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# Air Pollution in Urban Areas and Health Effects

## Pencemaran Udara di Kawasan Bandar dan Kesan terhadap Kesihatan

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*ABSTRACT*

*The world's population is becoming ever more urbanised, causing deterioration of air quality in many of the most rapidly growing cities. The common air pollutants include carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulphur dioxide and lead. In their most extreme form, air pollution episodes are accompanied by physical discomfort, disruption of day-to-day living, widespread public fear, illness and even death.In many cities air pollution is reaching levels that threaten people's health according to an unprecedented compilation of air quality data released today by WHO. For example, a study of air pollution in 20 of the 24 megacities of the world shows that ambient air pollution concentrations are at levels where serious health effects are reported. Moreover, in year 2004, urban air pollution is ranked as the 14th global risk factor for mortality. For 2008, the estimated mortality attributable to outdoor air pollution in cities amounts to 1.34 million premature deaths. Thus, epidemiological studies have consistently associated adverse health effects with exposures to particulate air pollution. However, the effects of air pollution on health are dependent on several factors. Apart from the concentrations and chemical properties of the pollutants, the person's age and general state of health, the duration of exposure, factors such as the weather condition and the distance from the emission sources also affect the nature and extent of the health effects observed.Therefore, the ambient air quality is much urgency in instituting control and preventive measures and at the public level there is a long-standing commitment to improve air quality.*

*Keywords: Urban; air pollution; pollutants; health effects; diseases*

*ABSTRAK*

*Penduduk dunia menjadi semakin bercirikan pembandaran, menyebabkan kemerosotan kualiti udara di kebanyakan bandar-bandar yang paling pesat berkembang. Bahan pencemar udara biasanya termasuklah karbon monoksida, nitrogen dioksida, ozon, bahan zarahan, sulfur dioksida dan plumbum. Dalam bentuk yang paling buruk, episod pencemaran udara disertakan dengan ketidakselesaan fizikal, gangguan kehidupan seharian, ketakutan orang ramai secara meluas, penyakit dan juga kematian. Dalam kebanyakan bandar pencemaran udara mencapai tahap yang mengancam kesihatan manusia, kompilasi yang belum pernah terjadi sebelumnya menurut data kualiti udara yang dikeluarkan hari ini oleh WHO. Sebagai contoh, satu kajian pencemaran udara di 20 daripada 24 bandar mega di dunia menunjukkan bahawa kepekatan pencemaran udara adalah pada tahap di mana kesan-kesan kesihatan yang serius dilaporkan. Selain itu, pada tahun 2004, pencemaran udara bandar disenaraikan sebagai faktor risiko global ke-14 untuk kematian. Bagi tahun 2008, kematian yang dianggarkan berpunca daripada pencemaran udara luar di bandar-bandar berjumlah 1.34 juta mengakibatkan kematian pra-matang. Oleh itu, kajian epidemiologi telah dilakukan secara konsisten berkaitan kesan kesihatan yang buruk dengan pendedahan kepada zarah pencemaran udara. Walau bagaimanapun, kesan pencemaran udara terhadap kesihatan adalah bergantung kepada beberapa faktor. Selain daripada kepekatan dan sifat-sifat kimia bahan pencemar, umur seseorang itu dan keadaan umum kesihatan, jangka masa pendedahan, faktor-faktor seperti keadaan cuaca dan jarak dari sumber bunyi yang juga memberi kesan kepada jenis dan takat kesan kesihatan yang diperhatikan. Oleh itu, kualiti udara ambien adalah lebih mendesak dalam memulakan kawalan dan langkah-langkah pencegahan di peringkat awam dan memerlukan komitmen yang lama untuk memperbaiki kualiti udara.*

*Kata Kunci: Urban; pencemaran udara;pencemaran; kesan terhadap kesihatan; penyakit*

## INTRODUCTION

In 1900, 14 percent of the world's population lived in cities, increasing to over 50 percent by 2000. Over the next 30 years, the world's urban population is expected to double to more than five billion, with virtually all the growth taking place in less economically developed countries. Therefore, air pollution is a common phenomenon in urban areas.

Air pollution refers to the release of air pollutants. Air pollution is a mixture of solid particles and gases in the airand become common phenomenon

in urban areas. Early references date to the Middle Ages, when smoke from burning coal was already considered such a serious problem that in 1307, King Edward I banned its use in lime kilns in London. Fog disaster in Meuse Valley (1930), Donora Death Fog (1948) and London Smoke (1952) were a few of air pollution episodes (http://www.windows2universe.org/milagro/effects/health.html.).

