthma, heart disease (Mayor Clinic, 2016). It is therefore not surprising that pneumonia is the largest diseases presented among smokers, non-smoker who were not working in toxic environment (figure 30), non-smoker who works in the toxic environment (figure 33) people that are exposed to combined effect of air pollution due to smoking and workplace and those that were not exposed to any of these pollutant according to the context of this thesis. Another shocking revelation about pneumonia according to the result of this research is that out of total 114 hospital cases of pneumonia from Table 2, only two cases were presented as a comorbidity indicating that pneumonia is a major primary disease in this hospital.

The result also shows clearly that hypertension is the most presented comorbidity presented by 91 patients out of 229 patients analysed. It is a common diseases with very high prevalence above the age of 65 (Margaret D. Carroll, 2012). This studies corroborate the numerous studies of comorbidity of respiratory diseases for instance in COPD (Wissam M. Chatila Byron M.

Thomashow, 2008). This studies is also in line with the established facts that there is a relationship between exposure to environmental air pollution and hypertensive disease as pointe out earlier in this research. It is important for the hypertensive patients to be aware of this risk so that they can avoid exposure to air pollution because epidemiological studies has shown that there is an increase in cardiopulmonary death in the cities with more air pollution compared to city with less air pollution (Kleinman, 2003)

Certain diseases are common among smokers in this hospital for instance, in the order of commonest, COPD, pneumonia, hypertension, asthma, tuberculosis, respiratory failure and lung carcinoma and when compared to non-smokers with pneumonia, hypertension asthma and COPD from figure 32 and figure 30. This studies also agreed with many authors and researcher that smoking is a risk factor to many diseases and number one risk factor for lung cancer according to centre for disease control and prevention. Cigarette consist over 4000 chemical substances, some of which are carcinogenic. The result of this studies is also in line with previous finding by other researcher when looking at the Table 31, out of the total number of 16 cases of lung carcinoma, 14 of them are smokers and only one non-smoker has lung cancer. Working in toxic environment also have large impact on human health in this study as seen in figure 32 page 43 where respiratory diseases such as pneumonia, tuberculosis, COPD, pleurisy, respiratory failure are the disease that common. The reason why tuberculosis cases was higher among this group of patients was the fact that some of them are working in the agricultural sector and mainly farmers and shepherd and hence the risk of exposure to the mycobacterium causing tuberculosis is very high. Positive family history of tuberculosis was also seen among these patients presented with tuberculosis which could explain the air borne transmission of this disease.

Combined effect of smoking and exposure to environmental air pollutants was also seen to have major effects on human health. Among this group of patients, the most presented case is COPD, followed by hypertension, pneumonia, hypertension, tuberculosis, asthma, respiratory failure, pulmonary fibrosis and lung cancer as seen in the Table 4. Patients in this group have a combined high risk of high severity of these diseases although more studies will be needed in future to support this observation.

On analysis of those that were considered to be exposed to environmental air pollution which is either by working in a toxic environment or by smoking or both, in the order commonest, the following diseases could be attributed to environmental air pollution pneumonia, hypertension, COPD, tuberculosis, asthma, respiratory failure and diabetics. These group of cases which

represent the exposure to environmental air pollution. This results shows that the aforementioned diseases are in line with the established facts stated in the literature review.

The statistical results of the analysis, Pearson correlation coefficients of **0.99** which shows that there is a strong correlation between the exposure to environmental air pollutants and total hospital cases representing total hospital visit shows the strength of this studies. It is therefore of public importance to limit exposure to environmental air pollutants at workplace and strict regulation on smoking especially at public place to reduce the effect of passive smoking effect. The P value of **0.004** at 95% confident interval which shows that exposure to environmental air pollutant has a significant effect on the hospital visit due to illness is another strength of this study.

However, non-existence of data of the nature, types and level of exposure of air pollution for these patients are limitations of this study which would have shed more lights on the cause and effect of the air pollution. In future studies, more data related to the nature of exposure could be obtained in the department of occupational medicine.

9 CONCLUSION

Certain diseases are more common among exposed patients when compared to non-exposed patients. It can be concludes that COPD, pulmonary abscess, respiratory failure, pulmonary abscess, lung carcinoma, pulmonary emphysema and other form of carcinoma more common among patients that were exposed to environmental air pollution.