The first major air pollution event occurred in 1930 in the Meuse Valley of Belgium. A dense blanket of smog hung over the valley for five days, which killed 63 people and caused 6000 others to become ill. A similar event occurred in Donora, Pennsylvania in 1948. Almost 6,000 of the 14,000 people in the town became ill, and 20 died. The most notorious of these tragedies occurred in London in 1952 as a result of dense smog caused by the burning of coal fires. More than 4000 people died over a five-day period. But tragic consequences are not always immediate. Slow and subtle health effects from long-term air pollution exposure are also of great concern and may culminate in life-threatening illnesses such as cancer. Several serious episodes focused attention on the need to control the quality of the air (http://www.windows2universe.org/milagro/effects/health.html.)

People have generated air pollutants, gases and particulate material added to the atmosphere that can affect climate or harm people or other organisms. Across the world, city air is often thick with exhaust fumes, factory smoke or soot from coal burning power plants. Rapid industrialisation, development and transportation have increment of harmful pollutants. The greatest air pollution problem today is emission of greenhouse gases that contribute to global climate change. World Health Organisation (WHO), has attributed 2-3 million deaths annually worldwide to air pollution.

Substances that are emitted directly into the atmosphere are called primary pollutants, whereas others that are created by various physical processes and chemical reactions that take place in the atmosphere are called secondary pollutants. Nitrogen dioxides and hydrocarbons emitted when fuel are burned are primary pollutants, but the ozone that is created when those chemicals react with each other in the atmosphere is a secondary pollutant. Furthermore, anthropogenic air pollution is emitted from point sources and non point sources. A point source describes a specific location from which large quantities of pollutants are discharged. A factories and power plants are an example of a point source. Non point source are more diffuse, often consisting of many small sources spread across a wide area such as automobiles on the roadways.

## AIR POLLUTION IN THE URBAN AREAS

The land area covered by cities covers about 5 per cent of the planet. Urban areas are characterised by high density population, who are accommodated by the development of extensive road networks, housing schemes, service and production industries and recreational facilities.

Fully half of the world's population now live in urban areas. The world's population is becoming ever more urbanised, causing environmental pressures, not the least of which is deterioration of air quality in many of the most rapidly growing cities. Scientists estimate that 60% of the world population will be city-dwellers by 2025. It is estimated 93% of urban growth will occur in developing nations, with 80% of urban growth occurring in Asia and Africa (Ankerl 1986). According to the UN State of the World Population 2007 report, the majority of people worldwide will be living in towns or cities, for the first time in history; this is referred to as the arrival of the "Urban Millennium" or the 'tipping point'.

Urban population's are growing for two reasons: (1) the human population overall is growing and (2) more people are moving froms rural to cities. Since 1950, the global urban population has grown by 4.7 times whereas the rural population has not quite doubled. The United Nations projects that the urban population will nearly double between now and 2050 whereas the rural population will decline by 16% (Withgott and Brennan 2011). In cities such as Karachi, Pakistan; Lagos, Nigeria and Delhi, India, population growth often exceeds economic growth and the result is overcrowding, pollution and poverty.

Air pollution is usually concentrated in densely populated urban areas, especially in developing countries where environmental regulations are relatively lack or nonexistent. Thus, urban air quality is a major concern throughout the world. For example,in Year 2004, urban outdoor air pollution is ranked as the 14th global risk factor for mortality. Even populated areas in developed countries attain unhealthy levels of pollution, for examples Los Angeles and Rome whereas Osaka-Kobe, Tokyo, Sao Paulo, New York and Buenos Aires are the least polluted megacities.

Pollutants can be in the form of solid particles, liquid droplets or gases. Sources of air pollution refers to the various locations, activities or factors which are responsible for the releasing of pollutants into the atmosphere. Some air pollutants are poisonous and inhaling them can increase health problems. Pollutants can be classified as primary or secondary. Primary pollutants are directly produced from a process, such as ash from a volcanic eruption sulfur dioxide released from factories. Secondary pollutants are form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone — one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants.

Polluted air can cause respiratory irritation or breathing difficulties during exercise or outdoor activities, even for healthy people, which they may experience temporary symptoms such as irritation of the eyes, nose and throat; coughing and shortness of breath.There are possible short-term and long-term health effects of exposure to air pollution. In the short term, high levels of air pollution lead to an acute condition however the possible long-term health effects of exposure to air pollution are unknown and difficult to detect.

In most megacities, the principal source of air pollution is motor vehicles. In almost all cities in the developing world, leaded fuels are still being burned; a high percentage of the vehicles are diesel-powered trucks and buses with no emission controls; many streets are unpaved and traffic congestion, which intensifies emissions is overwhelming. The resulting concentrations of Pb, CO, NOx, $O_3$ and TSP are often many times higher than air-quality guidelines defined by WHO. In addition, some countries have coal-fired power plants and other industrial facilities within city limits, so levels of SOx, NOx and particulates are correspondingly high (Masters and Ela 2008).

There are a few types of air quality standards to measure the quality of air. Air quality standards define clean air and tell how much of a substance can be in the air without causing harm**.** In Canada, air pollution and associated health risks are measured with the The Air Quality Health Index or (AQHI). It is a health protection tool used to make decisions to reduce short-term exposure to air pollution by adjusting activity levels during increased levels of air pollution. The AQHI provides a number from 1 to 10+ to indicate the level of health risk associated with local air quality. Occasionally, when the amount of air pollution is abnormally high, the number may exceed 10. The higher the number, the greater the health risk and need to take precautions. The index describes the level of health risk associated with this number as 'low', 'moderate', 'high' or 'very high', and suggests steps that can be taken to reduce exposure (Table 1). The AQHI provides a local air quality current value as well as a local air quality maximums forecast for today, tonight and tomorrow and provides associated health advice (Environment Canada 2008).

TABLE 1. Air Quality Health Index in Canada

| Health Risk | Air Quality Health Index | Health Messages | |
|---|---|---|---|
| | | At Risk population | General Population |
| Low | 1-3 | Enjoy your usual outdoor activities | Ideal air quality for outdoor activities |
| Moderate | 4-6 | Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms | No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation. |
| High | 7-10 | Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy. | Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation |
| Very high | Above 10 | Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion | Reduce or reshedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation. |

*Source:* Environment Canada (2008)

In Malaysia, Air Pollution Index (API) system which closely follows the Pollutant Standard Index (PSI) system of the United States was used in order to measure the air quality (Table 2). API is the maximum index among $PM_{10}$, $NO_2$, $SO_2$, $O_3$ and CO.

TABLE 2. API in Malaysia

| API | Status | Level of Pollutant | Health Measure |
|---|---|---|---|
| 0-50 | Good | Pollution low and no ill effect on health | No restriction of activities for all group of people |
| 51-100 | Moderate | Moderate pollution and no ill effect on health | No restriction of activities for all group of people |
| 101-200 | Unhealthy | Mild aggravation of symptoms among high risk person (lung and heart diseases) | Restriction of outdoor activities for high risk people.<br>Public should reduce outdoor activities. |
| 201-300 | Very unhealthy | Significant aggravation of symptoms and decreased exercise tolerance in person with lung or heart diseases | Person with heart or lung diseases should stay indoor and avoid physical activities. |
| 301-500 | Hazardous | Severe aggravation and endanger health | Person with heart or lung diseases should stay indoor and avoid physical activities.<br>Public should avoid rigorous outdoor activities. |
| Above 500 | Emergency | Severe aggravation and endanger health | Public advised to follow the order of National Security Council and always follow announcement through mass media |

Worldwide, WHO ranked Mexico City as the world's most polluted city. $O_3$ concentrations above 0.10 ppm occur as many as 300 days per year (the U.S 8-hr standard is 0.09 ppm). Recently, Mexico City has lost that dubious distinction, with the 10 most polluted cities in the world now being in China. Table 3 shows the most polluted cities by $PM_{10}$ in the world in 2004. The current WHO air quality guidelines are annual mean concentrations of 20 micrograms per cubic meter for particulate matter less than 10 microns in diameter ($PM_{10}$).