The result of the Pearson correlation coefficients rejects the null hypothesis (H0) that there is no correlation between the disease cases presented as a result of exposure to environmental air pollution and total hospital visit. The Pearson correlation between the exposure to environmental air pollutants against total hospital visit (represented by total cases seen or recorded) is 0.99 shows a strong correlation.

The P value of 0.004 at 95% confidence interval also reject the null hypothesis (H0) that exposure to environmental air pollutant do not have a significant effect on the total hospital visit due to illness. Therefore, it can be concluded that that exposure to environmental air pollutant has a significant effect on the total hospital visit due to respiratory symptoms and illness.

REFERENCES

Akhmat G, Z. K. (2014). A contemporary landscape of air pollution and greenhouse gas emissions leads to inevitable phenomena of low birthweight. *PubMed*.

Alfven T, E. C. (2000). Low-level cadmium exposure and osteoporosis. *Web of Science*.

Almeida SM, S. A. (2014). Effects of exposure to particles and ozone on hospital admissions for cardiorespiratory diseases in SetúBal, Portuga. *PubMed*.

Amitava Mukherjee. (2002). Perpesctives of the Silent Majority: Air Pollution, Livelihood and Food security. Hampshire: Ashgate Publishing Comapany.

Australian Government department of the Environment. (2014, september 14). Retrieved from Australian Government department of the Environment: http://www.npi.gov.au/resource/sulfur-dioxide

Bartra J, M. J. (2007). Air pollution and allergens. *J Investig Allergol Clin Immunol*.

Baumgartner J1, Z. Y. (2014). Highway proximity and black carbon from cookstoves as a risk factor for higher blood pressure in rural China. *PubMed*.

Bibhabasu Mohanty. (2014). Retrieved from http://www.slideshare.net/bibhabasumohanty/air-pollution-14820250

Bind MA, L. J. (2014). Air pollution and gene-specific methylation in the Normative Aging Study: association, effect modification, and mediation analysis. *pubMed*.

Biometeorol., I. J. (2013). Poaceae pollen in the air depending on the thermal conditions. *NCBI*.

Bos I, D. B. (2014). Physical Activity, Air Pollution and the Brain. *PubMed*.

Bräuner EV, A. Z.-N. (2013). Residential radon and brain tumour incidence in a Danish cohort. *NCBI*.

Bräuner EV1, A. Z.-N. (2013). Residential radon and brain tumour incidence in a Danish cohort. *PubMed*.

Briggs, d. (2003). Environmental pollution and the global . *Oxford journal*, 1.

Brucker N, C. M. (2014). Atherosclerotic process in taxi drivers occupationally exposed to air pollution and co-morbidities. *PubMed*.

Camarinho R, G. P. (2013). Chronic exposure to volcanogenic air pollution as cause of lung injury. *PubMed*.

Chen H, B. R. (2013). Risk of incident diabetes in relation to long-term exposure to fine particulate matter in Ontario, Canada. *PubMed*.

Cho J, C. Y. (2014). Air pollution as a risk factor for depressive episode in patients with cardiovascular disease, diabetes mellitus, or asthma. *pubMed*.

Chuang KJ, C. H. (2013). Indoor air pollution, nighttime heart rate variability and coffee consumption among convenient store workers.

Clougherty, J. E. (2009). A Growing Role for Gender Analysis in Air Pollution Epidemiology. *Environmental health perspectives*.

CNN news. (2013, Otober 17). *Air pollution causes cancer, world health authority says*. Retrieved from http://edition.cnn.com/2013/10/17/health/geneva-air-pollution-carcinogenic-who/

Cristina Pretrescu. (2002). Elements of Hygiene: Environment, nutrition and school hygiene. In C. Pretrescu. Timisoara: Editura SOLNESS.

Cuinica LG, A. I. (2014). Effect of air pollutant NO_2 on Betula pendula, Ostrya carpinifolia and Carpinus betulus pollen fertility and humanallergenicity. *PubMed*.