TABLE 3. Most polluted world cities by $PM_{10}$

| Particulate matter, μg/m³ | City |
|---|---|
| 168 | Cairo, Egypt |
| 150 | Delhi, India |
| 128 | Kolkata, India |
| 125 | Tianjin, China |
| 123 | Chongqing, China |
| 109 | Kanpur, India |
| 109 | Lucknow, India |
| 104 | Jakarta, Indonesia |
| 101 | Shenyang, China |

*Source:* World Bank Statistics (2007)

In 2003, Baldasano et al. published an assessment of the air quality for the principal cities in developed and developing countries. According to their study, the current state of air quality worldwide indicates that $SO_2$ maintains a downward tendency throughout the world, with the exception of some Central American and Asian cities. Whereas, $NO_2$ maintains levels very close to the WHO guideline value in many cities. However, in certain cities such as Kiev, Beijing and Guangzhou, the figures are approximately three times higher than the WHO guideline value. In fact, $NO_2$ concentrations are showing increasing trend in several Asian megacities. Particulate matter is a major problem in almost all of Asia, exceeding 300 mg/y/m³ in many cities, like two Latin-American cities, Tegucigalpa and Montevideo. In the Asian databases consulted, only Japan showed really low figures. Ground-level ozone presents average values that exceed the selected guideline values in all of the analysis by regions (Gurjar 2012).

Furthermore, study of populations and air quality in 20 megacities showed that high level of suspended particulate matter (SPM) is the most prevalent air quality problem. Of these 20 cities,

12 have serious problems with particulate matter, where "serious" is defined to mean WHO air-quality guidelines are exceeded by more than a factor of two. Beijing, Mexico City and Seoul have serious SPM combined with serious SOx problems, which is a lethal combination that leads to increased mortality and morbidity. In a number of areas, including parts of Beijing, Calcutta, Delhi, Shanghai and Seoul, combustion of coal and biomass fuels for cooking and heating leads to extremely high pollutant concentrations indoors where many people, women especially, spend most of their time (Masters and Ela 2008).

Urban air pollution can significantly degrade quality of life. The people of China for example, suffer some of the world's air pollution. China has fueled its rapid industrial development with its abundant reserves of coal, the most-polluting fossil fuel. Power plants and factories have sprung up pell-mell across the nation, often usind outdated, inefficient, heavily polluting technology because it is cheaper and quicker to build. In Beijing, 1,500 new cars hit the roads each day. In many cities on a regular basis, the haze is too thick for people to see the sun. Reports by Chinese scientist, the World Bank and WHO all estimate that outdoor air pollution causes over 300,000 premature deaths each year. China's government is now trying hard to decrease pollution.

In Malaysia, the overall air quality deteriorated slightly compared with in previous year. Several unhealthy air quality days were recorded at Kuala Lumpur, Selangor, Penang, Melaka and Perak. Particulate Matter (PM) and ground-level $O_3$ remainedthe prevailing pollutants in the country. In many urban areas in Malaysia, there are three main contributors to air pollution that are stationary sources, mobile sources and burning sources. Mobile sources include motor vehicles such as personal cars, commercial vehicles, and motorcycles. By the end of 2000, there were 10.6 million vehicles registered in Malaysia, compared to 7.7 million in 1996, an increase of almost 2.9 million vehicles or 26% (Department of Environment (DOE) 2001). The federal territory of Kuala Lumpur has the highest vehicle population followed by Johor, Selangor, Perak, and Pulau Pinang. These conditions have caused severe congestion in almost all parts of the highway network and corridors, especially in the central business areas, and inevitably the environment in these areas has deteriorated due to exhaust emissions from motor vehicles.

## CRITERIA POLLUTANTS

There are many sources of the gases and particulate matter that pollute urban atmosphere. There have six criteria of pollutants, that have been identified as contributors to both sulfurous and photochemical smog problems. The criteria pollutants are:

1. Carbon monoxide (CO)
   Carbon monoxides is a colorless and odorless gas produced primarily by the incomplete combustion of fuel. Vehicles and engines account for 80% of CO emissions in the United States. Other sources include industrial processes, combustion of waste and open burning. CO poses risk to humans and other animals because it can bind irreversibly to hemoglobin in red blood cells, preventing the hemoglobin from binding with oxygen.
2. Sulfur dioxide ($SO_2$)
   $SO_2$ isa colorless gas and has apungent odor. The vast majority of $SO_2$ pollution results from the combustion of coal for electricity generation and industry. Only about 5 percent comes from highway vehicles. In the atmosphere, $SO_2$ may react to form sulfur trioxide ($SO_3$) and sulfuric acid ($H_2SO_4$) which then settle back to Earth in the form of acid deposition.
3. Nitrogen dioxide (NOx)
   NOx is a highly reactive, foul-smelling reddish brown gas that contributes to smog and asid deposition. Most of NOx emissions result from combustion in vehicle engines, electrical utility and industrial combustion.
4. Tropospheric ozone
   Ozone (O3) from human activity forms and accumulates low in the troposphere and acts as pollutant. In the troposphere, this colorless gas with an objectionable odor results from the interaction of sunlight, heat, nitrogen oxides and volatile carbon-containing chemicals. A major component of smog, O3 can pose health risks as a result of its instability as a molecule; this triplet of oxygen atoms will readily release one of its threesome, leaving a molecule of oxygen gas and free oxygen atom. When ozone comes into contact with a surface it rapidly releases this extra force in the form of chemical energy. When this happens in biological systems, such as the respiratory tract, this energy can cause damage to sensitive tissues in the upper and lower airways.

5. Particulate matter
   Particulate matter is composed of solid or liquid particles small enough to be suspended in the atmosphere. Particulate matter includes primary pollutants such as dust and soot as well as secondary pollutants such as sulfates and nitrates. Particulate matter can damage respiratory tissues when inhaled. Most $PM_{10}$ pollution is dust whereas most $PM_{2.5}$ pollution results from combustion processes.
6. Lead
   Most of lead emissions in the past were from motor vehicles burning gasoline containing the antiknock additive, tetraethyllead $Pb(C_2H_5)_4$. In most of developed countries, almost all lead emissions from gasoline have been eliminated. Lead is emitted into the atmosphere primarily in the form of inorganic particulates. Much of this is removed from atmosphere by settling in the immediate vicinity of the source. Airborne lead may affect human populations by direct inhalation, in which case people living nearest to major sources such as highways or metals processing plants are at greatest risk. Despite the elimination of most lead emissions from moteor vehicles, the soil around highways is still heavily contaminated, and it become airborne when disturbed. It can also be ingested after airborne lead is deposited onto soil, water and food crops such as leafy vegetables and fruits. Lead can leach out of those older water systems especially if the water is acidic or particularly soft.

## AIR POLLUTION AND HEALTH EFFECTS

Epidemiological studies have consistently associated adverse health effects with exposures to particulate air pollution. Early studies implicated particulate and sulfur dioxide pollution in the acute illnesses and premature deaths associated with extremely severe pollution episodes in Donora, Penn., London, and New York in the 1940s, 1950s, and 1960s. The particle levels in a four-week pollution disaster in London in 1955 were more than 50 times higher than the California standard. Twenty percent of that aerosol was composed of acid sulfates -- probably sulfuric acid. The number of people hospitalized for lung or heart-related diseases was extraordinarily high, but more importantly there were more than 4,000 premature, or "excess," deaths in the London population (Kleinman 2000).

Over the past several years the incidence of a number of diseases has increased greatly. Asthma is perhaps the most important disease with an increasing incidence, but other diseases, such as allergic reactions, bronchitis and respiratory infections also have been increasing. The cause of these increases may be due at least in part to the effects of air pollution (Kleinman 2000). Meanwhile, air pollution may possibly harm populations in ways so subtle or slow that they have not yet been detected. Therefore, research is now under way to assess the long-term effects of chronic exposure to low levels of air pollution and its effects on health.

The effects of air pollution on health are dependent on several factors. Apart from the concentrations and chemical properties of the pollutants, the person's age and general state of health, the duration of exposure, factors such as the weather condition and the distance from the emission sources also affect the nature and extent of the health effects observed. The common air pollutants include carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulphur dioxide and lead.

Since urban are densely populated areas, it should not be surprising that most cities suffer from air pollution problems. In many cities air pollution is reaching levels that threaten people's health according to an unprecedented compilation of air quality data released today by WHO. For 2008, the estimated mortality attributable to outdoor air pollution in cities amounts to 1.34 million premature deaths. The number of deaths attributable to air pollution in cities has increased from the previous estimation of 1.15 million deaths in 2004 (WHO 2011).

Therefore, air pollution is a major environmental health issue (Figure 1). In their most extreme form, air pollution episodes are accompanied by physical discomfort, disruption of day-to-day living, widespread public fear, illness and even death. A study of air pollution in 20 of the 24 megacities of the world shows that ambient air pollution concentrations are at levels where serious health effects are reported.