Diane R. Gold & Jonathan M. Samet. (2013). Air Pollution, Climate, and Heart Disease. *American Heart Association*.

Ding G, J. R. (2014). Risk and Protective Factors for the Development of Childhood Asthma. *PubMed*.

Dossus L1, B.-R. M.-C.-d. (2014). Active and passive cigarette smoking and breast cancer risk: results from the EPIC cohort. *NCBI*.

Environment Nature and Energy Department. (2014). Retrieved from Environment and Health: http://www.lne.be/en/environment-and-health

Eran Sher. (1998). *Handbook of Environmental Air pollution from Internal Cobustion Engines.* san Diego: Academyc press.

European Environment Agency. (2011). *Nitrogen oxides (NOx) emissions (APE 002) - Assessment published December 2011.* European Environmental Agency.

European environment Agency. (2011). *Non-methane volatile organic compounds (NMVOC) emissions (APE 004) - Assessment published Dec 2011.* Copenhagen: European environment Agency.

Eze IC, S. E.-H. (2014). Long-term air pollution exposure and diabetes in a population-based Swiss cohort. *PubMed*.

Faustini A, S. M. (2013). Air pollution and multiple acute respiratory outcomes. *PubMed*.

Faustini A, S. M., & Group, E. C. (2013). Air pollution and multiple acute respiratory outcomes. *PubMed*.

Faustini A, S. M., & Group., E. C. (2013). Air pollution and multiple acute respiratory outcomes. *NCBI*.

Feki-Tounsi M, H.-C. A. (2014). Cadmium as a possible cause of bladder cancer: a review of accumulated evidence. *PubMed*.

Florin-Dan Popescu, A. M. (2011). Ambrosia pollen sensitization in allergic rhinitis. *Romanian Journal of the Rhinology*.

Gabriel N. Stover, M. a. (2003). Practice Is the Purpose of Public Health. *US National Library of Medicine* .

Geer LA, W. J. (2012). Ambient air pollution and term birth weight in Texas from 1998 to 2004. *PubMed*.

Gowers AM, C. P. (2012). Traffic emission factors of ultrafine particles: effects from ambient air. *NCBI*.

Gruzieva O, B. A. (2013). Exposure to air pollution from traffic and childhood asthma until 12 years of age. *NCBI*.

Guo Y, L. S. (2013). The burden of air pollution on years of life lost in Beijing, China, 2004-08: retrospective regression analysis of daily deaths.

Guxens M1, G.-E. R.-A.-S. (2014). Air pollution during pregnancy and childhood cognitive and psychomotor development: six European birth cohorts. *NCBI*.

Hammoud A, C. D.-J. (2010). Decreased sperm motility is associated with air pollution in Salt Lake City. *Pubmed*.

Hannuksela, M. (2013). About allergen. *NCBI*.

Hansell AL, B. M. (2013). Aircraft noise and cardiovascular disease near Heathrow airport in London: small area study. *PubMed*.

Hathout EH, B. W. (2002). Role of exposure to air pollutants in the development of type 1 diabetes before and after 5 yr of age. *PubMed*.

Health Canada. (2014, september 18). *Environmental and workplace*. Retrieved from http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/health-sante/respir-eng.php

Herrera AB, R. L. (2011). Biological pollution and its relationship with respiratory symptoms indicative of asthma, Bucaramanga, Colombia. *NCBI*.

Hong Kong Center of health protection. (2014, september 14). *Department of Health: The government of Hong Kong Special Administrative Region*. Retrieved from http://www.chp.gov.hk/en/content/9/460/3557.html

http://njcmr.njit.edu/distils/lab/Air_html/source.htm#1. (2014). Retrieved from http://njcmr.njit.edu/distils/lab/Air_html/source.htm#1

http://www.edb.utexas.edu/education/. (2014). *http://www.edb.utexas.edu/education/.* Retrieved from http://www.edb.utexas.edu/petrosino/Legacy_Cycle/mf_jm/Challenge%201/air%20pollution.pdf

Hystad P, D. P. (2014). Long-term residential exposure to air pollution and lung cancer risk. *PubMed*.

Ivan Blumenthal. (2001). Carbon monoxide poisoning. *Journal of the Royal Society of medicine*.