The study shows that each of the 20 megacities has at least one major air pollutant which occurs at levels that exceed WHO health protection guidelines. Beijing, Cairo, Jakarta, Los Angeles, Mexico City, Moscow and Sao Paulo, five of which are located in the Pacific Basin, are facing a variety of air pollution problems requiring comprehensive solutions (WHO 2011).

The study shows that the ambient air quality in majority of the megacities is getting worse as the population, traffic, industrialization and energy use are increasing, and there is much urgency in

instituting control and preventive measures. In degree of severity, the high levels of suspended particulate matter (SPM) are the major problem affecting the megacities as a group. SPM presents a very serious problem in 12 of the megacities surveyed, the majority of which are located in the Pacific Basin. The concentrations of SPM in these cities are persistently above the WHO guidelines by a factor as much as two or three (WHO 2011).

Therefore, epidemiological studies have established the link between air pollutants and health effects. There are possible short-term and long-term health effects of exposure to air pollution. In the short term, high levels of air pollution can lead to an acute respiratory distress. In addition, blockage of sunlight may promote the spread of harmful bacteria and viruses that would otherwise be killed by ultraviolet B.

However, the possible long-term health effects of exposure to air pollution are unknown and difficult to detect because it's involved various factors. Thus, direct assessment of health impacts of air pollution on individuals presents significant challenges, including the difficulty and expense of accurately assessing personal exposures, variation in exposure in home versus school/work and outdoor versus indoor environments and exposure to tobacco smoke. For example, components of smoke haze, including Polycyclic Aromatic Hydrocarbons (PAH), are known carcinogens, the effects of which may not be apparent for years. The consequences may be more severe for children, for whom the particulates inhaled are high relative to body size. Continued pollution levels above ambient air quality standards are likely to create a number of adverse health consequences and a subsequent economic impact.

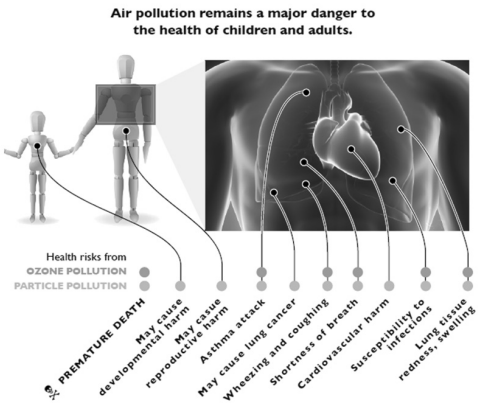


FIGURE 1. Air pollution and health effects
*Source:* http://www.stateoftheair.org/2013/health-risks/

High levels of particulate matter (e.g., $PM_{10}$ or TSP), for example, have been linked to a number of significant health problems, ranging from decreased lung function to increased respiratory and cardiac hospital admissions to premature death. The adverse health effects of particulate matter range from increased incidences of pneumonia and asthma, exacerbation of chronic obstructive pulmonary diseases, increased respiratory symptoms, and decreased lung function, to an increased mortality rate in human beings. $NO_2$, in recent epidemiological studies, has been increasingly associated with a number of respiratory and cardiovascular conditions, including worsening bronchitis, emphysema, heart disease, and even premature cardiovascular mortality.

The health effects of particulates are strongly linked to particle size. Small particles ($PM_{2.5}$ and $PM_{10}$) such as those from fossil fuel combustion are likely to be most dangerous, because they can be inhaled deeply into the lungs, settling in areas where the body's natural clearance mechanisms can't remove them. The constituents in small particulates also tend to be more chemically active and may be acidic as well and therefore more damaging. Particles of these sizes can permanently lodge in the deepest and most sensitive areas of the lung, and can aggravate many respiratory illnesses including asthma, bronchitis and emphysema. High levels of particle pollution have also been associated with a higher incidence of heart problems, including heart attacks. During major pollution events, such as those involving a 200-µg increase in particulate levels, an expert panel at the World Health Organization (WHO) estimated that daily mortality rates could increase as much as 20 percent (WHO 1994).WHO (1994) has identified particulate pollution as one of the most important contributors to ill health within Europe. In those cities where data on particulates were available, WHO estimated that short-term pollution episodes accounted for 7 to 10 percent of all lower respiratory illnesses in children, with the number rising to 21 percent in the most polluted cities. Furthermore, 0.6 to 1.6 percent of deaths were attributable to short-term pollution events, climbing to 3.4 percent in the cities with the dirtiest air. Even in the EU, average life expectancy is 8.6 months lower due to exposure to $PM_{2.5}$ produced by human activities.

Excessive ozone in the air can have a marked effect on human health. It can cause breathing problems, trigger asthma, reduce lung function and

cause lung diseases. In Europe it is currently one of the air pollutants of most concern. Several European studies have reported that the daily mortality rises by 0.3% and that for heart diseases by 0.4 %, per 10 μg/$m^3$ increase in ozone exposure (WHO 2011).

Epidemiological studies have shown significant association between several health effects and Carbon monoxide (CO), although it is difficult to completely isolate carbon monoxide's effects from those of other air pollutants. For example, asthmatic children in Taiwan who were exposed to high levels of traffic-related air pollution - using carbon monoxide and nitrogen dioxide as marker compounds - reported more respiratory symptoms than children with lower exposures (Kleinman 2000). Generally, CO reduces the oxygen carrying capacity of red blood cells. The health effects depend on the duration of exposure and the concentration of CO inhaled. Typical symptoms of exposure to low levels of CO include headache, dizziness and tiredness. Higher concentration of CO can lead to impaired vision, disturbed coordination and eventually death. CO may also have prenatal effects. Pregnant women who were exposed to high levels of ambient CO (5-6 ppm) were at increased risk of having low birth-weight babies.

Moreover, epidemiological studies have shown that symptoms of bronchitis in asthmatic children increase in association with long-term exposure to $NO_2$. Reduced lung function growth is also linked to $NO_2$ at concentrations currently measured (or observed) in cities of Europe and North America. Hence, lead is a highly toxic and is known to damage the nervous system and kidney, and interfere with the synthesis of hemoglobin. Children are more vulnerable to the effects of lead, which can result in learning disabilities and impaired neurobehavioral functioning.

$SO_2$ can affect the respiratory system and the functions of the lungs, and causes irritation of the eyes and nose. Inflammation of the respiratory tract causes coughing, mucus secretion, aggravation of asthma and chronic bronchitis and makes people more prone to infections of the respiratory tract. Inhalation of sulfur dioxide causes narrowing of the airways, which people suffering from asthma and chronic respiratory diseases are more sensitive to than other people. Therefore, hospital admissions for cardiac disease and mortality increase on days with higher $SO_2$ levels. When $SO_2$ combines with water, it forms sulfuric acid; this is the main component of acid rain which is a cause of deforestation.

However, there are a very limited number of studies that relate air pollution to its health impact in Malaysia. The lack of data gathering for environmental epidemiological analysis makes it difficult to estimate the health impact of air pollution. A few studies have been conducted on air pollution in Malaysia. Most of them are related to the haze episode. A study conducted by Nasir et al. (2000) in Malaysia suggested that in the 1997 haze episode the total health effects were estimated to include 285,227 asthma attacks, 118,804 cases of bronchitis in children, 3889 cases of chronic bronchitis in adults, 2003 respiratory hospital admission, 26,864 emergency room visits, and 5,000,760 restricted activity days. The whole population from all states in the country was at risk except Perlis, Kelantan, and Sabah. The total health damage cost was significantly high due to the long duration of the haze. The results show that restricted activity days accounted for about 79.3% of the health damage cost while asthma attack contributed 10.7% to the total health damage cost.

## CONCLUSION

Air pollution is a mixture of natural and man-made substances in the air such as fine particles produced by the burning of fossil fuels, ground-level ozone, which is a reactive form of oxygen that is a primary component of urban smog, and noxious gases such as sulfur dioxide, nitrogen oxides, carbon monoxide, and chemical vapors. The health effects of air pollution have been reported in research studies over the past 30 years. These effects include respiratory diseases such as asthma, cardiovascular diseases, changes in lung function and death.Air pollution also causes damage to plants and animals, affecting biodiversity and crop yields.

Although air quality has improved in many areas of the countries, air pollution still poses a health risk for millions people. Therefore, air pollution is a major environmental risk to health. Even relatively low concentrations of air pollutants have been related to a range of adverse health effects. Urban outdoor air pollution is estimated to cause 1.3 million deaths worldwide per year. Those living in middle-income countries disproportionately experience this burden. By reducing air pollution levels, the countries reduce the global burden of disease from respiratory infections, heart disease, and lung cancer. However, exposure to air pollutants

is largely beyond the control of individuals and requires action by public authorities at the national, regional and even international levels. The most important thing is, at the public level there is a long-standing commitment to improve air quality.

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