J Raph. (2004). *Environmental health criteria 213.* Geneva: World Health Organization.

Jakob, Ü. &. (2005). Re-defining 'Health'. *Bulletin of the World Health Organization*.

Jancic SA, S. B. (2014). Cadmium effects on the thyroid gland. *PubMed*.

Jarup L, B. M. (1998). Health effects of cadmium exposure—a review of the literature and a risk estimate. . *Scandinavia Journal of Work and Environment & Health.*

Jedrychowski WA, P. F.-R. (2013). Intrauterine exposure to fine particulate matter as a risk factor for increased susceptibility to acute broncho-pulmonary infections in early childhood. *PubMed*.

Jedrychowski WA, P. F.-R. (2013). Intrauterine exposure to fine particulate matter as a risk factor for increased susceptibility to acute broncho-pulmonary infections in early childhood. *NCBI*.

Jedrychowski WA1, P. F.-R. (2013). Intrauterine exposure to fine particulate matter as a risk factor for increased susceptibility to acute broncho-pulmonary infections in early childhood. *PubMed*.

Jevtić M1, D. N. (2014). Cardiovascular diseases and air pollution in Novi Sad, Serbia. *NCBI*.

Juliet Ikhuosho-Asikhia. (2014). EFFECT OF GENERATOR USAGE ON SMALL SCALE BUSINESSES IN NIGERIA. Tampere, Finland. Retrieved from https://publications.theseus.fi/handle/10024/76103

Kleinman, M. T. (2003). Air Pollution Role in Hypertension and Heart Attacks. *United State Evironmental Protection Agency*.

Lars Järup. (2003). Hazards of heavy metal contamination. *British medical Bulletin*.

Le TG, N. L. (2012). Effects of short-term exposure to air pollution on hospital admissions of young children for acute lower respiratory infections in Ho Chi Minh City, Vietnam. *PubMed*.

Lee BJ1, K. B. (2014). Air pollution exposure and cardiovascular disease. *NCBI*.

Li J, L. M. (2013). Characterization of biological aerosol exposure risks from automobile air conditioning system. *Jornal of Environmental Science and technology*.

Liu P, W. X. (2016). Effects of Air Pollution on Hospital Emergency Room Visits for Respiratory Diseases: Urban-Suburban Differences in Eastern China. *International journal of Environmental health research and Public health*.

Loftus A, L. B. (2014). Acute childhood asthma in Galway city from 1985-2005: relationship to air pollution and climate. *PubMed*.

M Nishijo, H. N. (1995). Mortality of inhabitants in an area polluted by cadmium: 15 year follow up. *Journal of Occupational & Environmental Medicine*.

Margaret D. Carroll, M. (2012). Hypertension Among Adults in the United States, 2009–2010. *Centers for disease Control and prevention*.

Mayor Clinc. (2016, March 22). *Mayor clinic*. Retrieved from http://www.mayoclinic.org/diseases-conditions/pneumonia/basics/risk-factors/con-20020032

Mayor Clinic. (2016, 04 07). Retrieved from http://www.mayoclinic.org/diseases-conditions/pneumonia/basics/risk-factors/con-20020032

Merck Manuals. (2008). *http://www.merckmanuals.com/.* Retrieved from http://www.merckmanuals.com/home/lung_and_airway_disorders/environmental_lung_diseases/building-related_illnesses.html

Medscape. (2016, April 07). *Environmental health in emergencies*. Retrieved from http://www.medscape.com/viewarticle/780507_2

Mengesha Admassu & Mamo Wubeshet. (2006). *AIr pollution.* Ethopia: Ethopia Public Health Training Initiative.

Milner J, S. C. (2014). Home energy efficiency and radon related risk of lung cancer. modelling study.

Milner J, S. C. (2014). Home energy efficiency and radon related risk of lung cancer: modelling study. *PubMed*.

Milner J1, S. C. (201). Home energy efficiency and radon related risk of lung cancer: modelling study. *PubMed*.

Murray RL, B. J.-B. (2012). Second hand smoke exposure and the risk of invasive meningococcal disease in children: systematic review and meta-analysis. *PubMed*.

Nakano T, O. T. (2014). Environmental air pollutants and the risk of cancer. *PubMed*.

National institute of drug abuse. (2016, march 24). *The science of drugg abuse and addiction*. Retrieved from https://www.drugabuse.gov/publications/research-reports/comorbidity-addiction-other-mental-illnesses/what-comorbidity

Nazli Hossain & Elizabeth Westerlund Triche. (2007). Environmental factors implicated in the causation of adverse pregnancy outcome. *PubMed*.

New Zealand Ministry of Environment. (2014). *Health effects of CO, NO2, SO2, ozone, benzene and benzo(a)pyrene in New Zealand*. Retrieved september 14th, 2014, from New Zealand Ministry of Environment: http://www.mfe.govt.nz/publications/air/air-quality-tech-report-43/html/page6.html

Nieuwenhuijsen MJ, B. X. (2014). Air pollution and human fertility rates. *PubMed*.

Nordling E, B. N. (2008). Traffic-related air pollution and childhood respiratory symptoms, function and allergies. *NCBI*.

Ogliari KS, L. A. (2013). Intrauterine exposure to diesel exhaust diminishes adult ovarian reserve. *NCBI*.

Oosthoek, Jan. (2014). *Environmental History Resources*. Retrieved from www.eh-resources.org: http://www.eh-resources.org/index.html

Oregon Public health authority. (2014). *oregon.gov*. Retrieved from https://public.health.oregon.gov/About/Pages/Goals.aspx

Parivesh Hazardous Air Pollutants. (2009). In C. P. BOARD. Parivesh Bhawan.

Pawel Migula, J. E., & Migula, P. (2003). How pollutant affect toxicology an human health. In *Environmental and Occupational mediccine* (p. 433). Baltic Unviversity press, Upssala university.

Pedersen M1, G.-A. L.-S. (2013). Ambient air pollution and low birthweight: a European cohort study (ESCAPE). *NCBI*.

Perera FP, W. S. (2013). Prenatal exposure to air pollution, maternal psychological distress, and child behavior. *NCBI*.

Perin PM, M. M. (2010). Effects of exposure to high levels of particulate air pollution during the follicular phase of the conception cycle on pregnancy outcome in couples undergoing in vitro fertilization and embryo transfer. *PubMed*.

Phung D, H. T. (2016). Air pollution and risk of respiratory and cardiovascular hospitalizations in the most populous city in Vietnam. *Science of the total Environment*.

Physician for Social responsibility. (2014, September 18). Retrieved from http://www.psr.org/assets/pdfs/air-pollution-effects-respiratory.pdf

Plé C, C. Y. (2013). Environmental pollution and allergy: immunological mechanisms. *NCBI*.

Qian Y1, Z. M. (2013). Epidemiological evidence on association between ambient air pollution and stroke mortality. *NCBI*.

Ritz B1, Q. J. (2014). Prenatal air pollution exposure and ultrasound measures of fetal growth in Los Angeles, California. *NCBI*.

Ruano-Ravina A, A. N.-R.-A.-D. (2014). Residential radon exposure and esophageal cancer. An ecological study from an area with high indoor radon concentration (Galicia, Spain). *PubMedd*.

Scottish Environmental protection Agency. (2014). *Making case fir the environment*. Retrieved from http://www.sepa.org.uk/flash/mtc_chem_of_air_pollution.html

S. K. Agarwal. (2009). Heavy Metal Pollution. New Delhi: APH Publishing Corporation.

S.balanarayanan & K.vetrivel. (2012). ENVIRONMENTAL DEGRADATION AND HUMAN WELFARE. *ZENITH International Journal of Business Economics & Management Research*.

Seidal K, J. N. (1993). Fatal cadmium-induced pneumonitis. *Scand Journal of Work, Environment & Health.* .

Seow WJ1, H. W. (2014). Household air pollution and lung cancer in China: a review of studies in Xuanwei. *pubMed*.

Sheet, Minnesota Department of Health Fact. (2014, september 14). Retrieved from Minnesota Department of Health: http://www.health.state.mn.us/divs/eh/indoorair/voc/

Sram RJ, B. B.-D. (2013). Health impact of air pollution to children. *NCBI*.

Staessen JA, R. H. (1999). Environmental exposure to cadmium, forearm bone density, and risk of fractures: prospective population study. Public Health and Environmental Exposure to Cadmium . *Web Of Sicence*.

State of New Jersey Department of Environmental protection. (2014). Retrieved from State of New Jersey Department of Environmental protection: http://www.state.nj.us/dep/airtoxics/sourceso99.htm

Steinvil A1, S. H.-A.-R.-B. (2013). Environmental exposure to combustion-derived air pollution is associated with reduced functional capacity in apparently healthy individuals. *NCBI*.

The North America Mosaic. (2014, 09 14). *cec.* Retrieved from http://www3.cec.org/islandora/en/item/986-north-american-mosaic-overview-key-environmental-issues-en.pdf

United Nation News centre. (2014). *utdoor air pollution a leading cause of cancer, say UN health experts.* United Nation.

United State Environmental protection Agency. (2014, September 17). Retrieved from http://www.epa.gov/groundlevelozone/health.html

United State Environmental Protection Agency. (2014, september 14). Retrieved from United State Environmental Protection Agency: http://www.epa.gov/airquality/sulfurdioxide/health.html

Unosson J, B. A. (2013). Exposure to wood smoke increases arterial stiffness and decreases heart rate variability in humans.

Vanos JK, H. C. (2014). Risk assessment for cardiovascular and respiratory mortality due to air pollution and synoptic meteorology in 10 Canadian cities. *PubMed*.

Vinikoor-Imler LC, D. J. (2013). Early prenatal exposure to air pollution and its associations with birth defects in a state-wide birth cohort from North Carolina. *NCBI*.

Vinikoor-Imler LC, D. J. (2014). Associations between prenatal exposure to air pollution, small for gestational age, and term low birthweight in a state-wide birth cohort. *PubMed*.

Wang L, J. L. (2013). Maternal genetic polymorphisms of phase II metabolic enzymes and the risk of fetal neural tube defects.

Wang Y, E. M. (2014). Short-term changes in ambient particulate matter and risk of stroke: a systematic review and meta-analysis. *PubMed*.

Wang Y, J. J. (2013). Passive smoking and risk of type 2 diabetes: a meta-analysis of prospective cohort studies. *NCBI*.

Weldy CS, L. Y. (2013). In utero and early life exposure to diesel exhaust air pollution increases adult susceptibility to heart failure in mice. *pubMed*.

WHO. (2016). *Risk factors of ill health among older people*. Retrieved from WHO: http://www.euro.who.int/en/health-topics/Life-stages/healthy-ageing/data-and-statistics/risk-factors-of-ill-health-among-older-people

Wissam M. Chatila Byron M. Thomashow, O. A. (2008). Comorbidities in Chronic Obstructive Pulmonary Disease. *American Thoraci Society*.

Wong IC, N. Y. (2014). Cancers of the lung, head and neck on the rise: perspectives on the genotoxicity of air Pollution. *Pubmed*.

World bank Group. (1998). *Nitrogen Oxides: Pollution Prevention.* World bank Group.

World Health Organization. (1992). *Cadmium. Environmental Health Criteria.* Geneva: World health Organization.

World Health Organization. (2005). *Environmental health in emergencies.*

World Health Organization. (2006). *Preventing diseases through healthy environments.* Geneva, Switzerland.

World Health Organization. (2014, September 20). Retrieved from Global burden of disease: http://www.who.int/topics/global_burden_of_disease/en/

World Health Organization. (2014, September 20th). Retrieved from The Global Burden of Disease concept: http://www.who.int/quantifying_ehimpacts/publications/en/9241546204chap3.pdf

Zhao A, C. R. (2014). Ambient air pollution and daily outpatient visits for cardiac arrhythmia in Shanghai, China. *PubMed*.

Zhao X, S. Z. (2014). Personal black carbon exposure influences ambulatory blood pressure: air pollution and cardiometabolic disease (AIRCMD-China) study. *PubMED*.

Zora JE, S. S. (2013). Associations between urban air pollution and pediatric asthma control in El Paso, Texas. *NCBI*.